

Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Nuclear Waste
166th Meeting

Docket Number: (not applicable)

Location: Rockville, Maryland

Date: Tuesday, December 13, 2005

Work Order No.: NRC-783

Pages 1-197

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

166TH MEETING

+ + + + +

TUESDAY,

DECEMBER 13, 2005

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ROCKVILLE, MARYLAND

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The Advisory Committee met at 8:30 a.m. in Room T-2B3 of the Nuclear Regulatory Commission, Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, Dr. Michael T. Ryan, Chairman, presiding.

MEMBERS PRESENT:

MICHAEL T. RYAN, Chairman

ALLEN G. CROFF, Vice Chairman

JAMES H. CLARKE, Member

WILLIAM J. HINZE, Member

RUTH F. WEINER, Member

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1 ACNW STAFF PRESENT:

2 NEIL M. COLEMAN

3 JOHN FLACK

4 LATIF HAMDAN

5 MICHAEL LEE

6 MICHAEL L. SCOTT

7

8 ALSO PRESENT:

9 SCOTT FLANDERS, NMSS

10 JOHN GREEVES

11 JANET KOTRA, NMSS

12 TIM MCCARTIN, NMSS

13 TOM NICHOLSON, RES

14 WARD SANFORD, USGS

15 CHEN ZHU, Indiana University

16

17 PRESENT VIA TELEPHONE:

18 KATHRYN HAYNES

19 RICK JACOBI

20 ALAN PASTERNAK

21 BUDHI SAGAR

22 STUART STOTHOFF

23 GORDON WITTMAYER, Southwest Research Institute

24

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I N D E X

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Opening Remarks by the ACNW Chairman 4

U.S. Nuclear Regulatory Commission Plans for the
 Implementation of a Dose Standard After
 10,000 Years 6

Reasonableness of NRC Infiltration Assumption in
 the Proposed Part 63 77

White Paper on Low-Level Radioactive Waste . . . 123

Adjourn

P R O C E E D I N G S

8:32 A.M.

CHAIRMAN RYAN: The meeting will come to order. This is the first day of the 166th meeting of the Advisory Committee on Nuclear Waste.

My name is Michael Ryan, Chairman of the ACNW. The other members of the Committee present are Vice Chairman Allen Croff, Ruth Weiner, James Clarke, and William Hinze.

Today the Committee will discuss with representatives from the Office of Nuclear Materials Safety and Safeguards their plans for the implementation of a dose standard after 10,000 years at Yucca Mountain. We will hear presentations from and hold discussions with experts on the reasonableness of NRC infiltration assumption in the proposed 10 CFR Part 63. We will also have discussions on the Committee's white paper on low-level radioactive waste with NRC staff and stakeholders. Finally, we will discuss committee letters and reports.

Neil Coleman is the Designated Federal Official for today's session.

This meeting is being conducted in accordance with the provisions of the Federal Advisory

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1 Committee Act.

2 We received requests from Mr. Alan
3 Pasternak of the Cal Rad Forum and Mr. Rick Jacobi of
4 the Jacobi Consulting who are participating by
5 telephone during the discussion of the Low-Level Waste
6 White Paper.

7 We've also received a written statement
8 from the Southeast Compact Commission. Their comments
9 will be made part of the official record for this
10 meeting.

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

15 It is also requested that if you have cell
16 phones or pagers, you kindly turn them off.

17 Thank you very much. I might add a
18 scheduling note. Based on the anticipation of some
19 bad weather on Thursday morning, we're going to try
20 and work a little bit extra to conclude business
21 tomorrow afternoon. So just if people want to make
22 advance travel plans, we'll not likely have any
23 session Thursday morning on letter writing or any
24 other matters.

25 We'll try and conclude business so that

1 folks don't have to drive in the ice and bad weather
2 coming in Thursday morning. I think all the Members
3 can support that and the Staff certainly can help us
4 out in that regard. So that's just a little
5 scheduling item for those of you who have traveled
6 from a distance to get here and want to make
7 alternative plans home. Thanks very much.

8 Without further ado, we'll begin. And our
9 first presenter is Tim McCartin from the NRC Staff.

10 Tim?

11 MR. McCARTIN: Good morning. Today, I'll
12 be talking about the implementation of the dose
13 standard after 10,000 years. And this really is part
14 two of this topic. At your last meeting, Janet Kotra
15 gave a very good explanation and background of the
16 proposal. Today, I'm not going to repeat any of those
17 points made, but what I'm going to attempt to do is
18 provide a little more detail on a couple subjects and
19 primarily --

20 CHAIRMAN RYAN: Tim, let me just
21 recognize, if I may, while you get organized there,
22 that we have members from the Center of Nuclear Policy
23 Research in San Antonio who are on the video
24 conference. Welcome, San Antonio.

25 You can hear us okay and the connection is

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1 okay?

2 Once again, we're in Ron Brown's capable
3 hands.

4 Thank you.

5 MR. McCARTIN: Yes, and the presentation
6 today is really both myself and Gordon Wittmeyer at
7 the Center. For continuity, I will be doing the
8 presentation here. When it comes to questions and
9 things, I may rely on Gordon for some additional
10 details. And today, I'll just give a brief statement
11 on the purpose of the proposed Part 63 that provides
12 for the discussions that will follow with respect to
13 the inventory, some dosimetry perspectives and then I
14 think of keen interest to the Committee is the
15 representation of climate change and I'll end with the
16 status of where we are with respect to Part 63.

17 In terms of the purpose of the proposed
18 rule, pretty much what you heard last time was we're
19 implementing a new standard for doses that could occur
20 after 10,000 years. We're also specifying that the
21 dosimetry for the worker and public would use the same
22 current weighting factors that EPA specified for
23 public doses in their standard, and lastly, specify
24 the treatment of climate change for Yucca Mountain
25 after 10,000 years.

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1 Going right to the inventory perspective,
2 in terms of how does the inventory change over this
3 time period and just briefly, looking at 1,000 years
4 over the next 100,000 years, you can see there's a
5 fairly substantial reduction in the overall inventory
6 in terms of curies over that time period. It's
7 approximately 2 percent of what it was at a 1,000
8 years at 100,000 years.

9 If we went out to one million years over
10 the next -- from the 100,000 years out to one million
11 years, there's approximately an order, another order
12 of magnitude decrease. So I'm not showing a curve
13 beyond that, but at one million years, it would be
14 approximately .2 percent, rather than the 2 percent it
15 is at 100,000 years.

16 More importantly, I guess, is what kind of
17 nuclides, what are the nuclides that are contributing
18 to this inventory at those time periods? And not
19 overly surprising at the 1,000 year time frame,
20 americium-241 is the dominant radionuclide in terms of
21 curies. There is some plutonium-240 and some
22 plutonium-239. Go out to 10,000 years, you can see
23 the americium-241 is gone. And really you're
24 dominated, in terms of curies, by the two isotopes,
25 plutonium-240 and -239.

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1 You're starting to see some of the longer
2 lived radionuclides like technicium start to show up
3 as things die down. I mean each of these percentages
4 are relative to the inventory at that time. Fifty-
5 thousand years, you can see you're dominated by
6 plutonium-239. Technicium is increasing in overall --
7 the relative percentage and you're starting to see
8 neptunium.

9 At 100,000 years, once again plutonium-239
10 is still dominant; technicium is increasing further
11 and so is neptunium. Continuing --

12 MEMBER WEINER: Excuse me, Tim?

13 MR. McCARTIN: Sure.

14 MEMBER WEINER: When I did this same sort
15 of analysis, I don't think it's critical, but I think
16 you should mention there are a couple -- there's also
17 ingrowth of a couple of uranium isotopes and thorium-
18 230.

19 MR. McCARTIN: Yes, thorium-230 will show
20 up beyond 100,000 years. There is some -- uranium, it
21 still is very small.

22 When we get beyond 100,000 years and
23 300,000 years, I've dropped off americium-241. At
24 10,000 years it was gone so there was really no reason
25 -- but what you see is thorium-230 now appears as

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1 approximately 10 percent. And you can see uranium-234
2 and -238 is there around 10 percent. Plutonium-242 is
3 decreased. Technicium is the dominant curie amount at
4 300,000 years and neptunium is there around 10
5 percent.

6 So you can see, other than technicium,
7 you've got a cluster of things around -- contributing
8 around 10 percent that continues approximately the
9 same, out to 500,000. Around 700,000 years to one
10 million years, you start to see the dominance of
11 neptunium. And when you get out to one million years,
12 it really is -- neptunium is the dominant
13 radionuclide.

14 But as you can see, there really aren't as
15 dramatic a change at this particular time frame just
16 because the things that have lasted out at least to
17 100,000 years, a couple hundred thousand years are
18 fairly long-lived radionuclides and they will persist
19 for a fair amount of time. But it does end up at the
20 end neptunium is the dominant curie amount in the
21 repository.

22 Now, the question is with that kind of
23 knowledge about the inventory, we are changing the
24 dosimetry. We are updating the dosimetry to more
25 recent values and suffice it to say previously the

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1 dose calculations were based really on FGR 11, Federal
2 Guidance Report No. 11. EPA puts these out for the
3 U.S. Government in terms of dose calculations. This
4 was September 1988.

5 You can see the update to the newer values
6 really reflects FGR, Federal Guidance Report 13 which
7 is September 1999. So you can see a new -- a decade
8 of information in terms of doing the dose
9 calculations.

10 What does this mean in some of the -- for
11 some of the nuclides that dominate the dose
12 calculations and this is just the change factor in
13 going from FGR 11 to FGR 13. You can see for
14 technicium and iodine, there's almost a doubling in
15 the dose. And this is for ingestion. The dose
16 conversion factor, so you would get -- for the same
17 amount of ingestion, you would calculate almost twice
18 the dose that you would have previously.

19 For neptunium, it drops approximately an
20 order of magnitude, so these two increased. This
21 decreased. For thorium-230, it increases slightly
22 also. And then for americium, plutonium and uranium,
23 they decrease somewhere between, a factor of 2 and 4.
24 So you can see there's a spectrum of changes. The
25 largest for the nuclides that we typically see in dose

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1 calculations are neptunium for beyond 10,000 years.
2 And for the first 10,000 years, we typically are
3 dominated by iodine and technicium. Those values
4 increased.

5 CHAIRMAN RYAN: Just a clarification
6 question, Tim. Is it fair to say that most of the
7 changes are based on updates to the metabolic model
8 for that element?

9 MR. McCARTIN: That I really don't know.
10 I'd have to get back to you on that one. I'm not that
11 familiar with --

12 CHAIRMAN RYAN: It's a detail and the
13 values are what they are, but I think it would be
14 helpful to understand if it's really an improved
15 knowledge of the metabolic model or some other issue
16 that's come up and how the doses were previously
17 calculated, risk factors to an organ.

18 There are several key things here that
19 change it. That might help us understand the bases
20 for the changes.

21 MR. McCARTIN: Right, yes. I'll have to
22 get back to you on that. The one thing I know that
23 I'm sure you're familiar with is as we get further and
24 further away from the time of Hiroshima and Nagasaki,
25 things get updated in that sense. I mean some changes

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1 are a result of that, but --

2 CHAIRMAN RYAN: And metabolic models.

3 MR. McCARTIN: Yes, right.

4 CHAIRMAN RYAN: Because it's a fairly
5 limited number, there's really seven. It would be
6 interesting, I think to just document that thorium is
7 for this reason, neptunium is for that reason and so
8 on. It would be interesting, I think and helpful to
9 us to get a better picture of that.

10 MR. McCARTIN: Yes.

11 CHAIRMAN RYAN: Thanks.

12 MR. McCARTIN: In terms of just looking at
13 those were relative changes, in terms of -- if I look
14 at the previous calculations in terms of what and just
15 making everything relative to the largest value,
16 previously, the single largest dose conversion factor
17 was neptunium for FGR 11. And you can see americium
18 and plutonium were comparable. And iodine, thorium,
19 uranium were quite a bit lower. Technicium was very
20 small. It is the smallest dose conversion factor we
21 had.

22 You'll remember that there was a fair
23 amount of time where technicium is dominating the
24 curie inventory amount, but it is of note that
25 technicium is for the nuclides that we've looked at,

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1 I believe it is the single lowest dose conversion
2 factor that we use.

3 Yes?

4 MEMBER WEINER: What exactly is this graph
5 telling me? Is it if you simply -- is it that if you
6 simply looked at the radionuclides and weight them in
7 the sense of dose, ingestion dose conversion factor,
8 this is what you get? Is that what I'm looking at?

9 MR. McCARTIN: Yes, the previous one was
10 just what the changes were.

11 MEMBER WEINER: Right.

12 MR. McCARTIN: This tells you, in FGR 11,
13 neptunium was by far the dominant dose conversion
14 factor and you can see -- the change is one thing.
15 It's another thing to know that actually technicium
16 has a very lose dose conversion factor, regardless of
17 its change. It did double, but the fact that it
18 doubled when you have a very small value, doubling a
19 very small value is not necessarily significant
20 change, whereas you can look at your single largest
21 dose conversion factor, dropping an order of
22 magnitude, you can get a sense of what might happen to
23 the dose calculation.

24 MEMBER WEINER: I was simply trying to
25 clarify that this is a graph of dose conversion

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1 factors?

2 MR. McCARTIN: Yes.

3 MEMBER WEINER: And not of doses from --

4 MR. McCARTIN: Yes, correct, correct.

5 Absolutely. And rather than using the units of dose
6 conversion factors which have various meanings to
7 various people, percent, I just made it all relative
8 to the largest.

9 If we look at FGR 13, you can see somewhat
10 as I said before, technicium doubling a very small
11 number. Still, leaves you with a very small number.
12 Technicium is still a very low dose conversion factor.
13 But you can see neptunium was pulled back to some of
14 the other radionuclides and actually plutonium-237 is
15 the largest dose conversion factor for ingestion.

16 Next, is a curve that I went back and
17 forth what the appropriate title for this curve should
18 be and I decided with the word illustrative, and the
19 reason, it's important for me to explain why I'm using
20 that title.

21 We are in the process of modifying our TPA
22 code to accommodate this long-term calculation. We
23 are not done with those changes and I believe this
24 gives a picture of how things might behave in a
25 general sense, but changes are continuing. There are

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1 many important factors to account for in this
2 calculation and we're not finished yet. And so it's
3 really sort of an intermediate point.

4 And I think one part that was of interest
5 to us that given the changes in the dosimetry, what
6 nuclides would dominant. And interestingly enough,
7 neptunium, despite its decrease is still the dominant
8 radionuclide in our calculation.

9 These two down here, iodine and
10 technicium, but you know, our doses right now track
11 very well with neptunium. There are a number of
12 things, I guess I'd like to mention with respect to
13 this calculation that we continue to look at.
14 Plutonium colloids need to be looked at. And we're
15 continuing to do developments in our TPA code for
16 plutonium colloids.

17 As you saw, plutonium is for FTR 13 is the
18 largest dose contributor. It still didn't show up
19 significantly here, but we are looking at plutonium
20 colloids.

21 There are aspects of our calculation that
22 we are thinking about, that -- and it would be nice if
23 one could say, gee, I need to correct one, two and
24 three, or modify one, two and three in our code and
25 we're done. It really isn't that simple. And the

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1 reason we have a code is it is very difficult to
2 integrate all the competing factors that will affect
3 this peak dose and there are a lot of them that we're
4 thinking through and doing analyses to date and I'll
5 just -- I'll bring up a few that and I'll say the way
6 the waste package fails, the release rate and the
7 retardation are all very important that will affect
8 what that peak dose is. And in that sense, I'll say
9 the way the waste package fails, right now in our code
10 we assume when it fails there's a single mode for
11 water getting into the waste package and water exiting
12 the waste package. We're not certain, in terms of if
13 the waste package gradually degrades over a couple
14 hundred thousand years, so that early on maybe there's
15 a few pit holes, but very little water gets in. Later
16 on, these pits grow. There's more pits. There's
17 patches as the DOE model has and more water gets in.

18 Water has always been an important part to
19 the release of radionuclides. How that package
20 degrades over time, how important is that to
21 estimating the peak? An that's something we have not
22 looked at in great detail in our previous
23 calculations. We need to understand that with respect
24 to this one.

25 Release rate from the waste form. How

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1 quickly does the material, the fuel degrade? Is it
2 100 years? A couple thousand years? A couple hundred
3 thousand years? And where that's important -- now,
4 when things get out of the waste package, there's
5 different parts of the repository, different
6 infiltration rates, different flow paths, different
7 transport times to the accessible environment.

8 Generally, this peak is a result of the
9 combination of a lot of leaky containers getting to
10 the same point and overlapping. If I have a high
11 release rate and I get stuff out of one part of the
12 repository very quickly and then in another part of
13 the repository at a later time, maybe they don't
14 overlap. What are the conditions that cause this
15 overlapping of releases?

16 And those are some of the issues in
17 modifying the code, we want to think through and look
18 at the uncertainties and clearly I would way, in
19 general, this peak occurs because there's a lot of
20 overlap of different areas of the repository at the
21 same time.

22 And if you had a quicker release rate,
23 does it actually get better? Things don't overlap as
24 much? That would be an interesting result. Things to
25 think about and so the beauty is we have a code and a

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1 capability to try to look at all these issues, to look
2 at what seems to be a reasonable way to represent the
3 behavior of the repository over this very long time
4 period.

5 Like I say, trying to integrate this in
6 your head is just too difficult. And the code is a
7 way to help us think through these issues and those
8 are some of the changes we're making with our code is
9 to help us provide capability to look through these
10 different issues, to understand where and when things
11 overlap and what kinds of conditions are causing the
12 peaks to occur or the peaks not to occur. And so,
13 it's a problem that we haven't looked into as much
14 detail beyond 10,000 years. And like I said, the
15 calculation here, that's why it's illustrative. We
16 have a lot more work to do.

17 We would expect to come back in and brief
18 the Committee at some later time, as we progress in
19 this work. The one fascinating thing -- I didn't know
20 which way, what was going to happen with neptunium,
21 with that fairly large substantial reduction in the
22 dose conversion factor. It still was the dominant
23 radionuclide.

24 CHAIRMAN RYAN: Tim, I was just going to
25 say, it sounds like you reported previously, as you

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1 just mentioned on the before 10,000 years risk
2 insights kind of approach and a vertical slice through
3 the system, looking at the different components. It
4 sounds like you're now on the high side of 10,000 and
5 trying to develop that capability and those insights
6 again.

7 Is that a fair --

8 MR. McCARTIN: Absolutely, and there's
9 things that require more thought. Pre-10,000 years,
10 we weren't as concerned about how the package
11 degraded. We had some degradation and we had a model
12 to represent the limitations on water entering a
13 degraded package. But now, degradation over hundreds
14 of thousands of years and how might this look? It's
15 something that we want to think about more with our
16 current approach and on the plus side, there is some
17 capability in the code already that we can look at
18 this to see does it make that much of a difference in
19 estimating the peak.

20 But it is -- there's a lot of subtleties
21 to doing the calculation much further that you
22 certainly want to know the impact of -- and right now,
23 I'll tell you. We have the capability for doing the
24 time-dependent degradation of the waste package,
25 allowing more water to come in at later times.

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1 We have never utilized that capability.
2 I think we'll take high marks for having that
3 capability, if we needed it, but we in the first
4 10,000 years, we weren't as concerned about what's a
5 credible model for that that variation. Now, over the
6 longer time period we have the capability, but it's
7 not an easy thing to come up with a basis for what
8 seems to be a reasonable way to represent it.

9 But we can do the sensitivity analyses to
10 get a sense of is there a -- is this a huge deal? And
11 depending on how we vary that, those -- that
12 parameter, does this peak change a lot?

13 And I'll say we're in the process of doing
14 a lot of work and here and at the Center to just get
15 a better sense of what seems to be an important aspect
16 of the calculation.

17 Your first reaction is oh, a higher
18 release rate, more water, get things out real quick.
19 Will give you a higher dose. Maybe. But if you start
20 to separate and you can see this little split here is
21 a separation of where parts of the transport path have
22 -- are slower than other parts.

23 As you separate these and have more detail
24 on that, maybe the doses go down, if you have higher
25 release rates. And they go up if you have slower

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1 release rates. You have more overlap. Or maybe it
2 doesn't matter. And it just -- there's a lot of
3 things. And that's why to get back to my original
4 point, the word illustrative, that we're in the
5 process of looking at this and as I said, I think
6 we'll be happy to come back at some later time when
7 we're further along.

8 For today, I thought it was important to
9 show that with the dosimetric changes we were still
10 seeing neptunium as the dominant radionuclide.

11 MEMBER HINZE: If I might, Tim, I realize
12 this is illustrative, but I don't see the igneous
13 activity peak in the first couple thousand years. And
14 that just left off in this calculation?

15 MR. McCARTIN: Yes, I was just doing the
16 ground water pathway. Sorry about that.

17 MEMBER HINZE: And are you looking here at
18 the mean or are you looking at the median? Are you
19 looking at the mean up to 10,000 years and then the
20 median?

21 MR. McCARTIN: Well, this particular curve
22 is based on the mean. This is a mean curve.

23 MEMBER HINZE: Oh. Do you have any
24 feeling for how that's going to change as you move to
25 median?

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1 MR. McCARTIN: Not really. I thought I
2 had a better idea a while back. As I've done more of
3 the calculations and once again, we're at the early
4 stages and the reason I did not show a median curve or
5 any percentiles on this particular curve, it was
6 purposeful.

7 And that is that because of what I talked
8 about the way the waste package fails, the release
9 rates, the overlap that may cause the peak, as we
10 modify our model and do things differently, I don't
11 know how it's going to affect that dose estimate. And
12 I'm reluctant to put up any additional statistical
13 measures for this calculation, but --

14 MEMBER HINZE: Load your guns first, sure.
15 Let me ask you though, are you using the mean up to
16 10,000 years and then looking at the median when you
17 do go to the median?

18 How is that handled?

19 MR. McCARTIN: Well, to date, I mean this
20 is just the mean curve and it's from zero to one
21 million years. There is no change. Just as easily
22 one could plot a fifth percentile, 90th percentile, a
23 median value of 50th percentile for zero to 10,000
24 years. My guess when we do the calculation, it's
25 probably more trouble than it's worth to try to

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1 separate the two, that you would have a curve with
2 this statistics on it.

3 MEMBER HINZE: Thank you.

4 MEMBER WEINER: Tim, at the risk of one
5 more question, recognizing this is an illustrative
6 curve, can you separate the factors that affect the
7 time of the peak dose from the factors that affect the
8 value of the peak dose? It's just -- can you in your
9 model separate those two influences or do they
10 conflate?

11 MR. McCARTIN: We can try and that's what
12 we're in the process of doing. The trouble is,
13 there's things that shift the time which can have an
14 affect on changing the time of the peak also and I
15 mean generally, the start, of course is and has always
16 been failure of the waste package, as the first
17 barrier. It always shows up as until the waste
18 package fails, you don't get a dose. So that
19 certainly has an effect.

20 But there are the transport path and for
21 our particular model, we have eight subareas for the
22 repository in the unsaturated zone; four subareas for
23 the saturated zone. And so there is a split in the
24 length of the alluvium and the overall transport path
25 and time.

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1 So the timing is affected by retardation
2 and characteristics of each of those flow paths and so
3 there's a fair amount of -- it's trickier to try to see
4 that, but you raise a good point and as we're looking
5 at this I think it would be trying to provide a
6 measure of is this more significant to shifting things
7 or raising it up or down and that's something to think
8 about.

9 I'll say I have been doing a myriad of
10 calculations and generally, at this early stage we try
11 a lot of different combinations of sometimes just
12 doing one subarea at a time, so I get one -- and vary
13 things for it to see how it changes. And then look at
14 each subarea by itself.

15 There's just a lot of things going on with
16 that, especially release rates are important also and
17 certainly the water.

18 CHAIRMAN RYAN: Tim, just to pick up on a
19 point, I think you said something that's fairly
20 profound, things that will affect the X axis are
21 things that will affect the time axis.

22 And just sorting those things out would be
23 a huge step toward insights of things, don't you?

24 MR. McCARTIN: Yes, no, I agree. I think
25 that's what Dr. Weiner was referring to and it's a way

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1 to try to -- and there might be the third bin of
2 things that affect both and you almost can't pull them
3 apart and it's a good suggestion in terms of when we
4 come back. I'll make a promise that we'll talk to
5 those three bins, if you will, in some way, if
6 possible. I won't say that we can pull it apart. It
7 may be something that they're so horribly intertwined
8 that is very difficult, with the exception, like you
9 say, the waste package.

10 I mean as the first barrier, it's easy to
11 get a handle on what that does, but everything past
12 that, but it's -- it's part that when in our review of
13 any potential license application, in terms of
14 estimating that peak dose, what are the things that we
15 want to review in more detail that are affecting it.
16 And that's really ultimately what we're trying to get
17 a better handle on. And I guess the bottom line is
18 hopefully, we'll find out it's much simpler than we
19 think, but to date, I can't give you any concrete
20 evidence of that it will be that simple. It may be a
21 little more complicated.

