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UNITED STATES NUCLEAR REGULATORY COMMISSION'S
ADVISORY COMMITTEE ON NUCLEAR WASTE

NOVEMBER 28, 2001

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
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ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)
130TH MEETING
WORKSHOP ON RESEARCH NEEDS
+ + + + +
WEDNESDAY,
NOVEMBER 28, 2001
+ + + + +
ROCKVILLE, MARYLAND
+ + + + +

The workshop met at the Nuclear Regulatory Commission, Two White Flint North, T2B3, 11545 Rockville Pike, Rockville, Maryland, at 8:30 a.m., George M. Hornberger, Chairman, presiding.

COMMITTEE MEMBERS:

GEORGE M. HORNBERGER, Chairman
RAYMOND G. WYMER, Vice Chairman
B. JOHN GARRICK, Member
MILTON N. LEVENSON, Member
WILLIAM J. HINZE, ACNW Consultant

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1 STAFF PRESENT:

2 RICHARD P. SAVIO

3 SHER BAHADUR

4 JOHN T. LARKINS

5 F. PETER FORD

6

7 NRC MEMBERS PRESENT:

8 TIMOTHY J. McCARTIN

9 WILLIAM R. OTT

10 JACK E. ROSENTHAL

11

12 ACRS MEMBERS PRESENT:

13 MARIO V. BONACA

14

15 ALSO PRESENT:

16 DARRELL K. NORDSTROM

17 JOHN L. WILSON

18 JOHN H. KESSLER

19 STEPHEN RATTIEN

20 KENNETH ROGERS

21 D. WARNER NORTH

22 DAVID C. KOCHER

23 TOM KING

24 BUDHI SAGAR

25 WESLEY C. PATRICK

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

(8:34 a.m.)

1
2
3 CHAIRMAN HORNBERGER: The meeting will
4 come to order. This is the second day of the 130th
5 Meeting of the Advisory Committee on Nuclear Waste.
6 My name is George Hornberger, Chairman of the ACNW.
7 Other Members of the Committee present are John
8 Garrick, Milton Levenson and Raymond Wymer. We also
9 have Mario Bonaca and Bill Hinze with us.

10 In addition, Mario Bonaca, Chairman and
11 Vice Chairman of the ACRS, George Apostolakis is on my
12 sheet here, but George is not going to be here. Peter
13 Ford, I am told, will join us this afternoon.

14 During today's meeting, the Committee will
15 finish its workshop on research needs and will then
16 discuss the following: preparation for our January 9,
17 2002 Commission briefing and preparation of ACNW
18 reports.

19 Richard Savio is the designated federal
20 official for today's initial session. The meeting is
21 being conducted in accordance with the provisions of
22 the Federal Advisory Committee Act. We have received
23 no written comments or requests for time to make oral
24 statements from members of the public regarding
25 today's sessions. Should anyone wish to address the

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1 Committee, please make your wishes known to one of the
2 Committee staff.

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

7 So we're going to start right in on our
8 workshop on the future of NRC's nuclear waste related
9 research and we're talking about research needs and
10 prioritization today. Again, thanks to all of our
11 invited guests who have joined us. We're looking
12 forward to hearing from you.

13 Let's see, first thing on the schedule, we
14 have scheduled a half an hour for a summary of
15 previous workshop discussions. I doubt that we'll
16 need a half hour. I think we're probably going to get
17 started before that.

18 One of the things that I noted yesterday
19 that I wanted to make mention of is that whenever we
20 talk about research, of course, what we do is we
21 highlight things that we don't know. That's the
22 nature of research. We focus on work that needs to be
23 done on problems, issues that are unresolved and I
24 think that perhaps when we get into a discussion like
25 this, an audience could be misled into thinking that

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1 problems is all that there are and that we can't
2 possibly make any decisions. And I think that's a
3 perspective that I don't think any of us share, at
4 least on the ACNW. The ACNW really believes that
5 there are lots and lots of licensing decisions that
6 the NRC makes that the information certainly is
7 adequate to make these decisions and as we look
8 forward to some of the future decisions that the NRC
9 has to make, what really we're trying to focus on here
10 is what new research tasks could be accomplished to
11 make those decisions more efficient, better, better
12 informed, more risk-informed, for example.

13 I had that reaction yesterday and as a
14 university researcher, I'm comfortable talking about
15 problems and issues and unresolved things and what
16 exciting new things need to be done, but I did think
17 about that afterwards and perhaps in listening to it
18 an audience might be misled into thinking that
19 problems is all that there were.

20 Other Members, do you have any other
21 comments or summary comments?

22 Raymond -- from yesterday?

23 VICE CHAIRMAN WYMER: No, other than the
24 sort of platitudinous comment that I thought the
25 presentations were excellent, right on target, and

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1 there was a very broad spectrum of coverage from the
2 fairly detailed research ideas to the very broad sort
3 of fundamental bases for -- reasons for the research.
4 So I thought it was a very good kick off.

5 CHAIRMAN HORNBERGER: Milt? John?

6 MEMBER GARRICK: I think I have a number
7 of comments, but I think I'd prefer to wait until the
8 workshop is nearer the end to extend them.

9 CHAIRMAN HORNBERGER: That's fine. That's
10 what I assumed.

11 Okay, we're also probably, the schedule,
12 as it is indicated, we had some compression of the
13 morning schedule so that we may, in fact, just launch
14 right into what is on your schedule as the afternoon
15 schedule, somewhere around late morning because
16 everybody is here and I think that we can do that.

17 Greg Choppin from Florida State,
18 everybody, I think, has a copy of the slides that Greg
19 would have presented were he able to attend. He
20 called in because of an illness he could not attend.
21 I don't really think that we're going to take time to
22 go through his slides. I think that everybody can
23 read them. If the Committee or any of the experts
24 have any comments that they think deserve discussion
25 we can do that in question periods.

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1 So I think what we're going to do is
2 proceed right to Dave Kocher's presentation. Dave is
3 at Oak Ridge.

4 MR. KOCHER: Yes, good morning. I very
5 much appreciate the opportunity to come speak with you
6 this morning on these important issues. I should give
7 you a little background about myself. I worked at Oak
8 Ridge National Laboratory for nearly 30 years and back
9 in the 1980s I had a research project with the Office
10 of Research here that was looking into issues of
11 uncertainty in modeling high level waste disposal.
12 For about the last 10 years or so at Oak Ridge, I was
13 part of teams that performed performance assessments
14 for about 4 low level waste facilities at Savannah
15 River and Oak Ridge. So I've had some experience in
16 performance assessment on both sides of the fence.

17 I should also say that I'm a nuclear
18 physicist by training, a health physicist by osmosis
19 --

20 (Laughter.)

21 I have absolutely no experience or
22 technical training in geology, hydrology, chemistry or
23 material science.

24 MEMBER GARRICK: That gives you an
25 advantage.

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1 MR. KOCHER: Which I guess makes me
2 eminently qualified to talk about source term and
3 transport issues.

4 (Laughter.)

5 That's the truth.

6 CHAIRMAN HORNBERGER: So physicists tell
7 us.

8 (Laughter.)

9 MR. KOCHER: Physicists are always seeking
10 the truth.

11 I did, when I got the call to make this,
12 I was frightened because I don't know these subjects,
13 so I did call some of my friends out there and
14 solicited some input. I got some input from Mick
15 Apted from Monitor Scientific and Don Lee from Oak
16 Ridge and Roger Setz from INEL, but for their benefit
17 you should know that the opinions that I express are
18 entirely my own. They're not responsible for this.

19 (Slide Change.)

20 MR. KOCHER: I started -- I took a little
21 bit different tact on the problem. I tried to make a
22 list of what I thought we knew enough about already to
23 begin and I identified basically item 1 is in the
24 source term area. I thought we knew enough about
25 inventories and physical chemical properties of waste

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1 forms in the areas that I listed there. Notice that
2 low level waste is absent from that list.

3 In the transport area, I felt we knew
4 enough about atmospheric transport and transport of
5 surface waters, although there are some surface water
6 issues about partitioning between solid and liquid
7 phases and things like that. But in general, I
8 thought for purposes of assessing waste problems we
9 knew enough, and of course, this is a very short list.

10 Everything else in my opinion is open
11 season.

12 (Slide Change.)

13 MR. KOCHER: I have been a modeler in
14 previous incarnations and I'm probably going to lose
15 my union card by the end of this talk. But I want to
16 make some basic points so you know where I'm coming
17 from.

18 We write down model equations that we can
19 solve. Now this is obvious, but it is profound
20 because it immediately affects the way we think about
21 a problem. It constrains our concepts about thinking
22 about waste disposal issues because we immediately
23 write down an equation we can solve. And I think one
24 of Jane Long's messages from yesterday is that we need
25 to look beyond. Our conceptual thinking should not be

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1 constrained by the models that we can solve and I
2 agree with that and I'll make this point again later.

3 We'll never be able to model these
4 disposal systems precisely, so to me, the question is
5 how good is good enough?

6 We talk about models and data as if they
7 are somehow different, but I tend to think of them as
8 being largely the same in the waste area, because we
9 don't have models based on first principles for the
10 most part. So when we say we need better models, that
11 often means we need better or more data.

12 Item 3 I think is particularly important
13 in regard to decision making. Whenever we model a
14 waste disposal site, we are always going to have
15 significant extrapolations of information, either from
16 laboratory to field, from one site to another and one
17 that I didn't list there that's very important is
18 extrapolations in time, because we take a long time
19 horizon in the waste area. And because we don't,
20 can't write down the Maxwell equations for this
21 disposal system, the validity of any of these
22 extrapolations is always subjective and at any site,
23 including Yucca Mountain, the data will be sparse by
24 necessity.

25 I think Jane's zebra analogy is very apt

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1 for -- we just can't make Swiss cheese out of these
2 sites if we expect to put waste there. So sparse data
3 is a problem.

4 (Slide Change.)

5 MR. KOCHER: There has not been much talk
6 about this workshop so far about how standards
7 themselves can influence the kind of research that we
8 find we need to do. And I'm pretty big on the issue
9 of standards and how important they are. So I want to
10 make some totally off-the-wall statements here.

11 A lot of what's in our current day
12 standards in my view is basically unrelated to this
13 issue of long term safety. We have some things in
14 there that just don't really get at the problem.
15 Number one is this business of time cutoffs. Yeah, if
16 you go out in time, your uncertainty perhaps
17 increases, perhaps not, depends on how you look at the
18 problem. But I want to emphasize in my view a 10,000
19 or a 1,000 year cutoff like DOE uses in the low level
20 waste area today, these cutoffs are completely
21 arbitrary in regard to the safety of a disposal
22 system. They perhaps help you to make a decision down
23 the road, but I'm not so sure.

24 The concern about cutoffs in my mind is
25 two. First of all, it may distort the analysis that

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1 you do. If you have a time cutoff, you're always
2 looking for higher K_D s to make the problem go away.
3 Is this real? Is it not? I don't know. But to me,
4 the number one issue is that it can discourage full
5 disclosure of your state of knowledge of how this
6 system is going to perform. I think full disclosure
7 of your state of knowledge is essential in making good
8 decisions.

9 Drinking water standards is an ox that I
10 gore often and the fact that we have to limit the
11 effect of those from 0.3 mrem/y, anything above that
12 is seen as a threat to public health and safety, of
13 course, this offends the intelligence of every tree
14 stump in the nation.

15 (Laughter.)

16 But more importantly, it can -- there's
17 going to be serious money spent, I suspect, on trying
18 to solve the I-129 problem because of this constraint
19 and is that a wise use of resources? I don't know.

20 Another example that I sometimes point to
21 is there are important radionuclides missing from the
22 classification system in part 61 and this can skew the
23 way we look at low level waste.

24 A point that is rarely appreciated is that
25 our whole system of regulating waste disposal is based

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1 fundamentally on how we started regulating protection
2 of workers back in the 1930s. And so we have fallen
3 very comfortably into standards that are expressed in
4 terms of limits on individual dose and what this
5 requires, as was pointed out yesterday is you have to
6 estimate radionuclide concentrations in the
7 environment at specific times and this is a hard
8 problem. There are easier ways to do this and Bernie
9 Cohen is always asking how many people do you expect
10 to die from this activity? And when you regulate
11 based on individual dose, you can't answer that
12 question. So the standard just makes for a harder
13 assessment problem.

14 This doesn't really affect anything in the
15 way of research, but just to kind of give you a
16 feeling for how I think about some of these problems.

17 (Slide Change.)

18 MR. KOCHER: Now the next two pages are
19 sort of my own personal wish list and again, I did get
20 some input from the colleagues of mine that I talked
21 about. The number one, in my opinion, the number one
22 problem in the low level waste area by far is the
23 issue of what's in the waste. All the radionuclides
24 that bubble to the top when we do an assessment that
25 I listed here are very poorly known in most low level

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1 waste.

2 Why is this the most important issue?
3 Well, if we know what's in the waste, all of our
4 regulations set limits on the quantities of
5 radionuclides that can go into a shallow land burial
6 system and those limits, by definition preclude
7 catastrophic consequences of waste disposal. We can't
8 have really bad things happen because there's just not
9 that much radioactivity in the waste. And so it
10 lessens the need for more realistic models of source
11 term and transport, for example, but to the extent
12 that we don't know the inventory, we have our hands
13 tied behind our back when we do these assessments and
14 we really -- at Oak Ridge for many years, they tried
15 to estimate the inventory of Carbon-14 in waste by
16 doing measurements of external exposure rate of low
17 level waste package. Fairly amazing.

18 Moving on. Number two, chemical controls
19 on release. That's a general problem for any waste
20 and something that we've routinely ignored in low
21 level waste, but I notice it was in the research
22 program plan was the influence of microbes and
23 organics on releases from a low level waste site.
24 Because I guarantee they're there. In low level
25 waste, we basically don't know the chemical forms of

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1 many of the wastes.

2 Another problem particular to low level
3 waste, we model every disposal facility as if the
4 waste is in place homogeneously and that there's no
5 preferential flow of water through the disposal
6 facility, but of course, that's not the way a real
7 facility looks. The wastes are very heterogeneous and
8 we will have preferential flow paths, except in cases
9 like well, the salt stone facility at Savannah River.
10 I mean that's going to be a grout monolith if it works
11 and so you'll have cracks, yeah, but it's not like
12 putting barrels in a trench.

13 And the reason this is a problem in low
14 level waste is because we typically put our compliance
15 point about a hundred meters from the location of
16 waste and so you don't have a lot of environmental
17 buffer to kind of smooth out the inhomogeneous
18 behavior of the disposal facility before you get to
19 your receptor location, but we've never, in my
20 understanding, we've never really tried to understand
21 and model this phenomenon and see how important it is.

22 I think the rest of my remarks are sort of
23 on waste in general.

24 Number four, Mal Knapp talked about
25 yesterday and I think this is really important. I

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1 don't see that we've done very much work on what
2 happens when we have multiple contaminants and
3 multiple foreign substances in a waste repository of
4 some kind. We do all of our studies one substance at
5 a time. But what happens when you put 40 different
6 chemical elements out there and they're competing with
7 each other for whatever is going on? What happens?
8 Whether this is important or whether unusual things
9 would happen, I don't know, but I don't see a lot of
10 attention being paid to this.

11 (Slide Change.)

12 MR. KOCHER: Well, flow and transport of
13 the vadose zone is a clearer problem. How do you
14 determine moisture characteristic curves at specific
15 sites? Do we even know how transport depends on
16 moisture content? My understanding is that it could
17 either be inversely proportional to moisture content
18 or directly proportional to moisture content. Well,
19 that's a big difference. What is it?

20 (Laughter.)

21 Take your pick. This is a basic problem.
22 Flow and transport in fractured or highly structured
23 media; when you combine 5 and 6 together, it's not
24 even clear that we know what the conceptual model is
25 that we ought to be trying to describe for some of

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1 these things and I think that came through in Jane
2 Long's presentation yesterday where her student had a
3 new way of looking at the problem. Do we even know
4 what the right concepts are in these areas of complex
5 environments and unsaturated zone?

6 In the low level waste area we have tended
7 to take the unsaturated zone and throw it away.
8 Because we don't know how to model it, we take no
9 credit for it. We show compliance by assuming that
10 the release from the disposal facility goes right into
11 the aquifer and if we can meet that, we're fine, but
12 you know, Yucca Mountain is a different problem.

13 We've all talked about this. We all know
14 this before. Extrapolating laboratory data to field
15 scale and I just gave a couple of examples. We
16 basically don't know what the scaling relationships
17 are in many cases, but things like longitudinal
18 dispersivity are extremely important, say, in
19 addressing this iodine problem. Accelerated testing,
20 you all know this. And one that I'm probably totally
21 wrong about, I wonder if there have ever been any
22 serious field studies to investigate the validity of
23 Darcy's law and the linear sorption isotherm which we
24 all use. These things certainly work in the lab. They
25 certainly work in sand boxes, but I'm not so sure

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1 they've really been tested in the field.

2 We have preferential flow paths at many
3 sites and how do you interpret the kind of hydrologic
4 tests that we do in the field when you have these flow
5 paths. And underlying all of this is something we
6 talked about yesterday, I totally support. We
7 absolutely have to study historical disposal sites for
8 what they can teach us. That overrides all of this
9 stuff, except for what's in low level waste.

10 (Slide Change.)

11 MR. KOCHER: My charge, as I read it, was
12 to talk about how NRC would use research for their
13 purposes and so Ken, I did not borrow this from you,
14 but I completely agree with two points that you made
15 yesterday. In addition to getting data to use in
16 models, there are two fundamental things that NRC has
17 to do with the research and number one is getting at
18 this issue of what are the right conceptual models to
19 describe the behavior of different parts of a system.

20 And the more research you have, the better
21 you are able to constrain credible alternatives and
22 Bill Ott raised a question yesterday, what do you do
23 if you have several alternatives that you can't choose
24 between and my answer to that is you don't choose.
25 You address the consequences of both and you use both

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1 of those approaches to define your state of knowledge
2 about this system, what the uncertainty is. You don't
3 choose one or the other if you can't.

4 And to me, the investigate alternative
5 conceptual model is just a key to obtaining reasonable
6 assurance of safety. Now I worked on an IEA committee
7 several years ago where we tried to define different
8 elements of what went into reasonable assurance and we
9 had a list of about 15 or 20 different things that you
10 needed to do, but at the top of the list was that you
11 had to embrace the world of alternative conceptual
12 models and really follow through on it.

13 And number two, this was talked about
14 several times yesterday, we're going to end up with
15 extremely complex models of complex systems and
16 somehow we have to be able to still this down to the
17 essence of how this facility works and describe it to
18 the public in simple terms. If we can't do that, I
19 don't really think that we'll gain acceptance of
20 decisions for very visible projects like Yucca
21 Mountain.

22 This has not been much of a problem in the
23 low level waste area because in the DOE system
24 permitting of low level waste sites has kind of gone
25 under the radar screen. The commercial area may be a

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1 little different, but certainly for Yucca Mountain,
2 you're going to have to reduce this complex system and
3 its descriptions as something that is fairly simple
4 that captures the essence of this thing.