22 CHAIRMAN RYAN: Just from a conceptual
23 point of view, you can think about failure mechanisms
24 or modes that would increase the concentration, that's
25 likely something that would increase does or failure

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1 modes that would make the duration of some
2 concentration longer.

3 MR. McCARTIN: Yes.

4 CHAIRMAN RYAN: That's, to me, the kind of
5 translation into the physical environment from the
6 waste package environment. So it's -- there's lots of
7 good things to think about. It sounds like you're on
8 the right track.

9 MR. McCARTIN: Yes.

10 MEMBER CLARKE: Tim, before you go on past
11 that slide, all is truly all, it's all the
12 radionuclides, not just the three--

13 MR. McCARTIN: Yes. It's the --

14 MEMBER CLARKE: And it looks like up to,
15 I don't know, it's before 100,000 years, neptunium and
16 all are pretty much the same. And then you've got a
17 delta 2 millirems down to less than 1 which is -- I
18 just find that pretty interesting, what happens around
19 that time.

20 You really use neptunium pretty much?

21 MR. McCARTIN: Yes, and part of this I
22 would say, in general, are release rates for the spent
23 fuel, is on the order of 10^4 versus $10^{5\text{th}}$ years. So
24 it's not too surprising that we're getting around
25 100,000 years spread, this pretty much mirrors the

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1 uncertainty in our release rates from the spent fuel,
2 at least, when I saw this I saw okay, that makes
3 sense, especially with neptunium being the dominant
4 radionuclide.

5 Now once again, there are some suggestions
6 with respect to schopite and other things in terms of
7 neptunium release, so --

8 MEMBER CLARKE: Neptunium is a risk prior
9 to --

10 MR. McCARTIN: Yes. Even more so, yeah.
11 And I was -- I guess maybe I shouldn't have been
12 surprised but I thought neptunium might decrease in
13 significance.

14 Now I will say depending on how you
15 approach plutonium colloids, they can add more to this
16 dose. This particular curve does not have plutonium
17 colloids. It has plutonium in solution. But it does
18 not have plutonium colloids and I know previous
19 analyses we have done have shown that plutonium
20 colloids contribute. They did not dominate over
21 neptunium, but we continue to refine our -- the model
22 we have for plutonium colloids and that's something
23 that will be in our code in the future. If you look
24 at the DOE results, certainly, they have a
25 contribution from plutonium colloids.

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1 MEMBER WEINER: This means that one of
2 your factors that you will probably be considering is
3 changes in the redox environment because plutonium-4
4 is an intrinsic colloid and if you get a lot of that,
5 then you get a major contribution.

6 MR. McCARTIN: There's a lot of work going
7 into thinking about the environment within the waste
8 package such causing plutonium colloids, etcetera.
9 Yeah. That is an area where we certainly are putting
10 some effort into.

11 DR. SANFORD: Tim, Ward Sanford, USGS. It
12 sounds like one of the things you're talking about was
13 looking at the different parameters and how they
14 control the dose and the timing. Are you guys using
15 or considering using automated parameter estimation
16 routines that can help quantify parameter correlation?

17 MR. McCARTIN: Oh yes. We use Latin
18 Hypercube sampling and we have a variety of
19 statistical techniques for analyzing the results and
20 -- yeah, yeah.

21 I knew the dose curve would bring out a
22 lot of interesting questions and good ones.

23 With that and recognizing now, going back
24 to the standard, and EPA proposed that the assessment
25 could be limited to the effect of increased water flow

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1 through the repository as a result of climate changes
2 beyond 10,000 year analysis. The nature and degree of
3 climate change can be represented by constant
4 conditions after 10,000 years. And they said that NRC
5 should specify in regulation the values to be used to
6 represent climate change, such as temperature,
7 precipitation or the infiltration rate of water.

8 And that's the backdrop for what the
9 standards said about climate change beyond 10,000
10 years. And in terms of what we have proposed, we
11 looked at deep percolation, recognizing somewhat as I
12 said before -- notwithstanding igneous activity, the
13 thing that moves waste out of the repository is water.
14 And so the deep percolation or the amount of water
15 flowing to the repository horizon is what directly
16 influences performance.

17 Certainly, recognize that deep percolation
18 is affected by a variety of processes, the
19 precipitation, the temperature, evaporation, plant
20 transpiration, etcetera. But ultimately what are you
21 interested in, what affects the performance of the
22 repository? It really is the depercolation.

23 And so rather than looking to temperature
24 and climate change that we think is certainly
25 important and is the most -- given the weather we see

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1 today, climate change are things you recognize on a
2 daily basis. People associate temperature and
3 precipitation with climate, but it really is
4 depercolation for the performance parameter that is
5 most directly controls the dose estimate.

6 In estimating future depercolation, and we
7 were looking for setting a reasonable test for the
8 repository to meet, there were a couple of things that
9 in terms of depercolation, there's really two aspects.
10 One is what's the range for the mean annual
11 precipitation. How much is it going to rain? And
12 really, what fraction of that rain ends up as at
13 depercolation?

14 And in looking at that, I will say in
15 terms of rainfall, there's a recognition that when we
16 look at the past record in the Pleistocene glacial
17 transition and monsoon states dominate the long-term
18 climate state. There tends to be more rainfall over
19 the majority of the time in the past. That is the way
20 we saw the record.

21 In terms of estimating this increase in
22 rainfall, it was really -- we have tried to do a very
23 straight forward simple approach. We looked for
24 analog sites based on vegetation and generally there's
25 packrat middens that suggest a certain vegetation that

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1 was growing in the late Pleistocene, in the Yucca
2 Mountain region. We looked for that same kind of
3 vegetation at modern sites and those are the analog
4 sites or in the literature, I'd say. And in terms of
5 at those analog sites, there was an estimate made for
6 precipitation on the order of 266 to 321 millimeters
7 per year. This is somewhat representative in that
8 report that we referenced in our proposal of the last
9 glacial maximum.

10 And so in terms of how much might it rain?
11 We have that as our estimate.

12 MEMBER HINZE: Tim, would it be
13 appropriate to ask you how you arrived at those
14 numbers?

15 MR. McCARTIN: They were reported in a
16 USGS document that we reference.

17 MEMBER HINZE: Yes, the open file report,
18 right?

19 MR. McCARTIN: Yes.

20 MEMBER HINZE: But one of the things in
21 looking at that open file report, there's a great deal
22 of uncertainty in those numbers.

23 MR. McCARTIN: Absolutely.

24 MEMBER HINZE: And I think your use of
25 things like 266 and 321, how many decimal points can

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1 one really use here?

2 (Laughter.)

3 MEMBER HINZE: Considering the uncertainty
4 of the correlation factors that -- in the late, last
5 glacial maximum, the correlation factors that were
6 used to arrive at that are in the range of .75. Those
7 don't give a -- don't really seem to suggest that one
8 should use those precise a number. Is that correct?

9 MR. McCARTIN: Well, certainly three
10 significant figures is impressive for that estimate.
11 Those were the reported values. And I'll show in my
12 next slide, I mean we -- for numbers that we
13 calculated, we were not as precise, but we felt we did
14 not want to change the numbers that were reported in
15 that document. I don't believe the final number that
16 we arrived at is significantly affected if say we made
17 this 250 and 300.

18 DR. SANFORD: So are those numbers what
19 was reported for the analog site based on modern
20 precipitation at the analog site?

21 MR. McCARTIN: Yes.

22 DR. SANFORD: And what are the analog
23 sites? Where are the analog sites?

24 MR. McCARTIN: That one, I don't remember.
25 Gordon, do you remember what the analog sites were?

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1 MR. WITTMEYER: I don't remember the exact
2 locations that were used. I believe they were spread
3 throughout the Great Basin area, but I don't recall.
4 I'd have to go back to that report by Tom Senedal to
5 identify those sites.

6 MEMBER HINZE: Well, I think Yucca
7 Mountain, Gordon, I think Yucca Mountain falls right
8 on a division between two different regions of NOAA's
9 averages and as a result, you kind of can pick either
10 the area 3 or area 4 and the open file report was just
11 selected, the higher precipitation areas.

12 It was based upon a regional value, not
13 specific sites.

14 But I wondered, Gordon, did you go back or
15 did anyone go back and look at the original NOAA data
16 that was used to develop those? Those are not given
17 in that open file report.

18 MR. WITTMEYER: We did not go back to
19 those data, Bill.

20 MEMBER HINZE: Do you think that might be
21 worthwhile to look at? I mean there must be --

22 MR. WITTMEYER: Go ahead, Tim.

23 MR. McCARTIN: That's okay, Gordon, go on.

24 MR. WITTMEYER: It's probably something we
25 should examine a little more closely.

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1 MR. McCARTIN: So that's the basis for the
2 precipitation that we used. The next step was well,
3 what fraction of that precipitation ends up as
4 depercolation? And for that, we used our TPA code.
5 And the TPA code estimates depercolation, including --
6 but includes the consideration of the things we talked
7 about before, precipitation, temperature, soil dep.,
8 evaporation and transpiration, all these things are in
9 -- are considered within the TPA code. So we ran the
10 TPA code. Quite simply for varying all those
11 parameters.

12 And what we saw was that and here's where
13 I'll get to -- maybe we could have made this 4.866
14 percent but it's approximately -- it was around 5 to
15 20 percent of the precipitation could reach the
16 repository under conditions where the variation that
17 we had for those conditions was approximately 250 to
18 420 millimeters per year precipitation. So what we
19 saw was that, in general, 5 to 20 percent of the
20 rainfall would end up as depercolation as based on our
21 TPA code results.

22 MEMBER WEINER: Have you any plants to
23 validate this part of the TPA code against measured
24 results? I mean there are plenty of places in the
25 United States with rainfall between 10 and 11 inches

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1 per year and you can measure the depercolation. Do
2 you have any plans to look at such measurements or to
3 do things like that?

4 MR. McCARTIN: Well, over the years, for
5 the TPA code and its models, we have done a variety of
6 things to try to get a sense that we're in the right
7 area. And I don't know if Gordon, if you have with
8 respect to the infiltration models over the years. I
9 mean these codes have been developed for quite a while
10 and continued to be improved.

11 Do you have a sense of any of any
12 benchmarks we might have done?

13 MR. WITTMAYER: Tim, going back to the
14 original development of the process level model that
15 was used for the TPA construction that was the breath
16 code developed back in the mid-90s. We did do some
17 comparisons to other codes that were used to estimate
18 infiltration or the water getting below the roots of
19 and found that breath did a good job of estimating
20 under similar conditions.

21 So that was the level of -- I think we're
22 getting feedback. Can you hear me okay?

23 MR. McCARTIN: Yes, we hear you fine.

24 MR. WITTMAYER: Okay, so I think we felt
25 pretty good about the process level model that we're

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1 using to estimate infiltration as a function of soil
2 depth, temperature, etcetera.

3 I know Ruth referred to some sites where
4 they had 10 to 11 inches per year and compare a model
5 to the values of infiltration or depercolation,
6 actually, she said that had been measured. We have
7 not gone and looked at those data.

8 MEMBER HINZE: Speaking of looking at
9 data, have you used any of the Apache Leap work, the
10 results of Apache Leap in this analysis?

11 There was a great deal of work done in an
12 area very analogous to Yucca Mountain by the Nuclear
13 Regulatory Commission over a series of years, using
14 the University of Arizona as a contractor. And I'm
15 wondering how that information was folded into this.

16 MR. McCARTIN: Yes, certainly we have
17 followed and used the Apache Leap work for years. I
18 know, boy, going back many years, I've modeled some of
19 the experiments with some of the models we have used
20 as support for the TPA code to try to represent some
21 of their field tests, etcetera.

22 In terms of infiltration, boy, in terms of
23 pointing my finger on anything particular, I'm not
24 aware of any one particular set of information, but we
25 certainly have used the information.

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1 I don't know, Gordon, are you aware of
2 anything?

3 MR. WITTMAYER: Well, I don't believe we
4 used the data from Apache Leap directly in attempting
5 to assess the underpinnings of the breath code or the
6 extraction that used in the TPA code and we're
7 certainly aware of the research done at Apache Leap,
8 NRC research over the years.

9 It is a little bit of a different site,
10 the fracturing is quite a bit different. I think if I
11 recall correctly, it actually has a fair amount more
12 rainfall. It might be a reasonable analog for future
13 sites, but we really are choosing for future climate,
14 but we really have not evaluated the Apache Leap data.

15 MR. SAGAR: This is Budhi Sagar. Most of
16 the major names at that site were for shallow
17 infiltration of the operation. I'm not sure which
18 sites you're referring to where one would have a
19 depercolation say at 200 degrees meter depth?

20 MEMBER HINZE: Excuse me, Budhi, what was
21 the depth of the tunnel in Apache Leap? It seems to
22 me that was a couple hundred feet anyhow?

23 MR. SAGAR: Yes, the depth of the tunnel
24 was a couple of hundred feet, but the direct
25 correlation between what was happening at the surface

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1 and what they saw in the tunnel as I remember it was
2 never established. I mean they got some signals, they
3 did some statistical analysis and it was not -- and
4 maybe even geochemistry, just to see what the signal
5 was telling them.

6 The last I heard which was six or seven
7 years ago, from Randy, was that it was difficult to
8 conclude at the tunnel based on the precipitation at
9 the surface, unless they had ephemeral streams, I
10 don't know.

11 MR. McCARTIN: Yes. I mean with respect to
12 the tunnel, as I recall, if they had a very
13 significant precipitation event, and one of the
14 ephemeral streams was running approximately six months
15 later, they would see flow through some major fault
16 zones in the tunnel.

17 MEMBER HINZE: It was a fracture.

18 MR. McCARTIN: yes.

19 MEMBER HINZE: It was the same thing that
20 we have at Yucca Mountain.

21 MR. McCARTIN: Yes, but trying to get a --
22 say what fraction of the precipitation ended up in
23 there is -- I mean it's --

24 MEMBER HINZE: I guess what I'm trying to
25 get at is that the scientific basis and background and

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1 verification, validation of these results and I guess
2 that brings me to another question, if I can, because
3 it's of a similar nature and that is have the heater
4 tests in the alcoves, and their recovery provided any
5 information that has been useful to you at all in
6 looking at depercolation?

7 MR. McCARTIN: That's a loaded question.
8 I really am not prepared to talk to that one. I don't
9 know if Gordon has anything with respect to the heater
10 tests and depercolation, but --

11 MR. WITTMAYER: I followed the heater
12 tests somewhat, but I never seen anyone really look at
13 if there is any information from that test that could
14 tell you anything about depercolation. It's mainly
15 been looked at for the near repository thermal
16 effects.

17 MR. SAGAR: Recirculation.

18 MR. WITTMAYER: Recirculation, etcetera.
19 Driving the liquid water away from the heated area.
20 But I haven't seen anyone examine the data from those
21 experiments to see what it can say about
22 depercolation.

23 MEMBER HINZE: Well, I think we also have
24 the inverse and that is the movement of the water back
25 in and that is of interest because it does duplicate

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1 in a very real sense depercolation.

2 MR. McCARTIN: Let me hit on one point
3 that I think -- if there's something that we have seen
4 in the modeling of trying to estimate depercolation
5 from precipitation temperature, soil depth is
6 incredibly important in this environment in terms of
7 where you have enough soil that water -- precipitation
8 goes into the soil, held there as a sponge and then
9 there's a delay for it to evaporate out, is a very
10 dominant role which is why we've chosen the modeling
11 that -- and we've done a fair amount with respect to
12 looking at the soil depths at Yucca Mountain which is
13 why for the DOE model as well as our model, where you
14 see the largest infiltration is where you have very
15 little soil, near the peak. So water just goes into
16 the fractures and goes away quickly.

17 And so there's -- it's a very complicated
18 problem which is why we were trying to get a somewhat
19 general approach that we think provides a reasonable
20 test for Yucca Mountain. And once you start factoring
21 in precipitation, temperature, soil, the amount of
22 evaporation, it becomes complicated quickly. Like you
23 said, the calculations, we believe the code correctly
24 does a good job of estimating these processes, but
25 there is uncertainty with respect to how much is the

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1 soil depth.

2 There's many factors there and like you
3 said, we came with, we think, 5 to 20 percent, in
4 terms of providing a proposal for people to comment on
5 was not an unreasonable range for going out and
6 seeking public comment.

7 MEMBER HINZE: I guess, Tim, that's one of
8 my problems in this and the modeling because it's a
9 question of how good that model does represent the
10 actual earth conditions. And soil depth is important,
11 but it is particularly important out in the basins.

12 On top of Yucca Mountain, my recollection
13 is listening to the flints and back in those days and
14 the primary recharge was coming through, jointing
15 faults, cooling cracks, etcetera in the exposed
16 bedrock which overlies the repository and therefore is
17 the most important. And how to quantify in a model,
18 appropriately, those cracks, fractures, etcetera, is
19 a difficult process.

20 MR. McCARTIN: Yes, fortunately, there are
21 a lot of fractures. It is a hard value to estimate.
22 I will say and I don't know if Gordon can add more to
23 this, but in terms of the soil depth in that area, the
24 Center did a lot of work to try to get -- and I'm not
25 exactly certain how, but in fairly pixels -- they did

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1 a very detailed map of the Yucca Mountain area and had
2 soil depths that were estimated by -- and I think
3 Gordon would have to help me out there, but there was
4 a fair amount of work to ensure that there was a
5 fairly extensive information base in terms of soil
6 depth and slope, et cetera.

7 Now, can you add to that, Gordon?

8 MR. WITTMAYER: Yeah. I'm going to
9 actually have Dr. Stuart Stothoff explain a little
10 bit, maybe take three or four minutes here and explain
11 how the modeling was done at Yucca Mountain using the
12 breath code.

13 Stu, why don't you go ahead and explain
14 that.

15 DR. STOTHOFF:

16 What we have for the TPA code is a pre-processor
17 that is designed to look at uncertainty and spacial
18 variability and incorporate all of the uncertainties
19 that we feel are out there.

20 So, for example, it accounts for
21 uncertainties in soil depth by running multiple
22 realizations of infiltration at different depths of
23 soil. And it accounts for uncertainties in fracture
24 densities by running the same realizations with
25 different fracture densities, different apertures.

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1 And the bedrock properties similarly will have the
2 different hydraulic properties will be sampled
3 accounting for all of the uncertainties that we know
4 of.

5 The code is based on the process level
6 simulations in BRAC. We ran around 500 simulations to
7 derive a response surface in terms of all the
8 hydraulic parameters, in terms of all the climatic
9 parameters, temperature, precipitation, soil depth.
10 All of those factors are incorporated. And then
11 plugged into the code to do all the realizations.

12 So we've, in fact, I think that the code
13 explicitly accounts for most of the uncertainty in
14 what's going on with infiltration. If there's more
15 questions on that --

16 MR. SAGAR: You had a, these case
17 resolutions, 30 meters, was it 30 meters?

18 MR. STOTHOFF: Correct.

19 MR. SAGAR: And the time resolution was?

20 DR. STOTHOFF: In the process level model,
21 we ran hourly increments using National Weather
22 Service data to generate the inputs for the
23 simulations from desert rock. We account for changes
24 in temperature over the elevation of the Yucca
25 Mountain. We account for changes in precipitation due

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1 to elevation. We account for solar radiation being
2 different on the north-facing and the south-facing.
3 We account for different wind speeds on the ridge
4 versus in the washes. So it accounts for I think most
5 of the factors. It incorporates overland flow as a
6 additional, effect of precipitation, lowering the
7 slopes based on water shift scale modeling --

8 MEMBER HINZE:

9 Can I ask a question, then?

10 In those realizations to deal with the full glacial
11 climate conditions, did you, and to reach the 20-
12 percent percolation, did you assume that there was no
13 evapo-transpiration, or no transpiration? How did you
14 reach that 20 percent?

15 DR. STOTHOFF: The way we would do that in
16 the breath simulations is to take the meteorologic
17 record and multiply the precipitation, every
18 precipitation value by a constant factor, say one-and
19 -a half.

20 MEMBER HINZE: Let me interrupt you if I
21 might. What we're really talking about here is the
22 second bullet of Tim's overheads and this is the
23 intermediate to full glacial climate, so it's not the
24 present-day climate that we're dealing with?

25 DR. STOTHOFF: Correct.

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1 MEMBER HINZE: So, how did you modify this
2 in the TPA or the TSPA for the full climate
3 conditions, to get that 20 percent?

4 DR. STOTHOFF: What we, in the breath
5 simulations, what we did was change the precipitation
6 to increase the precipitation by multiplying by a
7 factor and dividing, or reducing temperature by a
8 constant factor. Each hour. Once, and this is used
9 to derive the response surface. So, once we had the
10 response surface, then that response surface was
11 plugged into the ITYM code to the pre-processor and
12 then, a function of mean annual precipitation and mean
13 annual temperature, we could simply multiply
14 precipitation by one-and-a-half for whatever factor.

15 MR. McCARTIN: One thing to add would be
16 that the, certainly the higher percent resulting in
17 deep percolation is going to be due in part to cooler
18 temperatures, where evaporation is less. So it is
19 accounted for. But when you have the potential for
20 more rainfall and cooler temperatures, actually, the
21 cooler temperatures do a lot to allowing less
22 evaporation and, thus, more deep percolation. And I
23 know Janet has a comment to make.

24 MS. KOTRA: Yeah. I feel compelled to
25 just note what we are trying to accomplish here. What

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1 the EPA in its proposed revisions to Part 197 is
2 asking for here is more akin, less to a precise
3 prediction of what the actual deep, what the actual
4 climate is going to be in these long time frames as it
5 is to the, it's more akin to the human intrusion
6 scenario. A stylized approach in a sense that, you
7 know, looks at, you know, we look at a reference
8 biosphere, we're looking in a sense at a reference
9 geosphere here.

10 In this range of five to 20 percent, is
11 this a reasonable range within which we would expect
12 that, knowing what we know about the past, is this a
13 reasonable range to assume that how much wetter and
14 colder could it be and what effect would that have on
15 performance? But not, in any sense of the
16 imagination, a precise prediction. And I think it's
17 important to keep that in mind as we evaluate the
18 reasonableness of what we've proposed here.

19 DR. SANFORD: Tim?

20 MR. McCARTIN: Yeah.

21 DR. SANFORD: One thing I didn't see
22 addressed was the temporal variation in precipitation.

23 I mean, these climates, you know, the extreme events
24 can result in 90 percent of the recharge. Are these
25 accounted for in the TPA simulations and is there any

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1 idea, in a change in climate, how that's going to
2 change the frequency and intensity of the storms that
3 might account for a lot of the recharge.

4 MR. McCARTIN: Well, as Stuart indicated,
5 the breath code, the calculations were done on an
6 hourly basis. So there is some evaluation, or you
7 could have short-duration events.

8 In terms of, once again, I mean, I echo
9 what Janet says. As I was saying, we're looking to
10 what's a reasonable test to subject Yucca Mountain to?
11 And I think we're looking at, you know, we aren't
12 trying to say we have the Rosetta Stone for
13 predicting climate for the next million years, but we
14 think, based upon, we believe it's going to be wetter
15 and cooler for a lot of the time. That we're
16 proposing these values and, like I said, the comment
17 period has recently ended and we'll be very interested
18 in looking at the comments people provide us.

19 We'll be looking for feedback from the
20 committee in terms of what do you think of this
21 approach? And, you know, I personally believe we've
22 put forward something that is reasonable to be
23 considered. That's why we proposed it. Are we
24 saying, hell no, we're not going to change anything of
25 this? No. That's why we go out for comment.

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1 And, you know, it, but I think it was a
2 reasonable starting point for our proposal and the
3 beauty is, as today, which is great, it elicits
4 comments from people. And then we can go back and
5 look at the comments we've received and see what seems
6 to be a reasonable approach for the final rule.

7 MEMBER WEINER: Tim, does your five to 20
8 percent, do you believe that that encompasses the
9 uncertainty and what kind of distribution, just
10 generally speaking, is this the ninety-fifth
11 percentile? Is it, what's the shape of your
12 distribution? Is it flat?

13 MR. McCARTIN: Oh boy --

14 MEMBER WEINER: What have you thought,
15 what are your thoughts?

16 MR. McCARTIN: Right. Well, the shape of
17 the distribution, of that distribution, I didn't
18 really, I couldn't even hazard a guess as to what it
19 is other than saying it's log-normal, because most
20 things are log-normal.

21 But, I think it is a reasonable range
22 that, given precipitation is between 250 and 420.
23 Now, 420 could be at the high end of the rainfall
24 amount. This is definitely due to larger rainfall
25 amounts and cooler temperatures. And, I'll say for

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1 the technical people here and at the Center, when we
2 sat down and did this, the desire was no more than
3 what I said. That, gee, here's a simple approach. I
4 think, we think we're in the right ballpark. Let's go
5 out for comment. Let's see what people tell us. I
6 mean, there's no, it's very complex situation.

7 There's all kinds of uncertainties and
8 debate about climate change over the next million
9 years. It is just, I think that's not an unreasonable
10 range. I mean, 20 percent sounds a bit large. It's
11 hard for me to imagine a number any significantly
12 larger than that. But that's my -- Gordon, I don't
13 know if you want to -- he was one of my cohorts in
14 crime if you want to just give a perspective on the
15 values.