5 So I think these are really the two
6 important uses by NRC. They will, no doubt, have many
7 challenges in reaching a licensing decision, but I
8 would say the good news for the NRC, and I'm going out
9 on a limb here, the NRC will not be -- probably not be
10 the final arbiter in Yucca Mountain. I'm guessing
11 that the final decision about go or no go of Yucca
12 Mountain will either be made by Congress, the
13 President or the Supreme Court because whatever
14 decision NRC makes is likely to be challenged by
15 somebody, but the NRC has to make a confident, a very
16 confident decision with a good basis and what are
17 their challenges in doing this?

18 (Slide Change.)

19 MR. KOCHER: No matter what we do in the
20 way of modeling or site characterization, there's
21 going to be a substantial amount of irreducible
22 uncertainty in our knowledge of the outcome of these
23 activities and how to gain acceptance of -- as Mike
24 Ryan said, binary decisions, yes or no, go or no go,
25 in the presence of this uncertainty which we really,

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1 we can get a handle on some of it, but certainly not
2 all of it. This will be a challenge.

3 Budhi mentioned the unknown unknowns. I
4 think this is an important area of thought in high
5 level waste. How to take into account what it is that
6 we don't know and to remember that because we're using
7 geologic environments as our friend, hopefully, some
8 important issues of long term safety don't have
9 engineering solutions. We can't entirely engineer our
10 way out of this problem, I don't think. Unless we
11 just decide that the geologic environment is kind of
12 like a warehouse and we're going to store it some way
13 using an engineered system to store it. We could do
14 that.

15 Mike talked about this third point, how to
16 judge compliance with fixed standards when confidence
17 intervals at the end of the day are going to span
18 several orders of magnitude for sure. And I've seen
19 ideas in the NRC that well, we come up with a
20 probability distribution function and if the 85
21 percent confidence limit of that distribution is below
22 the standard, we're okay.

23 This is nonsense. You can't quantify this
24 decision by a rigorous statistical analysis. We are
25 not going to be able to make objective comparisons of

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1 model outputs with standards. There's judgment in the
2 modeling and there's judgment in the decision and the
3 question is how much technical support do you have to
4 marshal to make your decision, but you can't do it
5 objectively on statistical grounds.

6 (Slide Change.)

7 MR. KOCHER: There's been a lot of talk
8 about the realism versus conservatism and my thoughts
9 here were not well posed when I wrote this slide, so
10 I kind of want to backfill a little bit here.

11 I think conservatism in modeling is
12 essential, but as has been pointed out correctly, to
13 be confident that you've made a conservative decision
14 is not an easy problem. So I think what I believe
15 realism is about is gaining enough information on the
16 behavior of a disposal system so you can be quite
17 confident that you've made a conservative evaluation
18 of the system and that's not an easy problem, not an
19 easy problem at all.

20 I really get worried about people who
21 insist that the question we should be answering is how
22 safe is it? I think the question is is it safe
23 enough?

24 As Mike said yesterday, if our state of
25 knowledge suggests that the outcome is well below some

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1 standard, I don't really care what the outcome is.
2 It's good enough. Because I worry about when you get
3 into a court of law, how can you defend -- you may not
4 be able to defend a statement about "I know how safe
5 it is." I don't know. I'm probably being
6 unnecessarily alarmist, but I can't think of any other
7 NRC program and radiation protection that really tries
8 to answer the question how safe is it. Even in
9 radiation protection of workers in 10 CFR 20, we're
10 not estimating real doses to real people. Never have.
11 So this may be a slippery slope.

12 Scientific judgment underlies everything
13 we do in the waste business and we should never forget
14 that. It's how we establish the models. It's how we
15 establish the inputs and therefore, it determines the
16 outputs. We hope that this judgment is informed by
17 good science, but there will be limits to that. So
18 judgment is everywhere.

19 A point that was made yesterday, modeling
20 doesn't determine the outcome of this system. We have
21 to have the right concepts at the front end and as my
22 friend Gary Roles used to say, paper is not a barrier.
23 It just doesn't determine the outcome.

24 (Laughter.)

25 (Slide Change.)

1 MR. KOCHER: What do we have to do to
2 assure safety of this system and this is an idea that
3 I think has been -- I don't know whether I necessarily
4 support this, but I put this out because I think we're
5 clearly heading in this direction in our national
6 policies. I mean the only way to really ensure long
7 term safety is to maintain perpetual control over
8 these sites. I mean to start out today as if we're
9 going to watch them forever.

10 That doesn't necessarily mean we're
11 actually going to do it because a future society could
12 change its mind. But we could start out as if we do
13 this and when I read the EPA rule, Part 197, I think
14 that's in there, that you really have to have the
15 mindset that institutional control and monitoring is
16 a barrier. It's part of the multiple barrier system
17 and we should take it seriously. And so I would
18 support the idea of how to monitor long term
19 performance of a disposal system is an important area
20 for future research.

21 Are you all aware that we've already
22 signed up for perpetual care at Mill Tailings low
23 level waste and hazardous waste sites? We've already
24 agreed to do this. So why not Yucca Mountain as well?
25 The public would seem to favor that and the question

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1 is how to do it.

2 (Slide Change.)

3 MR. KOCHER: I'm getting just about to the
4 end here. This is sort of a summary of what -- some
5 of the things that NRC should be doing and I talk
6 about all of these issues.

7 Look at the performance of disposal
8 systems unconstrained in time. Forget 10,000 years,
9 forget 1,000 years. Yes, you have to meet the
10 regulations, but when you do an assessment to support
11 a license decision, to me, you have to bring the full
12 range of information to the table. You have to
13 express your state of knowledge completely and this
14 means going out in time however far you care to do.

15 I think there's work to be done on
16 developing ways to identify credible alternative
17 conceptual models compatible with existing data, but
18 unconstrained by the kind of models that we
19 immediately want to put on top of the data. I think
20 this is what Jane was talking about yesterday. This
21 is not an easy mental exercise to do.

22 Point 3, simple ways to describe complex
23 systems. The NRC is probably going to have to improve
24 its skills in communicating licensing decisions in the
25 presence of substantial uncertainty. I mean there's

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1 a lot more uncertainty about this than some of the
2 other licensing decisions they've made in the past.
3 Research on monitoring and performance and the last
4 one, I don't know whether NRC is doing this, but
5 especially for Yucca Mountain, I wonder if it would be
6 worthwhile to periodically engage in a serious mock
7 licensing exercise. Say "DOE, bring me a rock." And
8 really sit down and sweat bullets over whether you
9 would license this facility based on the information
10 you were given or not. Maybe you do that kind of
11 thing already, but this gets a point Mal made
12 yesterday about the limited quality of the
13 application.

14 (Slide Change.)

15 MR. KOCHER: I got this from Bob Budnitz.
16 Eminent geohydrologist, Robert Frost, I think hit the
17 nail right on the head. And you can just read that as
18 you wish, but I think there's a message here that we
19 do need to be fairly in awe of what we're doing here.
20 These are unusual ventures, unlike anything we've ever
21 tried to do and we're never really going to understand
22 everything and that we will achieve surprises along
23 the way and some of them will be good news. So be
24 serious, but be humble at the same time.

25 Thank you.

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1 CHAIRMAN HORNBERGER: Thanks, Dave. I'll
2 start this time.

3 Some of your first remarks struck me as
4 perhaps being in the vein of something that Mike said
5 yesterday, if you're not making measurements you're
6 making conversation, but your final slide seemed to be
7 for what NRC should be doing, seemed to be more
8 oriented toward what I might call paper studies. Do
9 I detect a disconnect there or not?

10 MR. KOCHER: No, I have wrestled a little
11 bit with the issue of what should NRC do versus what
12 DOE should do and my research wish list was really
13 without regard to who would do it and sort of toward
14 the end I was putting sort of the licensing hat on NRC
15 and saying the next to the last slide is really kind
16 of what, when they get into the licensing arena, what
17 should they do. I suppose there's a role for NRC to
18 actually get out and move direct and do some lab
19 studies and things like this, but I'm not really in a
20 position to say what they should do relative to what
21 DOE should do.

22 It's the question of what do they need to
23 be doing independently to help them review a license
24 application? An so the research that NRC does could
25 very well be different from the kind of research that

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1 DOE has to do to make their case. I don't know.
2 These are hard decisions, but there's not a
3 disconnect. NRC has unique needs because they have to
4 make a decision.

5 CHAIRMAN HORNBERGER: Okay, thanks. Other
6 questions?

7 MEMBER GARRICK: Have we got time for
8 them?

9 CHAIRMAN HORNBERGER: Yes.

10 MEMBER GARRICK: I just wanted to pick up
11 on a couple of thoughts because I think they're
12 important from a communication standpoint.

13 You said something about that you can't
14 make decisions based on statistics or statistical
15 analysis or whatever and I'm troubled by the
16 implication there because that sort of is implying
17 that they've been making decisions on the basis of
18 statistics, that is, the NRC or whomever. I think
19 there's a couple of points there. One is that I
20 sometimes think that people who are not heavily
21 involved in the risk business, for example, have a
22 conception that risk assessment is 90 percent
23 statistics and 10 percent something else. And it's
24 just the opposite.

25 The 90 percent is understanding what's

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1 going on and being able to characterize what's going
2 on in transparent models and logic diagrams and what
3 have you. And I think it's kind of important that we
4 always try to put that issue in context.

5 The other thing you said is, and I like
6 this, I like 90 percent of what you did say.

7 (Laughter.)

8 MR. KOCHER: My batting average has gone
9 way up.

10 MEMBER GARRICK: The other thing I just
11 wanted to comment on, you probably are correct, that
12 the proper question is is it safe enough? But
13 unfortunately, that's not our job. Our job is to
14 calculate the safety. That is our job. The decision
15 of whether it's safe or not is not made by us, not
16 made by the NRC. That's made by the citizenry. We
17 put our citizenry hat and we vote just like everybody
18 else as to whether that's enough.

19 So I think that the challenge here is to
20 do this in such a way, to calculate the safety in such
21 a way that that transition can be made rationally and
22 logically and you're absolutely correct that the NRC's
23 biggest challenge may be to come up with methods of
24 communication that enhance that whole process.

25 So that's just a couple of thoughts.

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1 MR. KOCHER: Yes. Let me respond to the
2 first one about the statistics. The key word there
3 was an objective comparison.

4 MEMBER GARRICK: Right.

5 MR. KOCHER: And I did not mean to imply
6 that the NRC has ever done this, but there was a kind
7 of a trial balloon about this in the low level waste
8 area and I just kind of wanted to shoot it down, that
9 an objective comparison of some probability
10 distribution function with a fixed standard is not the
11 decision. It doesn't dictate the decision.

12 MEMBER GARRICK: Yes.

13 MR. KOCHER: It's what went in at the
14 front end in your understanding of the system, so I
15 think we basically agree there and I don't see that
16 NRC would ever do this, but it's just a caution.

17 MEMBER GARRICK: I understand.

18 MR. KOCHER: I'll let it go at that.

19 MEMBER GARRICK: Yes.

20 CHAIRMAN HORNBERGER: John and then Ray
21 and then Mario.

22 John?

23 MR. WILSON: Yes, John Wilson. I want to
24 make a couple of comments and then get your response.

25 I'm sort of surprised having sat here for

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1 two days and being naive, I guess. I haven't bene
2 involved in this business in 15 years. When people
3 talk about conceptual models, alternative conceptual
4 models, that's what modelers do. I mean I've never
5 been in a job where there's been a fixed model or one
6 model and that's the only one that exists.

7 Models contain the essential features for
8 the system and the problem you face. And if you face
9 different problems, two different people working on
10 the same site with two different issues in front of
11 them might have two different conceptual models, both
12 equally valid for what they're doing.

13 And then that leads me to this issue that
14 you brought up and was discussed yesterday about what
15 is realism in a model. I guess it's whatever is right
16 for the problem you're investigating and the system
17 you're looking at, but does that make it possible to
18 have just one right conceptual model. And in my
19 experience there are clearly wrong conceptual models,
20 but I don't know that you'll ever find the right
21 conceptual model for a problem. You'll find a whole
22 family of them that can serve that purpose.

23 MR. KOCHER: Yes, I think the issue is to
24 constrain, in some way constrain the ones that do fit
25 the information rather than find the one. I would

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1 agree with that completely.

2 CHAIRMAN HORNBERGER: Mario.

3 MR. BONACA: I just was, first of all, I
4 appreciate the presentation because being a neophyte,
5 yesterday I was left to the question of where do we
6 have adequate knowledge and at least you offered -- we
7 had so many presentations identifying what the needs
8 are and I was still left with the question of where do
9 we have adequate knowledge.

10 Now when you presented a slide, the first
11 bullet, you pointed out that we have sufficient
12 knowledge of radionuclide inventories, physical and
13 chemical properties of waste forms.

14 Now later, you pointed out that for low
15 level waste that's not the case.

16 MEMBER GARRICK: That's correct.

17 MR. BONACA: And I was trying to
18 understand how could you possibly, given the source of
19 the low level waste, how could we characterize in fact
20 and develop adequate knowledge? Do you have any idea
21 of how that could be done?

22 MR. KOCHER: Well, it may turn out that
23 proper characterization of the inventory by itself
24 would solve a lot of problems because if you -- the
25 fact that the limit, the inventories are limited for

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1 shallow land disposal systems allows you to get away
2 with a lack of knowledge in a lot of other areas
3 because you just -- bad things just can't happen if
4 you don't have much radioactivity. But some of these
5 long lived ones, their environmental behavior could
6 very much depend on the chemical form.

7 I mean there is plutonium and Americium in
8 low level waste and I know enough by osmosis that the
9 environmental chemistry of plutonium is very complex,
10 so that in selected areas you may be able to gain some
11 knowledge, but I mean I have to repeat that I know
12 knowing about chemistry, but waste manifest, as far as
13 I know, you don't really have to have any information
14 about what's the chemical form of the stuff that's in
15 there.

16 MR. BONACA: And I imagine right now for
17 the incineration will bring many elements, just mixed
18 together in the incinerator, so it's very hard to do
19 the tracing --

20 MR. KOCHER: Well, incineration is
21 probably good because you get a -- you might often get
22 a predictable chemical form of a radionuclide that
23 way, but it's just a mixed bag of junk that we put out
24 there that good God, what's in it?

25 MR. BONACA: That's right. That's what

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1 goes into it.

2 Thank you.

3 CHAIRMAN HORNBERGER: Other questions or
4 comments?

5 MEMBER HINZE: I guess I would like to ask
6 about the -- your third bullet on what NRC should be
7 doing and develop waste that describe disposal systems
8 using simple models. I'll leave out "credible"
9 assuming that they will be credible.

10 That seems to me to be a very difficult
11 problem, especially in view of the complexity that we
12 see in our current TSPAs where many of us do not
13 understand all the subtleties that go into them.

14 How does one go about simplifying this so
15 that they are really understandable, even to the
16 entire Agency?

17 MR. KOCHER: Well, if I knew how to do
18 this, perhaps we wouldn't be sitting here.

19 MEMBER HINZE: Do you have any examples of
20 how we can start to approach that?

21 MR. KOCHER: No, because it depends on --
22 I think it's going to be a site specific, waste
23 specific thing. It would be different in the low
24 level waste arena from Yucca Mountain.

25 My general answer to that question is the

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1 same as I would respond to John on the question about
2 is it safe enough or how safe is it? We're going to
3 learn as we go here, but it really comes down, I
4 think, in the end to focusing on do you have right
5 concepts up front. I mean we've known for the last 40
6 years about how these systems are supposed to work if
7 they work well. We have a waste package. We have a
8 waste forum. We have dirt as our friend. And we have
9 to somehow distill all this information to show that
10 those basic components are doing what we think they
11 are. But is there a prescription that I can write
12 down for how to do this? No, no. I can't do that.

13 CHAIRMAN HORNBERGER: How about just to
14 push it just a little farther, take a specific
15 example. And I'll take one of the low level waste
16 sites that you've worked on. Did you -- were you
17 successful in coming up with a simplified way to
18 present results?

19 MR. KOCHER: Yes. Well, low level waste
20 disposal site at Oak Ridge was a good example, because
21 there the key was what was the behavior of water in
22 this very unusual environment and the fact that the
23 hydrologic regime there was fairly well characterized
24 and understood was really the key in identifying how
25 this facility would work, all things being taken

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1 together. Because we took very little credit for much
2 of anything else.

3 MEMBER GARRICK: I don't want to get into
4 this subject too deeply because it's something I've
5 been preaching for 7 or 8 years on this Committee that
6 we need simplified models, but trying to pick up on
7 Bill's question and speaking from experience, the way
8 we did this in the reactor field was through the
9 abstraction of complex models to simpler models that
10 were also very physics based in terms of the way
11 things were described and the way things were defined.
12 And it worked very well.

13 These simplified models, as a matter of
14 fact, have become the basis in many plants for
15 something approaching a risk meter for the plants.
16 And they've had a tremendous impact on -- if nothing
17 else, in elevating the consciousness of the operations
18 people of what's going on, somewhat globally, because
19 of their simplicity. And as long as you appreciate
20 that the simplified model is not the big model and
21 that the big model is not the plant and never forget
22 that, as we've been reminded several times, then these
23 things can be quite useful.

24 MR. KOCHER: Let me give an example that
25 I did think of. It's not waste related. It

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1 illustrates how this process works. We've been
2 studying the global carbon cycle since the 1950s and
3 the very first model of the global carbon cycle was
4 developed, it was a linear compartment model and it
5 had two boxes, the atmosphere and the oceans.

6 And right away this model was realized
7 that it could describe a lot of details about what the
8 global carbon cycle was doing and so over the years
9 the model got more and more complicated, more and more
10 detailed, but as the knowledge of the details of
11 carbon behavior in the environment increased, the
12 ability to develop a simple three compartment model to
13 describe this system increased to the point where
14 based on good understanding of the system we could
15 define an adequate simple model.

16 So I think really the answer to Bill's
17 question is as we develop the level of detail of
18 understanding of disposal systems, then the essential
19 elements will emerge that we can then use to have a
20 simplified description. But that's very site
21 specific.

22 CHAIRMAN HORNBERGER: Okay, thanks very
23 much, Dave. We'll move on to in our presentations of
24 what research is need and Kirk Nordstrom is going to
25 do our next presentation.

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1 (Pause.)

2 MR. NORDSTROM: How's that? Well,
3 normally one says it's a pleasure to be here. I
4 wasn't sure whether that was the case.

5 (Laughter.)

6 When I was first invited to come here, I
7 gave it serious thought because I didn't really want
8 to do it. I had spent a lot of time on the Board of
9 Radioactive Waste Management and that sort of did me
10 in. I didn't go all the way to alcohol, but also a
11 thought consideration. But when I learned that George
12 was Chairman, I said well that has a definite plus.