16 MR. WITTMAYER: Well, as an unindicted co-
17 conspirator --

18 (Laughter)

19 MR. WITTMAYER: -- I'll just say, I don't
20 think that we had a distribution for that five to 20.
21 That was the lower end of what we were getting from
22 the averaging of all the breath simulations,
23 effectively for the Yucca Mountain area. The 20
24 percent was the upper end for the cooler, wetter
25 climates we were simulating. And so we used those as

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1 an upper and lower value. And, I don't know what the
2 distribution would be if we looked at all the
3 intermediate values, or if we looked at something that
4 pushed the ends, both the lower and then the upper
5 end. That would require a bit more investigation on
6 our part.

7 VICE CHAIRMAN CROFF: Tim --

8 MR. McCARTIN: Yes.

9 VICE CHAIRMAN CROFF: If I could ask you
10 to go to your next slide. I think it may be in the
11 interest not only of time but I think it would help me
12 --

13 MR. McCARTIN: Sure.

14 VICE CHAIRMAN CROFF: -- I'll make my
15 point. With the top part of it just being pretty much
16 a multiplication.

17 Stepping away from the business of,
18 needing to stylize this if your will, my, and I want
19 to get to the reasonableness --

20 MR. McCARTIN: Yes.

21 VICE CHAIRMAN CROFF: -- part of it.

22 MR. McCARTIN: Sure.

23 VICE CHAIRMAN CROFF: If I understand what
24 people seem to think reality will be very generally
25 into the future, it is, we're sort of in a relatively

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1 dry period right now. The future, at least some
2 believe, tendency towards some glaciation which would
3 be warmer and, if I understand what's being said, more
4 of the time, I'm sorry, I don't mean warmer, wetter,
5 and more of the time wetter than dryer like we are now
6 but cycling between the two --

7 MR. McCARTIN: Yes.

8 VICE CHAIRMAN CROFF: -- over a million
9 years. And, when I look at that and then I look at
10 this range of 13 to 64 with the lowest value being
11 two-and-a-half times what we experience currently, it
12 just doesn't seem reasonable to me the range into the
13 future doesn't encompass the current situation. I'm
14 not claiming this current situation should be the mean
15 or median or something --

16 MR. McCARTIN: Sure.

17 -- like that, but it certainly
18 seems that some of the time into the future, what we
19 experience now should be there and some of the time it
20 will be wetter. If we believe, you know, if we
21 believe the glaciation people. There is, I, if I
22 understand it, there's another camp that sort of tends
23 to believe we may be dryer for a much longer period of
24 time, but I'm not going to promote that view. But
25 when I just stand back from the whole thing, it seems

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1 to me this range it's somehow it's reasonable that it
2 should include the current situation.

3 MR. McCARTIN: Well, I --

4 VICE CHAIRMAN CROFF: So that's, let me
5 leave that as a comment for a second. I think the
6 second part of this is, when we go to the stylized
7 thing, we're basically going to pick one value in a
8 range and say this maintains for, basically forever,
9 out to a million years. Has anybody looked at the
10 comparative case where you assume a value, let's pick
11 50 from that range, and then looked at oscillation,
12 you know, or cycling if you will, to see if you get
13 about the same answer or whether the cycling makes a
14 really big difference in a performance assessment? I
15 mean --

16 MR. McCARTIN: Yes. Sure.

17 VICE CHAIRMAN CROFF: -- sort of a
18 validation of the stylizing assumption if you will.
19 So that's sort of my comment and thought.

20 MR. McCARTIN: Sure. Well, there's a
21 couple things there. And I think we as a group, when
22 we developed this approach, would disagree with
23 keeping the current conditions throughout the next
24 million years.

25 Currently, we tend to be at a very dry

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1 time. When we look at the information, and it's not,
2 and once again, I'm not trying to say we're right, but
3 I do want to explain our thinking process and that's
4 the reason we went out for comment. But we look at,
5 it seemed like there was strong evidence for the
6 majority of the time beyond 10,000 years, it is going
7 to be wetter. So, to hold one of the more important
8 parameters in calculating those, the amount of water
9 getting to the repository, at a low value would seem
10 not to be a fair test for, in our opinion, I mean for
11 Yucca Mountain water --

12 VICE CHAIRMAN CROFF: No. That's not
13 quite what I was --

14 MR. McCARTIN: Okay.

15 VICE CHAIRMAN CROFF: -- suggesting. It
16 seems to me the current situation should be within the
17 proposed range. Right now, it is well below the
18 proposed range. I'm not saying that it should be that
19 value.

20 MR. McCARTIN: Yes, yes. Certainly.

21 MR. WITTMEYER: This is Gordon at the
22 Center. What the, the estimates that we're providing
23 here are a long-term time average. You wouldn't
24 expect to see the lowest lows, let's say what we're in
25 right now, with the highest highs in a long-term time

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1 average. Think of averaging sine curves that are
2 slightly different in amplitude or maybe have a
3 slightly different root-mean-square value. You're not
4 going to see the lowest values like the current value
5 today. This is a long-term time average. It's a
6 little bit different kind of a number here, we're
7 talking about for this stylized climate scenario.

8 VICE CHAIRMAN CROFF: Okay. I hear you.

9 MR. WITTMAYER: Let me take a crack at it
10 because I think --

11 MR. McCARTIN: Well, but, but let me
12 continue with this. If this were some other things,
13 I mean, and with respect to performance, generally in
14 just about every repository calculation I've seen,
15 more moving water is bad to performance. So, there's
16 an understanding that indeed the more water will be
17 bad. Higher release rates.

18 In terms of looking at this long-term
19 average, recognizing that most of the time it's
20 wetter, and with that as a backdrop. I think picking
21 the, I personally I was actually kind of comforted by
22 13 at the low end, that it's not that dissimilar than
23 what we see today and so, some people have estimated
24 10 millimeters per year as high. I mean, generally
25 it's five, but, you know, people have gone up to

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1 almost 10 for Yucca Mountain. There's a lot of
2 uncertainty in that. So, you know, as the low end I'm
3 not terribly troubled by it.

4 The oscillation, I think would add a
5 complexity that I don't know how anyone would deal
6 with it in terms of what's the right kind of
7 oscillation to do over time, in that, because now you
8 would be dominant, well it wouldn't be dominant, you
9 would be affected by when the waste package fails with
10 respect to this oscillation --

11 MR. WITTMAYER: That's it.

12 MR. McCARTIN: -- and gee, what if I get
13 a whole bunch of them failing when it's low, and so
14 I'm dribbling out some release and then, there's some
15 period where -- that's a complexity that I'm not
16 convinced, understanding the behavior of a Yucca, of
17 a potential depository at Yucca Mountain is enhanced
18 by doing the oscillations rather than picking a range
19 where we're, it's going to be wetter, and I know when
20 it's wetter, when the waste packages fail, I will have
21 the wet conditions.

22 And I'm not overly concerned about whether
23 it's coming out of a dry, into a dry, out of a wet,
24 into a wet, whatever. And, it just, once again, in
25 terms of a reasonable test, I think the oscillations

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1 would be very problematic to try to describe how this
2 oscillations occur --

3 VICE CHAIRMAN CROFF: I don't think you
4 understand --

5 MR. McCARTIN: Okay.

6 VICE CHAIRMAN CROFF: -- all I'm
7 suggesting on the oscillation is you, maybe, I mean,
8 staff --

9 MR. McCARTIN: Yes.

10 VICE CHAIRMAN CROFF: -- needs to run a
11 couple of cases, maybe failure at low, failure at
12 high, just so you understand where, what the
13 boundaries of this thing are. I'm not suggesting that
14 it should be the stylized --

15 MR. McCARTIN: No. Okay.

16 VICE CHAIRMAN CROFF: -- proposal, if you
17 will.

18 CHAIRMAN RYAN: Tim, at the end of the day
19 we're trying to figure out what the concentration is
20 that's going to enter some sort of transport scheme.
21 And I think about infiltration and rainfall. And your
22 earlier comment that sometimes the episodic events,
23 the big rains, are, you know, controlling in some
24 circumstances and some not.

25 If I have a dry period, that means I have

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1 very little water entering the system perhaps, so
2 movement's minimized. Just accept that as a premise.
3 What happens if I now shift gears into a wetter
4 system? I think you've got to at least explore this
5 idea of oscillation because -- well, maybe that's not
6 the right word for it, because can't you get higher
7 concentration slugs coming out? And I don't mean a
8 slug all in one day. I mean over some period of time?

9 I'd at least want to explore that somehow
10 and make sure that when I'm operating within your
11 range, that I don't have the possibility of what
12 happens after a dry period and now it transitions into
13 a wet period. Do I really get increases in release
14 rate or am I off-base?

15 MR. McCARTIN: Well, certainly the -- as
16 any natural system, the rainfall does not come out, or
17 the depercolation does not enter as a uniform amount
18 over time. And there will be sometimes large
19 variations in that.

20 However, one aspect of slugs and these
21 variations, the transport time is generally fairly
22 long and dispersion and other hydrodynamic effects
23 will tend to smear out these slugs. And might you see
24 some oscillations? There could be some. I would
25 argue that we do represent differences in transport

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1 paths and we do see some variation as a result of it,
2 but there does come a point where I think the episodic
3 nature, certainly of infiltration rainfall, I mean,
4 you could have dry years and then wet years. But the
5 hundreds of years, sometimes thousands of years of
6 transport will tend to smear that out.

7 CHAIRMAN RYAN: And again, I don't
8 disagree with your point, but I'm just saying that
9 when you see a factor of say 5 or so of infiltration
10 rate, I wouldn't want probably the wrong conclusion to
11 say well, that translates to a factor of five and dose
12 or concentration.

13 MR. McCARTIN: Right.

14 CHAIRMAN RYAN: And I think that's kind of
15 what Allen, what you're getting at a bit. If you
16 explore those ranges and how variations over time
17 within the range, either at the low, the medium or the
18 high, what effect that might have on concentration on
19 an estimate of dose. That's helpful to get an
20 insight.

21 MR. McCARTIN: Yes, and certainly most
22 processes are not that linear with respect to
23 performance, that doubling infiltration will double
24 the release rate.

25 CHAIRMAN RYAN: And of course, certainly

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1 --

2 MR. McCARTIN: For solubility, lots of
3 radionuclides can do that, it depends on the release
4 rate. There's many factors that come into play, but
5 yes. It's not a one-to-one with that.

6 CHAIRMAN RYAN: Thanks.

7 MEMBER HINZE: Tim, to help clarify this,
8 it's my recollection of the proposed EPA standard is
9 that they have directed you to minimize the temporal
10 variations going out to a million years, but to assume
11 average conditions. Is that correct?

12 MR. McCARTIN: To minimize?

13 MEMBER HINZE: To minimize the
14 oscillations, if you will.

15 MR. McCARTIN: They have suggested it
16 could be represented as constant conditions.

17 MEMBER HINZE: Right. And so they should
18 be represented as an average constant condition of
19 what you are suggesting and that's what you are --
20 you're really taking some bounding conditions here,
21 well, maybe not bounding, but some limiting conditions
22 of the 5 to 20 percent and the precipitation.

23 MR. McCARTIN: Yes.

24 MEMBER HINZE: I think that's --

25 MR. McCARTIN: And people will have

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1 different views and comments have come in about the
2 reasonableness of what these numbers represent, but
3 yes, the desire is that we're doing a long-term
4 average and -- Janet?

5 MS. KOTRA: I know the Committee
6 understands this for the benefit of the broader
7 audience, I think it's important to remember that
8 while EPA suggested that a single constant level might
9 be appropriate, we're not calling for that here. What
10 we're calling for is in the multiple iterations that
11 DOE will conduct, that each time they do an iteration,
12 they sample over this range.

13 Now I know like I said, I know the
14 Committee understands that, but I think sometimes in
15 our shorthand, the way we speak, it gives a false
16 impression that somehow we're only interested in a
17 single value over all time and that's not what we're
18 doing here.

19 VICE CHAIRMAN CROFF: This range of 266 to
20 321, that's your best stab at the average
21 precipitation over very long times?

22 MR. McCARTIN: Yes, that was based on the
23 site at USGS document on the analog sites that was
24 representative of the last glacial maximum.

25 And so all we did was just take the --

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1 VICE CHAIRMAN CROFF: Those are the words
2 that are confusing me, "last glacial maximum."

3 MR. McCARTIN: That's out of the report.
4 That's what they estimated the infiltration because
5 they took --

6 VICE CHAIRMAN CROFF: I mean is a glacial
7 maximum representative of the average climate over a
8 million years?

9 MR. McCARTIN: And we expect to get
10 comment on that. In general, there is this range that
11 we think is not unreasonable for most of the time from
12 the -- for the monsoon and interglacial. It's close
13 enough that we are using it.

14 VICE CHAIRMAN CROFF: Forgetting whether
15 it's reasonable or not, I'm just trying to establish
16 fact. That range is representative of a glacial
17 maximum?

18 MR. McCARTIN: Yes.

19 VICE CHAIRMAN CROFF: Thank you.

20 MEMBER WEINER: To get back to one of the
21 comments that Dr. Sagar made, there are places in the
22 United States which have this range of rainfall. I
23 happen to live in one of them. And it seems to me
24 that it ought to be possible to measure, to get some
25 kind of field measurements of deep percolation over a

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1 period of years in places that today mimic this
2 rainfall pattern. Because they certainly exist and
3 you could look at a range of, you have different soil
4 depths, different bedroom exposed. You could look at
5 a range. And it seems to me that would anchor your
6 estimates in some kind of valid reality.

7 MR. McCARTIN: Yes.

8 MR. WITTMAYER: Can I just say something
9 before we proceed? We've actually looked at a lot of
10 different studies conducted in similar air to semi-air
11 climates where there has been some very good
12 quantitative work done on many scales from using
13 simple wing lysimeters run over time to I suppose
14 different types of regional recharge estimates, such
15 as using a tool like the Demecci-Ekin formula and this
16 range of 5 to 20 percent of the annual precipitation
17 becoming net infiltration is the term I'll use from
18 those studies, isn't very reasonable range for similar
19 climates.

20 MEMBER WEINER: Thank you. I think that's
21 a very important statement.

22 MEMBER HINZE: I think one of the problems
23 here, Ruth, is that we don't want to just duplicate
24 the precipitation. What we have to duplicate, the
25 other conditions that go along with the last glacial

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1 maximum. And that very much affects evaporate
2 transpiration, in particular. And also, well, many
3 other factors, but particularly evaporate
4 transpiration. So you just can't go to your backyard
5 where you have 11 inches of rainfall to do that. It's
6 not going to be comparable to the last glacial
7 maximum.

8 MEMBER WEINER: No, I understand that.
9 But I think Gordon's statement was very cogent that
10 there is a basis, a measured basis.

11 MR. McCARTIN: Just to finish this up,
12 obviously, we took the too low values and multiplied
13 them and two high values to get a range. We did use
14 a log-uniform distribution. Why log-uniform? Well,
15 depercolation is really a multiplicative process. This
16 would suggest a logarithmic distribution.

17 We really have no basis for favoring
18 either end of the distribution and so that would
19 suggest a uniform distribution. We ended up with a
20 log-uniform distribution.

21 In terms of that distribution, what
22 happens? Really, when you sample this, you'll end up
23 with a mean value of approximately 32 millimeters per
24 year which is approximately 6 times greater than is
25 currently estimated for Yucca Mountain under the

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1 current conditions.

2 And now to the status. The EPA comment
3 period ended on November 21st. Our comment period
4 ended on December 7th. As I said, we put forward what
5 we believe was reasonable basis for proposal. We'll
6 consider the comments and we would expect to finalize
7 our regulation shortly after EPA finalizes its
8 standard. That's really where we're at, at this
9 point.

10 A lot of good questions, suggestions. I'd
11 be happy to answer further questions.

12 CHAIRMAN RYAN: Let's go around. Jim, do
13 you have any questions?

14 MEMBER CLARKE: Going back to your
15 illustrative-dose calculation, the neptunium really
16 tracked well the dose for all the radionuclides. You
17 did mention that you think it is important to look at
18 other waste package degradation scenarios. I guess
19 that reflects a particular set of assumptions.

20 Can you then use neptunium as a surrogate
21 to look at a number of scenarios or would that be
22 beneficial too?

23 MR. McCARTIN: Certainly, I think just
24 before other purposes, we would continue to include
25 iodine and technicium.

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1 MEMBER CLARKE: The more mobile --

2 MR. McCARTIN: Yes, just because of their
3 mobility and we are in the process of adding plutonium
4 colloids. We're not aware of any significant change
5 that will make, but certainly in looking at the DOE
6 calculations, plutonium colloids do contribute, but
7 it's certainly at present we have approximately 21
8 radionuclide -- 21 or 22 radionuclides that we
9 simulate for the groundwater pathway.

10 And we are looking at ways to simplify
11 that list of radionuclides just to make it more
12 efficient, because it's a million year calculation.
13 It just takes a little bit longer than 10,000 years.

14 MEMBER CLARKE: It just struck me that the
15 area, to me would have a great deal of uncertainty as
16 when they fail, how they fail and what happens after
17 that. And limiting the number of radionuclide, I
18 would think, would let you do a -- look at a lot of
19 scenarios perhaps. I don't know the details about the
20 model and the time required and all that.

21 MR. McCARTIN: Certainly what I'll say,
22 the gedanken experiments that I do with the code, I
23 often use neptunium and occasionally I'll throw in
24 technicium or iodine, but you can learn a lot from
25 neptunium. You obviously, whatever -- if you feel

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1 you've learned something significant, you go back and
2 redo it for the full suite of radionuclides, but
3 you're absolutely right that just running the code
4 with neptunium, you can learn quite a bit.

5 MEMBER WEINER: Couple of things. Tim, if
6 you go back to your slide 11, the infamous slide 11,
7 I assume that from what you said that you were
8 including mobility, some kind of mobility in this
9 slide.

10 MR. McCARTIN: Oh yes.

11 MEMBER WEINER: My question is since your
12 peak looks to be eyeballed at around a little more
13 than 100,000 years, maybe 125,000, 150,000, why are we
14 going out to a million years?

15 MR. McCARTIN: Well, you don't know the
16 peak is there unless you go out longer. I mean it's
17 easy to say where the peak is after the fact, but --

18 MEMBER WEINER: But now looking at this,
19 you know, you can see that after 500,000 years, your
20 dose is very greatly decreased and it even decreases
21 markedly after 200,000. Would it make sense if this
22 were not a regulatory world, but would it make sense
23 to say okay, we only need to go out to 200,000 years?

24 MR. McCARTIN: Oh sure. And certainly in
25 terms of when you're using the code, yeah, I've

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1 flipped it at 500,000 years, just because -- just to
2 get the numbers out faster for no other reason. And
3 once you know things, you'll still need to at some
4 point go to a million to convince someone of what
5 happens. And certainly -- I mean the reason this
6 occurs at that location, in general, in our code, most
7 of the waste packages have failed around 80,000 years,
8 60,000 to 80,000 years. And that's why it occurs
9 there.

10 And we have a single non-time dependent
11 degradation of that waste package. If we put in time
12 dependent degradation of that waste package, it may
13 move this around, do some other things, so there are
14 other things that might occur.

15 MEMBER WEINER: I have two more quick
16 ones. How does your estimate of the influence of
17 climate change compare to the Department of Energy
18 estimates? We had a presentation more than a year ago
19 of their estimates of climate change and I just
20 wondered, are they very far apart? Are they similar?

21 MR. McCARTIN: Well, certainly our
22 proposal is looking to specify a long-term average
23 value and neither prior to this current rulemaking, no
24 one was estimating climate change in that manner and
25 I can talk to our previous -- the code we currently

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1 have, the TPA-401 code has Milonkovitch cycle, 100,000
2 thousand year cycle of going up and going down with
3 climate change, a relatively gradual up and down for
4 climate change. That was our representation.

5 The Department had these steps, these
6 very instantaneous steps to represent climate change,
7 some of which were fairly large, so I think we're both
8 -- the similarity is we were both estimating that that
9 conditions would get wetter out in the future, but we
10 had a smooth Milonkovitch 100,000-year cycle whereas
11 they had a very rigid step function that was repeated
12 for every realization it was exactly the same in terms
13 of the timing of when climate changed, etcetera.

14 MEMBER WEINER: Thank you.

15 CHAIRMAN RYAN: Bill?

16 MEMBER HINZE: Couple of questions,
17 please. Are the questions and comments of the public
18 going to be made public?

19 MR. McCARTIN: Well, they are. They
20 currently are on our website. If you go to either the
21 internal NRC or the public NRB website, there's a --
22 I think on the home page, there's a tab that says
23 rulemaking and you can get to proposed rules. There's
24 a couple clicks and as comments are received, docketed
25 and put into ADAMS, they are made available on that

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1 website. And I will say the last time I looked which
2 was either late last week, yes, I think it was late
3 last week, there were six comments, I believe, on the
4 web site. Six.

5 More have been received, because they have
6 come in under the -- you tend to get more right at the
7 last minute and the State of Nevada's comments, I was
8 told, I have not seen it, is approximately a thousand
9 pages. And so reading that -- getting that scanned
10 into ADAMS takes a while. So the State's comments
11 have been received, putting that up on ADAMS will take
12 a while. So there is some delay, but certainly
13 additional comments have been received and as
14 appropriate, SECY puts them on the website, yes.

15 MS. KOTRA: I just want to add that within
16 that six that may have been up prior to the close of
17 the comment period, there were many repetitions of
18 some of those same ones that were received and have
19 been treated, you know, we put discrete comments in,
20 but we don't repeat multiple bulk mailing type of
21 things.

22 MEMBER HINZE: And one final, more
23 philosophical question. One of the things that we've
24 seen during the past decade and the past two decades,
25 we've seen a tremendous increase in our ability to

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1 predict recharge or what we think is recharge. The
2 processes, we understand better, the input, etcetera.

3 And so we're doing a much better job. I'm
4 wondering as you looked at the surrogate for climate
5 change, if you considered the possibility of not
6 specifying specific values for the recharge, but to
7 make this in a more general sense so that based upon
8 principles that would help us to -- would make it
9 possible to incorporate new technologies, new
10 information?

11 MR. McCARTIN: As I remember it, that
12 particular approach did not come up in our discussions
13 based on the language that was in the standard, that
14 we felt we should provide a value and it would be no
15 question in terms of what it is.

16 The Commission always has at its disposal,
17 if at some later time, they learned something is
18 either incorrect or not appropriate, we can modify
19 anything in our regulations. So I appreciate the fact
20 that yes, knowledge goes forward, but it just seems
21 for the most direct way for us to provide the value is
22 an explicit number.

23 MEMBER HINZE: It kind of smacks of the
24 groundwater travel time show which we had in 60, of a
25 very specific number. Thank you.

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1 MR. McCARTIN: Although I tend to look on
2 it more, as Janet indicated, this is a stylized
3 approach for something that trying to get a handle on
4 what the climate is going to be for the next million
5 years is a daunting task. Likewise, for the
6 reasonably maximally exposed individual in the rule,
7 how much water is someone going to drink per day? We
8 specify, the EPA specified two liters a day. Now
9 people are going to drink less. People are going to
10 drink more. That's a reasonable test. I believe that
11 specifying this value, our desire was a similar kind
12 of thing.

13 I can no more -- I can't tell you how much
14 people are going to drink in the future, but two
15 liters a day is reasonable. The approach, we tried to
16 put forward something that we believe is a reasonable
17 test for an average climate to use in the calculation.

18 So I prefer to look at it more like well
19 two liters a day is something that the absolute
20 number, here it is, use it, a similar kind of thing
21 for climate change.

22 CHAIRMAN RYAN: We have for perhaps one or
23 two more questions. John, you had your hand up, John
24 Flack?

25 MR. FLACK: John Flack from ACNW Staff.

1 I'm curious about the curve you have up there and the
2 sensitivity of that curve to the integrity of the
3 waste packages. And should the waste packages fail
4 early or later, how sensitive is that curve?

5 And then given that, if it's wetter
6 earlier, will that fail the packages sooner and is
7 that all accounted to by the model?

8 MR. McCARTIN: Well, the model certainly
9 accounts for the potential for different failure times
10 of the waste package. We have approximately eight
11 sub-areas and we calculate a representative package
12 for a sub-area. So there's only eight, but within
13 that sub-area, you have different infiltration rates.
14 Most importantly different temperatures and so you
15 have the potential for different corrosion rates and
16 that impacts the time that the package fails.

17 It certainly is very sensitive to when the
18 waste package fails. The peak, I would maintain,
19 would not be sensitive, that neptunium has, I believe,
20 a 2 million year half life and so if I move this out
21 to say 400,000 years, and I'll do that test. I can
22 artificially extend the lifetime of the waste package
23 and see what happens, but the neptunium inventory is
24 going to be pretty much the same. My guess it would
25 be unaffected.

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1 The only -- the biggest thing that I would
2 say from a time standpoint that affects the
3 calculations is extremely early waste package failure.
4 Extremely early as in the first thousand years. When
5 the source term is hot, the release rate tends to be
6 higher and so if you had waste packages early on, you
7 tend to get a higher release rate but that's --

8 MR. FLACK: That's what I mean. If you
9 can show that the packages will survive for the first
10 10,000 years, then it really doesn't pay to go and
11 pursue how they're going to degrade post-10,000 years
12 or spend a large effort in there. I guess all the
13 action is up front, right?

14 MR. McCARTIN: Right. But and I agree
15 with that statement, but as a reviewer of the DOE,
16 potential DOE license application, I want to review it
17 from a position of understanding. And I want to
18 understand, as I was talking before, does the way this
19 waste package fails affect that dose estimate so I can
20 understand better how DOE represents. They have a
21 different model than we have. They have patches that
22 grow with time and there's different release
23 mechanisms, so they have a slightly different way of
24 representing that waste package degradation.

25 My gut tells me it probably doesn't make

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1 a big difference, but it's something that we haven't
2 really looked at much in the very long time frame and
3 it's something to explore, but in general, the early
4 on, during the thermal phase is when the waste package
5 failure is of most concern.

6 CHAIRMAN RYAN: Just one last question and
7 then we'll take our scheduled break so we stay on
8 schedule for early speakers here and then we'll come
9 back after break.

10 MR. SCOTT: Mike Scott, ACNW Staff. Tim,
11 would you care to hazard a guess as to what that curve
12 would look like if DOE goes back to the cold
13 repository concept?

14 MR. McCARTIN: It might not look any
15 different. It might not.

16 Assuming and this is assuming the -- and
17 there continues to be updates in the parameters and
18 models of our code. Assuming the waste package
19 failure continues to be in the 60,000 to 80,000 year
20 time frame, because a cold repository, if you're
21 looking at eliminating bad chemistries early on that
22 could potentially fail the waste package, at least in
23 our code, we don't have those bad chemistries
24 occurring early on.

25 So the failure of the waste package is not

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1 being caused by this bad chemistry early on during the
2 thermal period and so I don't -- at least as a first
3 assumption, I don't think it would change much.

4 However, I will say -- I am not -- we can
5 get back to you with the corrosion experts. Corrosion
6 is the long-term corrosion with a cool repository,
7 would this be pushed out even further? I -- we don't
8 have the people here to talk to the corrosion, but the
9 bad chemistries early on aren't the issue. If it was
10 cooler, does it change it dramatically? I don't now.
11 In our models, so I draw the distinction. It's
12 possible in the DOE models. Maybe that would make a
13 much bigger difference.

14 CHAIRMAN RYAN: Tim, to finish up before
15 our break, I think the idea of how the package
16 interacts with these new views of infiltration might
17 be a topic for our discussion down the line, same as
18 developing your thinking a little bit more, but there
19 are some good questions on those aspects.

20 So with that, we're scheduled for a break
21 at 10:15 to 10:30. Let's come back at 10:35 and we'll
22 start promptly, picking up with our other speakers and
23 hopefully continuing the discussion through the end of
24 our morning session. We'll start with some other
25 questions after our presentations.

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1 Thank you.

2 (Whereupon, the foregoing matter went off
3 the record at 10:20 a.m. and went back on the record
4 at 10:37 a.m.)

5 CHAIRMAN RYAN: Okay. We'll reconvene and
6 begin with some additional presentations on the
7 reasonableness of infiltration. The NRC infiltration
8 assumption that proposed Part 63.

9 Leading us for the rest of the morning
10 session will be Profession Hinze. Bill?

11 MEMBER HINZE: Thank you very much. We
12 have two speakers in this unit on the reasonableness
13 of NRC's infiltration assumptions and their proposed
14 changes to Part 63.

15 The first presentation will be involved
16 with the chloride mass balance which takes a prominent
17 which takes a prominent role I this. And it will be
18 given by Ward Sanford, Dr. Ward Sanford who is the
19 research advisor on groundwater for the U.S.
20 Geological Survey.

21 And as Senior Hydrogeologist for the
22 Research Hydrologist for the Survey, he has written
23 extensively on recharge and particularly the chloride
24 mass balance method which is referred to in the
25 discussion of the revised Part 63.

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1 With that word, it's yours.

2 MEMBER HINZE: Thank you. Ward?

3 DR. SANFORD: So from what I understand
4 now, in the Federal Register there was a reference to
5 some work done using the chloride mass balance method
6 at Yucca Mountain to also estimate recharge rates
7 during the last glacial maximum. So this is sort of
8 a two part presentation here.

9 I'm going to start with a broader context
10 for those of you who aren't familiar with the chloride
11 mass balance technique. And we'll give you some of
12 the assumptions, the backgrounds, a couple of simple
13 cases where it has been used successfully.

14 And then what are some of the issues
15 involving estimating recharge at Yucca Mountain that
16 it might involve understanding how the chloride mass
17 balance assumptions might work there.

18 So as I was saying, first I'll give some
19 background on the chloride mass balance methods,
20 assumptions and examples. And talk about a little
21 more general about transport water and chloride in the
22 unsaturated zone in arid environments. I think there
23 have been some very interesting things that have been
24 learned just in the last few years.

25 And then how this might apply at Yucca

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1 Mountain. A very simple first presentation of how
2 some numbers were calculated and then give it over to
3 Chen Zhu who will go into a lot more detail on how
4 that approach was used at Yucca Mountain.

5 So here's the simplest form of the
6 chloride mass balance approach. First of all, it
7 really is just applying to any conservative solute
8 that is in the precipitation then ends up in recharge.
9 It's just the chloride happens to typically be the
10 most conservative solute so that's what is most often
11 used. And it has now been just called the chloride
12 mass balance.

13 Essentially you are just balancing mass as
14 you have precipitation fall on the land surface and
15 evaporation then from the rube zone near the
16 evaporation and transpiration. And then what gets
17 below that down to recharge and deep percolation also
18 has chloride in it.

19 So the key factor here is that evapo-
20 transpiration does not -- it takes water but not
21 chloride. So you can write a simple balance equation
22 here that the precipitation times the chloride
23 concentration in precipitation has to equal what comes
24 out the bottom here, which is the recharge flux times
25 the concentration of chloride in the deep percolation

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1 water or the groundwater.

2 Since these two terms are equal, you can
3 rearrange and solve for recharge so that if you know
4 the precipitation rate, the concentration in the
5 precipitation, and the concentration in the
6 groundwater, you simply can then estimate recharge.

7 So if the chloride in the concentration of
8 groundwater, for example, is ten times that of
9 precipitation, then that's telling you that only one-
10 tenth of the precipitation ended up down here as
11 recharge.

12 Now there are some important assumptions
13 if you are going use this. One, if you're going to
14 use that simple form I was just describing, you need
15 to assume that there is steady state flow for your
16 measurements. You also assume in that consideration
17 that there is no runoff from the system. If there's
18 runoff, you have to somehow account for that.

19 Also that somehow you've accounted for
20 your anthropogenic sources or that you've measured the
21 dry input on the land surface if there are any there.
22 And that your measured samples have to be a good
23 statistical average.

24 If you take one core at one place and get
25 numbers, you have to ask yourself does that represent

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1 the whole area I'm interested in or do I need to take
2 a whole range of samples?

3 Typically what you are sampling is in the
4 matrix fine grain material. If it is a fractured
5 rock, then you've got to worry well, is there a lot of
6 bypass going on around what I've sampled for example,
7 through fractures or macropores?

8 And if all of these assumptions are valid,
9 then you might expect a chloride profile in the
10 unsaturated zone to look like this where right at the
11 surface, you've got concentrations of chloride
12 represented precipitations. These are going to
13 increase as you go below the land surface a meter or
14 a few meters until you get below the root zone, there
15 is no more transpiration.

16 Then if you are at steady state, those
17 concentrations should be relatively constant down to
18 the watertable.

19 So just a couple quick examples where this
20 seems to have worked fairly well. I worked with
21 Warren Wood when he was at the USGS in the High
22 Plains, Southern High Plains in Texas. And we did a
23 simple calculation looking at wet and dry chloride in
24 precipitation all across the Southern High Plains.

25 We also looked at the published chloride

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1 values in groundwater from 3,000 wells across the High
2 Plains, took an average. Turns out there is very
3 little runoff across the High Plains. A lot of it
4 focuses into very little small playas which then
5 recharge the Ogallala Aquifer there.

6 And doing these very simple calculations,
7 we came up with a calculation of 11 millimeters per
8 year average recharge to the Ogallala. And it was
9 interesting back in 1937, C. V. Theis made a very good
10 estimate of recharge just looking at the slope and the
11 water table and the known transmissivity of the
12 aquifer and came up with a number that was very
13 similar. So we -- very close to this, in fact, so we
14 thought that was a good way to estimate recharge there
15 on the Southern High Plains.

16 Another case I was recently sort of
17 involved with was in the Albuquerque Basin where we
18 were doing a lot of work collecting environmental
19 tracers in the basin. We were creating a groundwater
20 model for the Albuquerque Basin and using C-14 and
21 doing paleo simulations in trying to estimate what the
22 recharges were in the Albuquerque Basin.

23 And along there -- along the eastern side
24 of the Albuquerque Basin there's the Sandia Mountains
25 and other mountain ranges there. So a lot of the

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1 recharge in the basin falls in the mountains and then
2 runs through these little streams and ephemeral
3 streams in Arroyos. And then discharges out onto the
4 flats here. And that's how a lot of the recharge
5 curves right along the mountain front.

6 So Scott Anderholt at the USGS in
7 Albuquerque did this study along the mountains there
8 looking at these individual little watersheds that run
9 off. So he calculated the area here and how much
10 precipitation came in, what the concentration was.
11 That all got focused out here onto the mountain fronts
12 and into the streams.

13 He took concentrations of groundwater out
14 here and made some comparisons. And so in this case,
15 he wasn't looking at a flux versus flux but simply
16 calculating total volume and mass of chloride and then
17 putting it into the mountain front here and coming up
18 with a volume metric rate of recharge. And that came
19 up with about 11,000 acre feet per year along the
20 entire mountain front.

21 We compared that with our model which we
22 were calibrating using carbon-14 from these values
23 here and we came up with quite a good similar number
24 to what he got with the chloride mass balance. So we
25 think the numbers are at least consistent with other

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1 methods there.

2 So now you might want to ask yourself --
3 and remember that profile has shown you what chloride
4 should look like if you are assuming steady state in
5 the unsaturated zone, does chloride tend to look like
6 that in arid climates? And the answer is no.

7 If you look at steady state chloride
8 profiles, for example, these were plotted and compiled
9 here by Michelle Woolvard who is now at the USGS from
10 some different sites around the west here. Typically
11 this is what you see. You get a great big bulge in
12 chloride her in the top few meters. And then it goes
13 down relatively -- quite dilute for the rest of the
14 way below that.

15 So it doesn't look at anything like the
16 steady state model. You get this bulge in chloride.
17 And what this high chloride then might be suggesting,
18 of course, is that very little recharge has occurred
19 in the last hundreds to thousands of years. It has
20 been accumulating here in the top part of the soil
21 profile.

22 So what does that mean? Is there anything
23 we can do when we come to a situation like that?
24 Well, one approach people have tried to use is
25 something you might call a transient chloride mass

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1 balance approach.

2 Let's just assume that there's piston flow
3 down through here. And that there has been a constant
4 precipitation flux. You can do some calculations. If
5 you assume the chloride constant precipitation is also
6 constant and you can assume the recharge then varies
7 with time, you can actually sort of calculate the
8 accumulation time through past here for this vertical
9 segment of the profile.

10 If you do that, then you -- the
11 calculations reveal actually that this amount of
12 chloride, for example, would take several thousand
13 years to accumulate at very small infiltration rates.
14 So it's sort of an adapted chloride mass balance
15 approach.

16 What Michelle Woolvard also did recently,
17 just in the past few years, is some very interesting
18 simulations of the unsaturated zone here. And here
19 she has looked at four different profiles out in
20 southern Nevada here in an area not too far from
21 interest to us.

22 And she did some detailed modeling of
23 vertical profiles to match both the tensions they see
24 in the unsaturated zone, the hydraulic tensions, and
25 also the chloride bulges trying to get fits to

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1 chloride bulges.

2 So you'll see you get these little
3 chloride bulges here in a few meters below the land
4 surface like I was showing before. A couple of these
5 you get bulges a little bit deeper which suggest,
6 perhaps, some older things going on there.

7 Let me see here. But what she found out
8 was actually very interesting. How do I go back here?
9 Can I go back? Previous? There we go.

10 She simulated not only water movement but
11 also water vapor movement, heat transport, and
12 solutransport. And discovered that under these dry,
13 steady state conditions, there is a net -- in this
14 deep section, contrary to what a lot of people have
15 sort of assumed that there is some very small movement
16 downward continuously of this water, there is a net
17 movement actually upward in this system.

18 The plants up here, the desert plants are
19 keeping the system very dry because they are very
20 efficient at taking out water. There is actually a
21 small network of movement of water upward in this
22 system. And not downward over time.

23 MEMBER HINZE: Are any of these -- Ward,
24 if I might, are any of these in fractured rocks where
25 there is a matric flow but rather fracture flow?

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1 DR. SANFORD: I don't so. If they are
2 what they probably sampled here are the matrix
3 materials. But what she was able to do is to try to
4 fit those different curves of chloride -- as I was
5 saying, she simulated water, heat, and vapor and
6 chloride transport. She was using the FEHM model from
7 Los Alamos Laboratory. And these are the four
8 different profiles she was simulating.

9 She could adjust -- and this is time here
10 along the X axis. So here is present and this is back
11 in time. She could adjust between dry periods where
12 she would set the tension in the top of the soil very
13 dry approximately to what the plants are keeping it
14 at.

15 And then you get these intervals of some
16 type of net recharge event that would move the
17 chloride downwards.

18 So they essentially build up in the dry
19 periods and then get moved downward in these wet
20 periods. So as you can see -- remember the profile,
21 these two profiles 1 and 3 showed some lower bulges.
22 Those were essentially -- had to be reproduced by
23 having wet periods a long way back about 100,000 years.

24 And there was an interval of dry here
25 until about the last glacial maximum or the end of the

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1 last glacial maximum where the precipitation occurred
2 to help move the profiles down a bit. Then
3 essentially in the last 10,000 years there has been
4 zero recharge.

5 So what might all this add in terms of our
6 discussion about recharge at Yucca Mountain -- and
7 these issues have been brought up this morning already
8 as well.

9 This was just something out of Fred
10 Phillip's recent paper sort of summarizing a lot of
11 what he knows about climate change in the desert and
12 how it effects recharge, saying it is clear that a
13 focus solely on changes in precipitation constitute a
14 great oversimplification. Changes in other fluxes
15 that redistribute precipitation after it hits the land
16 surface must be considered.

17 So these are a generation of runoff,
18 evaporation, and transpiration. And in talking in the
19 discussions this morning, all of these are being
20 considered.

21 MEMBER HINZE: Excuse me.

22 DR. SANFORD: Yes?

23 MEMBER HINZE: Let me ask you a question.

24 DR. SANFORD: Sure.

25 MEMBER HINZE: In terms of fracture flow

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1 rather than matrix flow, are any of these prominent in
2 one or the other? Or are they prominent in all? Or
3 how do you see that?

4 DR. SANFORD: How do I see --

5 MEMBER HINZE: See the --

6 DR. SANFORD: -- relation to the chloride
7 mass balance?

8 MEMBER HINZE: -- for example, thermal
9 gradients, matric potential?

10 DR. SANFORD: As far as I'm concerned --
11 as far as I am aware of -- from what I'm aware of, I
12 have not seen those simulated. I mean it is a much
13 more complicated system. So maybe somebody out there
14 is trying to simulate these. But the simulations that
15 Michelle did were the first I've seen, you know, the
16 fully coupled simulation in the unsaturated zone
17 period.

18 So the simplest thing to start with was
19 this matrix material. So I have not seen it progress
20 to look at what the effects are in a fractured rock.
21 However, I'm sure the theory is out there. And
22 perhaps the codes are there to do it. But it's
23 complicated. I haven't seen any results yet. But
24 people can correct me if they've seen something.

25 MEMBER HINZE: Thanks.

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1 DR. SANFORD: So you're talking about
2 vegetation changes. The Pleistocene-Holocene
3 transition showed the widespread replacement of a
4 pinon-juniper forest by desert scrub vegetation. Now
5 I haven't read -- this morning we were talking about
6 the analog sites.

7 And I haven't read that USGS report. I
8 was actually glad to hear they were looking at analog
9 sites. It's one of the first things I thought of, you
10 know, I was thinking about why don't they look for
11 some analog sites. So likely those sites were pinon-
12 juniper forests which seem to be the type of
13 vegetation around during the last glacial maximum.

14 And in know there has been one study at
15 least by Woolvard and Phillips of these different
16 vegetation types. I believe it was in West Texas
17 where they looked at these different -- recharge under
18 the different sites where they tried to see that all
19 other factors being equal, essentially the forests
20 allowed more recharge to infiltrate and come down as
21 deep percolation.

22 Essentially the desert scrub are much more
23 efficient at sucking up every last drop of water
24 whereas the forests, for example in their study under
25 the desert scrubs, there were thousands of years of

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1 chloride beneath the scrubs but under the pinon-
2 juniper forests, there was only about 200 years of
3 chloride built up under the forest, suggesting, of
4 course, that the recharge is significantly higher
5 under forest than under desert scrub.

6 So this leads to another point which I'm
7 sure people are aware of here but if you're trying to
8 estimate the percentage of precipitation that ends up
9 in recharge, it's not a simple linear function where
10 you can say in one area it is always going to be five
11 percent but it is going to change as precipitation
12 changes.

13 In arid areas, it could be very close to
14 or equal to zero. But then at some point, you get
15 this threshold, and it is possibly related to
16 vegetation here, where suddenly you can get a much
17 faster increase in this percentage of precipitation
18 that is recharged. So that that percentage increases
19 with increasing recharge. And it is nonlinear.

20 So as has been pointed out this morning,
21 recharge in Basin and Range Province in Nevada,
22 typically in Yucca Mountain, tends to be more aerially
23 distributed at the high elevations. And in the
24 fractured rock areas with low soil horizons.

25 But then it gets focused down into

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1 channels at the intermediate elevations. As you go
2 from the ranges out onto the slopes into the basins
3 you get channelized flow. And then typically out in
4 the very broad areas of the basins, the recharge is
5 nonexistent -- is very low or nonexistent.

6 Also another point I was just trying to
7 make this morning and I think people are aware of,
8 there is high temporal variability in this
9 precipitation. And so it leads to greater recharge.
10 When you've got focused events while less variability
11 if you have very frequent but not intense storms,
12 you'll actually get less recharge. There's more time
13 for that water to evaporate and transpire than if you
14 have single, you know, large events that are very
15 infrequent.

16 MEMBER HINZE: Is that also true of snow
17 on these higher elevations? That you get more
18 recharge from snow than you would from precipitation
19 -- from liquid precipitation?

20 DR. SANFORD: I'm not a snow -- I mean
21 I'm not an expert there on snow. I'm sure there is a
22 difference because the snow will stay there for a long
23 time. Depending on your conditions, a lot of it can
24 evaporate before it infiltrates. But I'd have to
25 refer to someone who is --

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1 MEMBER HINZE: But the chlorine stays in
2 that. And if it is recharged, it will go into the
3 subsurface, right?

4 DR. SANFORD: Yes.

5 Also, the fact that there is a lot of
6 variability in recharge here, so it is a function of
7 elevation, vegetation, and thickness of soil. A
8 couple of Alan Flint's diagrams looking at
9 statistically how the recharge might be distributed
10 based on that. The Yucca Mountain Repository here.

11 Then it is also a function of the geologic
12 framework under the system. In this case, it is quite
13 complicated because as Bill is pointing out, there are
14 a lot of fractures in the system. And we've got some
15 geology in there with different permeabilities,
16 different capillary conditions in the different
17 layers. And, for example, we've got perch layers in
18 there as well.

19 And as I was saying, the temporal
20 variability, most of the recharge will occur often in
21 the largest precipitation events -- things that should
22 be considered and are being considered, I believe.

23 And if you just look at -- this was an
24 interesting plot of some C-14 ages from groundwater in
25 the Amargosa Desert and Yucca Mountain. And

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1 unfortunately, you can't see the difference here
2 between the dark and the lighter ones as it comes out.

3 The dark areas are up here, here, here.
4 Those are Yucca Mountain. But the overall picture
5 here is if you just look at some raw C-14 data, you
6 can see that most, if not virtually all of the
7 recharge has occurred during the wetter period of the
8 last glacial maximum.

9 I'm sure you are all familiar with these
10 and more familiar with these sections than I am.
11 Sections here through Yucca Mountain, potential
12 repository watertable here. But what has come up now
13 using the chloride mass balance is both in the
14 watertable and in these perched horizons here.

15 There are values for chloride and some
16 other isotopes that could be used to make some
17 calculations using a balanced sort of approach,
18 chloride balance -- or maybe extended chloride
19 balance, if you will, calculations of how much of that
20 water is Holocene water versus Pleistocene water. And
21 what might the recharge rates have been to get those
22 values in these perched water table and also in the
23 saturated ground water.

24 I'll just show you quickly here and
25 example of one that was done. Chen Zhu is going to go

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1 into more detail about these kinds of calculations.

2 One of the numbers that was used was the
3)180 and the deuterium which shows similar things
4 here. But the)180 of Holocene precipitation here is
5 about minus 12. And from that in the Pleistocene,
6 they're assuming it is about minus 14, about two per
7 mil lighter.

8 They got these numbers looking at the
9 long-term record from Devils Hole that Ike Winograd
10 and others have collected. And during the shift,
11 there was about a two per mil shift in O18 in the
12 rainwater due largely to the fact of the cooler
13 temperatures.

14 So if you sample the waters under there at
15 Yucca Mountain in the perch zone, some of the
16 unsaturated zones, and in the groundwater, you can see
17 this variation between what looks like Holocene water
18 and what looks like Pleistocene water. So this water,
19 for example, in the perch zone is approximately right
20 here. So this means this water recharged some time
21 during the transition period between Pleistocene and
22 Holocene or perhaps it is a mix between Pleistocene
23 water and Holocene water.

24 And if you assume that, then you could
25 simply do a fraction calculation here to say okay,

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1 what fraction of the water was Holocene water and what
2 was Pleistocene water. So here are some tables of
3 their calculations. Here are some fractions they came
4 up with based on that -- based on these two different
5 bore holes that were in the perch zone.

6 There are the) 180 numbers. They've also
7 got chloride precipitation they're using. The measure
8 chloride in the perched water. And then from there,
9 you can calculate and fraction out what is the
10 Holocene and the Pleistocene water.

11 Then if you use another number, this
12 chlorine 36 number, which there are data what it is
13 today and what it might have been in the Pleistocene,
14 you can come down to estimating actual fluxes here for
15 Holocene and Pleistocene that must have occurred to
16 give you the concentrations in the water you see
17 today.

18 So you see the Holocene ones are lower
19 than the Pleistocene. They range from about seven
20 millimeters a year up to 40 millimeters per year in
21 that case.

22 MEMBER HINZE: While you have that up
23 there, can you speculate on the source of the
24 variation in the Pleistocene of a fourfold nature
25 between between UZ-14 and SD-7? Is that in the

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1 method? And is that in the geology? Is that in the
2 surface topography?

3 DR. SANFORD: I think there's a lot of,
4 you know, a lot of variability what can come into the
5 number, the chlorine numbers, there is available.

6 I'm sure chloride in that perched zone
7 there is probably variability. In chlorine 36, there
8 is some variability in)180. So given those
9 variabilities and you run it through, this may be the
10 variability you can see. Or the other possibility I
11 think one of these is farther south. Maybe one is
12 farther north. Maybe there was variability in the
13 space.

14 But just given those single numbers, it's
15 hard to, you know, tell which one of those is
16 responsible for those variations.

17 Perhaps one of the other issues we have to
18 think about is where did that perched water come from.
19 Are we talking about direct infiltration from above
20 into these pools of perched water? You know knowing
21 the geology, that's probably not likely. There is
22 some distorted path down through the system through
23 which that perched water has been accumulating.

24 So maybe one of the questions is when you
25 do this kind of calculation, are you assuming that

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1 recharge rate in an area directly above the perched
2 water only in that area? And is there variability?
3 Or does that represent an average for the whole
4 mountain? Or is that just fracture flow and so
5 somehow those numbers might be a bit distorted? I
6 think those are questions that you might want to
7 discuss.

8 PARTICIPANT: It's interesting that
9 Holocene gives pretty consistent value there. And yet
10 the Pleistocene does not would suggest that its --
11 maybe in the variability of the assumptions rather
12 than the geology. I don't know.

13 PARTICIPANT: I mean you are also assuming
14 and I know in isotope hydrology, this is kind of
15 assumed a lot. People find N members. And they like
16 to mix N members. So this is what has been done here.
17 Essentially you are assuming you got one water that's
18 Holocene water. And the other is Pleistocene water.
19 And somehow those exact N members mix. Where in
20 reality that's not exactly what happened, you know,
21 that potentially effect the number you get here.