13 But actually, I have to say that I'm glad
14 I came and the reason is because of all the
15 presentations I heard yesterday and one this morning.
16 There's a consistent set of themes that's not hard to
17 figure out. It's running through these talks.
18 They're very similar and I think this is going to help
19 the ACNW in their deliberations. And that also helps
20 me that I don't have to spend more than the allotted
21 time to try and say what I want to say. I'm going to
22 have "something to say" messages. I'm just going to
23 beat them home in a different way, perhaps.

24 One comment for David, I liked everything
25 that you mentioned. I just was going to say in the

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1 USGS we have a lot of work going on in unsaturated
2 zone as well as saturated zone is a very complex
3 topic. Some of that work has been supported by DOE,
4 but not very much. I don't think any of it has been
5 supported by the NRC, but it's an important area. So
6 that's sort of the good news. The bad news is that a
7 lot of these points that have been made have been made
8 before, sometimes many years before. And it's
9 astonishing to me that it takes so long for some of
10 these points to strike home with the DOE.

11 So moving ahead.

12 (Slide Change.)

13 MEMBER HINZE: Could you clarify that?

14 MR. NORDSTROM: I'm sorry, I don't have
15 enough time. I would.

16 (Laughter.)

17 So the issues for this meeting are
18 radionuclide transport and source term. We have the
19 hydrology of the system. We have the geochemical
20 reactions. You have to know hydrology and then the
21 geochemical reactions are an overprint on that. They
22 may attenuate or sometimes enhance the mobility of
23 certain radionuclides and trace elements. We use
24 modeling to improve our understanding and hopefully
25 predictability of how the repository system will

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1 function.

2 Next, please.

3 (Slide Change.)

4 MR. NORDSTROM: Now I've drawn on quite a
5 bit of quotations from Naomi Areskes because among all
6 the people that I've met and talked to she articulates
7 some of these problems most clearly and again, this is
8 sort of repeating in a different way some of the stuff
9 that you've heard already. "In recent years, there
10 have been great advances in mathematical treatments of
11 complex systems and staggering advances in
12 computational power, but these have not been matched
13 by comparable advances in data from the natural world.
14 Like any chain of reasoning, computerized models are
15 only as strong as their weakest link."

16 Next, please.

17 (Slide Change.)

18 MR. NORDSTROM: This is, by the way, from
19 a book that I recommend to all of you called The Earth
20 Around Us, edited by Jill Schneiderman and she chose
21 that title because it mimicked Rachel Carson's title,
22 The Sea Around Us and all the chapters in this book
23 are excellent. Naomi's chapter is called Why Believe
24 a Computer? It seems a little bit appropriate for
25 some of the discussions going on in this meeting. She

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1 continues by saying "Without evidence from the
2 physical world, both as input to models and as a check
3 on them, we run the risk of constructing a
4 computational house of cards."

5 And I think this has happened, especially
6 with respect to radioactive waste research. "And
7 without discussion of the criteria by which we judge
8 our models, we run the risk of obscuring the profound
9 social issues at stake in the shadows of our edifices
10 of computational prowess."

11 (Slide Change.)

12 MR. NORDSTROM: So what can we do? Well,
13 one obvious consequence and this has been said before,
14 get more and better field parameters. How does the
15 actual chemistry, for example, I'm a hydrogeochemist.
16 I mostly do field work.

17 I also do modeling, but from my own
18 experience I know that if I want to understand how an
19 environmental system works, the only way is to get out
20 there, get my feet wet and muddy and make
21 measurements. I try to measure rates of reactions.
22 I try to see if solubility is really controls
23 something in the real world by getting as good a data
24 from the field as I possibly can and then I do
25 calculations, not modeling calculations to predict

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1 what something is going to happen in the future
2 necessarily, but to test hypotheses about processes
3 that are going on in a groundwater or sometimes in
4 surface waters.

5 So how does the actual chemistry change
6 along a flow path, for example and why. These are
7 questions that we struggle with in the survey. We've
8 had programs for many decades looking at both large
9 scale and small scale aquifer systems and we've
10 developed tools to help us interpret those.

11 Some of those have been used, but a lot
12 have not been used in the radioactive waste
13 environment and they should be.

14 To improve the reliability of the physical
15 and chemical data bases, this is the other part of the
16 input data. For example, for geochemical modeling,
17 you need thermodynamic data, sometimes you need
18 kinetic data. Thermodynamic data has been discussed
19 by a few people and some of that is known very well,
20 probably as well as we need to know it for the
21 purposes of regulatory requirements and understanding
22 solubility. It's things like uranium.

23 There's a whole book thermodynamic data of
24 uranium that I reviewed. It's evaluated the data very
25 well. There's another one on Americium. I believe

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1 there's one coming out or may have come out already on
2 Neptunium and these have been done by some of the best
3 experts in the world and they're fairly reliable. The
4 weak link here is that solubilities are one thing from
5 laboratory studies and evaluating thermodynamic data.

6 The other question is when this stuff
7 leaks and gets out, how does it react with a
8 particular ground water with a specific pH in
9 chemistry and so forth? Now that's sort of what we
10 study an awful lot of, but we haven't done so much of
11 that. When uranium actually gets out and gets in a
12 particular kind of aquifer, is it more mobile or less
13 mobile and what causes that?

14 And as was mentioned before, there's lots
15 of sites where this has happened, but it hasn't been
16 studied and monitored. Like there's a uranium plume
17 at Rocky Flats. That's a perfect place to find out
18 how fast and what are the reactions that attenuate
19 uranium in that environment. We know it's been
20 attenuated because there was nitrate solutions that
21 were poured into these solar ponds along with the
22 uranium solutions. The nitrate has far outpaced the
23 uranium, but we haven't quantified that difference in
24 partitioning, if you will, and what factors have led
25 to that.

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1 Next, please.

2 (Slide Change.)

3 MR. NORDSTROM: Model utilization is
4 another factor. We're using models, but why? Have we
5 developed criteria for the applicability of those
6 models? We need to think about that. We need to
7 think about when is a model likely to be useful and
8 when not. Which model should be used and why?

9 In some cases, there's a half a dozen
10 perfectly good models that will give you the same kind
11 of calculations, the same kind of results, given the
12 same initial conditions, but there are other models
13 that won't. Some models are built specifically for
14 sorption and work well for that and there's other
15 models that have been built for just speciation and
16 mass transfer reactions and are good for that.

17 The previous experience with the same
18 model indicate that the objectives will be achieved.
19 That's another way of looking at models and developing
20 this criteria for aquiferability.

21 Next, please.

22 (Slide Change.)

23 MR. NORDSTROM: Now here's -- getting back
24 to Bill's question and some of the discussion, here
25 are some other things that you can do to improve the

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1 applicability and to look at model evaluation. Have
2 an independent modeler, these are things that the NRC
3 could do -- have an independent modeler run the model
4 for the same conditions, say that somebody in DOE has
5 done, but apply his interpretation or even better,
6 have an independent modeler run a different model that
7 supposedly does the same kind of thing, say
8 groundwater flow or geochemical modeling for the same
9 conditions and see if he gets the same kind of answers
10 or not. Then you have the problem of well, if they
11 kind of match, are they right? They might not. They
12 might both be wrong. This is a problem with models.
13 If they don't agree, which one is wrong? Again, you
14 have a problem. You don't really know because you
15 don't know the truth. You don't know the final
16 answer, what you're after.

17 And this is sort of the problem when it
18 comes right down to it, it's a problem of science in
19 that we approximate, hopefully better and better, the
20 real processes in the world, but they are
21 approximations and we have this non-uniqueness problem
22 of a model and all we can say is hopefully the more
23 consistent the information is, say from different
24 models and different field constraints and laboratory
25 experiments that we do, hopefully, the closer we are

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1 to what the correct answer is.

2 So it's a matter of consistency and the
3 better you can hope to approximate reality or approach
4 better accuracy is by doing it more -- looking at the
5 same problem as many different ways as you possibly
6 can.

7 This one needs a little explanation, "use
8 standard reference systems to test models." I'll
9 explain what this means in geochemistry. I think most
10 of you are somewhat familiar with speciation. We know
11 that, for example, plutonium or uranium, uranium is a
12 good example, exists in many different ionic forms.
13 We know that in carbonate solutions, uranium is very
14 soluble and that's because uranium ionic forms a
15 complex with carbonate and tends to stay in solution.

16 How do we know the speciation models are
17 any good? Well, I've done a little bit of evaluation
18 of that. They're not real great. You can get
19 significant differences, especially for trace elements
20 sometimes, depending upon the thermodynamic data.

21 What we did back in 1979 is published a
22 paper in which we took seawater, average seawater
23 composition and we made up an average river water
24 composition and we asked about a dozen different
25 people who use speciation models to calculate their

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1 results and then we would compare them and discuss the
2 discrepancies. And we did that and most cases for the
3 river water example the results were pretty similar
4 because river water is very dilute and you don't get
5 much complexing going on.

6 It was a bit different for seawater, but
7 the point of it is that we set up two sort of standard
8 reference water samples that could be run through and
9 we encourage people if they build a new speciation
10 program, to run these standards through and see how
11 they compare with this round robin evaluation that we
12 did. Some people have done that. A lot of people
13 have ignored that. We've built some more standard
14 reference systems for groundwater since that time and
15 one could do the same thing for mass transfer
16 reactions. This would help us a lot in knowing
17 whether those kinds of models really have anything to
18 do with reality.

19 Next.

20 (Slide Change.)

21 MR. NORDSTROM: Vocab and meaning, this
22 gets to communication. There's been some discussions
23 on that. This is my personal opinion. Please delete
24 the phrase "model validation" from your vocabulary.
25 The reasons have been clearly stated by Naomi Oreskes

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1 and several other people, Andy Konikow, John
2 Bredehoft, a host of experts.

3 The problem is it gives the implication
4 that when you validate a model, the model is okay,
5 it's good, it's reliable and through the discussions
6 that we've had, that's not the kind of meaning or
7 connotation that you want to get across to the public.
8 And that's not really how science works, so please
9 encourage others to do the same.

10 Next.

11 (Slide Change.)

12 MR. NORDSTROM: The other thing and this
13 has been coming up in the discussions as well, it
14 would help to keep the distinction clear between the
15 testable hypotheses of science, that is, you might
16 develop a model for a groundwater system and then
17 predict what it's going to be like 10 years down the
18 road and then 10 years down the road, hopefully,
19 you're still alive and you can test it and see if
20 you're right or not. Versus the intestable
21 simulations from time forward modeling, scenario
22 building or whatever you want to call it over hundreds
23 of thousands of years.

24 As people have said, these are very
25 uncertain. We don't have any reliable way of knowing

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1 if those results are any good. This is not the
2 direction that we should be going. You all know the
3 history of how that's happened.

4 Next, please.

5 (Slide Change.)

6 MR. NORDSTROM: Now here's another one,
7 beware the model complexity paradox. Again from
8 Naomi, "... the more complex a model, the harder it
9 is to refute." This is a very important thing to keep
10 in mind. So we face a paradox. "The closer a model
11 comes to a full representation of a complex earth
12 system, the harder it is to evaluate it.

13 Put another way, the better a model is
14 from the point of view of the modeler, the harder it
15 is for others to evaluate it." I've seen this happen
16 time and time again. One of the first evaluation
17 committee meetings I was on regarding mine-waste,
18 there was a very sophisticated model that said that
19 arsenic wasn't going to move through this groundwater
20 system in a thousand years to hurt any drinking water
21 supplied downstream. And I consider myself pretty
22 good at knowing hydrology and geochemistry and I
23 didn't understand what these guys were talking about.
24 I didn't know the model. I asked them questions about
25 it. They couldn't really explain it and so we had to

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1 say, we don't know if this is garbage or not and the
2 end result is this is one of those intestable
3 simulations anyway.

4 So there's a trade off between
5 representation and refutability. There are limits to
6 how far we can go on this.

7 Next.

8 (Slide Change.)

9 MR. NORDSTROM: For low level sites, well,
10 some of this applies to high level sites too.
11 Hydrologic and geochemical measurements and modeling
12 can be done. A monitoring system can then determine
13 and compare real time series data with the modeling
14 predictions. That's the kind of information that we
15 need and we actually have done a lot of this in the
16 survey. A lot of people from academia have also done
17 this. This is a very straight forward use of science.

18 Apply young groundwater age-dating
19 techniques. There's a lot of work that's been done on
20 the CFCs and tritium and helium, improvements for
21 dating young groundwater as well. A lot of this stuff
22 has been done both in the survey and outside the
23 survey and they could be applied to low level sites
24 for getting a better handle on transport times and
25 we're just about slipping off the slide here, but I'll

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1 read it out.

2 The last one is an important one and Jane
3 Long mentioned this. Apply mass balance and inverse
4 modeling methods to sites where monitoring data is
5 available. In geochemistry, what this means is you
6 collect groundwater chemistry data, along a flow path
7 and then you know something about the mineralogy and
8 you back out of that what minerals must have dissolved
9 or precipitated to give the end results that you get
10 in your water chemistry and of course, the more
11 chemistry and isotopic data that you have, the more
12 you can pin down the processes.

13 Next.

14 (Slide Change.)

15 MR. NORDSTROM: And finally, we have to
16 accept the limitations of the real world. Naomi put
17 it like this, "Because of the heterogeneity of the
18 natural world, uncertainty is inherent in the very
19 nature of the systems we are studying."

20 Now this is hard to get across to the
21 public sometimes too, but we have to do this. We have
22 to be honest. "The required empirical input
23 parameters are fundamentally inaccessible, not because
24 our instruments are not sophisticated enough, our
25 budgets not big enough, or we are not clever enough,

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1 but because the data do not exist in a form required
2 by the equations at the scale to which we have
3 access."

4 Just a couple of more comments that I'll
5 make. First, just a footnote on this. I wouldn't say
6 that it's impossible to figure out all the
7 heterogeneities say in a groundwater system. You can
8 do this, but to do it you would make Swiss cheese of
9 the place. You'd have to get so many samples that it
10 no longer has the original hydrologic geochemical
11 properties that it did. So there's a little bit of an
12 analog to the Heisenberg uncertainty principle there.

13 I've been involved with natural analog
14 studies. I think these are extremely useful as people
15 have pointed out. I'm not sure of the extent to which
16 they have -- the information from that has been
17 synthesized, boiled down and then applied to the
18 radioactive waste disposal problems that we have. And
19 if that's been done, fine. I'm very glad. If it
20 hasn't, it urgently needs to be done because there's
21 a lot of very good information there and I'm not sure
22 it's all getting to the right people.

23 In addition, the natural analog data, I
24 would say we have these anthropogenic analog sites
25 that we've talked about: spills, leaks, uranium

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1 plumes. There's a lot of information, for example, on
2 plutonium and plutonium colloids that's been worked on
3 at Rocky Flats and Los Alamos and other places. Just
4 to mention that I was on the Rocky Flats Advisory
5 Panel for almost 3 years and one of the big
6 discussions that came up was with regard to the
7 distribution coefficient for plutonium. I'm sorry
8 that Greg Choppin is not here because he's been on
9 that Panel longer than I and has some very strong
10 opinions about that.

11 The problem was that they wanted to take
12 some distribution coefficient, put it in the RESRAD
13 and use that for regulatory purposes and we kept
14 trying to say that plutonium from every bit of
15 research that has been done, including research on
16 site in the field, it is extremely insoluble. And the
17 partition coefficient they were using didn't make
18 sense, didn't apply. And if you've tried to put in
19 something that maybe approximated it, it didn't work
20 in the program. We ended up wondering exactly what
21 RESRAD did and we actually had a whole meeting to
22 understand RESRAD.

23 But there was a conflict here between real
24 data, experimental data that's very, very reliable and
25 trying to use that in RESRAD and we kept saying you

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1 don't really have to use RESRAD. That's not the goal
2 here. But they said no, regulatory requirements say
3 we have to. And so we had a problem and I think maybe
4 this is typical of a lot of problems that the
5 requirements and the policies that are put into place
6 are not necessarily reflecting the real issues that we
7 want to deal with.

8 I'll stop there. Thank you.

9 CHAIRMAN HORNBERGER: Thanks very much,
10 Kirk. Questions and comments?

11 John?

12 MR. KESSLER: Kirk, you mentioned you
13 thought a lot of the thermodynamic data bases were
14 pretty good. Did those extend up to the higher
15 temperatures for Yucca Mountain, thermodynamic
16 temperatures, somewhat above boiling and there's a lot
17 of uncertainty there about whether there is a decent
18 thermodynamic data base up in that range for
19 everything that would need to be considered.

20 MR. NORDSTROM: That's a good question.
21 Above about 50 degrees the uncertainty increases a
22 bit. Above 100 degrees, the uncertainty of
23 thermodynamic data increases a lot and that's one of
24 many reasons why -- not just me, but the survey has
25 said that it would be much better to have the

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1 temperature limited to 100 degrees, rather than
2 something higher.

3 MR. KESSLER: Would it be just an
4 insurmountable obstacle to attempt to improve the data
5 base rather than decrease the -- look at it the other
6 way. If we had better data, is that better data
7 obtainable at any time soon with anything that's
8 possible with joint research programs or whatever, to
9 get some of the more critical data base there?

10 MR. NORDSTROM: There is some data and I
11 would say it's not that difficult to get more data,
12 say in the range of 100 to 200 to 250, even degrees.
13 That would easily be done. There are some very good
14 labs. There are some of the national labs have been
15 doing measurements in that temperature pressure range,
16 so that could be done.

17 I think the bigger uncertainty is with the
18 physical and geochemical aspects of the site itself
19 it's undergoing this high temperature change, so --
20 and I'm glad you brought that up because there's
21 another point that I want to make and that is you know
22 even in an unsaturated system like most of Yucca
23 Mountain, there is some water and there is going to be
24 movement of gases when you start heating this thing
25 up. Presumably some kind of convective cells may be

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1 set up, but geochemically, you're going to start
2 dissolving silica in some places and precipitating at
3 others. Likewise, you're going to dissolve calcium
4 and precipitate calcite in places.

5 There are some analogies to this kind of
6 a system in mineral deposits which people have been
7 studying for a very long time and again, this has been
8 pointed out a few times before, but we could use those
9 analogies to help us understand a repository
10 environment much better.

11 CHAIRMAN HORNBERGER: Bill?

12 MEMBER HINZE: Kirk, following up on that
13 and following up on your theme of lessons learned and
14 analogs and so forth, one of the severe problems, one
15 of the severe uncertainties I think is the coupled
16 process area and chemistry is paramount to that. Is
17 it possible that we can get a warm fuzzy feeling
18 regarding coupled processes by investigating some of
19 these other analogs? Are there lessons that we can
20 derive from studies of mineral deposits or radioactive
21 ore deposits, etcetera, that will help us with that
22 coupled process area? As a geochemist, I'd like to
23 get your ideas on that.

24 MR. NORDSTROM: The simple answer is
25 absolutely. There is a lot of information there. The

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1 people who have studied some of these natural analog
2 sites have considered the coupled processes. They
3 have to because they see, for example, zonation of
4 trace elements and certain minerals with distance that
5 has to do with a cooling effect of some high
6 temperature source.

7 And they've looked at groundwater flow
8 paths and how that relates to radionuclide migration
9 and there's -- I don't know how many natural analog
10 studies there have been, but I'm sure there's over a
11 dozen, world-wide. These are all in different
12 settings. Some are in granite, some are in
13 sedimentary rocks, some are close to the surface, some
14 are deep, some are at repository depth or depths of
15 say 400 or 500 meters, so there's a whole range of
16 conditions and in every case that I know of, they
17 brought in both a hydrologist, the geologist,
18 geochemist, geophysicist and so forth to understand
19 how this site operates.

20 And they've also done some things I didn't
21 like too much, but it's along the right thinking of
22 blind prediction tests where they analyze the
23 groundwater samples along the flow path for a range of
24 trace elements, but they kept the trace element data
25 secret, okay?

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1 And they told two or three or four
2 modelers to go out and model what ought to be the
3 uranium concentrations, nickel concentrations and
4 other things and then this one guy who had the data
5 would compare that, the modelers results with the
6 actual concentrations in the groundwater and there was
7 a criteria which was pretty reasonable that if they
8 agreed to within an order of magnitude then they felt
9 like they understood the processes.

10 That sort of testing is sort of helpful.
11 What I didn't like about it is the same problem as I
12 mentioned earlier, a model could have comparable
13 results, the real world data, but for the wrong
14 reasons. Maybe they were just doing mineral
15 solubilities, but in fact, attenuation had to do with
16 sorption. So that's the kind of problem you run into.
17 It's a start anyway.

18 CHAIRMAN HORNBERGER: John, you want to --

19 MEMBER GARRICK: Real quick follow-on to
20 that. Is this particular example amenable to inverse
21 modeling? Was there enough data to do that?

22 MR. NORDSTROM: Yes. I was involved in
23 one site, Pocos de Caldas in Brazil, and I did the
24 inverse modeling of that site and showed how it worked
25 and it helped us a lot in quantifying the relative

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1 proportions of minerals that were dissolving and
2 precipitating and what were the driving forces.

3 CHAIRMAN HORNBERGER: Ray.

4 VICE CHAIRMAN WYMER: I want to make an
5 observation which is perhaps obvious, but I've noticed
6 over the years people make good livings by stating the
7 obvious, so I'm not going to be any different.

8 (Laughter.)

9 It seems to me that there's some ambiguity
10 or possibility for some in the use of the model. Some
11 people mean it to be a very limited process. Some
12 people mean it to be like the TSPA which is certainly
13 not a very limited process. And it seems to me that
14 we ought to be a little bit more careful when we
15 discuss models and say what we mean by the word model.

16 That's it.

17 MR. NORDSTROM: Is that something that
18 people want to discuss or not?

19 (Laughter.)

20 Because I've thought a lot about it,
21 exactly that question too.

22 CHAIRMAN HORNBERGER: John?

23 MR. WILSON: I think that's an incredibly
24 good point. I tend to use the word model from a
25 conceptual point of view, not from the point of view

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1 of computer code, for example. Freak is not a model.
2 It's a code to me, for example.

3 (Laughter.)

4 But I was involved 15 years or 20 years
5 ago on some studies which were quite interesting that
6 you alluded to the concept that if you had different
7 people work on the same problem without talking to
8 each other, what kind of results would you see? Would
9 there be similar results or significantly different?
10 Is this some measure of uncertainty?

11 And what we discovered through that
12 process is that if you have almost no information, you
13 find that people come up with pretty much the same
14 model because if they're good engineers and
15 scientists, they go back to everything we all know and
16 that leads to pretty much the same kind of model.
17 Very parsimonious model, quite simple.

18 On the other hand, if you have an
19 incredible amount of information, you condition the
20 result so that everybody has to come with the same
21 result as well.

22 This in between where you have some
23 information, but not everything, in other words,
24 before you get to the Swiss cheese stage and then you
25 get complete variance in model results, everybody

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1 working with the same thing. The funny thing is if
2 you talk to modelers about whether they get the same
3 thing or not, no. They say things like I used the
4 finite difference model. He used the finite element
5 model.

6 Of course, we had different results. And
7 they misunderstand. They look at the numerical
8 methods and so on instead of the conceptual aspects.
9 It's a conceptual thing that the variance grows at in
10 this intermediate stage. And for most of the problems
11 we deal with, we're in that intermediate stage.

12 MR. NORDSTROM: That's a good point.

13 CHAIRMAN HORNBERGER: Kirk, I had a
14 question that I wanted to at least pose for you. You
15 outlined some things that you see as need doing
16 including getting, for example, better field
17 parameters and a host of other things. And I was just
18 wondering, do you have any thoughts on what the role
19 of the NRC is as opposed to other people who do this
20 kind of research should be and we'll set aside the
21 fact that the NRC should be funding the University of
22 Virginia and the U.S. Geological Survey and others.

23 (Laughter.)

24 MR. NORDSTROM: Yes, I thought a little
25 bit about that. It seems to me that the role of the

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1 NRC is a bit analogous to the role of regulators who
2 are licensing, permitting sites and dealing with
3 hazardous waste sites of a non-radionuclide type. And
4 some of these regulators that I know have some of the
5 same problems that I think the NRC has. And so my
6 recommendation is going to be very similar which is
7 that it seems to me that DOE constructs some kind of
8 a model or group of models and the NRC needs to
9 understand that.

10 They need to understand that to the point
11 that they can see the flaws in it, the problems with
12 the assumptions, and then that can be worked on.
13 That's why I put up that slide about get an
14 independent person, somebody who's independent say of
15 the DOE that the NRC asked to investigate a model and
16 its conclusions and how reliable and relevant they are
17 and use a different model to investigate the same set
18 of conditions and same problem. And make it real
19 clear, spelling out for everybody just what those
20 assumptions, what the differences in the model results
21 are and why and then how relevant is this to the whole
22 problem of licensing a site and so on.

23 And a lot of it is communication. It is
24 hard to understand a sophisticated model. Maybe
25 sometimes impossible. I mean you've probably

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1 encountered the same thing where somebody presents a
2 model that you should understand, but you don't and
3 you keep plugging away at it and that's what we have
4 to do. If we can't understand the model, then there's
5 no point in doing that work. It just shouldn't be
6 done. I think we can if we use the right kind of
7 approaches and right criteria for testing it.

8 CHAIRMAN HORNBERGER: Milt.

9 MEMBER LEVENSON: A question out of
10 ignorance, just because you mentioned hazardous waste
11 dumps other than radioactive. In the administration
12 of that program, do they -- what do they use as a time
13 of compliance? How long?

14 MR. NORDSTROM: You mean like at a Super
15 Fund site?

16 MEMBER LEVENSON: Yes, or just hazardous
17 waste dumps of any kind, municipal dumps, all the
18 others.

19 CHAIRMAN HORNBERGER: Dave is offering to
20 help you out here.

21 MR. NORDSTROM: Yes, go ahead, David.

22 MR. KOCHER: They have not wrestled that
23 bear for even one round yet. The way the law is set
24 up at the moment, you put the waste in the ground,
25 there is no calculation of any kind about what the

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1 long term impacts of this will be. You basically
2 monitor ground water and in 30 years you make a
3 decision about whether to watch the site forever or
4 let it go. But the kind of assessments we do in the
5 waste business have never been done for hazardous
6 waste.

7 CHAIRMAN HORNBERGER: John?

8 MR. WILSON: I think if you go back and
9 look at the original Super Fund act and the first set
10 of amendments, the idea was that you could clean up
11 these sites, that there was no long term issue because
12 at the end of the day it would all be gone and then it
13 was the obvious discovery over the last 15 or so years
14 that that's not the case. You're in this intermediate
15 stage where now people are just sitting on it. And
16 EPA and Congress has finally admitted that they can't
17 clean these things up.

18 MR. KOCHER: Well, I was thinking about
19 RCRA where you're deliberately putting new waste into
20 the ground. There was no -- they had some kind of
21 idea that they might be able to meet groundwater
22 standards if the facility were engineered properly,
23 but the kind of forward looking performance assessment
24 that we do in the radioactive waste business is not
25 done under RCRA.

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1 MR. NORDSTROM: Getting back to reality,
2 the answer to that question is coming out from trial
3 and error and hard experience. The Iron Mountain site
4 in California that I've studied a lot, a very nasty
5 acid mine water with very low pHs has been settled,
6 the beginning of this year, for \$862 million. The
7 settlement is such that all the EPA costs have to be
8 recovered now. The companies that have liabilities
9 spend some more money and they take a remaining \$500
10 million which is something that they start building on
11 and at the end of 25 years, if they have not
12 completely cleaned up the site, then they pump that
13 big chunk of money into it and finish it off.

14 That gives you some idea of the
15 complexities, how hard it is. They're not really
16 completely cleaning up these sites. They're not walk
17 away sites yet. At that site they have a
18 neutralization plan in that removes 95 percent of the
19 metal loading to the Sacramento River. But they don't
20 have the final answer.

21 At Summitville, they're in the process of
22 settling. They're almost done. They've admitted that
23 they can't completely clean up that site. It's a mine
24 site in Colorado and they've said that it may take 100
25 years which is sort of another way of saying they

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1 haven't got the permanent effects and they don't know
2 how they're going to do that. So that's how it's
3 coming out because they didn't have any time line.

4 MEMBER LEVENSON: I was thinking not so
5 much of the sites you're cleaning up, but if you clean
6 up a site, you move that stuff somewhere else like the
7 RCRA sites which are somewhat closer to the sites
8 we're talking about and the context of the question is
9 that the waste going into many of those sites, things
10 like lead and arsenic and cadmium have even longer
11 half lives than plutonium.

12 (Laughter.)

13 And from a standpoint of risk to society,
14 and diversion of resources, are we going too far with
15 de minimis risks compared to what we're doing
16 elsewhere.

17 MR. NORDSTROM: That's a very good point.

18 CHAIRMAN HORNBERGER: Is that a point in
19 need of research, Milt?

20 (Laughter.)

21 Okay, we're going to take a 15-minute
22 break and we'll continue 10 past 10.

23 (Whereupon, the proceedings went off the
24 record 9:54 a.m. and resumed at 10:10 a.m.)

25 CHAIRMAN HORNBERGER: The meeting will

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1 reconvene, please.

2 Okay, we're going to continue with our
3 presentations on needed research. And our next
4 presenter is John Wilson.

5 MR. WILSON: Now is it working? There we
6 go. We got all the buttons on it.

7 I actually wrote two talks for this
8 meeting. The first one is sitting in a hard disk
9 drive, on my desk at home, torn apart with the rest of
10 the computer that went down the other day. And then,
11 as I looked again over the agenda for what we were
12 supposed to be talking about, I reread the thing and
13 came up with a slightly different talk than what I
14 originally developed, which is more like the kind of
15 very good talks we just heard from Kirk and Dave.

16 There was a question in there that said
17 something like this: How can research be used to
18 develop the needed knowledge and technical tools? In
19 other words, the question I reread was not, what is
20 the important research? But, how can we used research
21 to develop the things we need? And I approached this,
22 then, a little bit differently.

23 I kept my focus on transport and source
24 terms. And since I know very little about source terms
25 -- I'm a groundwater hydrologist, by the way, with an

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1 engineering background, and I chair an Earth and
2 Environmental Science Department, so I do some
3 geology. But, I really don't know about source terms
4 in this kind of problem, so I'm going to focus mainly
5 on the transport part.

6 This, by the way, is a view of cesium-137
7 underneath the tanks at Hanford, if you're not
8 familiar with that. And this little gadget in the
9 lower right-hand side, to remind you, is the effect of
10 heterogeneity on fluid flow and transport --
11 multiphase flow, as a matter of fact; something that
12 we're quite interested in.

13 So, I asked the question, what kind of
14 knowledge and tools do we need? This kind of thing
15 we've been talking about, knowledge of processes --
16 physical, chemical, biological processes. We need
17 characterization and monitoring tools for doing any
18 number of these things; basically, gadgets and
19 methods. And we need modeling tools, to do synthesis,
20 data assimilation, and to prediction and decision
21 support.

22 For example, risk assessment -- the kinds
23 of things we've been talking about. I'm not going to
24 spend my time talking about these today.

25 Except, in the next slide -- where every

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1 time I push the space bar, the thing sort of spits
2 back at me here -- I want to mention my favorite
3 process studies, my favorite characterization and
4 monitoring studies and modelings -- Processes. You
5 keep hearing this. Trust me. Multiphase flow in a
6 fractured rock is something we know very little about.
7 And given that that is, in fact what goes on at Yucca
8 Mountain, I find the whole thing very disturbing.

9 Characterization. Scaling -- we know very
10 little about how to scale processes in time-space,
11 particularly scaling up from the measurement scale to
12 what we might use in a computer code or a model of
13 some sort, or the synthesis of measurements made at
14 different scales. This is true for the geochemistry,
15 for the flow physical parameters, and a variety of
16 other things. Biology -- if we don't understand it
17 very well for physics, we have no clue when it comes
18 to biology. So scaling is my second favorite topic
19 today.

20 Modeling -- quantifying and reducing
21 uncertainty -- particularly, this conceptual model
22 uncertainty. And when you throw in heterogeneity, I
23 really think of that as part of the conceptual model
24 issue, as much as it is a parameter issue. We really
25 need to do a lot of work on that.

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1 I have been on the NSF panel for some
2 years now reviewing proposals, and in all of this
3 time, we only had one proposal come in that talked
4 about trying to quantify model uncertainty, and do
5 something about it, to do an inverse problem on it.
6 And you know who that was? That was from somebody who
7 submitted a proposal to do parameter estimation.

8 And then after they were rejected, the
9 panel suggested that they retest this new idea. So,
10 they responded to the panel's request, in so many
11 words, and a year later came through with a proposal
12 that was funded.

13 There's not much work going on in this.
14 I know of two projects now -- Shlomo's project in
15 Arizona and the NSF-funded project at UCLA. It turns
16 out, in other areas of modeling, besides the one we're
17 talking about here, there is work in this field of
18 quantifying and reducing conceptual model uncertainty.

19 Okay. Well, here's the question, again.
20 How can research be used to provide the needed
21 understanding or knowledge and tools. And I'm going
22 to give you a very naive point of view. Although I
23 get lots of funding from DOE and others that has
24 something to do with the subjects here, I'm so far
25 removed from the practical side, I haven't thought

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1 about it in years.

2 But, 15, 20 years ago, I did a lot of
3 performance assessment modeling on all the salt sites.
4 And the last time I was here, 15 years ago, I was here
5 to show a videotape for the \$15,000 that NRC gave me,
6 of multiphase flow and fractures, to demonstrate my
7 hypothesis at that time that there were fast
8 multiphase flow paths through the fractures at Yucca
9 Mountain.

10 We showed videotape of little drips and
11 drops moving down through fractures. And that was the
12 last funding for that topic for ten years, until work
13 was done about five years ago on that same topic,
14 leading to the kind of thing that Jane talked about
15 last night. Fifteen years ago, nobody wanted to hear
16 that story.

17 So my naive point of view comes about from
18 the fact that I went on to other things. However, we
19 all know what really will work in this situation. We
20 wouldn't be here if this wasn't the problem. Notice,
21 that's not my handout.

22 (Laughter.)

23 MR. WILSON: Dollars -- if we had lots of
24 dollars, we could probably figure out what's the most
25 important research -- which you need to do anyway --

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1 prioritize it, and we could come up with a whole
2 scheme of different mechanisms to approach it through
3 contractors, through extramural funding to
4 universities through consortia, through all sorts of
5 things. But, in fact, you don't have much money, so
6 let's see what else we can do.

7 I'm going to break this up into two types
8 of research, what I'm going to call fundamental, God
9 forbid, "basic research". I don't mean that in the
10 sense that NSF means basic research. I mean it in the
11 sense that you've probably been talking about it here
12 as anticipatory.

13 And then, I'm going to break it into a
14 second category, which I'll call "site-" or "problem-
15 specific research". The second of these things is
16 sort of the thing I do as a consultant; the first of
17 these is the thing I do as a scientist and a
18 researcher. Okay.

19 Fundamental research is going to be on
20 processes, particularly risk-significant processes,
21 but also on characterization and modeling methods.
22 Building new computer algorithms, for example, might
23 fall into this category. It's the kind of stuff that
24 allows you to go in and do site-specific work,
25 problem-specific work.

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1 The kinds of problem-specific things you
2 deal with are conceptual model issues. How does
3 something work? What's going on, on this particular
4 site? It's not the process that you don't understand;
5 it's the site. And, it's all conditioned by what kind
6 of decisions you have to make.

7 You might call this confirmatory because
8 it's in the regulatory context that you have that
9 comes up in response to something that someone else
10 has brought to you. I'm going to talk first about
11 this fundamental research, and probably the term
12 "basic" is not the one I should be using.

13 Others, especially other agencies, are
14 sponsoring lots of this kind of work. Can NRC
15 leverage this? Yeah. We all know that. Can you rely
16 only on that? The answer is, no matter what somebody
17 else might tell you, no. And I think everybody here
18 feels that way anyway.

19 But why is it you can't rely only on this
20 work? A couple of reasons. One is, if you don't have
21 your own in-house expertise, you don't know what's
22 going on. You really can't understand what's
23 happening. And that is one of the reasons I'll bring
24 up below.

25 What should NRC do in this area of more

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1 fundamental work or anticipatory work? Keep enough
2 work here at NRC, and in the contractors, so that
3 you're on the leading edge. You know what's going on,
4 so that somebody's not informing you for the first
5 time about an issue, that you've recognized it on your
6 own.

7 For some of these most important issues,
8 I would say you want to be in a leadership role in
9 science. You're not. Curiously, if I go out in
10 hydrology, I don't ever see anybody from NRC there.
11 I don't see NRC contractors there. I'm on all sorts
12 of committees and consortia. NRC has no presence on
13 those things. Where are you guys?

14 If you're going to be involved in doing
15 this kind of stuff, if this is that important, you
16 should be in a leadership role. Where is it? I don't
17 see it. Some of your researchers are. Schlomo's in
18 a leadership position, but that's about it. And I see
19 Tom Nicholson from time to time.

20 What else should NRC be doing? Important
21 work that others are neglecting because they haven't
22 bothered to do it, or it's too hard -- that's usually
23 the case. It's much too hard; we heard some of that
24 yesterday. That's a good reason to work in those
25 things. It's important for the kinds of risk-based

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1 decisions that are being made here, and it's being
2 neglected for any number of other reasons.

3 And I heard yesterday about the EPRI model
4 of, work in those things, get it stimulated, get it
5 started, and bring others into it. Okay, make sure
6 that you're doing that. That makes a lot of sense to
7 me. So, the second thing here to do is important
8 research that is otherwise being neglected.