22 Maybe I'll turn it over to Chen Zhu.

23 PARTICIPANT: Well, let's see if there are
24 any questions. Jim, questions?

25 MEMBER CLARKE: Well, I was just wondering

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1 where those bore holes are in relation to the charts
2 that you gave us.

3 DR. SANFORD: I'm not even sure I can
4 answer that question. I'm sure somebody else here
5 knows the answer to that. Let's see. I have a --

6 MR. HAMDAN: Okay, UZ-14 would be this
7 right here.

8 PARTICIPANT: It's in the northern part,
9 okay.

10 PARTICIPANT: Here is the repository.
11 It's up here?

12 PARTICIPANT: Right.

13 PARTICIPANT: Okay.

14 MR. HAMDAN: And in the south, way south.

15 DR. SANFORD: Farther in the south. So
16 one is up in the north. One is farther in the south.

17 PARTICIPANT: Yes. And that was your
18 guess as I recall.

19 MR. HAMDAN: But according to Mr. Lee,
20 both of these rings have perched water.

21 PARTICIPANT: Perched water.

22 MR. HAMDAN: So that's why the 14 versus
23 10 seems suspicious.

24 MEMBER HINZE: Any more questions? Ruth?

25 MEMBER WEINER: This may be an unfair

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1 question but could your comment on what we heard from
2 Tim McCartin estimating from the rainfall the five to
3 20 percent deep percolation? Could you comment on
4 that in the light of statements you made on some of
5 your earlier slides?

6 DR. SANFORD: Some of the general
7 statements --

8 MEMBER WEINER: Yes.

9 DR. SANFORD: -- about what should be
10 considered?

11 MEMBER WEINER: About what should be --

12 DR. SANFORD: Well, I mean as I was
13 listening to them, just the things that came to mind
14 were this temporal variability. And they were -- it
15 sounded to me like they were using the model and
16 running it through some modern conditions.

17 And so since they had an hourly response,
18 they must have been looking at some rainfall events
19 for modern conditions. So I was just curious as to
20 what extent of those they looked at, how big of
21 rainfall events did they actually consider?

22 And is it possible or has anybody done a
23 statistical look at the size of rainfall versus an
24 event versus what -- I mean they could simulate, you
25 know, a very large event with their model and say how

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1 much recharge does that get versus a lot of small
2 events. That is something, you know, that could be
3 looked at with the modeling and perhaps compared to,
4 you know, a long-term rainfall statistics.

5 Then one of the questions, I think then if
6 you go to a colder climate, not only does the
7 temperature and the total rainfall amount change but
8 does the frequency and the intensity of the storms
9 change?

10 So, for example, if the intensity has got
11 less, that could mean less recharge. But if for some
12 reason they got more, that could mean more recharge
13 than what simulations might suggest.

14 The other interesting thing I was thinking
15 about in terms of the vegetation, they were using
16 these numbers 266 and 321 which were to represent the
17 vegetation at the last glacial maximum because they
18 were taken from the similar vegetation areas of
19 whether those were these -- a pinon-juniper forests,
20 I'm not sure. I'd have to read the book.

21 But then the question might be raised,
22 okay, assume those are those forests. And the
23 estimated recharge in these areas today, they're
24 essentially measured -- going there today and
25 measuring what it is today.

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1 But if those same forests were in a
2 different climate in a different elevation, or
3 something, are those going to give the same recharge
4 events in the glacial maximum? And then you can
5 assume that because the forests are these, they like
6 a certain amount of rainfall.

7 And they probably allow a certain amount
8 of recharge through but just wondering you change the
9 climate dramatically and you put them in a different
10 place, is that going to change how much those forests
11 will allow it to pass through the recharge? So those
12 are just some thoughts I had.

13 MEMBER WEINER: So you really couldn't
14 make any guess. And again, I know this is asking you
15 to speculate.

16 DR. SANFORD: No, I mean you were going to
17 have Fred Phillips come talk. He would have given you
18 a good guess probably maybe.

19 MEMBER WEINER: Thank you.

20 CHAIRMAN RYAN: Okay. If there are no
21 more questions -- Neil?

22 MR. COLEMAN: Your slide on variable
23 recharge notes the importance of temporal variability
24 and that most recharge occurs in the largest praecipite
25 events. So this is actually a question for the NRC

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1 staff.

2 The spring of 2005 was one of the wettest
3 times on record for southern Nevada and Yucca
4 Mountain. In Death Valley, in fact, the desert
5 produced a veritable explosion of flowers that might
6 be seen only a few times in a lifetime.

7 At Yucca Mountain there was a reported
8 event. Water was found dripping into the tunnel, the
9 exploratory studies facility near the south portal.
10 Would the NRC model have predicted enhanced
11 infiltration in that area based on the rainfall that
12 had been occurring enough to cause dripping in the
13 tunnel? Has this been looked at as a model
14 calibration event? After all, that wet springtime was
15 rather like a mini monsoon event.

16 PARTICIPANT: Who are you asking the
17 question to?

18 MR. COLEMAN: NRC staff as I said.

19 MR. McCARTIN: Okay. I mean -- well
20 approximately -- it depends on which model you are
21 talking about. This is more of a process level
22 question. And I'll just say that oh probably on the
23 order of 15 to 20 years ago, we had work funded at
24 Sandia National Laboratories where we developed a dual
25 continual model, fracture matrix model. And it does

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1 predict certainly dripping in fractures with than
2 saturated conditions which is what I think you are
3 suggesting.

4 And so the models we have certainly
5 supported that which is why 15 to 20 years ago, we
6 certainly had estimates for infiltration at Yucca
7 Mountain that were dependent on fractures and not on
8 just matrix only flow.

9 And I don't know if that answers it. But
10 I'm not -- we have always -- I mean you can go back to
11 our iterative performance assessment Phase 1 approach.
12 And we have, you know, certainly fractures drip in the
13 unsaturated zone.

14 MEMBER HINZE: I would suggest that we
15 follow this up with some personal conversations. We
16 want to leave enough time for Chen Zhu to make his
17 presentation. Thank you very much, Ward, it was very
18 helpful.

19 The next presentation will be by Dr. Chen
20 Zhu from the University of Indiana. He is a chemical
21 modeler of wide repute. And is the lead author on a
22 paper dealing with -- they recharged in both Holocene
23 and Lake Pleistocene at the Yucca Mountain Region.

24 And Chen Zhu we welcome you. And we've
25 got about 20 minutes or so. If that will be

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1 sufficient, that will be great.

2 DR. ZHU: Thank you.

3 I don't know whether you are aware of the
4 Indiana --

5 PARTICIPANT: You'll have to stop and wait
6 for the microphone.

7 DR. ZHU: Thank you. The work I'm going
8 to talk about is what we published in 2003 in water
9 resources research. So we heard this morning that
10 when folks -- our discussion today is the amount of
11 volume water that has percolated down to the
12 repository level.

13 Okay. It turned out that to the accurate
14 estimate of infiltration rates or recharge rates for
15 an area and in some of our areas, it is extremely
16 difficult. That is because the water fluxes and
17 climate conditions are very low. And it is an
18 especially and temporally variable.

19 So people have tried many, many different
20 methods but not very successful.

21 So one method used and the water just
22 talked about is the core item as a balance equation,
23 what is a very low contender taught us about the
24 background today and is also very organized in his
25 papers, I'll just walk you through the equation more.

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1 So if the typical equation were used here
2 is this the recharge rates or infiltration rates in
3 terms of milliliter per year. This is the
4 precipitation, mean annual precipitation.

5 This term here is the effect of the
6 chloride concentration deposition rate. That's
7 including both in the wet and dry, wet in the rain and
8 dry it is mostly dust. And here is the core
9 concentration in the water.

10 So if we have an estimate of a
11 precipitation, estimate of the deposition rates and we
12 measure the chloride concentration which is very, very
13 straightforward, we can estimate as a first
14 approximation of the recharge concentration rates.

15 There are a number of assumptions and Ward
16 has already gone over most of that. The assumption is
17 chloride is the only source -- the only source of
18 chloride is from atmosphere and it is conservative.
19 And there are some hydrological assumptions like
20 there's no run-on or run off. And one dimensional
21 piston flow can represent the amount of the flow.

22 Very often ignored assumption in this
23 equation is that in the state if precipitation and
24 chloride flux.

25 And that lead to many misuses of this

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1 method by mixing parameters representing different
2 time. Typically you see in the literature, including
3 the literature on Yucca Mountain, that you see the
4 present day precipitation used in the equation. You
5 have the present day effective chloride concentration
6 in the equation and then use the groundwater chloride
7 concentration.

8 But groundwater, you know, mostly is from
9 the later processing. So we are actually mixing
10 parameters at different times.

11 And we know reasonably well that the
12 chloride fluxes to the groundwater system probably are
13 very different under different climate conditions.
14 And this is an ice core, this ice core from Greenland.
15 And you see the chloride concentration in the ice core
16 in terms of parts per billion. And this in the last
17 -- from 11,000 years ago to about 40,000 -- 35,000
18 years ago. You see about one order of magnitude in
19 the Holocene.

20 So we see very different chloride fluxes.
21 And also we can see in groundwater. This is in the
22 Carrizo Aquifer in Texas. You see chloride
23 concentrations change very differently. And in Aquia
24 Aquifer. And this is the result of different chloride
25 inputs and also from the distances from the coastline

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1 under different kinds of conditions.

2 So we cannot mix parameters. For
3 different time if we measure the water chloride
4 concentration, which is very easy to measure, and we
5 have used the precipitation of that time and the
6 effect of chloride concentration time.

7 One way we can deal with that is to use a
8 discreet state to state chloride model to separate
9 into the last glacial time 11,000 years ago in late
10 Pleistocene and Holocene. And we use the long-term
11 average values of the effective chloride concentration
12 precipitation. And the groundwater chloride condition
13 to estimate the long-term average values of
14 infiltration and recharge.

15 Now one question you may ask is whether we
16 can get higher resolution data rather than just
17 separate into two broad period. The question probably
18 is not because we don't have a detailed time series on
19 precipitation or chloride deposition over long time.

20 So this are the parameters we use for
21 Holocene and for late Pleistocene for Yucca Mountain.
22 This other chloride -- chlorine 36 chloride ratios
23 found and this is the precipitation rates from the
24 literature.

25 And then using the deposition rates of

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1 chlorine 36 and chloride to estimate the long-term
2 average effective chloride concentration in
3 precipitation. That included both wet precipitation
4 and dry precipitation.

5 So that's the long-term average. It is
6 well known that measured the dry deposition and
7 chloride concentration in land, various changes over
8 the period of time.

9 CHAIRMAN RYAN: Just a comment. I guess
10 it's my own bias. I have a hard time thinking about
11 16 atoms per square meter per second.

12 (Laughter.)

13 CHAIRMAN RYAN: Help me understand that a
14 little better.

15 DR. ZHU: Use accelerators, you can
16 measure this now. And I'm not an analytical sort of
17 expert. But I understand it can be measured.

18 CHAIRMAN RYAN: I challenge that because
19 I, you know, 10, 20, 16, you know I don't know how you
20 get to single atoms per square centimeter per second.
21 That's pretty amazing to think about. I'll leave it
22 until I ask you questions about your error analysis.

23 DR. ZHU: Okay. Very good.

24 DR. SANFORD: Maybe they measured that
25 over one year and just divided by 12.

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1 CHAIRMAN RYAN: Well, but by the same
2 token, if it averages to such a small number, then I
3 ask myself the question is that spatially accurate?
4 Because there are lots of huge uncertainty questions
5 when you are starting to predict single atom behavior
6 of that kind of integral type in terms of how it
7 correlates with other spatially discreet measurements
8 and so on. And temporally discreet measures.

9 DR. ZHU: Yes. Okay. Mainly from the
10 packrat midden data published by Plummer et al, 1996,
11 we know that there is a Chlorine 36 and chloride
12 initial change over time in late Pleistocene and
13 Holocene. It's about one and a half to two times
14 higher ration in the last glacial period.

15 All right. So use the estimated
16 precipitation data in the literature. And using our
17 estimate of the later processing effective chloride
18 concentration with the estimate of recharge rates,
19 using the groundwater that is underneath Yucca
20 Mountain.

21 So the letter falls here our estimates.
22 Now here we compare with some DOE estimates. You see
23 two different bars, a black and a blue because DO used
24 two different effective chloride concentrations. But
25 in the DOE estimates, they use the present day

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1 precipitation and present day effective chloride
2 concentrations and the mostly late-Pleistocene
3 groundwater to do the estimates.

4 We have another problem that is a spacial
5 problem. The water beneath Yucca Mountain in a
6 saturated zone may not be recharged from the Yucca
7 Mountain but probably from somewhere upstream of Yucca
8 Mountain. So it does not represent the local recharge
9 above the repository.

10 So that's why we look at it as perch
11 water. That's probably more representative of local
12 recharge in Yucca Mountain. And the perched water
13 most widely believe it's a mixture of late Pleistocene
14 and Holocene so we have the chloride measurement. The
15 question is how we can now -- what's percentage of the
16 water is Holocene, what percentage is later
17 Pleistocene?

18 In this case, we used chlorine 36 chloride
19 ratio. And the chloride concentration from all of the
20 wells from WT-27 and UZ-14. And they turn out to fall
21 along this mixing line. But now the chlorine 36 to
22 chloride ratio, we are able to estimate as a member of
23 the Holocene and Pleistocene chloride concentration.

24 And then we can plug this into the
25 equations to estimate the concentration rates.

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1 Of course each parameter has arrows. And
2 it is very difficult to assign uncertainty to this
3 parameters, So we did an error propagation analysis.
4 I assumed six percent uncertainty for chloride
5 analysis and uncertainties for the ratios and the
6 precipitations.

7 So to see how much come up in the total
8 estimated but the error propagation analysis cannot be
9 construed as a reassurance because we really don't
10 know much about the uncertainty assigned to it.

11 So the numbers come out from this
12 calculation is about five millimeter per year, plus
13 minus one for Holocene and this is a long-term average
14 and it's 15 plus minus five millimeters per year so
15 late Pleistocene.

16 And in terms of percentage, this is about
17 a three percent and this is about a five percent.

18 MEMBER HINZE: Is that -- linked
19 Pleistocene, is that comparable to the last glacial
20 maximum that we've heard about previously this
21 morning?

22 DR. ZHU: Yes.

23 MEMBER HINZE: Thank you.

24 DR. ZHU: In terms of comparison with
25 other methods, in general it agrees with the numerical

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1 models of the watershed. In a way, the two methods
2 are very different.

3 It's also comparable to -- we also apply
4 the same method to Black Mesa, Arizona where we have
5 very abundant hydrological data. And the agreement
6 seemed to be good.

7 One problem for -- one uncertainty is that
8 we only look at the perched water in the northern half
9 of the repository and how that is representative of
10 the whole Yucca Mountain area is unknown.

11 So in conclusion, we used the chloride
12 mass balance method to estimate the long-term average
13 value at Yucca Mountain and come up with two different
14 values for the two different periods of time. And in
15 the last glacial maximum, it was about three times
16 more than today.

17 And the estimates seem to be agreed with
18 the other methods. I think the methodology and the
19 climate estimate are reasonable under the -- what
20 circumstances are now but as we point out to you in
21 the paper, this estimate will also carry considerable
22 uncertainties because of the many assumptions and the
23 uncertainty with the parameters.

24 CHAIRMAN RYAN: Have you attempted to do
25 a propagation of error in a formal way to address

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1 this?

2 DR. ZHU: Yes. That's the formal error
3 for propagation assumed the errors are independent up
4 on each other.

5 CHAIRMAN RYAN: So what's the error on --
6 you know what you've shown is 15 plus or minus five.

7 DR. ZHU: Yes.

8 CHAIRMAN RYAN: Is that a considerable
9 error? I mean I'm trying to understand your comment
10 in the highlighted portion of your last slide says
11 that the myriad of assumptions and, you know, it
12 implies order of magnitude or greater-type
13 uncertainties. Yet you are showing that's a 30
14 percent error. I don't know if it is the standard
15 deviation or what.

16 DR. ZHU: It's about 30 percent, yes.
17 It's about -- it's from a formal error propagation
18 analysis.

19 CHAIRMAN RYAN: Yes, the error propagation
20 of what? You've got a whole list of assumptions that
21 all carry errors, one through seven --

22 DR. ZHU: The parameters. The parameters.

23 CHAIRMAN RYAN: So that's a numerical
24 propagation --

25 DR. ZHU: Yes.

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1 CHAIRMAN RYAN: -- of just some small
2 portions of what could be the smaller parts errors.

3 DR. ZHU: Right. We can get our hands on
4 them. We have some local hydrological conditions.
5 There is the fraction --

6 CHAIRMAN RYAN: Have you attempted to do
7 any kind of a probabilistic analysis to estimate
8 things where you don't know the estimate of error?

9 DR. ZHU: We did not do that.

10 CHAIRMAN RYAN: And I guess my view is
11 that those kinds of more formal propagation of error,
12 you know, this is like looking for your car keys under
13 the streetlight. That's where the light is so that's
14 where I look for my keys.

15 DR. ZHU: Yes.

16 CHAIRMAN RYAN: You know I think the
17 bigger error picture is that you have a whole bunch of
18 uncertainties and you can address those uncertainties
19 by propagating, you know, some kind of an error in a
20 probabilistic risk kind of way or probabilistic
21 analysis kind of way.

22 And that's where you get a better
23 understanding of the total system error. What we
24 don't know is from this uncertainty analysis in this
25 15 plus or minus five is that plus or minus five a

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1 small portion of the total system error? Or is it a
2 large portion of the total system error? That's what
3 I took away from your last comment on the last slide.

4 DR. ZHU: I agree with you. The biggest
5 error may lie in assumptions, conceptual assumptions
6 rather than numerical errors attached to each
7 measurement.

8 CHAIRMAN RYAN: So I'm on pretty solid
9 ground by saying you really don't have a grip on the
10 whole total system error potential but you have a grip
11 on these portions of it.

12 DR. ZHU: You are correct.

13 CHAIRMAN RYAN: Okay. Thanks.

14 MEMBER HINZE: Further questions?

15 MEMBER WEINER: On I think it is Slide 9,
16 the table where you give the -- go back -- keep going
17 -- keep going -- that one.

18 DR. ZHU: Okay.

19 PARTICIPANT: Please use your mike.

20 MEMBER WEINER: I'm sorry. On your Slide
21 9, on that last number, is there really any difference
22 between those two numbers -- .35 and .18 given the
23 errors that you have. And are those two numbers
24 different?

25 DR. ZHU: I think so. It is a factor of

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1 two.

2 MEMBER WEINER: It's a factor of two and
3 your error is not great enough to overcome that factor
4 of two? Okay.

5 The next question I have is if you go two
6 more slides to the one where you have the Department
7 of Energy, DOE slide -- keep going -- next one -- this
8 one. What's the difference between DOE 1 and DOE 2?

9 DR. ZHU: The use of two different type
10 effective chloride concentrations as a bracket.

11 MEMBER WEINER: As a bracket? Well, can
12 you comment on the fact that your study was really not
13 very different from DOE 1 and DOE 2 is very different.
14 What conclusions can you draw from that?

15 DR. ZHU: The numerical values may not be
16 that different but one is conceptually correct, one is
17 conceptually wrong.

18 MEMBER WEINER: Ah ha. So you are saying
19 that DOE 1 -- am I correct in inferring that DOE 1 is
20 conceptually more correct than DOE 2?

21 DR. ZHU: No. This is the same approach
22 but a use of two different effective chloride
23 concentration to bracket the real calculation.

24 MEMBER WEINER: Oh, I see. Okay.

25 Finally, if we go to the slide where you

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1 have the linear extrapolation --

2 DR. ZHU: Okay.

3 MEMBER WEINER: -- from Holocene to

4 Pleistocene --

5 DR. ZHU: Yes.

6 MEMBER WEINER: -- yes. Why did you draw
7 the straight line where you did?

8 DR. ZHU: Okay.

9 MEMBER WEINER: When you have all those
10 other points?

11 DR. ZHU: Yes. So first we have bailed
12 samples and pumped samples. And the bailed samples
13 now it turned out they may not be representative of
14 the chemistry.

15 But we really had trouble to fit this SD-7
16 on this line. But SD-7 has very different points --
17 has different uranium isotope as well. Somehow it
18 looks different. Whether this approach the body in
19 the north, I don't know. I don't have the answer why
20 it looks different.

21 MEMBER WEINER: But you just -- you've
22 made the decision that it was different enough that
23 you left it off your -- you didn't try to draw a
24 straight line between all the pumped points? Just the
25 --

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1 DR. ZHU: No, I did not try to draw a line
2 here like this.

3 MEMBER WEINER: Yes.

4 DR. ZHU: I have two wells and a series of
5 samples if you --

6 MEMBER WEINER: Thank you.

7 MEMBER HINZE: James?

8 MEMBER CLARKE: While we're on that slide,
9 what are the other symbols? The squares and --

10 DR. ZHU: All the open symbols are -- they
11 are the samples.

12 MEMBER CLARKE: Okay.

13 DR. ZHU: And this is WT-24 and this is
14 from UZ-14. And the other -- from the pumped samples
15 of the SD-7.

16 MEMBER CLARKE: Okay.

17 MEMBER HINZE: Any other questions?

18 DR. SANFORD: One comment I'm just going
19 to make here. The case I was showing, they did not,
20 you know, apparently account for a different chlorine
21 concentration in the Pleistocene versus the Holocene.

22 So if you actually use the chloride
23 concentration, in the Pleistocene it was half as much
24 as it is today. Their recharged numbers would have
25 been half as much.

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1 MEMBER HINZE: I'll try to ask a broad
2 question if I can Chen. And that is that from the
3 presentation of Dr. Sanford, we have the impression
4 that the chloride mass balance has worked rather well
5 on large basins, large regional aquifers.

6 We also understand the hydrologic, the
7 geological sources of uncertainty as well as
8 analytical, if you will, in the method. Are we
9 pushing this method too far to go to a very localized
10 region underneath a single mountain where there seemed
11 to be so many violations of the assumptions?

12 DR. ZHU: I think I possibly can answer
13 your question in combination with the earlier question
14 by the Chairman. I always think that when you apply
15 a method like this with big assumption is the
16 assumption with geology and the local hydro geology.

17 MEMBER HINZE: And so the complexities of
18 Yucca Mountain make it very difficult to apply this
19 method? Is that what we're saying?

20 DR. ZHU: I would think so.

21 MEMBER HINZE: Yes. One last question.
22 You used perched watertable. Did you use a perched
23 table above or below the repository level? Do you
24 recall?

25 DR. ZHU: Let's see, I have a cartoon

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1 where -- it's below. This is the cartoon. It's
2 below.

3 MEMBER HINZE: It's the one below on the
4 Calico Hills?

5 DR. ZHU: Yes. And that center showed a
6 real geological cross section actually.

7 MEMBER HINZE: If there are further
8 questions? Latif?

9 MR. HAMDAN: Yes. Dr. Zhu, just one
10 question. The errors, how much of the error are
11 generic and how much is it site specific?

12 DR. ZHU: How much? Okay.

13 MR. HAMDAN: Yes just something in the
14 ballpark from your experience, from your application
15 of this method --

16 DR. ZHU: Yes.

17 MR. HAMDAN: -- how much of the errors do
18 you attribute to the site-specific conditions as
19 opposed to the approach if you like.

20 DR. ZHU: The errors associated with
21 chloride analysis is very small. Whether they are
22 .36, I think an isotope specialist has to answer this
23 question. When you have the big assumption about
24 what's the precipitation in the later processing in a
25 certain area, I think that's sort of major

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1 assumptions. And that can be error specific as an
2 estimate of precipitation at Yucca Mountain is
3 different for the estimate of precipitation in
4 Arizona. Does that answer your question?

5 MR. HAMDAN: So you want to do it with
6 number?

7 DR. ZHU: No, I cannot do the numbers.

8 MR. HAMDAN: Thank you.

9 MEMBER HINZE: If there are no further
10 questions, I want to thank both of you for excellent
11 presentations, well illustrated and giving us some
12 insight into the pros and cons of the CMV. Thanks so
13 much.

14 CHAIRMAN RYAN: And let's add our thanks
15 to Tim McCartin for his excellent presentation as well
16 this morning and our two speakers here in this second
17 session. It's been a useful discussion of the topic
18 of the Part 63 standard revision. So we appreciate
19 everybody's input and good conversation and
20 discussion.

21 And also, yes, our colleagues at the
22 Center and your contributions from San Antonio.
23 Thanks very much. We appreciate having you with us
24 today.

25 With that, if there are no further

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1 question or comment, we will adjourn. And we're
2 scheduled to reconvene promptly at one o'clock. Thank
3 you very much.

4 (Whereupon, the foregoing matter went off
5 the record at 11:39 a.m. to be reconvened in the
6 afternoon.)

7 4) WHITE PAPER ON LOW-LEVEL RADIOACTIVE WASTE

8 CHAIRMAN RYAN: I am here this afternoon
9 to welcome you to what I hope is a session where we
10 have a good dialogue among participants and interested
11 parties. We're talking this afternoon about the
12 ACNW's low-level radioactive waste white paper that we
13 have developed with a couple of goals in mind.