9 And the last thing I've listed down here
10 at the bottom, if you can see it, in terms of what NRC
11 should be doing is the thing we've heard all along the
12 last two days, is form various different kinds of
13 partnerships and consortiums. You've been doing a bit
14 of that, and you've lost some of it.

15 The Apache Leap site, an incredible
16 research site, theirs was some leadership. I guess I
17 haven't forgotten that. That's five years ago. I
18 mean, that's where NRC was leading things. It's gone.
19 Go back to that model.

20 Let me talk about a couple of these.
21 Interagency partnerships -- DOE has come out with an
22 initiative on the Vadose Zone roadmap. Sixty-two team
23 members, an executive committee, with, among people,
24 like Ed Weeks from the USGS involved, put together
25 this thing over the last year or so.

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1 It provides a science basis for funding
2 research and communicating with stakeholders to
3 address a lot of Vadose Zone issues, primarily related
4 to the kinds of things you're interested in. Some of
5 us see it as going way beyond waste disposal issues
6 and to general science issues related to the Vadose
7 Zone, and they're making a move in that direction.

8 It's an order of magnitude -- it hopes to
9 lead to an order of magnitude improvement over
10 existing technologies for Vadose Zone processes, which
11 are things like multiphase flow and fractured rock,
12 over about a 25-year time span. It's a long-term
13 planning exercise.

14 It covers processes, including strongly
15 coupled non-linear processes. It covers
16 characterization, including the development of new
17 sensors and the testing of conceptual models. It
18 includes mathematical modeling exercises -- a little
19 about what I'll talk to you about in a minute --
20 including the development of a new center at one of
21 the national labs, with its own big, giant computer --
22 because, if you do anything at the DOE, it has to have
23 at least one enormous computer associated with it.

24 (Laughter.)

25 MR. WILSON: I finally broke down and we

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1 put that in there.

2 It involves a lot of infrastructure and
3 technological support. And there's a website on your
4 handout.

5 One of those things being proposed -- just
6 one -- under the modeling area, is to develop a
7 problem-solving environment, a user-friendly,
8 integrated software environment for examining
9 subsurface flow and transport modeling. An example of
10 something like this might be Mathematica, MatLab, or
11 if you don't know about those things, something like
12 Excel. Something easy to use.

13 The problem here is, if you're working
14 with somebody from one of the national labs, they have
15 a code that does something. If you want to use it,
16 you basically have to go there for two weeks, train on
17 it, and maybe you'll assimilate it. Everybody has
18 their own little thing, and it's very difficult to do
19 easy problem-solving.

20 And so, the idea is to begin to integrate
21 all of that following certain protocols into one
22 enormous, but coupled, system. So it's bits and
23 pieces that can be brought together. You can add what
24 you need to it. There's a whole library of things
25 there, including data-assimilation libraries,

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1 visualization libraries, data management libraries --
2 all sorts of things.

3 It would unify the mathematical,
4 scientific and engineering idea in one framework,
5 allow for much faster testing of hypothesis and
6 evaluation of decisions, and inspire greater
7 confidence in those decisions.

8 The kind of thing we're talking about, our
9 proposal is, it would have aspects available over the
10 web to the public to allow this whole thing to go
11 easier. This is just one of those things in that
12 Vadose Zone roadmap, which, as you can tell, is rather
13 ambitious. But it's a 25-year plan.

14 Here's something else to consider. Former
15 university consortium in this area that we're talking
16 about, transport and sources, modeled on the NSF
17 Science and Technology Center; EPA Hazardous Substance
18 Research Center, some of which have been remarkably
19 successful; the NIEHS Centers, superfund centers that
20 pick little bits of the system and look at it for
21 superfund-related work.

22 I think there are lots of things. For a
23 few million bucks a year -- which is more than you
24 have, I found out --

25 (Laughter.)

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1 MR. WILSON: -- but for a few million
2 bucks, you can get a lot out of this. What can you
3 get out of such a center? You could have it focus, of
4 course, on an issue of special interest to NRC. As a
5 consortium, it would give you a large pool of people
6 available to work, only a small percentage of which
7 would be working on the center at any one point in
8 time. But, if a new issue comes along, you can go out
9 and grab faculty and staff from the consortium members
10 in the area that's new.

11 But, it also would condition those people
12 to think about NRC problems, so that it's on the front
13 of their minds and it gives you a resource that you
14 otherwise would not have.

15 It provides this enormous pool of talent
16 and can form the foundation for a center that can then
17 go out and seek additional funding. So, this center,
18 which you might give two-, three million bucks a year;
19 gets another half a million from EPRI, goes out; and
20 gets, oh, two million bucks from DOE in a way that is
21 not inconsistent with the mission to NRC; a million
22 bucks from the Army; half a million bucks from the Air
23 Force; two million bucks from the Navy. Before you
24 know it, this thing is a real deal, not to mention all
25 the private places it can go out and get money from.

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1 And, it can serve as a model for others
2 kinds of consortiums that NRC could sponsor in other
3 areas besides this transport area.

4 Let me go to site- and problem-specific
5 research -- I've finished with the anticipatory bit --
6 and take a look at things here. I didn't know how to
7 deal with this. I do this kind of research in
8 consulting, and it seemed to me that the kind of thing
9 the NRC does has some similarities but some
10 differences.

11 So, I asked myself some questions. What's
12 special about research and support of regulations?
13 That seems to be what you're conditioning on. And I
14 couldn't answer that question until I thought of some
15 examples. These examples may be entirely wrong. I've
16 never done a regulation. Actually, I used to be a
17 commissioner in the Commonwealth of Massachusetts, so
18 I have been a regulator, but all we were trying to do
19 was keep people from building houses in swamps.

20 (Laughter.)

21 MR. WILSON: Here's the first example I
22 came up with. And you tell me whether this is
23 reasonable. An issue is presented to the Commission
24 by some advocate -- and I'll say an advocate; if
25 somebody wants to do something, they're an advocate --

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1 where they take advantage of the gray of uncertainty
2 to shade it their way, okay.

3 We see the same thing in court cases. You
4 don't want to lie, but you want to make it look good
5 because you want to be successful. That's one
6 possibility. I don't know whether this happens but it
7 seems to me it's a reasonable expectation because it
8 happens all the time in the things I deal with.

9 The second kind of problem you might run
10 into is an unbiased view is based on data, methods,
11 such as modeling and assumptions, that are
12 inconsistent or weak. You look at them and you say,
13 the pieces don't fit together. You know, they've got
14 stuff in there that doesn't work. Or, quite frankly,
15 you look at it and say, well, it's not as good as it
16 should be.

17 How do you determine what to do about
18 these kind of situations, or even recognize that they
19 exist? And to do this, I had to go in and look at,
20 how is NRC unique. And before I could figure out how
21 NRC is unique, I asked myself the question, what the
22 hell does research do for regulators in the first
23 place? What do regulators do? So, I sat here
24 yesterday and I made this list up.

25 Research supports the development of

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1 regulations or the implementation of them by making
2 sure that whoever the regulator is understands the
3 industry they're dealing with. Okay, that's one
4 thing.

5 And then, it supports the ability of the
6 regulator to assess whether a licensee -- probably
7 misspelled -- is competent to assess whether the
8 facility is adequate for the purpose and safe, to make
9 sure it performs correctly. So that's this next one.
10 Constrain the licensee and facility to operate in a
11 safe and reasonable way. Rules, laws, things like
12 that. Investigate and learn from accidents and
13 failures, leading to changes in all of these.

14 Something that Mal Knapp said yesterday I
15 found interesting, which I absolutely agree with --
16 you want to make sure that the decisions made by this
17 regulator are robust in the presence of uncertainty.
18 So, anything in here is robust. Now, you probably
19 have your own version of all of this, so I'm just
20 relearning something.

21 So, if we look at NRC, how does the NRC
22 situation for sources and transport differ from the
23 sort of standard thing that FAA may deal with. You
24 have much less -- I say no opportunity here -- but
25 much less opportunity to learn from accidents and

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1 failures. If Yucca Mountain is a failure, first of
2 all none of us are going to be alive to determine
3 that. And secondly, it's really not going to be
4 allowed as a public policy issue.

5 And we've heard a lot of versions of this.
6 Planning for the future without experience for the
7 past -- we can't take advantage of those problems, and
8 that makes the decision perhaps necessary that they be
9 very robust. And that leads to over-conservatism in
10 the minds of some people for doing these things.

11 So, what do you do to deal with this
12 situation? I think you need expertise. It goes back
13 to the anticipatory stuff. You need to use the
14 knowledge you develop from fundamental research on
15 processes, characterizations and modeling, to develop
16 the ability to deal with these situations. You need
17 to, basically, train and prepare for it.

18 Your research has, as a very important
19 component of it, training people who are going to be
20 involved in dealing with these site- and problem-
21 specific kinds of things. If you're not doing that,
22 you're not doing your job. You need to do that so
23 that everybody's adaptable and flexible.

24 This is like training for war. You don't
25 want to go to fight the last war; you want to be ready

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1 for the next one. You train the troops so that they
2 can go out and deal with some new kind of feature that
3 may be thrown at them, some kind of new condition.
4 And that's where this anticipatory research really
5 pays off.

6 And then, you can do confirmatory
7 measurements, experiments, modeling -- all, perhaps,
8 incremental, learning from prior steps in doing this,
9 to investigate the kind of proposals or applications
10 that are coming to you.

11 But it still boils down to, the way to do
12 confirmatory work is, in fact, to do anticipatory
13 work. If you're not involved in developing the
14 research that is used to examine these things, then
15 how can you examine them? You're not going to be
16 prepared to do it.

17 Focusing particularly on confirmatory
18 research, I had a suggestion here. In many fields
19 that we deal with, it's difficult to fund or publish
20 confirmatory research. In hydrology, it's basically
21 impossible. This is the opposite of the situation in
22 medical science, where it's encouraged -- in fact,
23 demanded. Change that tradition, and NRC will get a
24 big bang for the buck.

25 Talk to other sponsors; talk to the editor

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1 of journals; change the tradition. Make it possible,
2 in fact encourage, to do and publish confirmatory work
3 on issues that are important to NRC. But then, of
4 course, everybody else would benefit.

5 In hydrology, if I measure something and
6 Kirk measures it a year later, that's too bad. Now,
7 my measurement could be wrong.

8 (Laughter.)

9 MR. WILSON: It doesn't matter. Of
10 course, all -- some of the dynamic rate coefficients
11 are wrong.

12 Focus on transport and source. Surprises
13 -- I heard several people mention this, and I think
14 surprises are a real big deal. The tanks out at
15 Hanford -- I don't know how well you can see this
16 little picture down here, but we've been excavating
17 plastic dykes under these -- not under the tanks,
18 thank God, but they are under the tanks and they're
19 all around that area.

20 Plastic dykes are a geological feature
21 that could have profound hydrologic consequences,
22 particularly for the movement of fluids and waste. And
23 nobody bothered to deal with them until now. I call
24 that a surprise. And, you go to K25 at Oak Ridge
25 It's built on carst and nobody, in dealing with

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1 conceptual models at Oak Ridge, said, geez, carst.
2 Duh -- that's different. It has holes.

3 The conceptual models at K25 thought of it
4 as a porous media. That's really not a surprise.

5 CHAIRMAN HORNBERGER: Don't say what it
6 is.

7 (Laughter.)

8 MR. WILSON: But anyway.

9 I don't think multiphase flow and
10 fractures at Yucca Mountain is a surprise in five
11 years. I mean, this is something that should have
12 been anticipated. But anyway, what do we do about
13 that? Surprises and disasters? Somebody could say,
14 let's do so much research that there are going to be
15 no more surprises ever again. Not possible.

16 There are going to be surprises, and the
17 reason for doing anticipatory research is, among other
18 things, the develop the ability to handle surprise
19 smoothly. Something goes wrong, you don't say, oh
20 shit, that's it -- we're finished. Don't record that,
21 by the way.

22 (Laughter.)

23 MR. WILSON: Okay, who's doing research on
24 surprises? I don't know. Every time I ask somebody
25 who should be doing work in this area, they look at me

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1 like I'm an idiot. You know, how can you do research
2 on a surprise? And I've labeled disasters in that, as
3 well.

4 There is research going on in the science
5 of predictability. The ability to predict -- it's
6 related to things like chaos theory and the like,
7 particularly in the climate. And I think there's some
8 close relationships to that.

9 Since accidents and failure play a large
10 role in the evolution of knowledge in a regulatory
11 environment, and the NRC can't wait for these
12 accidents to occur, how do you compensate for that?
13 This is the serious side of conceptual model
14 uncertainty. This is why I feel conceptual model
15 uncertainty is a much bigger problem than parameter
16 uncertainty because this is where you get hit with
17 surprises.

18 An additional reason for training,
19 preparation, adaptation and flexibility -- by the way,
20 this is where you lose credibility. Let me give you -
21 - do you have enough time for one quick war story?

22 I had a graduate student a few years ago
23 that George knows, Jaimin Won, who did a study on
24 colloids and the behavior in multiphase flow, the
25 attachment of colloids to gas-water interfaces in the

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1 Vadose Zone. It's a great piece of work.

2 Well, I get a call from a guy named
3 Naretniks, who some of you may know, who wants to
4 visit and learn about all this work. And he comes
5 into her new lab at Lawrence Berkley, and my labs.
6 And we talk about this.

7 He spends about two weeks visiting us over
8 and over again, and it turns out that there's a
9 concern in Sweden, at least this was two years ago or
10 so, now. And that is, when they're going to put
11 nuclear waste in these deep granite batholiths and let
12 them reflood. They'd be under water table, except
13 they're dewatered right now. And when those things
14 reflood, they're going to have a saturated zone
15 disposal site.

16 They're going to have a cask of some kind
17 buried inside of Bentonite, sealed inside the room.
18 Does anybody know about this particular proposal?
19 Okay, if I go wrong, straighten me out. And so, here
20 was the scenario. Eventually, water was going to
21 corrode the outside cask, which I believe is steel --

22 AUDIENCE: Copper.

23 (Laughter.)

24 MR. WILSON: Copper -- and then get to the
25 inside cask, which is steel. Right? Did I get that

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1 right?

2 MR. NORTH: Yes, over a very long time.

3 MR. WILSON: Over a very long time, okay.

4 So here is the issue. It breaches the cooper, gets to
5 the steel; the steel corrodes, releases hydrogen gas;
6 the hydrogen gas bubble builds up; eventually, it
7 builds up enough pressure, it hydrofracts through the
8 Bentonite, up through the cracks, and you release gas.
9 Okay, no big deal. Except now, the Swedes are
10 thinking Bentonite, and water and bubbles and bubbles,
11 Bentonite; Bentonite attaches to the bubble surface --
12 because we talked about colloids as attaching to -- so
13 as the bubbles rise, they're carrying Bentonite
14 attached by forces, various forces, various
15 interactive potentials, on the surface of these
16 bubbles.

17 So, we're now eroding and carrying
18 Bentonite right up to the surface real fast. And
19 then, Bentonite absorbs plutonium. And so, you have
20 an elevator carrying the Bentonite to the surface.
21 That's what Neretniks was quite interested in. And he
22 had gone and made a big deal back in Sweden; this was
23 important, something to do. There's a surprise for
24 you.

25 The biggest surprise was about five weeks

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1 later, there was an airplane flying to Zurich, and
2 there was a guy from Sweden next to me and he was
3 reading a newspaper and I looked at it. It looked
4 sort of strange; it was a Swedish newspaper, stranger
5 letters and stuff --

6 (Laughter.)

7 MR. WILSON: -- and I asked him -- there
8 was something on there that struck me. And it was an
9 article about this whole issue, and the proposal that
10 had come up from the scientific community,
11 particularly Neretniks. And there was a furor in
12 Sweden, apparently. And the furor was basically, gee,
13 you guys told us you knew what you were doing. But
14 you don't.

15 Here, you want new money to do some new
16 work on something you had no clue about last month,
17 last year, and now you want us to give a whole bunch
18 of money. What's going to happen next year or the
19 year after? What other surprises have you for us?

20 Somehow or another, you have to build into
21 this whole thing the ability to deal with surprises.
22 I think it's an incredibly important thing, and we
23 don't do much research on it because we can't figure
24 out what to do. You know, I don't know what to do on
25 it, but I do know that we have to be prepared to deal

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1 with it. That's where the training aspect comes into
2 play. But I'd like to actually do some science on it.

3 And the last thing I'd like to ask, and
4 this is because I'm incredibly naive, is, whose job is
5 it anyway, when you have an applicant come to you for
6 something? It's always easier to disprove a
7 hypothesis than to prove it. So, if I'm coming in
8 here with a proposal -- maybe this goes to the issue
9 of, not how safe is it, but is it safe enough?

10 If I come in here with a proposal, I'm
11 really in a position where I have to prove it. All
12 you have to do at NRC is show that it's broke. I don't
13 have to dissect it. If I can show that it's broken up
14 and it ain't going to work, that's all I have to do.
15 That's an advantage because you don't have to do
16 research on everything. You have to just be able to
17 identify the broken bits and pieces, or the main
18 broken bits and pieces.

19 An example is Yucca Mountain. Water will
20 not flow in fractures until the surrounding matrix is
21 saturated. The USGS -- I hate to say this -- research
22 program -- even the NRC research program on Apache
23 Leap designed every experiment that the only way you
24 could get water in through that experiment is through
25 the matrix. The fractures never flowed because of

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1 capillary forces until the matrix was saturated. If
2 you just poured water on the top of the darned thing,
3 water would go right down that fracture to the bottom
4 of the experiment.

5 But that's not the way those experiments
6 were designed. They were designed to support the
7 hypothesis and prove it -- but it didn't prove it; it
8 just supported it -- that the fracture will not blow
9 until the matrix is saturated.

10 A slightly different design would have
11 done something completely different, in which what I
12 think is going on at Yucca Mountain today, and for
13 which we've seen a lot more evidence, both laboratory
14 experiments and otherwise.

15 Design defining experiments. Go in and
16 test applications for the defining elements. We do
17 that. We talked about it. Sensitivity analysis is
18 one of those aspects used to get at this. But
19 surprisingly, to me, we don't take advantage of this
20 enough, and to do that, to focus on those defining
21 experiments, assumptions, data, measurements and
22 models, you've got to go back and have that foundation
23 in anticipatory research.

24 That's the bottom message. Thanks.

25 CHAIRMAN HORNBERGER: Thanks, John -- a

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1 lot to challenge all of us, I think, at the NRC.
2 Questions? Comments?

3 (No response.)

4 CHAIRMAN HORNBERGER: John, I'm curious
5 about -- I'll do it in two parts. I'm curious, first
6 of all, about the status of the Vadose Zone roadmap.
7 Is it likely to come out of DOE any time soon, in your
8 opinion?

9 Number two, how do you think the NRC might
10 be a player in that? It's pretty clear, I think, if
11 you looked at the radionuclide transport research
12 plan, that some of the same questions come up,
13 obviously, for the NRC.

14 MR. WILSON: The Vadose Zone roadmap -- as
15 matter of fact, I left here yesterday for a half an
16 hour. We had a conference call with the executive
17 committee. What we were addressing was our request to
18 the Academy to review that roadmap. So, that request
19 -- and it's already been gone over with the Academy
20 staff, and it was just to finalize the wording. So,
21 that's going in for review status.

22 I think the roadmap initially came out of
23 DOE in the previous Administration. And that has
24 something to do with the fact that the pace has slowed
25 up a little bit right now. So, that's going forward

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1 for Academy review and I'm not sure what the support
2 at DOE is because that's been evolving under the new
3 Administration.

4 It's to be an interagency thing, so
5 participation by NRC would be very interesting, even
6 if it's just to attend meetings and suggest where
7 priorities lie.

8 I think if you looked at the agenda for
9 that research project, I think it would fit very
10 closely into what NRC's interested in. And, although
11 it's labeled the Vadose Zone Project, and it does have
12 that Vadose Zone focus, a lot of the work that goes on
13 has spin-offs, I guess, in other areas. Not just
14 hydrology and contaminant transport, but other areas,
15 as well.

16 MEMBER HINZE: Is the NRC involved in any
17 way at this point?

18 MR. WILSON: No. Many other agencies have
19 been involved in putting it together, but nobody from
20 the NRC participated.

21 MEMBER HINZE: You mentioned
22 predictability, and that seems to be a recurring
23 theme, and the need to avoid surprises, if at all
24 possible, and that's part of the predictability
25 situation.

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1 You mentioned the use of chaos theory and
2 non-linear dynamic systems. Is there research going
3 on, on this in the subsurface realm, and what kind of
4 progress is being made?

5 MR. WILSON: Not much research is going
6 on. In fact, it's part of the Vadose Zone roadmap, to
7 invest some additional resources in that area, and
8 that's principally because in the Vadose Zone, and
9 particularly in fractured rock, there is reason to
10 believe there is chaotic behavior in the flow system,
11 not to mention transport.

12 And that's based, among other things, on
13 some unsaturated flow tests done up at INEL by
14 Lawrence Berkley Labs and some INEL people, where
15 there's clear evidence of chaotic behavior in the
16 flow. And you can think of the little pools that have
17 to spill, and then another one, and you're sort of
18 like, come on; cascade on down.

19 And that's one area. But quite frankly,
20 over most of subsurface hydrology, there's little
21 evidence for chaotic behavior, outside of that kind of
22 thing, so there's a need for studies like that and an
23 emphasis on that, but it's not probably the dominant
24 behavior. There's a reason why chaos theory wasn't
25 discovered by groundwater hydrologists.

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1 (Laughter.)

2 CHAIRMAN HORNBERGER: John.

3 MEMBER HINZE: I thought you were going to
4 tell us what it was.

5 MEMBER GARRICK: One of problems that
6 problem solvers, or people that have to make a
7 decision -- one of the problems they have with
8 researchers is that the researchers never admit that
9 the problem is ever solved.

10 We've talked some about this business
11 about how much is enough. And there hasn't been a
12 great deal said about the kind of analysis you need to
13 go through to define a research program.

14 Coming from the world of modeling complex
15 systems -- primarily engineered systems -- and
16 thinking about your comments about surprises, one of
17 the fascinating lessons learned in the application of
18 probabilistic risk assessment to nuclear power plant
19 safety was the pinpointing of some of those surprises.

20 And also, more important to me was the
21 revelation that there's a lot of things, technical
22 questions, that you don't need to know very much about
23 in order to solve the problem, in order to make a
24 decision, which is what the NRC has to do, is to make
25 decisions.

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1 An example I've used many times is, when
2 we started taking a serious look at the impact of
3 external events on safety and started developing the
4 kind of seismic information that would allow one to
5 transform this into a probabilistic format; and
6 started to get seismic risk curves of specific sites;
7 and were able to calculate the frequency and magnitude
8 of different earthquakes, we began to really put some
9 focus on how important it was to continue to study
10 seismic events. Because we found out in many cases,
11 for example, that we could tolerate seven orders of
12 magnitude of uncertainty in the contribution of
13 seismic events to reactor safety because it didn't
14 make much difference whether it was seven orders or
15 two orders, because we had a pretty good idea of what
16 the end points were of these distribution curves.

17 What I'm really getting to is, as I listen
18 to the researchers, I don't -- it seems as though
19 there is not a real connection between the research
20 that needs to be done and the guidance that comes from
21 the decision-making world of when you have done
22 enough.

23 And, you know, if I were an outsider
24 sitting in this room the last two days, I would walk
25 away from the room thinking we are hopelessly in a

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1 dilemma with respect to ever making a decision on
2 something like Yucca Mountain because of all the
3 uncertainties. And, of course, I don't believe that's
4 true.

5 I guess I'm really concerned that we have
6 not done a very good job, in my opinion, of focusing
7 on this issue of defining a research program and
8 defining what we need to do. You said that you need
9 to do research to define the experiments, the
10 assumptions, the data, the measurements and models,
11 and that leads us back to anticipatory research.

12 It seems to me, we need something up front
13 that's a frame of reference that sort of tests how far
14 we need to go in these areas. One of those frames up
15 front, and I keep coming back to it, that's been
16 enormously beneficial to us in the reactor safety
17 field has been a large-scope risk assessment. And the
18 pay-off has been marvelous. The pay-off has been in
19 the bottom line.

20 Twenty years ago, there were no U.S.
21 plants on the top ten list in the business of
22 performance of nuclear power plants. Now we dominate
23 it. And while risk assessment hasn't been the primary
24 reason, it's been one of the major reasons because
25 it's focused what the real issues are.

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1 We now know the role of different
2 contributors to risk, when we did not know before. We
3 now know what kind of contributions we're getting from
4 our different mitigation systems. Before we did not
5 know. And I'm sensing here, on Yucca Mountain in
6 particular, and on what NRC is up against, that, you
7 know, the performance assessments are a step in the
8 direction to provide us with this, but I don't see the
9 researchers doing a very good job of making a
10 connection to what I would call a global model here
11 that's going to test the validity here of what is
12 being suggested.

13 I know that's a tough thing. But in the
14 interest of looking for convergence and in the
15 interest of realizing that the only reason we do
16 research, the only reason we do risk assessment and
17 the only reason we're here is that somebody has to
18 make a decision. And the more I listen to this, it
19 sounds like a totally open and weakly constrained
20 system. There does not seem to be a template here
21 that forces some sort of convergence. And I think the
22 NRC needs that.

23 MR. WILSON: Well, first of all, I'm
24 fundamentally an engineer and done a lot of
25 consulting. And there's always enough information to

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1 make a decision. You know, no matter what it is, if
2 you have to make a decision, you have enough
3 information.

4 That's not NRC's position, I realize, but
5 I'm simply saying that if you go out into the real
6 world and ask a lieutenant over in Afghanistan who has
7 to make a decision, now, what he's going to do; is he
8 going to wait for more information? The answer's no.

9 We always have enough information. The
10 question is, what do we do with that information in
11 terms of making a decision.

12 Researchers live in a whole different
13 world. You're absolutely right. And I don't think
14 you should expect them to necessarily do what you just
15 said. That comes into the response side of, what do
16 you do with the research once you have it kind of
17 thing.

18 In that last slide I had -- would it be
19 possible to put that up?

20 I'm not saying it's the answer, exactly,
21 to your question. But what the research does is
22 prepare you to deal with that issue. It is not that
23 you do the research only with that issue in mind; if
24 you don't have anticipatory research -- I know this is
25 not what NRC wants to hear -- that looks at things

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1 that may become important or might become important,
2 then when a surprise occurs, you're not ready to deal
3 with it.

4 MEMBER GARRICK: Yeah, then let me tell
5 you what bothers --

6 MR. WILSON: Let me just finish one thing.

7 MEMBER GARRICK: Yeah.

8 MR. WILSON: That is, you want to be able
9 to go in when something like this comes up and be able
10 to do defining experiments or tests or models that
11 allow you to determine whether what is being proposed
12 makes any sense. I'll throw it out from DOE's point
13 of view -- and I've worked on performance assessment
14 for DOE.

15 Too many times, it was due to the
16 performance criteria are not met; change the
17 conceptual model. That's one of the reasons BWIP died
18 years ago because that was actually in their -- in the
19 loop of how they were going to make decisions. Change
20 the conceptual model if you don't meet your
21 performance assessment criteria. It doesn't make any
22 sense.

23 What we have seen in Yucca Mountain and
24 other things is an approach to engineering those
25 systems, as if it were building an airplane. If we

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1 can't make it fly with this element, we'll add another
2 element to it.

3 The idea of rejecting Yucca Mountain has
4 been so low on the priority list at DOE, in my opinion
5 -- and this is speaking out of a large degree of
6 naivete, I admit -- it's been so low in the priority
7 list that everything's designed to make it work.

8 And the reason we're in trouble on Yucca
9 Mountain is we've spun our wheels a lot trying to make
10 it work without making sure that it was done on a
11 sound scientific and engineering basis. In other
12 words, we didn't allow the possibility that it would
13 fail; therefore, we never really were able to do a
14 good, objective job on it until more recent years.
15 And I think that's where the problem lies.

16 MEMBER GARRICK: Well, the only analogy
17 I'd give, and then I'll stop, is that when we first
18 started to utilize the reliability technologies in the
19 safety field, of course the first thing everybody
20 thought of was data, and the first thing they all
21 tried to do was go out and define a comprehensive data
22 program.

23 In most cases, it turned out to be a
24 disaster because the guidance for what constitutes a
25 reasonable data program was also very weakly

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1 constrained, and so they tried to do everything. And
2 all the budgets and all the money and all the
3 enthusiasm was consumed in trying to get a database to
4 support the kind of analyses they wanted to do.

5 When they started doing the analysis
6 first, when they started trying to calculate what it
7 is they were interested in calculating, then they
8 began to bring some focus on what the data
9 requirements really are. And it was a remarkable
10 change that took place. And if you look at where the
11 reliability projects have been most successful, they
12 have been where it was preceded by a very genuine
13 attempt to calculate, on the basis of the information
14 that existed, the parameters that you were interested
15 in.

16 And that's what I'm sort of missing here,
17 is there does not seem to be anything effective and
18 scientifically based to telegraph what we really need
19 in the way of research.

20 And while all these brilliant researchers
21 are here, we want to press you into sharing with us
22 your experiences on how this is done because I don't
23 think we'll get anywhere in terms of a defensible and
24 high-quality research program until we somehow, up
25 front, have some sort of mechanism to keep us focused

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1 and to keep us from trying to solve all the problems
2 of the world.

3 MR. WILSON: And I thought that's what we
4 heard from David.

5 MEMBER GARRICK: Yeah, and they did. Dave
6 made the comment that you kind of do it as you go
7 along.

8 MR. WILSON: Yeah.

9 MEMBER GARRICK: As a matter of fact, the
10 "Rethinking Radioactive Waste Management" document
11 that was written many years ago had that theme, as
12 well. And I think that, as a theme, is rational. But
13 we're kind of way down the road here, and I'm just
14 curious as to just, given the circumstances that we
15 face, how do we do this? How do we rationally evolve
16 a research program on the basis of where we are and
17 what should be the guiding light in doing that.

18 CHAIRMAN HORNBERGER: Okay. We have a
19 bunch of questions. I have Budhi, and then Ray, and
20 then John Kessler.

21 Budhi. You need a microphone.

22 MR. SAGAR: Come over there?

23 CHAIRMAN HORNBERGER: Wherever a
24 microphone -- wherever you can get to a microphone.

25 MR. SAGAR: Well, I had a real question,

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1 but before I get to that, I want you to comment, John,
2 on your comment on BWIP.

3 MR. WILSON: Uh-oh -- a BWIP guy.

4 (Laughter.)

5 MR. SAGAR: And there is another one here.

6 (Laughter.)

7 MR. SAGAR: I frankly don't think the
8 impression you're giving is because of a flow chart
9 where the conceptual model was related to the data.
10 There was a question, of course, asked -- and that's
11 a good question -- is, for making a decision, when do
12 you stop and say I have enough data? And you have to
13 make a flow chart to figure out how you would go in
14 the loop.

15 But that wasn't related to whether or not
16 you met the compliance criteria, but whether these
17 calculations that you were doing stopped changing, is
18 when you said, okay, I don't need any more data for
19 that particular decision -- site selection, for
20 example. And these criteria change as you move
21 through steps.

22 In my view, the reason BWIP died was, one,
23 that was a site about which we knew the most, among
24 all the sites, and data is not always good, frankly,
25 because you know too much. You know the weaknesses.

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1 Others, you say, oh well, Yucca Mountain is dry.
2 Right?

3 MR. WILSON: Yes.

4 MR. SAGAR: And the second, it was seen as
5 very expensive. So, those were the reasons; not
6 because of the flow chart.

7 But coming to my real question on
8 predictability, I think it was David Kocher who said
9 we should not use the term "model validation" because
10 it has a connotation, to the public anyway, that it's
11 not quite right.

12 It's the same thing about predictability.
13 I would say that for natural systems, for predicting
14 for 10,000 or a million years, you can't predict.
15 Period. Even after 25 years of research. So, maybe
16 we shouldn't be using that term, either. Estimate is
17 the best; extrapolation; whatever else you want to
18 call it; projection.

19 MR. WILSON: But predictability is a
20 measure of prediction. It basically -- if you have
21 poor predictability, then you have what you just said.

22 SPEAKER: It's a semantic thing like
23 validation.

24 MR. SAGAR: Yeah. The connotation of
25 predictability is -- despite the plume you are

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1 showing, the complicated plume, that's not --

2 MR. WILSON: I think the point is taken.
3 There's a usage of the term. There's a technical
4 usage of the term "predictability" that has grown out
5 of, in particular, climate science. And it doesn't
6 mean what we are assuming that it means here. So I
7 think we take the point that we have to be careful
8 with the semantics.

9 But in the technical literature,
10 predictability, particularly in the climate sciences,
11 does not mean that something that you can predict for
12 10,000 years. In fact, predictability in the climate
13 sciences --

14 CHAIRMAN HORNBERGER: Means you can't
15 predict.

16 MR. WILSON: -- indicates the limits. So,
17 for example, chaos theory limits the predictability of
18 weather something like seven to ten days into the
19 future. That's the connotation of predictability in
20 the technical sense. But we take your point.

21 CHAIRMAN HORNBERGER: Ray.

22 VICE CHAIRMAN WYMER: Yes, John and I
23 think most of the other speaker have done a really
24 good job of identifying what the really knotty issues
25 are, the real thorny problems that we haven't got a

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1 handle on. And the thing that disturbs me is that
2 usually, then, they wind up by saying, well, I don't
3 know how to handle this, and I don't know what to do
4 with this.

5 MR. WILSON: Oh, I do. Money.

6 (Laughter.)

7 VICE CHAIRMAN WYMER: Well, there are some
8 that don't even yield to that.

9 MR. WILSON: Ask any university professor.

10 VICE CHAIRMAN WYMER: But that wasn't my
11 whole point.

12 (Laughter.)

13 VICE CHAIRMAN WYMER: My point is that, I
14 think if I were to trying to decide what a research
15 program is, for starters, I'd go back through the
16 transcript of this meeting. And every time somebody
17 identified a knotty issue and said "but I don't know",
18 I'd take a good hard look at that and decide whether
19 or not that's something that needs to be known as a
20 basis for research. I think the really tough issues
21 have, in fact, been identified, but we don't know what
22 to do about many of them.

23 CHAIRMAN HORNBERGER: John Kessler.

24 MR. KESSLER: I want to get back to the
25 earlier discussion on, you know, how do you define

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1 what research needs to be done that's targeted toward
2 making a decision?

3 I mean, a lot of this seems like it could
4 easily fall into the category of, well, we don't know
5 what we don't know. And therefore, let's just go out
6 and study everything.

7 To me, your example of Neretniks looking
8 at the -- we call it the Bentonite burping -- is an
9 example of appropriately directed research. This is
10 because SKB was going to take credit for a Bentonite
11 barrier behaving in a certain way. And it's a
12 perfectly legitimate set of research that challenges
13 whether that barrier is really going to perform the
14 way that they said it performed.

15 To me, that's the way you direct research,
16 is that somebody's going to claim a barrier or claim
17 some performance that's really important. And then,
18 that's the research you go after. I'm not saying all
19 of what --

20 MR. WILSON: No. That's what this is
21 trying to say. I mean, it may not have come across
22 that way, but it's basically figuring out what's
23 important, and then direct your research at that.

24 MR. KESSLER: Exactly. All I'm saying is
25 that sometimes it needs to be a little bit more

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1 targeted than perhaps a 62-panel member Vadose Zone
2 committee might come up with over 25 years.

3 (Laughter.)

4 MR. KESSLER: And I don't mean to --

5 MR. WILSON: No, the research is 25 years.

6 (Laughter.)

7 MR. KESSLER: I don't mean to --

8 CHAIRMAN HORNBERGER: There goes your
9 half-million from EPRI, John.

10 (Laughter.)

11 MR. WILSON: Yeah, might be.

12 (Laughter.)

13 MR. KESSLER: All I'm saying is, these are
14 national problems that need to be looked at in a more
15 generic basis; and therefore, things like that are
16 appropriate. But it certainly cuts somebody like me
17 out, and it may cut somebody like NRC out, with a
18 limited budget. It needs something a little bit more
19 defined that is really challenging particular
20 barriers.

21 I would argue that this is where I asked
22 for, can you separate out this confirmatory from the
23 anticipatory because the kind of work I would assume
24 they'd want to do was going to be first attesting,
25 challenging the claims for barriers.

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1 Now, the other thing is, what do you do
2 about this idea that there's always going to be
3 surprises. Yes, there's always going to be surprises,
4 and you answered your own question because you said,
5 you come up with a more robust system. You'd better
6 not be living on the edge, such that if one of your
7 barriers goes or is somehow degraded, the whole thing
8 falls apart.

9 I think that DOE is taking that onboard.
10 I would say that the final Part 63 clearly talks about
11 multiple barriers and is looking at things that way.
12 So I'm heartened by all of those approaches. But
13 again, this idea of, what anticipatory research do you
14 do to get at surprises where you don't know what you
15 don't know is tougher.

16 CHAIRMAN HORNBERGER: My suggestion is
17 that we have segued nicely into talking about how one
18 prioritizes. And in fact, that is the topic of the
19 next item on the list. So, what I suggest we do is go
20 ahead with these presentations. And we will then have
21 ample time to come back and have a totally full
22 discussion, but in light of the new information we're
23 about to get from some of the other people on our
24 distinguished panel.

25 I think Jack Rosenthal has come in, so

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1 we're going to start with Jack.

2 (Pause.)

3 MR. HORNBLOWER: Is this a pop quiz, Jack?

4 (Laughter.)

5 MR. ROSENTHAL: I assure you, if we all
6 rate the same issue, we'll come out with different
7 ratings.

8 I've just got a few slides in the package
9 that's being handed out to you, and then just one
10 separate piece of paper.