14 In my presentation, I will go through the
15 development of this white paper and some points on
16 what kinds of issues we reviewed, what kind of
17 documentation we pulled together, and what sort of
18 interesting opportunities that this analysis might
19 provide for the theme of better risk-informing
20 regulations regulated to radioactive waste management
21 questions.

22 In our Commission briefing last year,
23 2005, -- next slide, please -- low-level radioactive
24 waste was raised as an issue. I am sure that all of
25 you in the room have heard that Barnwell's current

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1 schedule is that they won't be receiving waste from
2 out of the compact after 2008. And Envirocare WCS
3 recently announced they are not going to seek to
4 expand their operation to higher classes of low-level
5 radioactive waste and there is a development activity
6 in Texas for a site there. But that's underway, and
7 it's yet to be determined.

8 NMSS identified this as an emerging issue
9 from their standpoint. And ACNW offered to identify
10 opportunities of areas in part 61 that might be better
11 risk-informed.

12 I want to quickly emphasize that the
13 Committee and its staff have been in communication
14 with NMSS management and their staff to understand
15 their views. And we will continue to have a real
16 productive open dialogue.

17 The goal of our identifying opportunities
18 is not necessarily to tell NMSS what to do but to
19 identify from our point of view from the science of
20 risk-informing waste analysis that we might find some
21 opportunities to provide guidance that may even be at
22 a licensee level or it may be at the guidance level
23 within the agency or other opportunities as well. So
24 we look forward to our continued cooperation with the
25 NMSS staff on these opportunities.

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1 NRC's low-level waste regulation in part
2 61 is really deterministically based. If you study
3 the preliminary environmental impact statement, the
4 final environmental impact statement, and other
5 documents used to prepare 61, the crux of 61 is in the
6 intruder scenario, which is a deterministic and
7 somewhat in my view extreme bounding case here.

8 Lots of things have to happen to the
9 intruder. It's designed to estimate the highest doses
10 that are envisionable for that kind of situation. The
11 concentrations in the classification system fall from
12 that.

13 By the way, I did not ask. Do we have
14 anybody on the telephone we need to introduce at this
15 point? Rick Jacobi from the State of Texas. Welcome,
16 Rick. I apologize for not gathering you into the
17 meeting earlier than this.

18 MS. HAYNES: Kathryn Haynes from the
19 Southeast Compact Commission.

20 CHAIRMAN RYAN: Good afternoon, Kathryn.
21 Anybody else?

22 (No response.)

23 CHAIRMAN RYAN: All right. Well, welcome,
24 both of you. And we'll look forward to your
25 participation as well.

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1 MS. HAYNES: Thank you.

2 CHAIRMAN RYAN: As a follow-on to the part
3 61, agreement states developed regulations to comport
4 with part 61, in spite of the fact that decided states
5 all had low-level waste disposal regulations in place
6 at the time 61 was promulgated.

7 Slide 3, please. The Committee agreed to
8 develop the background paper to try to explain how the
9 U.S. commercial low-level waste program evolved, the
10 review processes by which 61 was developed evolved,
11 past ACNW advice on low-level waste, and agreed to
12 identify opportunities to improve part 61 to make it
13 better risk-informed.

14 Very clearly, this paper is not intended
15 to recommend how to implement any of these
16 recommendations or opportunities identified. That's
17 certainly not our role. As the Committee, we
18 certainly stand ready to help NMSS as they first
19 consider any or all of the opportunities we put forth
20 to them and how they then work their regulatory
21 development agenda as part of their overall program.
22 So it's that kind of a relationship that we look
23 forward to.

24 The paper was developed by ACNW members
25 and staff. I would like to recognize two members of

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1 staff: Sharon Steele, who participated in some of the
2 early drafting; and Mike Lee, who has really done
3 quite a thorough job of pulling together lots of
4 information and resources.

5 Let me go to slide 4 and comment that I
6 think the ACNW has certainly exhausted, but it's not
7 all-inclusive. We have not tried to be encyclopedic
8 in nature. I think in one comment I heard, that we
9 have condensed into a concise, small volume that could
10 easily expand to five or six volumes if we wanted to
11 cover every nuance and detail. So we tried to be
12 exhaustive but not necessarily globally exclusive or
13 encyclopedic in what we have covered.

14 Our literature is limited to perhaps 100
15 or so, Mike, key references, rather than the several
16 hundred that you could easily amass if you chose to do
17 so.

18 And we have had limited external review
19 thus far. Our plan forward is to complete the paper
20 and from today's meeting develop a letter to the
21 Commission. And as it goes to the Commission, of
22 course, that paper and letter will be made public.

23 The paper does not address some issues
24 that are tangential or related to low-level waste. We
25 did not try to cover mixed waste. Mixed waste is

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1 often considered to be in the same category because
2 mixed waste can include low-level waste. Of course,
3 it can include TRU or high-level waste, but we did not
4 try and address any questions that pulled mixed waste
5 in.

6 We did not address that study that is
7 underway that the National Academy of Science of
8 low-activity waste that's being prepared. We did not
9 try and review extensively foreign low-level waste
10 management experience. And, as yet, we have not
11 included but will include stakeholder views as part of
12 our writing that we provide in the document.

13 Next slide. Again, our goal for today's
14 path forward is to introduce the white paper, which I
15 will do in just a minute, to receive some preliminary
16 feedback and input from NMSS on their views and what
17 their activities are in these areas and where there's
18 common thinking, which I think we will see a little
19 bit of, and where there are other independent
20 opportunities they have identified.

21 We want to identify areas for which part
22 61 could be better risk-informed. And that is the
23 basis for our Committee letter for the opportunities
24 we see. And we will approve within the Committee and
25 transmit the Committee letter to any attached white

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1 paper to the Commission.

2 Our goal is, of course, to provide that by
3 the end of the month, in December, and in our
4 Commission briefing in January, which is scheduled, I
5 believe, for January 11th, that we'll report on the
6 activity at that time.

7 And we hope next year to pick up and
8 conduct a working group meeting that takes up some of
9 the higher-priority opportunities that NMSS may
10 identify so we can pull together a technical working
11 group meeting to address those two issues.

12 The white paper contents -- I'm on slide
13 6. It really has three main parts in it at the
14 moment: the low-level waste program history. We
15 start with ocean disposal under the AEC days and move
16 all the way through the current state of affairs in
17 low-level waste disposal in the United States. We
18 track through that history the low-level waste
19 regulatory framework. And we summarize past ACNW
20 observations and recommendations.

21 Plus, there's an extensive list of
22 references and four main appendices, which we have the
23 structure and content of 10 CFR Part 61; the final
24 Commission policy statement on the use of PRA methods;
25 the regulatory evolution of the low-level waste

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1 definition, which is an interesting and somewhat
2 convoluted definition. It's, as all of you probably
3 know, a definition of exclusion, which makes it a
4 challenge to explain to somebody new to that arena.
5 And then NUREG 1753 is summarized.

6 Part 1 on slide 7, please. In the earlier
7 approaches to management of low-level waste, there are
8 really a couple of approaches. First, there's ocean
9 disposal. I can't recall the exact year, but in 1969
10 -- is that right? Somebody will help me with the year
11 ocean disposal was banned by international treaty.

12 And then in the mid '60s, things shifted
13 to shell land burial and land disposal, in particular,
14 for what was then the first six commercial low-level
15 waste sites in the United States.

16 Congressional actions include the U.S.
17 Nuclear Regulatory Commission and 10 CFR part 61 being
18 promulgated. Later on we had the Low-Level Waste
19 Policy Act of 1980 and the Low-Level Waste Policy
20 Amendments Act of 1985 that took this from being a
21 national activity to a regional contact activity.

22 Again, we go through quite a lot of the
23 detail of these evolutions. I'm just trying to give
24 you the higher bullets and subject areas that you'll
25 see in the final report as it comes out.

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1 We have summarized the efforts over the
2 period from the time of three sites, South Carolina,
3 Washington state, and Nevada, moving into the compact
4 system, where we had 10 or 11 activities. And let's
5 see. California I think formally issued a license,
6 but it was never activated because the land transfer
7 did not occur. Otherwise, the other sites were not
8 successfully issuing new licenses.

9 And, of course, that's what's underway in
10 developing and considering a license. And that's yet
11 to be decided. I think the schedule there is 2007 or
12 '8 time frame for the decision to come forth in that
13 arena. And, of course, we talk a little bit about
14 current program status with recent developments in
15 stakeholder views.

16 In part two, we really go into quite a lot
17 of detail on the regulatory framework, including all
18 of the technical basis documents that we use to decide
19 who should be protected, what should the level of
20 protection be, what the 61 scoping activities were.

21 It was personally surprising to me to
22 remember some of those activities and recognize that
23 there were not many of my colleagues around who were
24 participants. I think it's timely that we do get all
25 of this documented in the place where we don't lose

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1 track of some of this institutional memory that we
2 have created over those decades.

3 That includes NUREG 0456, the proposed
4 low-level waste dose assessment model, NUREG/CR-1005,
5 a proposed radioactive waste classification system;
6 NUREG 0782, the low-level draft environmental impact
7 statement describing the waste streams considered, the
8 exposure pathways considered, approaches to developing
9 a 61 continuing on slide 9. We looked at the assumed
10 definition of safety, EPA's efforts to promulgate
11 low-level waste standards, NRC's selection of a
12 low-level waste default standard, and the proposed
13 classification system that NRC put forth, including
14 issues of the greater than classy low-level waste
15 management in both the NRC and DOE activities that
16 follow that arena.

17 We also included other NRC low-level waste
18 program developments, including low-level waste
19 regulatory guidance and policy, NRC's strategic
20 planning in the area of low-level waste.

21 It's interesting that the Committee, the
22 ACNW, was not in existence when part 61 was
23 promulgated. Nonetheless, we have gone back and
24 reviewed all the ACNWs that have touched on either
25 low-level waste regulation or low-level waste

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1 generator regulation and guidance related to those
2 issues. And that's an activity worth continuing, even
3 as we speak.

4 We looked at in the letters the Committee
5 has developed since 1988 some general low-level waste
6 issues but specifically issues on groundwater
7 monitoring; mixed low-level waste, which we included
8 for completeness but we have not addressed in detail
9 in the document; on-site storage issues; performance
10 assessment issues; waste package and waste form
11 issues; and so on.

12 In addition, the summary of our
13 observations and conclusions really, again, covered
14 some of these basic issues. For example, on waste
15 packaging and waste form, we now have the branch
16 technical position on waste form and waste plus
17 spatial.

18 I see Mike Tokar in the room, who worked
19 on the cement solidification process control programs
20 and other activities in that area, where waste form is
21 a critical issue to assessing performance. So there's
22 lots of, again, intimation.

23 One thing we tried to do very rigorously
24 is not interpret the history but report it so that
25 folks that use this document will have a concise

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1 volume that the regulatory history without any
2 embellishment or interpretation of what went where or
3 why.

4 We need to very carefully lay it out on a
5 timeline so that everybody can read it and see that
6 it's as hopefully accurate and complete as we can make
7 it and useful to folks as they think about what
8 opportunities might lie ahead. So that's part three.

9 In the appendices, we again cover the
10 structure of 10 CFR part 61, the final Commission
11 policy statement, and use of PRA methods, the
12 regulatory evolution of the definition.

13 Just a word there. A lot of folks -- I
14 always ask my students, "Where do you find the
15 definition of low-level waste?" And they tell me the
16 Atomic Energy Act of 1946. I challenge you to go back
17 and read it. It's called the McMann Act.

18 The word "safety" appears in the act four
19 times: three with regard to dynamite and once with
20 regard to sewer treatment systems for AEC facilities.
21 It was very clearly focused on safeguards and security
22 and our original definitions of source special nuclear
23 and byproduct material are really centered on
24 safeguards and security from that very first Atomic
25 Energy Act. They exist almost with just a minor word

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1 change here or there as they existed in '46.

2 So our translation into safety, you know,
3 safety considerations, has really come after those
4 original definitions. So that's, in part, where
5 low-level waste came from.

6 We all know it's a definition of
7 exclusion. It doesn't include what, fuel, spent fuel.
8 It doesn't include TRU. It doesn't include high-level
9 waste. It's everything else. Well, it was the
10 unimportant things from a security or a safeguards
11 perspective that got it into the everything else
12 category. So it's an interesting history to read,
13 hopefully informative to all of you as you read it.
14 Again, the performance assessment methodology for
15 low-level waste disposal facilities is the more recent
16 NUREG 1573 also covered.

17 Let me turn to page 13 and shift gears a
18 bit. I think as the Committee has considered this
19 mountain of information and thought about it, we
20 thought about sort of one central idea. And that is
21 that part 61 is really deterministically based.

22 I mentioned the intruder. The intruder
23 has to spend 18 hours a day getting external exposure.
24 It has to grow all of its food in class C waste. He
25 has to drink all of his own water that he produces in

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1 a well that comes up through class C waste and so on
2 to the primary and secondary pathways of exposure.

3 And if I read the draft environmental
4 impact statement right, concentrations are based
5 primarily on consideration in the dose at what was
6 then the limit for members of the public, 500 millirem
7 per year, with an additional caveat.

8 So you could take the view that it was a
9 bounding case or even an extreme bounding case because
10 the number of pathways and the opportunities for
11 exposure were certainly maximized and not uncommon for
12 the kinds of thinking of bounding analyses for the
13 purpose of radiation protection at the time or even in
14 use today for some ALARA situations or other workplace
15 activities, it's still relatively common practice and
16 useful.

17 Nonetheless, in the view today of
18 risk-informing an exposure, you might think about a
19 couple of additional points. For example, the
20 probability of intrusion in 61 at year 100 was one,
21 one. Now, I'm not sure if that is the best way to
22 think about it in a risk-informed setting, but it
23 certainly is what is in there. The probability of
24 getting a class C waste is one.

25 Now, just taking any given low-level

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1 radioactive waste site that has probably a couple of
2 hundred acres of which less than a fraction of an acre
3 is actually class C waste if you just drill randomly
4 from the top, that probability is probably 10^{-6} or 7 ,
5 not one.

6 Again, I'm not saying those are right
7 things to think about or not, but I think as we think
8 about risk-informing kinds of opportunities, those are
9 the kinds of questions that I think we should
10 challenge ourselves to think a bit about. So just in
11 that basic analysis, I think there are some
12 opportunities.

13 All right. 10 CFR 20 has been updated,
14 incorporating more recent ICRP recommendations from
15 ICRP 26 and 30. What that means is the organ
16 dose-specific limits in 61 somehow could be translated
17 to a more modern view.

18 Sixty-one is the only place where organ
19 doses still reside. And the basis for the 61 organ
20 doses are ICRP 2, which is a 1959 method of
21 calculating internal dose. It's interesting to think
22 about what would change if we applied a more modern
23 view of how to calculate or estimate doses, whether
24 it's in a performance assessment circumstance or some
25 other prospective analysis.

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1 Interestingly enough, the reference in
2 6154, 5, or 6 -- I forget which one -- says use part
3 20 to protect workers. So workers at low-level waste
4 sites are handled under the current part 40, as
5 opposed to the prospective calculation for
6 200-year-old ICRP 2. There might be an opportunity
7 there.

8 ICRP 2 calculations are dependent on the
9 mix of radionuclides that you're assessing; whereas,
10 the ICRP 20 methods are independent of that mix of
11 radionuclides.

12 The subpart D siting criteria we observed
13 are mostly qualitative. With the exception of the
14 requirement for the flood plain mapping that must be
15 done for a site, most of the other criteria are
16 qualitative. For example, a site must be capable of
17 being risk-analyzed and modeled. That's it.

18 And on down through the list, I think
19 there are a number of them. A site must not be
20 located so that it would impede the use of natural
21 resources. Is that a mile, 10 miles, 100 miles? You
22 know, what is the structure of that? I think there
23 are opportunities in the siting criteria to think
24 about how we would better risk-inform that with
25 today's thinking.

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1 So just, again, I don't pick these because
2 they are my favorites or I think they're at the top of
3 the list or they should be on NMSS' top list. I just
4 point them out as examples of the kind of thinking
5 that if we systematically go through, we might find
6 some opportunities to provide better guidance or more
7 detailed technical guidance that will make the process
8 clearer and more capable.

9 Part 61 institutional controls and
10 financial assurance measures do explicitly account
11 incorporating environmental monitoring data for the
12 institutional control period in the future
13 requirements. I think we've got a typo here.

14 Let me break that into two: institutional
15 controls and financial assurance. I thought about and
16 the Committee also considered that we have heard a lot
17 about those two issues in the decommissioning arena
18 and how financial assurance and institutional control
19 thinking is evolving in a risk-informed setting.

20 It's interesting to think about a
21 low-level waste site in perpetuity. And maybe that
22 thinking could be revised; again, just an opportunity
23 to think about. It may not be something that bears
24 fruit but one where there has been work done. In a
25 different arena, it would be I think instructive and

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1 helpful to think about how it might fly in another.

2 Another interesting aspect of
3 institutional control is environmental monitoring.
4 You know, we have heard in the decommissioning arena
5 that environmental monitoring is being thought of as
6 something integral to the decommissioning process over
7 time and continued evaluation of data or information
8 is helpful to decision-making and thinking about a
9 decommissioning facility or site. So is that
10 something that could happen to the low-level waste
11 arena?

12 There are clearly requirements for
13 long-term monitoring strategies, but what is the
14 requirement to go beyond simply demonstrating
15 compliance and perhaps gaining some insight into
16 system behavior all the time? There may be some
17 possibilities there.

18 One thing I think that is certainly
19 becoming the rule, rather than the exception, is
20 engineered barriers of all kinds are being
21 incorporated into low-level waste management. At
22 first, it's the waste form. You know, in the earlier
23 days of low-level waste, there were cardboard boxes
24 and adsorbed liquids and dry solids of all kinds and
25 maybe even some not so dry solids and D1 and exchange

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1 resins and the like.

2 And now we're at a place where there's a
3 lot more control of the waste form, certainly a lot
4 more rigor in the waste packaging in a number of
5 different arenas. And now even the incorporation of
6 engineered vaults and other structures in the earthen
7 part of disposal operations as well as multilayered
8 caps and other let me call them geotechnical systems
9 to help manage both surface water and infiltrate or
10 preventing infiltration and so on.

11 So there's a lot of interesting
12 developments that have occurred. And should a
13 risk-informed view of these kinds of engineered
14 barriers be taken into account? Some of them
15 certainly offer confinement and containment in waste
16 and others.

17 And we have frozen ponds on surface
18 systems. For example, do caps last a long time? If
19 they do, how long? What's the monitoring strategy to
20 understand their either success or failure over time
21 and so forth in the decommissioning arena? And,
22 again, I think there's opportunity to take up those
23 issues and see if there are some opportunities to
24 better risk-inform low-level waste.

25 That is kind of my introduction to begin

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1 the discussion. I guess next I would like to call on
2 Scott Flanders of the NMSS staff, who is going to
3 offer some NMSS views. And then I hope to have
4 members and others offer their comments and views and
5 our participants on the telephone and others here in
6 the auditorium.

7 Our goal is to capture as rich of a range
8 of views as we can. And this will help us develop our
9 letter and guidance to the Commission on what the
10 opportunities might be.

11 With that, Scott, let me turn it over to
12 you.

13 MR. FLANDERS: Thanks, Dr. Ryan. Can
14 everyone hear me okay?

15 CHAIRMAN RYAN: Let me introduce the
16 co-presenter that's with Scott: Jim Kennedy. Jim,
17 welcome, of course.

18 MR. KENNEDY: Thank you.

19 MR. FLANDERS: Thanks, Dr. Ryan.

20 Good afternoon. We're pleased to be here
21 today to provide our views on ACNW paper on low-level
22 waste.

23 Before I get started, I do want to
24 introduce a few members of my staff that I have with
25 me. First, I would like to introduce Ryan Whited, who

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1 is our section chief for our low-level waste section.

2 We recently reorganized and were able to
3 form a low-level waste section, primarily as a result
4 of the new responsibility that we have associated with
5 the Department of Energy's or at least consulting with
6 the Department of Energy on their non-high-level waste
7 determinations. And, as such, we folded our low-level
8 waste resources into that section. And Ryan is the
9 section chief for that.

10 I also wanted to introduce Jim Kennedy,
11 which I think most of you know. These are senior
12 scientists and resident experts on low-level waste.
13 So every time we come to talk about low-level waste,
14 I make sure Jim is close by.

15 May I have the next slide, please? We
16 appreciate the opportunity and the initiative that
17 ACNW has taken to prepare the white paper. And we
18 appreciate the opportunity, as I said earlier, to
19 provide comments.

20 In the past, NRC has stated while the
21 current low-level waste disposal system is safe, it is
22 not reliable or cost-effective. We, therefore,
23 welcome any insights that would help or ideas that
24 would help to try to improve the system, especially
25 from a group such as ACNW that has so much experience

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1 in the low-level waste area. So we look forward to
2 interacting with you on this.

3 The topics that I want to cover today,
4 briefly I want to provide a little bit of context,
5 first looking at what is going on nationally and also
6 what is going on internally to NRC that also shapes
7 and provides some perspective for the work that we
8 have on our plate.

9 I also then want to talk a little bit
10 about some of the efforts that we currently have
11 underway. And with that backdrop of discussing our
12 activities in a current environment, we provide our
13 views on the white paper. I think that background
14 information will help provide some perspective on the
15 views that we share on the white paper.

16 We also have a few recommendations for the
17 Committee's consideration in their preparation of the
18 white paper and then conclude with a few discussions
19 of next steps.

20 To provide some context on the national
21 low-level waste program where activities are going on
22 external to NRC, I think it's important to give some
23 context because it influences the work. And it has
24 typically in the past influenced our work.

25 Some examples, NRC as a result of

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1 activities that are going on had to participate and
2 provide input on issues associated with Ward Valley.
3 We have been recently involved in some of DOE's
4 greater than class E disposal actions or activities in
5 that area, certainly the role that we played in the
6 Low-Level Waste Radioactive Policy Amendments Act and
7 the activities that were assigned to us coming out of
8 that act.

9 Another example is Utah's decision to
10 provide an exemption for the Envirocare on private and
11 ownership, is another example of external events that
12 influence our work activities.

13 If you look at the current environment
14 around low-level waste, the disposal of low-level
15 waste continues to remain uncertain. I think, Dr.
16 Ryan, you touched on a few of these points in terms of
17 the potential closure with Barnwell as a key issue
18 around the uncertainty around low-level waste
19 disposal.

20 Certainly we don't see any change in the
21 opportunity to dispose of waste at the Hanford
22 facility beyond compact members of the Rocky Mountain
23 and the Northwest, West compact.

24 We do see, as you mentioned earlier, some
25 activity in the WCS application in the State of Texas

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1 as a possibility for a new disposal facility. And we
2 do see DOE moving forward as it relates to greater
3 than class C with the issuance of an advance notice of
4 intent to prepare an environmental impact statement.
5 And we expect soon that they would be issuing the
6 notice of intent to prepare that impact statement. So
7 there appears to be some activity by the department in
8 the area for greater than class C disposal.

9 In addition to those activities that are
10 going on, there are other external activities that are
11 going on that also could influence our work.
12 Currently GAO is working on a third report in recent
13 years, I think the first being in 2004. And this
14 third report focuses on best practices that are going
15 on in the international community with the intent of
16 identifying best practices that maybe could help
17 facilitate or improve the U.S. national system. And
18 there's likely to be information that comes out of
19 that report that we may need to consider as well or
20 potential actions for us as well that may come out of
21 that effort.

22 The earlier report they issued in 2004
23 resulted in a congressional hearing in September of
24 2004. Certainly with the possibility of GAO working
25 on this report, there is also another possibility for

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1 a hearing as well. So that's also another thing that
2 we need to keep an eye on to stay abreast to be
3 prepared to participate, if necessary and then
4 certainly the National Academy of Science's study,
5 which is expected to be completed soon, NRC was a
6 sponsor to that study. And we would expect that there
7 are recommendations that we would need to consider as
8 well that come out of that.

9 A few other areas that I want to touch on
10 briefly that influence the external environment are
11 the low-activity waste. There's been a great deal of
12 attention being received around disposal of
13 low-activity waste. What I mean by low-activity
14 waste, in this context, I'm talking about the lower
15 end of class A-type waste. So it's a little bit
16 different definition than what others have used, but
17 in this context, I'm focusing on that lower end of
18 class A waste. And there's been quite a bit of
19 attention in terms of disposal activities on that. As
20 a result, there have been some actions that I'll talk
21 about a little bit later that NRC has undertaken.

22 You know, an example of the attention is
23 an IAEA meeting that was held last December, an
24 international symposium, where there were about 250
25 attendees and representing about 60 countries.

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1 Certainly the topic of low-activity waste was
2 discussed in detail. Margaret Federline actually
3 provided one of the principal papers describing the
4 various U.S. programs for disposal of low-activity
5 waste.