11 Let me start by saying, my name is Jack
12 Rosenthal. I'm the branch chief of the safety margins
13 and systems analysis branch. Most of my activities
14 are in the reactor arena, although I do have some in
15 waste associated with storage. The reason that I'm
16 making the presentation is that I'm leading a little
17 team that's looking at prioritization in research, and
18 I've been involved in the past and have interacted
19 both with the ACRS and also with the NRR and NMSS.

20 I'm trying to have a reasonably uniform
21 scheme. So let me talk about the prioritization
22 scheme. I think we're both proud of where we are
23 today and recognize that we still want to improve the
24 system. So we're very interested in what you have to
25 say. We're part of the NRC, and the NRC has four

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1 performance goals. And we rank our activities against
2 the performance goals.

3 We typically have somewhere on the order
4 of 120, 130 activities which rank within any one year,
5 and then an activity might have several subparts. So,
6 the NRC's goals are to maintain safety, to be
7 efficient, to reduce unnecessary burden, increase
8 public confidence. And so, we feel those should be
9 our goals, too.

10 The current scheme does not differentiate
11 between arenas, the reactor materials and waste,
12 across the board. And the advantage of that is that
13 you get a 110 ranking of everything that research has
14 to do. The disadvantage, obviously, is that if you
15 don't have the same matrix or the matrix aren't
16 compatible, then you may get distortions.

17 But I assure you that not only does Waste
18 say wait a minute, we want a little bit more of the
19 pie, even within the reactor arena, if it's your area
20 that's not being ranked high, you say, well, let's
21 change the prioritization scheme so that my area gets
22 ranked high, too.

23 There's a real advantage of going across
24 the arenas in terms of research being scrutible. The
25 disadvantage is that the matrix may not quite work.

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1 If you go towards a ranking only within arenas, then
2 you will end up making a somewhat -- Ashok would have
3 to make a subjective decision about so many millions
4 here and so many millions there within a budget, and
5 I think it would be harder to defend. But we
6 recognize that there are merits, pro and con.

7 CHAIRMAN HORNBERGER: Could you -- before
8 you continue, could you just say something for my
9 benefit on how the 130 items that you have to decide
10 upon arise.

11 MR. ROSENTHAL: Some come from
12 congressional mandate. For example, you will have an
13 annual report -- I'm sorry -- AOs --

14 CHAIRMAN HORNBERGER: Abnormal
15 occurrences.

16 MR. ROSENTHAL: -- Abnormal occurrences to
17 Congress, where you talk about over-exposures of
18 individuals, or particularly severe events at nuclear
19 reactors. That's a congressional mandate.

20 There are issues that the Commission is
21 interested in, and we've received a Staff Requirements
22 memorandum from them.

23 There's user needs from NMSS or NRR.

24 And then, there's issues nominated by the
25 branches and the staff. And it's always this question

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1 of the -- ideas are precious things. And so, we've
2 gone out of our way to -- in addition to the top-down
3 approach, to try to permeate ideas from the bottom up,
4 or from other sources. And that would include public
5 workshops and soliciting information from a broad
6 variety of sources.

7 The scheme is quantitative. That is
8 advantageous because it gives you a degree of
9 scrutibility that you wouldn't have otherwise. And
10 it's a weighted score, which I'll get into.

11 At one time, we had a scheme with, I think
12 it was nine different metrics and a more formal AHP
13 pair-wise comparison method was used to come up with
14 relative rankings of the metrics. And then we applied
15 that to the hundred and some odd activities.

16 So this starts out in a more formal
17 analytic hierarchy process methodology and evolves
18 into the scheme that we have today, which it would be,
19 I think, incorrect to say is an AHP process, but
20 rather just a simple multi-attribute decision
21 analysis, I mean, in its simplistic form.

22 And we, in fact, thought about, maybe we
23 should go back to a more formal analytic hierarchy
24 process, which makes you do a lot of pair-wise
25 comparisons. When you start doing pair-wise

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1 comparisons against a hundred-some-odd activities, it
2 becomes onerous.

3 But, our scheme is a weighted score. And
4 I think that is less subjective than any of the
5 offices within NRC. All NMSS, NRR and RES are all
6 using the NRC's program goals.

7 The way the weighting works out, new
8 issues end up scoring higher than known issues or
9 previously known issues. That's a consideration that
10 we may want to reconsider.

11 Vulnerability to terrorism will end up as
12 a new issue and displace all other issues. The work -
13 - I have to use a reactor example. The emerging
14 issues connected with control rod drive mechanism
15 nozzle cracking on vessels -- primary system cracking,
16 in a sense -- ranked higher because we knew less about
17 it than other known issues. And I'll get back to that
18 in just a second.

19 This scheme does not currently have
20 consideration of sunk cost and there's no -- there's
21 a management overlay that you're going to do to
22 whatever ranking you're going to do.

23 But we don't consider some costs in the
24 prioritization. And one advantage is that it provides
25 opportunity for new issues to come in and displace

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1 older issues. So there's pros and cons about
2 considering the sunk costs.

3 A real strong advantage of what we're
4 doing going across arenas is that we get a one-to-n
5 ranking of all of our activities. Ashok Thadani can
6 bring that before the Budget Review Boards. And you
7 look at where your dollars are and you know where your
8 cuts are. And as I said, it's scrutable.

9 I'm going to spend a little bit of time on
10 our rankings now. For a hundred-some-odd activities,
11 you would score each activity. This is the scoring
12 sheet that we do. Then you put it into Access or
13 Excel and you're on your way. You can do sensitivity
14 studies to see if your weighting factors are affecting
15 your decisions, and to what degree. And if your
16 decisions are reasonably -- if your one-to-n ranking
17 is reasonably robust, this changes in the ranking
18 factors, then it gives you some confidence that you're
19 picking the right things to work.

20 Now, if you look, in general, what you do
21 is, if -- stop for a second. We keep track of which
22 items came from the Commission, which are formal user
23 needs, which come out of technology or operating
24 experience. But we don't use that in the ranking.
25 That's another consideration that we do. And we just

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1 plain add up the budget and say how much came from one
2 source or another.

3 If you look at safety, efficiency, burden
4 and public confidence, it really now goes five, three,
5 one and one. You are ranking safety in the broadest
6 sense at five; efficiency at three; public confidence
7 at one; burden reduction at one. As I've said, we've
8 done some sensitivity studies. I don't think that our
9 one-through-n ranking is overly sensitive to those.

10 People have raised the issue, including
11 some executives of the Agency, that in the NRC
12 strategic plans, we have four performance goals and we
13 don't rank those at the Agency level. We say we have
14 four goals; why shouldn't they be one, one, one and
15 one.

16 MR. BONACA: I just had a question.
17 Where do you evaluate your current level of knowledge?
18 What I mean is, you made an example of the CDRM
19 cracking. There is an area where it's safety-
20 significant and it challenges our current level of
21 knowledge. That would be a multiplier that would
22 apply on that item.

23 We might have a safety-significant issue
24 for which you assess and determine that you have
25 sufficient knowledge to support your criteria upon

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1 which licensing actions are based, and also to support
2 the technologies that the licensees have to use to
3 demonstrate that they meet the criteria. In that
4 case, you would have a lower multiplier.

5 At what level do you use this kind of
6 assessment? I mean, in a certain way, this points to
7 the issue that John Garrick brought up before. I
8 mean, in fact, it does because I could just echo his
9 statement regarding, you know, where do you come from
10 and how do you put a measure of that into this
11 ranking?

12 MR. ROSENTHAL: Well, we're really doing
13 it at some level of analysis. It's not looking at
14 safety, but rather a delta safety. And you say, well,
15 what do I know? And then, if I knew everything, how
16 would it change that answer? And that really becomes
17 -- addresses the new safety issue and it gets the
18 highest ranking of all things.

19 Just to give a comparison -- again, from
20 the power reactor arena -- diesel generators are very,
21 very important, but we already know that they're
22 important and we know a level of importance that we
23 want, and we monitor that they're at that level of
24 importance. And we accept the risk associated with a
25 certain level of performance.

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1 So we would not rank that as high as the
2 new issue, where we don't know, and we look at what is
3 the increment in what I'm calling safety, associated
4 with the knowledge of that issue.

5 MR. BONACA: The reason why I raise that
6 issue, by the way, was because in all the
7 presentations that I saw, which were extremely
8 informative -- and again, I am one of those neophytes
9 who doesn't know much and was really confused at the
10 end of yesterday, knowing what's important and what is
11 less important.

12 At the end of that, you know, I looked at
13 the wish list on what each presenter saw that they
14 would recommend, and they were somewhat different,
15 which would lead me to believe that each one of them
16 would use a different multiplier in their mind to
17 support one task or the other. And so, how do you set
18 some order unless you make it explicit in the listing
19 so that you can tackle that.

20 I understand you make a judgment. Who
21 makes a judgment? I mean, how is it made? Is there
22 a basis?

23 MR. ROSENTHAL: For the judgment about
24 how you're going to give it this --

25 MR. BONACA: No. I'm saying the judgment

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1 of how much is needed in what area. I mean, how much
2 do we know that supports a decision versus what we
3 need to know in addition, and what items are more
4 important than others, you know, from a perspective of
5 what needs to be done first?

6 CHAIRMAN HORNBERGER: How do you justify
7 a high number in the safety?

8 MR. ROSENTHAL: The reactor arena, which
9 is the arena for me to speak about -- it would be
10 those things for which we have a large change in a
11 delta core melt or a large delta risk public health
12 consequence, from your base knowledge level.

13 CHAIRMAN HORNBERGER: So, if somebody
14 does an analysis --

15 Let's take our base knowledge level as
16 NUREG 1150, let's say, in which I have some assumed
17 primary system break frequency. And now I get a new
18 emerging issue, like this control rod drive mechanism
19 issue, and I say, that has the potential for
20 significantly changing my small break -- actually,
21 it's large break event frequency. I know that's
22 important. I'm going to give that a high ranking.

23 Now, that doesn't -- because we're so
24 reactor-oriented and because we have 1150 so imbued in
25 our consciousness, it's reasonably easy to go that

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1 way.

2 When I get into the waste arena, it
3 becomes -- well, clearly harder for me because it's
4 not my arena. And there's, again, the question of the
5 transition. You know, what was built in the reactor
6 world -- how good is it in the waste materials world?
7 That's how we derive in the rankings.

8 MEMBER LEVENSON: I'm sorry. To follow
9 up on that question because I interpreted Mario's
10 question slightly differently. And that is, suppose
11 in the reactor case, you have two issues that pop up.

12 You're evaluating -- well, you say you
13 evaluate for the potential impact, but the other half
14 of that is, two new issues pop up, one of which you
15 know quite a bit about. You're still surprised, but
16 you've got a lot of background. The other is really
17 a big surprise; you have background. Your scoring
18 system would not differentiate between those two -- is
19 that correct? Because they both have --

20 MR. ROSENTHAL: Actually -- wait. But in
21 one case, my level of knowledge is greater than in the
22 other case.

23 MEMBER LEVENSON: Right.

24 MR. ROSENTHAL: In that case, for the
25 high-risk one, for which I have knowledge, I would

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1 give it a ranking. Actually, what happens is that my
2 safety significance would get multiplied by a .6,
3 while, for the one for which I have less knowledge, my
4 safety significance would get multiplied by a three
5 times a one.

6 As I say, what we're willing to do is,
7 where we know -- where we know of a safety issues --
8 and presumptively, we run through the generic issue
9 process and we have made a decision about whether it
10 is a significant safety issue and it's cost-beneficial
11 to change, or we decide to live with that risk, at
12 that point it's a question of maintaining where we
13 are.

14 MEMBER LEVENSON: So, you're saying,
15 you're not using the words are there for your rating
16 because -- the case I posed, they're both new issues
17 so it's not a matter of maintaining the current level
18 of safety; they're both new issues that challenge
19 safety. There's a different amount of background. Is
20 that the issue?

21 MR. BONACA: I think so. I can see how
22 you can use this system probably. My concern was,
23 essentially, you're making certain judgments on the
24 inspection of CRDM. You always have axial cracks.

25 MR. ROSENTHAL: Yes.

1 MR. BONACA: The judgment was, you know,
2 periodic inspections and monitor that at a certain
3 pace. Or you discover that those, now, result in
4 circumferential cracking. That's really the new
5 issue. So your criteria, your licensing criteria for
6 inspection frequency, wasn't a problem.

7 Now, that becomes, suddenly, a very
8 different issue because your level of knowledge has
9 changed there. And if it is different, you have
10 different expectations for how the licensees will
11 demonstrate that they can live with that kind of
12 crack. So, I guess you could use steps two and one to
13 measure how far, and determine that you've moved from
14 step two to step one and now you need to --

15 MR. ROSENTHAL: Yes.

16 MR. BONACA: -- it doesn't say it, but I
17 think that probably that's how you do it.

18 MR. ROSENTHAL: Now, things may have
19 high-risk achievement worth but are well-known, and
20 they'll receive a lower score than new stuff. This is
21 biased towards where you don't know -- now, I actually
22 wrote these words on this chart that we use. And of
23 course, you only have so many words to fit on a little
24 chart.

25 At one time, Bill Morris, former deputy

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1 office director in research, wrote out a long essay on
2 what the factors that we were using at that time would
3 be. And what we found is that by the time you went up
4 to about 20 pages, nobody was reading it, and they
5 were just doing the scoring. The other end of the
6 spectrum is to just have some cryptic words on a piece
7 of paper, and people don't know quite what they mean.

8 The reality is that there are only seven
9 branches in research. We talk to each other. We
10 propose the rankings. And then we do a scheme where
11 two senior people will sit down and try to normalize
12 what's going on in the office.

13 MR. BONACA: Just one last statement. On
14 the other hand, on the presentations that we've had to
15 date, since I really cannot make personally a judgment
16 between which item one of the presentation Mr.
17 Nordstrom, and item one of David's presentation is
18 more important, I would rate them both three-one
19 because they seem very safety-significant to me.

20 The criteria that determines which one
21 should be above should be, do we have enough
22 information about each one of them that says, yeah,
23 but the priority of that issue is less important
24 because I can make an informed decision on the issue
25 today without further work, while in that particular

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1 area I'll need to spend more time. That's really
2 where the ranking comes from. That's why I brought it
3 up, and I don't see it here, really, in those terms.

4 MR. ROSENTHAL: In the reactor area -- as
5 I say, we walk around with these PRA models in our
6 heads, so we're doing a ranking effectively, in terms
7 of the metrics, of man-rem, etc., and I don't know how
8 to make quite that same transition to the materials
9 arena. But it ought to be in terms of dose to the
10 public.

11 What we do is simply -- you rank this and
12 then you go three times your multiplier plus two times
13 another multiplier plus two times another multiplier,
14 and you add up a score and compare scores. And that's
15 how you come with the one-through-n list.

16 And let me just spend just a moment or two
17 -- how many licenses involved was clearly a reactor
18 concept? Although, at one time when we were working
19 with -- we had a similar material side, clearly NMSS
20 has thousands of licensees. So there are many, many
21 radiographers, and that would receive a high score,
22 too.

23 I've got a problem where there's one
24 repository, and I'll get to that, when I talk about
25 how we're considering change.

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1 Yes, sir.

2 MEMBER LEVENSON: If I look, taking at
3 face value, at the ratings that are there, I would
4 guess that most of the congressionally mandated things
5 rate very, very low. How do you cope with that?

6 MR. ROSENTHAL: An example is the AO
7 report. You do it. You do it. An example that we
8 had was the abnormal occurrence report to Congress,
9 which dates back to a time when the congressional
10 committees want information, but really predates
11 things like the internet and just the way we
12 disseminate information today.

13 If it's small cost, you do it, and if it's
14 big cost, then you have to go back to the
15 congressional committee.

16 CHAIRMAN HORNBERGER: John.

17 MR. KESSLER: A quick question. I don't
18 see a scope in cost on here. I mean, I know that as
19 a small funder, I'm always messing about with the
20 scope to get it within lines of my cost. And then,
21 you know, if I've still got enough left to make it a
22 really worthwhile endeavor or not, how does all that
23 fit in with your prioritization?

24 MR. ROSENTHAL: That -- the current
25 scheme, for better or worse, does not consider, as I

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1 say, either the cost or the sunk cost on something
2 that you've been studying. You do this one-through-n
3 ranking. You have so many million dollars, and you go
4 down your list and it gets cut at a certain point.
5 Now that may be --

6 MR. KESSLER: You can reduce the scope.
7 You can reduce scope for things above the line to get
8 some things below the line up.

9 MR. ROSENTHAL: Sure.

10 MR. KESSLER: How does that work?

11 MR. ROSENTHAL: It's not part of our
12 formal prioritization scheme today. I recognize it as
13 a consideration, area that we can improve. I think
14 that it is part of our informal prioritization scheme,
15 in the sense that issues that are put forward are
16 reviewed by management at various levels, and that we
17 can come up with how much resources do you need to
18 reasonably resolve an issue? But it's not currently
19 explicit.

20 MR. KESSLER: So you're assuming you're
21 going in with the leanest, meanest proposal that
22 you've got?

23 MR. ROSENTHAL: That's the presumption.

24 MR. KESSLER: You might want to look at
25 that.

1 MR. ROSENTHAL: That's the presumption.
2 We even had another discussion, and it goes something
3 like this. Once you put forward a scheme, whatever
4 the scheme is, you can game the scheme. And you just
5 have to accept that and that we're all honest brokers
6 and that there is management review. And then we do
7 an office-level normalization.

8 The bang-for-the-buck part is not in the
9 current scheme, and maybe it should be. The leverage
10 was easy to put in as something that we thought was an
11 appropriate attribute. At one time, two years ago, we
12 actually didn't have public confidence in our
13 weighting scheme because we simply didn't know how to
14 put in public confidence. And then, last year we did
15 put it in because it is an NRC performance goal.

16 It's a difficult area, and I've compared
17 some of the scores that we get with ones that NRR and
18 NMSS do, because we do talk to each other. Doing good
19 work does not necessarily increase public confidence.
20 So, we've found in some of the schemes, people will
21 rate things that have high safety significance or high
22 risk significance as also of high public confidence.
23 And we decided that, in research, that just wasn't
24 necessarily the case.

25 And so, what we're really doing is

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1 ranking, in which -- actually, what Professor Sandman
2 at Princeton would call outrage -- and that is, how
3 involved is the public or how concerned is the public
4 with that activity?

5 And so, you can have -- that's what we're
6 doing. That's a very difficult one for us to capture,
7 though it gets a ranking of one, at best, compared to
8 the risk or safety significance, which gets a ranking
9 of as much as five if it involves a lot of licensees.

10 So, that's where we stand today, bumps and
11 warts and what not.

12 As I say, we should be proud because we've
13 gone from in years past something far more subjective
14 to something that's numeric. It does give you 1
15 through n ranking, it does go across arenas, and the
16 biggest thing is it's scrutable, that we can go and
17 talk to other offices, or other people, and say, okay,
18 here's how we derived our ranking for better or worse.