6 Another example of the interest around
7 low-activity. It involves the NCRP's annual meeting,
8 which focused heavily on this topic of low-activity
9 waste, as well as work that EPA started a few years
10 ago in terms of looking at or actually issuing an
11 advance notice of proposed rulemaking on disposal of
12 low-activity waste in RCRA facilities.

13 Whether they continue with that
14 rulemaking, I think it's still uncertain. I think EPA
15 is still making decisions around that, but certainly
16 one of the things they are continuing to look at is
17 the technical bases for disposal of low-activity
18 waste.

19 Other external activities are going on.
20 It's the recent call by various groups to change
21 certain aspects of the low-level waste policy system.
22 The Health Physics Society last September argued that
23 for a complete overhaul of the regulatory framework
24 for low-level waste as well as the limits to the
25 Low-Level Waste Policy Amendments Act or new

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1 legislation that would allow access to DOE facilities
2 for commercial generators, the ANS also last year
3 argued for consideration of the use of DOE commercial
4 facilities as well as the Council on Radionuclides and
5 Radiopharmaceuticals argued for consolidation or
6 improvements in the compacts and consolidation of
7 low-level waste compacts.

8 Now, I mention those just to provide
9 context as to the external environment. Currently NRC
10 has not taken any positions on any of those
11 statements, but I point them out in an effort to
12 provide some context for the current environment.

13 For completeness, it's important for me to
14 mention that the Low-Level Waste Forum has also taken
15 a position. And its position has been one that's
16 urged caution in making any changes to the current
17 system.

18 So these are all different perspectives
19 that are being voiced and certainly could get the
20 attention of Congress as well. So it provides some
21 context as to what is going on externally.

22 If I could have the next slide?
23 Internally, just to provide some context, our
24 statutory responsibility under AEA is for safety,
25 security, and protection of the environment as it

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1 relates to low-level waste.

2 But one of the points I wanted to make on
3 this slide, emphasize a point on this slide, is in the
4 most recent strategic plan that was issued by the
5 Commission for fiscal years 2004 to 2009, one of the
6 means to satisfying our safety goal was to include a
7 strategy to assess the key issues affecting safe
8 management of civilian low-level waste disposal to
9 ensure that potential disruptions in access to the
10 three disposal sites does not adversely affect
11 licensees' ability to operate safely and decommission
12 safely.

13 So it is certainly an important issue to
14 the Commission and is included as one of the
15 strategies that we continue to assess, key factors
16 that could have an impact on licensees' ability to
17 dispose of their waste.

18 One point also to provide some context
19 about our low-level waste program is that there was a
20 strategic assessment that was done about ten years
21 ago. At that time, in its formal strategic assessment
22 for key direction setting, the Commission decided to
23 reduce the low-level waste program.

24 At that time, we had an effort as high as
25 20 FTE in the late '80s, early '90s. As a result of

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1 us completing much of the work under the Low-Level
2 Waste Policy Act as well as not expecting to see any
3 particular siting programs, the fact that they had
4 ended in most states, we reduced the level
5 significantly, where we have about a three FTE, three
6 to four FTE, program now. So that's also important as
7 we go forward in talking about some of the activities
8 and how we are going to intend to work some of the
9 opportunities.

10 Next slide. I just want to just briefly
11 touch on some of the current activities that we have
12 underway. The first one that I want to mention is an
13 effort to update our low-level waste stores guidance.
14 At this point, we're in the process of assessing as a
15 part of direction from the Commission the need to
16 update our extended storage guidance. At this point,
17 we are expected to provide a Commission paper in March
18 which would make a recommendation as to whether we
19 believe it's necessary to update extended storage
20 guidance.

21 Much of the extended storage guidance is
22 over 20 years old. The last time we looked at the
23 need to update it was at least ten years ago, in 1995.
24 There's certainly a consideration in terms of trying
25 to consolidate it in various places. So that's one of

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1 the activities that we're working on right now.

2 We're also looking at improving the
3 transparency in the 20.2002 alternate disposal
4 process, which is actually also directed by the
5 Commission for us to take a look at ways to improve
6 the transparency in their 20.2002 process. And we're
7 looking at how best to do that and provide
8 recommendations to the Commission.

9 We're also working to develop guidance for
10 our 20.2002 reviews, internal guidance for our staff.
11 And also we would share that guidance with external
12 stakeholders as well so that they understand what
13 we're looking for as it relates to 20.2002 type of
14 disposal requests.

15 Another issue that we recently is
16 responding to a Commission order regarding disposal of
17 large quantities of depleted uranium. This is
18 something that came out of the LES hearing, the
19 Commission's review of issues associated with the
20 hearing. That's another activity that we're starting
21 to engage on.

22 And then, of course, there are a number of
23 other activities that we currently also do associated
24 with technical assistance to states and PET reviews,
25 work to support international import/export of waste

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1 issues. There's a whole list of other activities.
2 This just gives you a flavor of some of the activities
3 that we have on our plate and what we try to do with
4 the resources that we have.

5 Next slide, please. One of the things
6 that we're also embarking on that we think is very
7 important and I think fits nicely with what you're
8 proposing to do with the white paper is that one of
9 the things that we want to do is complete a strategic
10 planning effort to try to figure out how best to
11 utilize our resources in an effort to most effectively
12 focus on the expectations of the Commission, our
13 statutory responsibilities given the limited amount of
14 resources that we have, how best to focus on those
15 responsibilities given the current environment.

16 So what we would like to do is assess what
17 is going on in the current environment, receive
18 stakeholder input as to whether a key issue is one of
19 our important issues associated with low-level waste
20 and, from that, assess what are the key things, work
21 that needs to be done in the area of low-level waste
22 and then how best to prioritize and use our resources.

23 So we see this strategic assessment as
24 really an important effort to effectively prioritize
25 and utilize the resources that we do have in an effort

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1 to try to focus and facilitate improvements in the
2 low-level waste system.

3 Next slide, please. With that background
4 in terms of the work that we have on our plate and the
5 current summary of the current environment around
6 low-level waste, we provide that to you to give some
7 focus and background on some of the comments that
8 we're going to have on your white paper and some of
9 the recommendations that we provide.

10 In general, we think that the white paper
11 provided a very good summary, particularly of the
12 development of part 61. We think it was very factual.
13 It was well-written.

14 We agree with you. We do view it as a
15 tool that is important for management and knowledge
16 transfer. As you said, many of the folks who worked
17 on the rule are now gone. We are fortunate to have a
18 few folks that we were able to obtain, such as Jim
19 Kennedy, Jim Shaffner, Mike Tokar, who were around in
20 the days when we had a program of 20 FTE for low-level
21 waste. And they bring a lot of experience to bear,
22 which is very important to us. But we think that the
23 paper was well-written and provided a good summary.

24 We think that, you know, as you mentioned,
25 the paper focuses heavily on part 61. Others may have

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1 taken maybe a different tack in terms of focusing in
2 on the history of low-level waste, but we recognize
3 that in trying to focus in on the history of low-level
4 waste, you could write volumes, as you said earlier.

5 So, you know, this was just an observation
6 that we made, not necessarily any particular criticism
7 in terms of how you focus the paper, but it's just a
8 recognition that it focuses heavily on part 61, which
9 lends itself to a focus on opportunities, primarily
10 borne out of modifications associated with part 61
11 rule and guidance.

12 The next comment that I want to make is on
13 the importance of stakeholder views. We saw that you
14 had a placeholder in section 4 of part two of the
15 paper to receive stakeholder views. We assume that
16 that is going to be stakeholder views on the current
17 environment as well as maybe the part 61 and the
18 implementation of it. We think that is important to
19 seek that stakeholder input as it helps. It would be
20 beneficial in helping to formulate opportunities and
21 to help focus on what opportunities may be most
22 beneficial.

23 CHAIRMAN RYAN: Just for everybody's
24 benefit, Scott, we certainly are going to put
25 something in that place on the two points you've

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1 mentioned. So that's kind of what we're working on
2 right at the minute to finish up. So there is
3 material that is going to be in there.

4 MR. FLANDERS: Okay. If I could have the
5 next slide, please? Just in the way of some
6 recommendations for your consideration on the white
7 paper, one of the things I mentioned earlier is the
8 interest on low-activity waste.

9 Right now a lot of the rule focuses on
10 part 61 in terms of low-level waste. There might be
11 some benefit in continuing to look at other ways to
12 focus on disposal of low-activity waste. That's an
13 area that there seems to be some diversity in
14 interests, and there might be some opportunities to
15 even further enhance disposal of low-activity waste.

16 When identifying the opportunities, we
17 think it may be important to consider certainly the
18 views of other key stakeholders Also positively -- I
19 know in your presentation, you said that you focus,
20 you didn't look internationally, but we think it might
21 be some benefit from looking at other countries
22 similar to what G.E. does in terms of managing risk
23 and how their programs are structured and some
24 insights possibly from DOE in terms of how they manage
25 their low-level waste program, possibly EPA. Just in

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1 terms of what they're doing and how they may manage
2 risk may provide some good information for us to
3 consider.

4 One of the other important points that we
5 think is important when considering opportunities is
6 consequences that may result. Certainly because of
7 the low-level waste regulations or so it's a patchwork
8 of regulations and they're so intertwined, when you
9 change one, there may be an unintended consequence on
10 another aspect of it. So that's something always to
11 keep in mind. Even in the space of guidance, we think
12 it's important to keep that in mind as well.

13 Our last recommendation really goes to a
14 recommendation in terms of how you proceed forward and
15 write your letter to the Commission. We would
16 recommend that the Committee consider identifying the
17 staff's strategic planning effort and consider
18 recommending the opportunities identified by ACNW be
19 folded into that effort, where we can take this more
20 integrated look so that we can come out with a suite
21 of activities that we think we need to focus on for
22 low-level waste and be able to prioritize them and try
23 to take on those things that give us the most return
24 on investment. And with limited resources, both ACNW
25 and the staff, we have to figure out ways to try to

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1 focus on those activities that give us the most return
2 on investment and things that we think can improve
3 their system the most.

4 If I can have the next slide? With that,
5 I just want to conclude with the few next steps that
6 we see. We are available to assist in finalizing the
7 white paper. We have some editorial and minor
8 comments to prove. And we'll provide those to Mike,
9 Mike Lee. We have pulled those together and we'll
10 provide those to Mike. And certainly we'll respond to
11 any direction provided by the Commission as a result
12 of the white paper.

13 So that's a high-level review. Again,
14 until just a few minutes ago, we hadn't seen the
15 opportunity. So we really haven't had an opportunity
16 to react to those. But we certainly think that some
17 of the things you identified are things that we want
18 to consider as we look, take this strategic look, at
19 how to prioritize our activities.

20 So, with that, I will conclude and welcome
21 any comments.

22 CHAIRMAN RYAN: Well, Scott, thanks very
23 much for a real informative presentation on the NMSS
24 views. I think if you'd just maybe back up one slide,
25 please, Michelle? I think we're in complete agreement

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1 on all of your recommendations. Certainly you've
2 added some key insights for us to think about,
3 evidenced by the fact that you have been working hard.
4 That's a good idea. Let's think about that.

5 Clearly -- and the one I wanted to point
6 to is the last one, really, in the mode of trying to
7 identify from our perspective as an outside technical
8 committee to the Commission to talk about things from
9 that perspective.

10 And, again, our focus is if you use our
11 risk-informed thinking that works in other areas, here
12 what are the benefits and what could they be and
13 certainly not to come up with an independent agenda
14 for NMSS but, in fact, to give you the insights that
15 may help you create a better agenda for the whole NMSS
16 team, particularly the low-level waste part. So we
17 clearly recognize that cooperative aspect of what we
18 want to accomplish here.

19 I might at this time before we take
20 questions invite our two speakers who are on the
21 phone.

22 Let me start with Kathryn Haynes from the
23 Southeast compact. Kathryn, we do have your letter
24 that you provided, signed by Mike Mulwood, you faxed
25 to us, the Southeast Compact Commission policy

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1 statement. And we will enter that into our record for
2 this meeting.

3 Hello? Kathryn? Rick?

4 MR. JACOBI: Yes, I'm here.

5 CHAIRMAN RYAN: Kathryn, are you on the
6 phone? Well, she's not there. So, Rick, do you have
7 any comments you would like to offer?

8 MR. JACOBI: No. I'm impressed with the
9 analysis that I heard today. And I appreciate the
10 opportunity to listen in like this because it's not
11 easy for all of us to make a trip to D.C. to attend
12 these meetings.

13 CHAIRMAN RYAN: Indeed. Just for our
14 record and for completeness, Rick, if you wouldn't
15 mind identifying who you are and your organizational
16 affiliation, that would help our record.

17 MR. JACOBI: Yes. I'm Rick Jacobi. I'm
18 a consultant in Austin, Texas. And part of my
19 consulting practice is radioactive waste disposal.

20 CHAIRMAN RYAN: Great. Thank you very
21 much.

22 Has Kathryn Haynes joined us on the call?

23 MS. HAYNES: I'm here.

24 CHAIRMAN RYAN: Oh, there you are. We
25 thought we lost you for a minute. Kathryn, we do have

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1 the letter, I guess it is, that you sent in to us by
2 fax. And we'll enter that into our written record of
3 the meeting.

4 But I wanted to give you this opportunity
5 to make any comments or observations for us at this
6 point.

7 MS. HAYNES: I have nothing to add. I
8 would just ask that the Committee carefully read the
9 letter and the policy statement. That was developed
10 by our commission over the course of several months.

11 As I know that you know, Dr. Ryan, there
12 are many individuals on our commission with a long
13 history of work in low-level waste management. And I
14 think they put a lot of careful thought into that
15 policy statement.

16 So we're hoping that the Committee will
17 consider it.

18 CHAIRMAN RYAN: Well, we appreciate you
19 giving us a copy of that. And we will certainly make
20 it a part of our record and our consideration. So
21 thanks for being with us today.

22 MS. HAYNES: Thanks very much.

23 CHAIRMAN RYAN: And we welcome your
24 continued participation on the phone.

25 MS. HAYNES: Thank you.

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1 CHAIRMAN RYAN: Let's see. Any initial
2 comments from Committee members? Dr. Clarke?

3 MEMBER CLARKE: Just a question for Scott.
4 On that slide, on your second bullet, could you tell
5 us a little more? And you did speak to it briefly,
6 but I just wonder if you could give us a little more
7 of your concerns about number 3, "Consequences that
8 may result." And I assume you mean unintended
9 consequences, adverse consequences.

10 MR. FLANDERS: Yes. I guess the point
11 there is just if you look at the way the low-level
12 waste regulations are put together; for example, the
13 Low-Level Waste Policy Amendments Act defines or uses
14 the classification scheme, class A, class B, greater
15 than class C classification scheme, that was put into
16 part 61. You make changes to classification scheme.
17 You know, are there some unintended consequences in
18 terms of the law itself?

19 So it's just the way the things are so
20 integrated. And it's important to always be thinking
21 about potential unintended consequences because we
22 hadn't seen the opportunities that you identified. So
23 not there are any concerns with any specific
24 opportunity that you have identified or that Dr. Ryan
25 mentioned earlier but just as a way of thinking about

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1 these, always to keep that in the back of your mind.

2 CHAIRMAN RYAN: And I think, Scott, that
3 is absolutely one of the key reasons to think very
4 carefully and, frankly, the reason we wanted to
5 document as detailed a legislative and regulatory
6 history as we did so that we at least have all of
7 them.

8 Okay. Where does that string lead? And
9 it leads to waste determinations. It leads to other
10 issues. And clearly that caution is one that I think
11 we'll all have to help each other make sure we don't
12 miss some connection that has a difference.

13 And even TRU comes in the definition some
14 places along the way. So it's something we'll have to
15 be mindful of.

16 MEMBER CLARKE: And just as a follow-up to
17 that, the opportunities that Dr. Ryan presented in his
18 overview of the white paper, any comment on those
19 opportunities? Is that a good list as far as you go?

20 MR. FLANDERS: In the amount of time we
21 had to react to it, I don't see anything that jumps
22 out at me as particularly alarming, but, as I said,
23 what I think is important is that we take those
24 opportunities that are identified and run through a
25 kind of a structured process where we can have an

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1 overall strategy in terms of identifying what things
2 are the most important, which things can give us the
3 most return on investment, how do these things affect
4 stakeholder concerns and issues, and then come out
5 with the right suite of activities to focus on.

6 So I think I see that as kind of a feeding
7 into that process. I wouldn't necessarily say that I
8 saw anything that we wouldn't want to at least start
9 into that process.

10 CHAIRMAN RYAN: And, to be fair to Scott,
11 I hope I identify at least three or four times that
12 these are ideas that if they fall off the table for
13 all good reasons, that's great. The process of
14 creating the list, modifying the list, and then
15 developing the list according to the protocol that
16 Scott mentioned is really our goal as well, so no
17 pride of authorship in any of those get the ball
18 rolling suggestions.

19 Any other questions, Jim?

20 MEMBER CLARKE: No, no thanks.

21 CHAIRMAN RYAN: Ruth?

22 MEMBER WEINER: I have a couple of
23 comments, really. First of all, I think this has been
24 a tremendous job, and I thank you very much. Scott,
25 I judge from what you say that you didn't have a whole

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1 lot of time to come up with comments.

2 One of the things you put up really caught
3 my eye. And that is the question of depleted uranium.
4 Now, depleted uranium is not, strictly speaking, waste
5 in the sense that it has a use. And I'm not proposing
6 here to argue whether DU is a waste or not a waste but
7 to draw your attention to the fact that this is an
8 example of something that is classified as a waste but
9 has uses other than simply being disposed of in some
10 kind of shallow, or burial shallow, land or otherwise.
11 I think that's an area that has not been considered.
12 And even if DU is the only thing that falls into that
13 category, I think it's an area that does need to be
14 considered.

15 The classification of depleted uranium as
16 a waste was done in a particular socioeconomic
17 context, if you will. And it's a substance that we
18 use a lot in a lot of different ways.

19 I would like to have your comments on
20 that, if I could.

21 MR. FLANDERS: That was quite a bit, and
22 I'll try to react to your comments. One issue there
23 still continues to be the debate around whether or not
24 depleted uranium is a waste. Certainly I am not aware
25 of any position where the Department of Energy has

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1 actually said that DU is a waste. So there are
2 certainly some stakeholder who hold that view that
3 depleted uranium is not a waste.

4 The issue that we have before us goes to
5 if the depleted uranium is converted for disposal,
6 which is one of the things that the department is
7 looking at, that whether the impacts associated with
8 disposal of depleted uranium is converted to an oxide.
9 And under the current part 61, 61.55 classification
10 scheme, is there a need to modify it if, in fact,
11 you're going to dispose of it in the commercial
12 low-level waste facility?

13 So that's the issue we're looking at. So
14 it's more of a question on the actual how would you
15 categorize it and how is it considered in the context
16 of 61.55 for disposal?

17 MEMBER WEINER: I would like to point out
18 that I was trying to suggest that perhaps you looked
19 not just at DU but at the large number of things that
20 are classified as low-level waste. There may be
21 others that actually have a use.

22 I mean, DU does, whether, you know, it's
23 recognized by NRC or not. There may be other things
24 that are very low specific activity, very low total
25 activity that still have a use. And there is

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1 presently in 61, to the best of my knowledge -- I
2 don't claim the kind of familiarity with 61 that
3 others here, especially the Chairman, have. But, to
4 the best of my knowledge, the question of dual use, if
5 you will, is not addressed.

6 And I would encourage you to look at it
7 because I think just to take this one example, just to
8 look at it and say, "Okay. How are we going to
9 dispose of it?" not only sends a message to the public
10 that I think you have to think very carefully about
11 sending. It really does confuse the issue a bit.

12 CHAIRMAN RYAN: Well, I think it's even
13 more complicated than that, Ruth. I think your focus
14 on DOE's DU or enrichment processes DU is -- and that
15 is what I am getting from your comment -- one area,
16 but there has been, perhaps not on a volume basis,
17 this kind of DU that we're talking about because a lot
18 of DU is exposed as commercial low-level waste, DU
19 metal, stuff that's being used in armaments, stuff
20 that is being used as DU shielding, even things like
21 trimmers that used to be used in X-ray machines narrow
22 beams and so forth, lots of little parts and pieces.
23 So there is a commercial aspect of it that's
24 completely independent of the enrichment system.

25 MR. FLANDERS: And I guess --

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1 MEMBER WEINER: I recognize that. That's
2 why I brought the whole thing up. The enrichment
3 thing was just something that brought it to mind.

4 MR. FLANDERS: Part 61 establishes
5 regulations associated with the disposal of low-level
6 waste. And certainly if there's material that could
7 be used for other purposes but also could be exposed
8 I think from the standpoint of establishing
9 regulations, which ensure that safe disposal, I think
10 you would want to make sure that that regulation
11 considers those things, not necessarily making the
12 assumptions that it necessarily has to be if there are
13 alternate uses for it certainly, but from the
14 standpoint of considering disposal impacts, I think
15 that's the angle on which we would look at it.

16 MEMBER WEINER: The only other comment I
17 have is I want to hark back to something that Dr.
18 Clarke said. And I want to congratulate you for the
19 third sub-bullet under your second bullet, "The
20 Consequences."

21 One of the stakeholders you mentioned as
22 making a statement, the American Nuclear Society, says
23 specifically -- I have their position paper here --
24 "10 CFR part 61 is a good regulation and should be
25 left in place as it is."

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1 I think you're all aware that to change
2 the rule is something that if that is found to be
3 needed or desirable is something where you want a
4 great deal of stakeholder input from, in particular,
5 the people who use 10 CFR part 61.

6 MR. FLANDERS: Actually, we agree. And
7 that's why we think it's so important. In addition to
8 looking at the unintended consequences, also to take
9 just above that in terms of getting stakeholder views
10 and input as well is very important to look at these
11 issues in a strategic, holistic way because there are
12 several factors you have to consider before deciding
13 to move forward on changes, whether it be the part 61
14 or the guidance, et cetera. So I appreciate that
15 comment.

16 MEMBER WEINER: Thank you.

17 CHAIRMAN RYAN: Just a follow-up, Scott.
18 I think, too, there I tend not to jump to the
19 regulation step, I think there are lots of
20 opportunities before that. And let's don't leave
21 those out of the discussion.

22 I think that sometimes, for example,
23 simple things on packaging for a specific case-by-case
24 sort of analysis -- and, again, 61 has that
25 case-by-case opportunity built into it for individual

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1 waste determinations and special case kinds of
2 considerations. So a licensee or an individual
3 permittee, whatever you want to think about, could
4 consider -- I call to mind some wastes that have been
5 disposed at the U.S. ecology hazardous waste facility
6 in North Dakota. Is that right?

7 MR. FLANDERS: U.S. ecology?

8 CHAIRMAN RYAN: U.S. ecology. I'm sorry.
9 Not North Dakota. I'm one state over. In Idaho
10 because they have been cleared through the regulatory
11 process on the NRC side. But, yet, again, they're
12 permitted carefully on the other side of the equation.

13 So there's kind of a very formal and very
14 clear hand-off of what went for that kind of disposal.
15 So that's a permit license kind of change. And then
16 up the life in that, we're all familiar with low-level
17 waste guidance documents, like the branch technical
18 position on waste form and waste classification,
19 certainly the guidance on averaging, for example,
20 irradiated hardware and what's the range of hot and
21 cold pieces you can average together to make a class
22 determination and things of that sort. So I think
23 perhaps there are lots of opportunities before you get
24 to that question in the regulations that some of these
25 may fall into.

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1 And, again, I'm assuming that when you
2 talk about your prioritization and strategic planning,
3 it's all those levels will come into your thinking.

4 MR. FLANDERS: Right. And that's an
5 important point that you make as we run these things
6 through this structured process. One of the things
7 you need to look at is, do you really need to change
8 a regulation to address an issue? Can you do it in
9 guidance? And then you have to prioritize, well,
10 what's the benefit of making that particular change in
11 general?

12 So yes. We agree that it's important to
13 look at that guidance --

14 CHAIRMAN RYAN: Sure.

15 MR. FLANDERS: -- and other ways of doing
16 it other than just the regulations.

17 CHAIRMAN RYAN: Thank you.

18 Allen?

19 DR. PASTERNAK: Dr. Ryan?

20 CHAIRMAN RYAN: Yes?

21 DR. PASTERNAK: Alan Pasternak here, Cal
22 Rad Forum.

23 CHAIRMAN RYAN: Welcome, Alan.

24 DR. PASTERNAK: Thank you. Should I add
25 a word or two here?

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1 CHAIRMAN RYAN: Well, how about I finish
2 going around the Committee members, and then we'll
3 catch up with you if that's okay.

4 DR. PASTERNAK: Okay. Fine.

5 CHAIRMAN RYAN: Great. Thanks. Allen?
6 I know that's Allen Croff I'm speaking to. Maybe
7 that's why you chimed in. But welcome on the call,
8 Alan.

9 VICE CHAIRMAN CROFF: A couple of
10 thoughts. First, I'll reiterate what others have
11 already said. Bringing up the unintended consequences
12 is a good thing to do.

13 I think all of us could rattle off a
14 number of things that interface with part 61 or would
15 be affected, but I'm not sure that any of us could
16 rattle off all of them. And it's I think a very long
17 list and a very intricate list.

18 I'm wondering if something that may be an
19 opportunity that's been implicit here that should be
20 made explicit is to simply try to figure out all of
21 the things that part 61 touches, other regulations,
22 activities. It might be a useful screening tool or a
23 useful tool to examine other opportunities, but to
24 make that explicit, I'm assuming it doesn't exist
25 anyplace except maybe in a couple of people's minds in

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1 part.

2 But it might be a good thing to know
3 because it has become a very pivotal regulation. And
4 maybe better understanding that would help everybody
5 figure out what can be done and how to go about it.

6 The second issue I would bring up goes
7 back to the law passed I guess it's been about a year
8 that gave the Commission jurisdiction over some NARM
9 waste, I think not the diffuse but the
10 accelerator-produced and concentrated radium sources,
11 as I remember it.

12 I'm not sure whether those are technically
13 low-level waste or they're a waste that's sort of
14 managed as low-level waste or what they are, but it
15 would seem another opportunity in this context might
16 be to figure out how do those get integrated into the
17 system, does something else have to be done, is
18 something like a part 61 okay, but to work through
19 that issue and that new responsibility. That's all I
20 have.

21 CHAIRMAN RYAN: That's great. Those are
22 a couple of good additions from the list.

23 Let me just pick up and maybe ask you
24 guys, should we think about either an appendix or
25 another chapter that address Allen's first point of

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1 what are the connections?

2 MR. FLANDERS: Actually, I think it's
3 actually kind of an intriguing thought. And to the
4 extent that you have time to do something like that,
5 that certainly would be useful.

6 CHAIRMAN RYAN: Either that or given that
7 we owe the Commission something by the end of the
8 month, maybe we'll tell them we'll go work on that
9 chapter for volume 2.

10 I don't want to lose that idea. I think
11 that is something that really gets at maybe even two
12 of your bullets there, Scott. And that's something
13 that I think we could help and do a lot of homework on
14 and offer the same kind of factual sort of document to
15 at least try and get us all started on the same page.

16 VICE CHAIRMAN CROFF: My initial view is
17 it's more than a couple of days of work. I think it's
18 --

19 CHAIRMAN RYAN: Yes. We're smiling over
20 that one. It is a couple of days of work. Thanks.
21 I think we might take that into consideration.

22 Bill Hinze?

23 MEMBER HINZE: Well, an observation that
24 may be helpful, it seems to me that it's very
25 important that there is some kind of consensus on what

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1 the problems and what the problems may be in the
2 future. And it seems to me that if you're going to
3 not only develop opportunities but also to prioritize,
4 that there has to be some consensus on those.

5 As I look at the document, it seems as
6 though the current program status could well be beefed
7 up in terms of that. What are some of the
8 consequences of the problems that we are facing in the
9 low-level waste arena? And how will that develop in
10 the future?

11 CHAIRMAN RYAN: Yes. And, again, I think
12 that's a much broader question than one we can take up
13 as a committee. Certainly NMSS staff, as they have
14 articulated and I think as we agree, have a strategic
15 planning effort to address those very questions. And
16 I think our input would give them some additional food
17 for thought and things is really the right first step.

18 Now, as they consider their process, we
19 certainly might be asked questions or hear
20 presentations and can offer further comment, but I
21 guess what I'm trying to say is I think that it would
22 be hard to have a ship with two steering wheels in it.

23 I think ultimately the NMSS staff will
24 have the responsibility to execute the Commission's
25 direction on any guidance or regulatory activities.

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1 In our role as advisers to the Commission, we
2 certainly can participate and offer technical comment
3 and comment to the staff on their strategic planning
4 efforts and all the rest.

5 At the end of the day, it's something
6 where I ultimately see the NMSS staff having to deal
7 with it in their framework and their strategic plan,
8 much like we do our own work.

9 MR. FLANDERS: We would certainly need to
10 deal with that as part of our framework. And we see
11 the importance of stakeholder input to assist in doing
12 that.

13 We also see the benefit of interacting
14 with the Committee to get your insights and knowledge
15 on those issues as well. So it is a good point.

16 CHAIRMAN RYAN: And I think at this point
17 we're at the point where we're thinking about how to
18 best cooperate and take advantage of what we can
19 contribute. That's certainly an open question where
20 I think one is ultimately one --

21 MEMBER HINZE: But if you are going to
22 prioritize, you also have to know the implications of
23 some of these problems.

24 CHAIRMAN RYAN: Clearly that's right up
25 there.

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1 MR. FLANDERS: Absolutely.

2 CHAIRMAN RYAN: Other questions or
3 comments? Mike Lee?

4 MR. LEE: In reference to the stakeholder
5 comments, last night and this morning I finished a
6 little paragraph accompanied by a table that
7 summarizes what published policy statements I found
8 based on low-level waste.

9 So I think I've gotten the statement that
10 was just distributed about Cal rads. I found about
11 seven. The only new one that I'm aware of is the one
12 that Scott made reference to, which is the Council on
13 Radionuclides and Pharmaceuticals. I'll see if I
14 can't find that.

15 CHAIRMAN RYAN: That's a good start.

16 MR. LEE: We've got that information

17 CHAIRMAN RYAN: If I could turn to Alan
18 Pasternak? Alan, would you help our record and just
19 tell us who you are and who you represent, please?

20 DR. PASTERNAK: Yes. I'm the Technical
21 Director of the California Radioactive Materials
22 Management Forum, which is an association of
23 organizations that use radioactive materials in the
24 four states of the Southwestern contact region:
25 California, the host state; Arizona; North Dakota; and

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1 South Dakota. We also have some members in some of
2 the other states.

3 My comments on what I have heard about the
4 white paper to date are fairly similar to what I had
5 to say at your last meeting. The overriding issue, I
6 think, is not the adequacy of 10 CFR 61, which is a
7 good set of regulations. The overriding issue is the
8 inadequacy of disposal capacity.

9 As has been mentioned, the Barnwell
10 facility, which now accepts waste from not only the
11 Atlantic compact but 36 other states, is scheduled to
12 restrict access from July 1, 2008. And at that point,
13 we'll accept waste only from Connecticut, New Jersey,
14 and South Carolina, the three states of the Atlantic
15 compact.

16 That means that organizations that use
17 radioactive materials in some 34 or 36 states
18 depending on whether or not Texas is successful will
19 have no place at that time to dispose of their class
20 B and C waste.

21 And as to class A waste, there will be
22 only one facility. That's the Envirocare facility in
23 Utah, which operates outside of the compact system,
24 only one place to which they can send their class A
25 waste.

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1 When you look back at the 25-year history,
2 26-year history of the Low-Level Waste Policy Act,
3 this is clearly a failure. We have made some
4 suggestions. I think your staff is familiar with
5 them. They were put on the record in testimony before
6 the Senate Energy and Natural Resources last year. We
7 have made some suggestions for alternative approaches,
8 which would probably require amendment of the
9 Low-Level Waste Policy Act.

10 Use these facilities for commercial waste,
11 at least on a near-term basis, and then the
12 development of one or two facilities under the aegis
13 of the federal government, new facilities.

14 You know, we have ten compact commissions
15 around the country. We don't need 10 or 12 disposal
16 facilities. Maybe at one time it was thought we
17 might, but we certainly don't today.

18 And so I think the foundations of the
19 Policy Act are no longer operative. And, in any
20 event, it has not worked. It has not produced the
21 needed new disposal capacity.

22 A second comment I would like to make is
23 that we all use the phrase "commercial low-level
24 waste" to talk about what we're talking about, to
25 describe what we're talking about. It's a bit

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1 misleading because the wastes that are subject to the
2 Low-Level Waste Policy Act, the wastes that we're
3 talking about, are produced not only by commercial
4 users of radioactive materials but also users in the
5 public sector: universities, medical facilities, and
6 so on.

7 In addition, there is another very
8 important category. And that is the government:
9 state and federal governments. The only organization,
10 private, public, government, whatever, that uses
11 radioactive materials that today has assured access is
12 the Department of Energy. Other federal agencies,
13 state agencies rely on the same commercial disposal
14 facilities that utilities, medical facilities,
15 universities. And I think that's an important point
16 to keep in mind.

17 Those are my comments, at least for today.

18 CHAIRMAN RYAN: Alan, thanks very much.
19 I do believe we have your previous comments and the
20 materials to which you referred in hand. We
21 appreciate you being with us today for the discussion
22 and offering us your views.

23 Are there any other comments, questions,
24 observations? Members of the audience? Yes?

25 MR. FLACK: John Flack, ACNW staff.

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1 You know, I heard the discussion on the
2 deterministically based regulations. And just
3 thinking back at the reactor side of thins, those
4 regulations were deterministically based and still are
5 today.

6 What has happened, what has evolved around
7 those is a probablistic framework for implementing and
8 showing that you meet these regulations. So it's not
9 so much the regulations themselves but how you
10 implement the regulations.

11 Now, with the reactor side, of course, you
12 know, we have things like safety goals, 1.174 and so
13 on, reg guide 1.174, that established that framework.
14 And I guess next month we're going to be hearing from
15 Dennis Damon about NMSS activities with regards to
16 those, you know, using a risk-informed framework for
17 the nuclear waste and materials arena.

18 And I think that's where a lot of this can
19 come to bear. I mean, the thinking, how one goes
20 about, I mean, we could talk about a dose that needs
21 to be met. But what you're really trying to
22 understand is what is the likelihood that those will
23 not be seated. And it's a different way of thinking
24 than just saying, "Well, this is the regulations.
25 Meet the regulations."

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1 So it's in that capacity that I think
2 you'll find the biggest benefit of risk-informing the
3 regulations, establishing a framework using the
4 current regulations that you have now. And then later
5 on you can go back and say, "Well, this regulation
6 doesn't really make sense in this context because
7 we've been spending a lot of resources trying to
8 implement this. And it's very low likelihoods and
9 very low consequences." Then eventually you go back
10 to change the regulation.

11 As you move ahead, I think the focus
12 really should be within developing a kind of
13 probabilistic framework to do this work.

14 CHAIRMAN RYAN: And I see a theme in some
15 of the things you're saying, John, with some of the
16 things we've heard from commenters about likelihood
17 and consequences. And that in my mind anyway kind of
18 ties to these very low activity wastes and other
19 opportunities. So having that framework at least at
20 something to think about I think is helpful as well.

21 MR. FLANDERS: That is true. And it will
22 be interesting to hear some of the views that Dennis
23 shares on what we're doing in the NMSS.

24 One other point I also want to point out
25 is we do have guidance I think that was actually

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1 referenced in your white paper, NUREG 1573, which
2 looks at how we do performance assessment. And we do
3 the performance assessment in a probablistic way from
4 low-level waste as well as for decommissioning
5 activities.

6 So, to that end, there is that
7 risk-informed thinking, but certainly we should look
8 to consider opportunities to continue that type of
9 thinking.

10 CHAIRMAN RYAN: And, again, when I think
11 ahead to strategic planning and then action planning
12 thereafter, where is the low-hanging fruit to be the
13 first or second or third application of that process
14 in thinking?

15 I think that's what you were referring to
16 earlier. It's where do we get the most return on our
17 early investments in this arena. And that is going to
18 take some thought and consideration and shuffling in
19 the list and all the rest of the usual things that
20 happen and that kind of exercise.

21 Any other comments or questions? John
22 Greeves, please? Tell us who you are.

23 MR. GREEVES: Good afternoon. I'm John
24 Greeves. It's good to be back. I'm former Director,
25 Division of Waste Management, Environmental

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1 Protection.

2 Like a lot of people on the phone, I've
3 touched this issue for 20-plus years. I, I think like
4 the others with the public, haven't gotten a copy of
5 this document. You're talking about a document that
6 we haven't seen yet, which we will presumably after
7 the first of the year.

8 Dr. Ryan, a couple of comments. There's
9 already a lot of information out there about part 61.
10 There's volumes of material out there. I look forward
11 to scanning what you're producing. But from my
12 perspective, the key is you're going to have to focus
13 on what the priorities are in moving forward, not
14 reviewing old material.

15 I think there's a mismatch here. You've
16 got the staff sitting over there with three FTE.
17 Based on experience, I can tell you that that FTE is
18 applied to a lot of licensing casework.

19 And if the staff is going to do a
20 strategic plan with three FTE on a project this
21 significant, I don't understand how you do that. So
22 I would suggest that there needs to be a focus.

23 It's the issues that the people on the
24 phone mentioned, as Al Pasternak mentioned. They have
25 already been mentioned, but, for emphasis, I'll tick

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1 them off.

2 I wrote down a list of five, the key of
3 which is the B&C waste issue. You're going to have
4 30-plus states without access in 2008. That's a focus
5 here. That's something that if you can provide a
6 solution to that, you'll be doing some good.

7 So that's one of them. The second one on
8 my list is greater than class C waste. There are
9 responsibilities out there now. Scott mentioned them.
10 The department has to do something when greater than
11 class C waste. There are lots of stakeholders who
12 would like to see that problem resolved. So that's a
13 second one.

14 The third one is the DU issue. The
15 Commission just issued an order that tangentially laid
16 it back in the staff's lap. Yes, it is a dual-use
17 material, but the volumes of this are so large. And
18 can they be used in near-surface disposal?

19 That issue has been handed over to the NRC
20 staff. That one issue could gobble up the three FTE
21 that Scott and Larry Camper have to address these
22 issues.

23 My emphasis is it needs to sharpen up the
24 scope of what you really are going to work on because
25 the resources are terribly limited here. Finishing

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1 off my list, internationally there is more and more
2 use of what's called a very low-level waste disposal
3 facility. It's very successful. It's not taken root
4 in this country. That's a solution that just hasn't
5 come here yet. Again, the international community has
6 taken leadership on things like this.

7 The last item is one that has been
8 mentioned by a number of parties. Call it what the
9 IAEA has done on clearance. It's a loose end. It's
10 a big loose end. And the rest of the world has moved
11 on. Lots of countries I actually do some consulting
12 for invoke that IAEA standard and making use of it.
13 It works. And it just is not here.

14 So that's a list of five. But without
15 focusing and deciding what are you going to do with
16 those three FTE, frankly, I don't see how you get it
17 done. So I just wanted to offer those comments from
18 some experience. And I would urge, you know, in a
19 small way, I'll help over time to try and focus what
20 you really can do with few resources because the
21 Commission doesn't have a lot invested in this
22 particular arena.

23 I just wanted to offer some candid
24 comments. And I'll be happy to --

25 CHAIRMAN RYAN: Any time you want to go up

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1 to the 19th floor and, you know, share those views,
2 John, please feel free.

3 MR. GREEVES: You're going to be doing
4 that yourself.

5 CHAIRMAN RYAN: No. I think everybody is
6 aware of -- first of all, thanks for the list of
7 issues. I think a couple that we haven't explicitly
8 talked about but a couple that are on the list of the
9 very low-activity waste question, which I think Scott
10 touched on a bit, but the other is the disposition of
11 solid materials, which in EU is safety directive 6 or
12 29- something or other. I can't recall the numbers,
13 but you're right. There are some examples from the
14 international environment or some of the things we
15 might be thinking about we ought to have models to
16 follow or at least be informed by. So we appreciate
17 your insights.

18 MR. GREEVES: Good. Thanks.

19 CHAIRMAN RYAN: Thank you.

20 MR. GREEVES: Thanks for listening.

21 CHAIRMAN RYAN: You bet. Any other
22 comments, questions, observations? Yes? Dr.
23 Nicholson, welcome.

24 DR. NICHOLSON: Tom Nicholson, Research.

25 One thing that struck me, I think back of

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1 the tremendous effort put in by the States of
2 Illinois, North Carolina, and California in trying to
3 cite a low-level waste site.

4 CHAIRMAN RYAN: Pennsylvania.

5 DR. NICHOLSON: Yes, Pennsylvania and
6 Texas. Have you thought about incorporating some of
7 the lessons learned from those examples of how they
8 tried, what worked, what didn't work, and the examples
9 that they bring to the table?

10 CHAIRMAN RYAN: I would say implicitly
11 yes. You know, a lot of those documents that aren't
12 necessarily readily available, but having participated
13 in three of the last that we ticked off together, I
14 would say implicitly yes.

15 Some of the questions surrounded
16 interpretation, for example, of siting criteria and
17 looking at new sites. That was always the issue. How
18 do I decide when I'm modelable and some of those
19 things?

20 So I think there are things in that arena
21 when you look at the siting criteria that would
22 probably be from those experiences perhaps some of the
23 questions, certainly not all but some.

24 So the other aspect was the engineered
25 barriers. How do you credit them in some way? You

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1 know, we would kind of get in the situation of having
2 lots of barriers and then immediately assuming they
3 aren't there. Not only did they fail in some mode,
4 but they're not there. That's radioactive material
5 mixed with soil, and water hits it.

6 So I think there was some sort of
7 discontinuities, for lack of a better term, coming out
8 of those examples. And I hope we've at least
9 identified a few to think about.

10 Now, whether they would float to the top
11 of the list after the staff considers the entire list,
12 I don't know. My guess is they might not be exactly
13 on the top of the hit parade. Some of the other ones
14 that John Greeves mentioned, the B and C question and
15 the greater than class C question, might have a higher
16 priority.

17 Again, I'm not trying to prejudge or offer
18 a comment, but I think the answer to your basic
19 question is yes but perhaps not explicitly from stuff
20 that's been published or those kinds of things. And
21 I don't think there's much literature out there on it.

22 Thanks.

23 MR. FLANDERS: If I could just --

24 CHAIRMAN RYAN: Yes?

25 MR. FLANDERS: -- take a minute? I just

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1 wanted to respond to some of the comments that John
2 made because he made some very good comments. I
3 think, John, your point is well-taken on the challenge
4 to do the strategic planning with the limited
5 resources that we have. But the fact that we have
6 such limited resources makes it all the more important
7 why we really feel it's important to do the strategic
8 look to make sure that we focus on those things.

9 Many of the activities you identified are
10 key things that certainly one would expect would be
11 key things that the staff would want to focus on. So
12 that's why we think it's such a valuable effort, but
13 it will be challenging for us to do it with the
14 resources that we have. You know that better than
15 anybody.

16 CHAIRMAN RYAN: And I think, frankly, too,
17 Scott, the idea that the Committee has got a keen
18 interest in this area and we can certainly, you know,
19 be involved in a way that is helpful to the staff in
20 their thinking or take up issues or other issues is a
21 way to take advantage of our shared resources or how
22 to combine our resources to a better effect.

23 MR. FLANDERS: And, again, that's why I
24 think it is also important for us to leverage the
25 insights and information and experience from

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1 stakeholders. It's very critical to do that as well.
2 And to get that stakeholder input is very important.

3 CHAIRMAN RYAN: Other questions, comments,
4 observations?

5 (No response.)

6 CHAIRMAN RYAN: Okay. Why don't we do
7 this? We'll take perhaps a 15-minute break, come back
8 about 10 minutes after 3:00, then have a brief wrap-up
9 session with everybody. And then we'll go on from
10 there. Fair enough? Thank you. Ten minutes to 3:00.

11 (Whereupon, the foregoing matter went off
12 the record at 2:35 p.m. and went back on
13 the record at 2:56 p.m.)

14 CHAIRMAN RYAN: We're going to go ahead
15 and reconvene and finish up our close-out discussion.
16 I think what we have had is a good discussion on the
17 elements of the white paper and on both the
18 Committee's views and staff's views on some
19 opportunities and some patch forward kinds of things.

20 I guess what I would like to do is maybe
21 kill two birds with one stone. I think we can clearly
22 bring the paper itself closure and bring that to the
23 Commission as a report or work product of the
24 Committee on the low-level waste arena. And then I
25 think what we have got to really focus our attention

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1 on is what detail we want to carry in the letter that
2 transmits it to them.

3 Clearly it's the Committee's effort to
4 review low-level waste as a topic and consider
5 risk-informed approaches to various issues in the
6 low-level waste area.

7 I think we should recognize that after
8 consultation with staff in this meeting, that we have
9 identified some further opportunities to recognize
10 their activities in their strategic planning in
11 similar areas that overlap ways that are complementary
12 to what we're doing. And that dialogue should
13 continue. And we plan to continue that dialogue with
14 staff.

15 The part I am thinking out loud here a
16 little bit about and we appreciate views on is how
17 much of the kind of straw man, if you will, for the
18 opportunities list do we want to put forward? My view
19 is less, rather than more, because I think that is
20 something that will evolve with staff over time. And
21 then we talk about the commitment to do that, rather
22 than trying to say this is an opportunity.

23 You know, if you said, well, what
24 direction are you looking for the Commission to tell
25 staff and us to continue working together to identify

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1 a more complete list of opportunities and, you know,
2 move forward with your analysis and bring what you
3 think are a list of opportunities and strategies to
4 better risk-inform this area of regulation.

5 Jim?

6 MEMBER CLARKE: I just want to support
7 that. I think we should not attempt to include an
8 inclusive list of opportunities. That's a work in
9 progress. And there might be merit to just giving a
10 couple of examples or potential examples.

11 CHAIRMAN RYAN: Yes, either that or we
12 could also give the categories of examples. I mean,
13 we talked about risk-informing the siting criteria,
14 risk-informing the basic scenarios from which the
15 concentration tables were developed, and then
16 risk-informing other related activities, which are
17 some of the ones that Scott mentioned and we're going
18 to continue: one, to build the list; and, two, to
19 support NMSS's strategic planning activities to
20 develop priorities for this list with their more
21 comprehensive view of the regulatory agenda in this
22 area. And that's kind of getting to closing the
23 letter up.

24 I don't see it as being very long, but I
25 see it as at least giving them something that will

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1 allow them to see what we have been working on and
2 give us their feedback and insights and perhaps ideas
3 for future directions.

4 MEMBER CLARKE: You know, there may be
5 merit to linking, at least referencing, the
6 decommissioning proposed decommissioning, guidance
7 revisions because they speak to some of these same
8 areas. And I continue to think that we can truly do
9 things that are more risk-informed way if we recognize
10 that engineered barriers and institutional controls
11 are part of an integrated system.

12 CHAIRMAN RYAN: We're kind of getting down
13 into the specific examples, but that may be something
14 we develop later on. I think the idea that there's
15 overlap on this instruction that could be taken from
16 the decommissioning arena and others that we mentioned
17 and talked about is something we want to study and
18 analyze more fully now that we would be taking this
19 first step. What do you think?

20 MR. FLANDERS: Yes. I think that's a good
21 approach to take. Really, it sounds like what you
22 want is agreement from the Commission in terms of the
23 effort in terms of trying to identify opportunities.
24 And I think if you'd keep it at a high level and say
25 that is what you want to do, it gives you time to

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1 think more fully through what those opportunities are
2 and address some of the issues that we're thinking.
3 So I think that's --

4 CHAIRMAN RYAN: And I think we'll tell
5 them the reason is some of the cautions, Scott, that
6 you actually provided us with today, which is what
7 unintended consequences could there be, what are
8 stakeholder views. And we heard several of those in
9 the telephone.

10 Are our telephone participants still on
11 line? Hello? Anybody on telephone?

12 MR. COLEMAN: The light is on on the
13 phone.

14 CHAIRMAN RYAN: Well, it's on, yes. I
15 know. It's green. So it's on.

16 But, you know, those are used as well, and
17 we can point to the reasons why we're continuing to
18 study. And we don't have this complete, comprehensive
19 list, but we'll press ahead.

20 MEMBER CLARKE: I don't think this will be
21 comprehensive until you've got some idea of
22 priorities.

23 CHAIRMAN RYAN: Exactly, yes. Anybody
24 have a different view?

25 (No response.)

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1 CHAIRMAN RYAN: So I guess, with that
2 said, Mike Lee, maybe you can and I can noodle before
3 we break for the day and divvy that up. And we'll put
4 together a straw man.

5 I guess I'm going to suggest, even though
6 it's relatively brisk scheduling, Mike, maybe you and
7 I can draft this letter tonight and we can review it
8 in the open session tomorrow in our letter-writing
9 period and get some concurrence from the Committee on
10 the short transmittal letter. That will give staff
11 time to have input in the public session. Off we go.
12 Fair enough?

13 (No response.)

14 CHAIRMAN RYAN: All right. With that,
15 we'll conclude our low-level waste discussion. I
16 appreciate everybody's -- oh, I did forget to mention
17 one thing for the record, which I will mention. Thank
18 you very much, Michelle.

19 Ralph Anderson from NEI was not able to be
20 with us. He had a family activity that he had to take
21 care of today and was at the late hour not able to
22 join us. So we do have his slides, which we will
23 enter into the record, and his views, which he was
24 going to give us verbally from NEI. So those will be
25 available to one and all as part of our record of the

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1 meeting. And I appreciate you reminding me to mention
2 that for the record. Thanks.

3 Okay. Any other comments or corrections,
4 items?

5 (No response.)

6 CHAIRMAN RYAN: Thank you all very much.
7 We appreciate your participation, and we will press on
8 from here. We'll conclude our formal record here.
9 Thank you.

10 (Whereupon, the foregoing matter was
11 concluded at 3:03 p.m.)

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