19 MEMBER LEVENSON: Jack, I have one
20 question. You explained how you rate the safety
21 because of the background of -- and PRA which lets you
22 assess relative importance. But now you've also said
23 you're using the same system across all other areas,
24 and what do you use as a device in other areas to
25 substitute for that where you don't have that tool?

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1 MR. ROSENTHAL: Let me, let Bill take a
2 turn at this one.

3 MR. OTT: It's a difficult question to
4 answer, and it's one of the reasons that in the plan
5 that we tried to explicitly lay out some kind of a
6 rationale for making those decisions. As Jack pointed
7 out, the original 20 page version that Billy Morris
8 used did tend to focus on reactor considerations, and
9 I mean it's very difficult for us to do those kinds of
10 reviews.

11 I couldn't tell you explicitly right now
12 exactly how it was done last year. We did it two
13 different ways and then they were adjusted. We came
14 out a little bit better last year because we started
15 thinking about things in a safety context for waste,
16 as opposed to a safety context for reactor accidents
17 and that kind of thing, and allowed ourselves to get
18 higher rankings in the safety areas.

19 I can't give you a good solid answer right
20 now, but one of the things we're working on is getting
21 a better answer to that question.

22 MR. ROSENTHAL: In Bill's plan he's got a
23 lovely table that proposes a mapping from the reactor
24 to the waste arena, and I think that the reality is
25 that that was used subjectively to come up with

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1 parallels.

2 But this is what we're currently doing
3 and, of course, it's an Agency, many of us come out of
4 the RES side. So now where do we go from here? So we
5 formed this time to reconsider what we would do. In
6 the short term I think we'd like to improve what we
7 have, in the longer term, we would be quite receptive
8 to ideas about going to quite formal, maybe to formal
9 methods such as AHP or other and maybe we have to take
10 better use of the operations research industrial
11 engineer type people.

12 But in the shorter term we'd like to
13 enhance the system. As I say, not only that there are
14 problems across arenas but even within an arena.

15 The first place that this would be used is
16 the fiscal 2004 budget cycle, which is approaching, so
17 we have to make some enhancements. There is advantage
18 of doing what we're doing, in the sense you get some
19 stability from year to year. You just can't revise
20 the schemes dramatically and have the confidence of
21 the senior management of the Agency.

22 What we're doing, as I say scoring against
23 the four goals is consistent with what the other
24 officers, and we really do have to face up to the
25 question about should we rank across arenas, or should

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1 we arbitrarily set a certain amount of the funds for
2 waste and then rank within the waste. We haven't
3 reached a decision, and we'd be interested in your
4 views clearly.

5 We end up doing about 90 percent of our
6 budget, 85, 90 percent of our budget is confirmatory
7 research, or research that's been asked for by the
8 user offices. At the same time, we would like to be
9 out in front; the Chairman has spoken about us being
10 forward looking. Ashok Thadani spoke about that at
11 the beginning of the session, and we all think that we
12 have bright ideas so, of course, we would like to put
13 effort into anticipatory research, on the other hand,
14 confirmatory research as a known customer. So it's
15 just a constant struggle with what's the right balance
16 between those two.

17 One idea that came forward came from our
18 generic issue process itself which has been
19 longstanding on the books, and that is that we look at
20 ultimately incremental ManRem and you get that by how
21 many sites would be affected, how many years would be
22 affected and what's the incremental individual risk
23 and you multiply it out.

24 The advantage of doing that is that for
25 reactor areas we typically thing of, well, okay,

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1 there's a hundred reactors and they might have 20, 30
2 years to go, so you end up with 30,000 reactor years
3 and then if instead in the waste arena maybe I put in
4 one repository, but then I put in all the years that
5 it would have to go to give it some sort of
6 equivalence. And so that's a concept that we're
7 thinking of.

8 Essentially, instead of where on the prior
9 slide I had what's the safety significance of the
10 issue, maybe what we should be saying is what's the
11 risk significance of the issue in a much more formal
12 PLG triad of, you know, what could happen, what's the
13 likelihood, and how bad could it be, to go to a more,
14 as I say, a more formal risk approach would be an
15 idea, a consideration. It works in the reactor arena
16 and it would be an easy transition for us, I don't
17 know how it would work in the materials arena. But
18 that's the concept for consideration that we have now.

19 And, as I said, because of the expected
20 duration, that itself, or if it's in the materials
21 arena, the number of people, radiographers, etc. might
22 put things on a more even footing.

23 So we're struggling with that. We don't
24 have an answer.

25 Other ideas in the thermal hydraulic

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1 arena, in the fuel arena, in the fission products
2 source term arena, we use PIRT, Phenomena
3 Identification and Ranking Tables, which is a very
4 formal expert elicitation process of independent
5 experts where you ask how important is an issue. And
6 you have to define what you mean by important, and you
7 have to define what scenarios you're talking about in
8 order to do a good PIRT. So the thermal hydraulic
9 area.

10 Well in the fuel area, for example, there
11 were separate PIRTS for Loca and ejected rod and
12 ATLAS, and you come up with somewhat different
13 rankings of what phenemonon are important.

14 But that's a way of science basing where
15 you'd like to go, based on a very formal expert
16 elicitation.

17 Ashok keeps talking about, and I was here
18 the first day, there's a fair amount of talk about
19 realism, put a fairly high bonus on realistic
20 evaluation and knowing what the uncertainties are, as
21 distinct from doing bounding analysis and just how
22 shall we consider it.

23 The sunk cost is really an issue that, as
24 I said, we haven't formally grappled with it but we've
25 got projects that are very near completion sometime

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1 that simply won't score high enough to complete. And,
2 you know, well on one hand maybe you should say I did
3 90 percent of the work, I know 90 percent of the
4 answer, I'm done. Okay? It's good enough. And let
5 it drop. And then the other argument is, no, let's
6 write it up, let's finish it up, let's complete it.
7 So we'd be interested in your ideas.

8 We would like to be more forward-looking,
9 this concept of prepare the Agency for the future, and
10 we continue to struggle with public confidence. So
11 that's where we are.

12 CHAIRMAN HORNBERGER: Thanks very much,
13 Jack. We may have asked our questions as we went.
14 Ray?

15 VICE CHAIRMAN WYMER: One question, yes.
16 I recognize that you're coming mainly out of the
17 reactor arena. The thrust of this meeting, of course,
18 is on waste and I just wanted to see what you really
19 do as opposed to what you'd like to do or what you're
20 presently doing.

21 Let me ask Bill, did you put the radio
22 isotype transport program, which is a significant
23 program for you, through this process to select it?

24 MR. OTT: Essentially, the work is divided
25 up into what we call activities. Each activity has

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1 related projects associated with it. Each one of
2 those activities was rated according to this rating
3 scheme. The reason I was waffling was that the rating
4 was done by Sheryl, I didn't do it last year, I tested
5 out our methodology and our methodology came up with
6 higher scores but that I don't think was what was
7 actually used.

8 But anyway those activities, right now I
9 believe there are six activities. One of those
10 activities lumps processes, for instance the hydrology
11 and geochemistry on work and research addressing
12 uncertainties would be classified in that one area,
13 and that activity would receive a rating and then any
14 projects would be funded out of the resources that
15 were allocated to that activity.

16 VICE CHAIRMAN WYMER: So this is kind of--

17 MR. ROSENTHAL: Bill, if I might, Bill,
18 why don't you take that example and like a gestalt
19 experiment we won't, even if doesn't match quite up
20 with what was done, and repeat the activity and
21 explain how you would rank that materials --

22 MR. OTT: What we have here?

23 MR. ROSENTHAL: Any example you feel
24 comfortable with.

25 MR. OTT: Well, let's take one that's

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1 probably more understandable to a lot of people, and
2 that's engineering barriers, okay, which is becoming,
3 there's increasing evidence that the barriers are
4 failing. So it's sort of an emerging issue as
5 something that there really is substantial information
6 and we ought to look at it. And it may cause
7 substantial doses in a relatively short time, so you'd
8 probably rate that as high in terms of a new safety
9 challenge. It's an emerging issue, there's increasing
10 evidence of failures and you need to deal with those
11 failures.

12 Scope of the licensees. Not all licensees
13 use barriers. In fact, if you're looking at
14 decommissioning, I'd probably say less than 50 percent
15 are actually going to have a specific disposal unit so
16 you must have a two for the scope of licensees greater
17 than 10 percent and less than 50 percent.

18 For realistic decision making, we'd be
19 trying to develop realistic tools or data to confirm
20 safety. We'd be trying to go out there and do that to
21 evaluate this problem, and that's what we're doing.
22 So we'd probably give it a one.

23 Industry participation or leverage. This
24 is an area where we had, I think matching effort from
25 the National Institute of Standards and Technology so

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1 the leveraging here would have been NRC and external,
2 NRC approximately 50 percent support. So you'd have
3 a one with a .6 on it. Not major because we would
4 have been putting in much greater than 25 percent.

5 Burden reduction contributors. I don't
6 think we necessarily would have been able to say that
7 we'd be saving anybody any money on this one so you'd
8 probably get the lower score, accumulative savings.
9 This doesn't allow you to give you a zero score, I
10 don't think we had a zero score did we? I can't
11 remember.

12 MR. ROSENTHAL: We forced -- it doesn't
13 matter.

14 MR. OTT: We would have forced the lower
15 score in this particular instance so it would have
16 gotten a .4 when in reality it maybe should have
17 gotten a zero.

18 Public confidence contributors. We'd
19 certainly think it's a response to public concern.
20 People don't like it when they see barrier facilities
21 failing, so we probably would have given it a one.
22 That's the considerations that would have gone into
23 ranking the work on engineering barriers.

24 MR. ROSENTHAL: And so if, I'm just trying
25 to do the arithmetic here, that would have received a

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1 score of 6 or 7, something like that, out of a
2 possible 10 and then be compared to other, the 120
3 other activities.

4 CHAIRMAN HORNBERGER: Okay. John?

5 MR. KESSLER: Again, it's not directed at
6 this particular example but, you know, the address is
7 the safety concern. Again, I would ask how you decide
8 well how well does it address the safety concern. I
9 mean the work may be dancing around the edges of the
10 issue or it may be really focused on the core of
11 whatever the safety concern is. And somehow you'll
12 need to distinguish perhaps one proposal from the next
13 on that.

14 It leads me to believe that obviously 20
15 pages of description as to how to fill these things
16 out is too much because, of course, it's not going to
17 fit for all circumstances. This is too short, but
18 somewhere, somebody should be writing down how one
19 decides how a score was arrived at, and that implies
20 that the people making this score have to be pretty
21 smart and pretty informed all the way across to make
22 these decisions like that.

23 CHAIRMAN HORNBERGER: Okay.

24 MEMBER HINZE: Could I ask a quick
25 question. There are many criteria that are used in

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1 peer review of research proposals and research
2 efforts. A couple of those are success of the trend
3 of the research. What has been the previous research,
4 what has been the success of that. Another is your
5 ability to really conduct that research. Do you have
6 the facilities, the personnel, are the people
7 proposing this?

8 Are those in any way glued into this?

9 MR. ROSENTHAL: Actually, about three
10 years ago we had as a metric, likelihood of success
11 and we removed it and said, and this is a policy issue
12 as much as anything else, let the four performance
13 goals and the safety or risk significance drive it
14 rather than the, and we stopped using likelihood of
15 success. It's a fair issue. It's a fair issue.

16 CHAIRMAN HORNBERGER: Is this evaluated on
17 an annual basis?

18 MR. ROSENTHAL: Yes. And all activities
19 go through the re-evaluation, both new and ongoing
20 work.

21 CHAIRMAN HORNBERGER: Another question.
22 You've talked about dispersing between arenas, what
23 about within arenas? Is there any attempt to maintain
24 the research edge within a discipline, within an
25 arena, and I presume an arena would be like waste.

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1 Where is this coming into this? Is this part of the,
2 you used the term management overlay. Is the
3 management overlay part of this, of the decision
4 process and distributing over disciplines?

5 MR. KING: This is Tom King. I'm Jack's
6 division director. Yes, the management overlay
7 sometimes when you come through and do a numerical
8 scheme you find out, for example, waste really got
9 short-changed because of, you know, problems with the
10 ranking system, and the management overlay will try and
11 correct that. Say, hey, we just can't go down that
12 low in waste, recognizing that there are important
13 issue that somehow aren't captured very well in our
14 prioritization scheme. And management will make
15 adjustments based upon trying to keep a reasonable
16 program underway.

17 CHAIRMAN HORNBERGER: I have a follow up
18 to Bill's question because he raised it. Bill and I
19 and others are probably much more used to evaluating
20 research proposals. What I gather is that what you're
21 doing is prioritizing research areas. Is that
22 correct? Or are you actually using this to evaluate
23 research proposals?

24 MR. KING: Jack used the word activities.
25 An activity is defined as the work that needs to be

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1 done to resolve an issue, a specific issue. It could
2 involve several projects at different locations, it
3 could be one big project at one location. We don't
4 really take proposals, for example, you know 189s from
5 the national labs, and look at those as the only
6 documentation that's considered. We basically use our
7 operating plan description of what the issue is and
8 the activity is and go from that level of detail.

9 CHAIRMAN HORNBERGER: Bill?

10 MR. OTT: One of the things that we're
11 trying to do is to consider what we would need to do
12 to prioritize at the project level.

13 CHAIRMAN HORNBERGER: Yes.

14 MR. OTT: We haven't done that yet, we're
15 planning on working on fairly heavily over the next
16 couple of weeks as a matter of fact. It's obviously
17 a concern of ours.

18 Balance has always been a concern of ours.
19 It's not explicitly considered in there but it's one
20 of these other factors that have to be considered by
21 the management chain. And so far, all the arguments
22 and all the informal discussions have managed to allow
23 us to maintain balance. That's the good thing that we
24 can say.

25 The other observation I wanted to make,

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1 Jack made a very good point earlier in his
2 presentation that you could call this an AHP informed
3 process as opposed to a strict AHP process. The
4 reasons are many. One of them is that in the AHP
5 ratings process that we developed this from, the final
6 scale out there is supposed to be an objective
7 measurement scale. And it's hard to say that what we
8 have right now is an objective measurement scale, and
9 possibly one of the improvements that we could make in
10 time is to figure out a way of doing an objective
11 measurement scale.

12 MR. ROSENTHAL: I see the sense of the
13 questions are going from how does research rank
14 relative, I mean a multitude of activities, what's
15 going to get funded and worked on, as distinct from a
16 little bit broader question about how does research
17 work. And in the sense for major activities we tend
18 to write plans, we tend to get well aired and
19 reviewed.

20 I know in my thermal hydraulic, in my fuel
21 and in my source term work which is my branch's work,
22 we have PIRTS, which are formal expert elicitation
23 processes, which would give the relative rankings in
24 terms of metrics such as risk. And then activities
25 would be formed from those tasks and then activities

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1 from that effort, and then I bring that to the budget
2 prioritization process.

3 So I mean it's a rich nomination that's
4 brought forward.

5 CHAIRMAN HORNBERGER: No, I understand and
6 I think that I understood that beforehand. I just
7 wanted to point out for the benefit of all involved
8 that when Bill says he and I will look at an NSF
9 proposal and prior track record as a big criterion,
10 you're not at that level. There's no such thing as
11 looking at prior track level for an activity because
12 you haven't gotten down to the people doing it yet.

13 I just wanted to make that clear. It may
14 not be. I mean at some areas it might be one big
15 proposal and you say, yes, the the National Lab has
16 done a wonderful job and we can take that into
17 consideration.

18 MR. KING: Yes, that gets down more to who
19 does the work.

20 CHAIRMAN HORNBERGER: Right.

21 MR. KING: You know, if the work is
22 important to be done and somebody that's selected to
23 do that work has a poor track record, that's where
24 that comes in.

25 CHAIRMAN HORNBERGER: Exactly. But it's

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1 separate from the AHP as Jack presented, right?

2 MR. KING: Yes.

3 CHAIRMAN HORNBERGER: John Wilson?

4 MR. WILSON: Where is the memory in this,
5 you know, most research takes some level of continuity
6 and if you're re-evaluating these areas every year,
7 things come, things go, is there any memory built in?

8 MR. ROSENTHAL: I think maybe you've
9 pointed out a weakness. We surely have the scores
10 from prior years just in access data base. That's
11 easy. But how you derive the score and the discussion
12 back and forth and why something was a .6 rather than
13 a 1, I think lies in our heads.

14 Now even more, let me point out again,
15 that we don't consider sunk costs. So you may have
16 funded an activity for four years and be 90 percent
17 done and not choose to complete that effort for all
18 your corporate history because there's a new emerging
19 issue that you consider more important.

20 CHAIRMAN HORNBERGER: That's fine. Okay.
21 Kirk?

22 MR. NORDSTROM: Just a quick follow up on
23 that. I really appreciate the discussion because it
24 enlightened me a lot about how things work, or maybe
25 don't work sometimes.

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1 But just a comment that I think it would
2 have better facilitated the workshop and it would have
3 helped the ACNW by having some kind of a summary from
4 the NRC on what's been done, how successful it's been
5 and how does this research affect the PA. Something
6 to think about for the future perhaps.

7 CHAIRMAN HORNBERGER: Good suggestion.
8 Maybe we'll suggest that.

9 MR. ROSENTHAL: Let me just close by
10 saying we really are at a formative time because we
11 really want to improve what we're doing and so we
12 really are receptive to ideas that you might bring
13 forward.

14 MR. BONACA: I just have one more simply
15 just looking at this list, you know, there are so many
16 attributes there and to the central question of, you
17 know, how much core level knowledge needs to be
18 improved. I wonder how much that is diluted by having
19 to go through such a long list. I mean and maybe
20 you're forced by the circumstances to address all
21 those issues but then you know that may be a handicap
22 in the way that -- is there any way I guess you can
23 simplify the process.

24 MR. KING: I think that's a good comment.
25 It's one that we've wrestled with internally. This is

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1 too complex. Do we need it to be this complex?

2 MR. BONACA: Yes, because I mean at some
3 point you lose sight of really where you want to go.
4 And you're worrying about, I went through some little
5 exercise here where I could take a burden reduction
6 issue, which has nothing to do with -- today and drive
7 it down to a very high ranking because maybe it's good
8 for the public and it has burden reduction contributor
9 sure, I mean and everybody wants it. Fine.

10 And then, on the other side, I can take
11 one item and I could believe them, you know,
12 multiphase flow in the fractured rock. It's an
13 important issue, and I can drive it down to a lower
14 ranking with respect to the other one. And then I'm
15 left with the question of what do I need to make the
16 decision today as an organization, and that's maybe a
17 critical issue. In fact, the presentation convinced
18 me of that. And yet it's not going to be ranking high
19 because there are so many attributes to this --

20 MR. KING: I agree. If you look at NRR
21 scheme for ranking, use their user needs, it's much
22 simpler than this. It's still built upon the four
23 performance goals but it in effect ends up binning
24 things high, medium or low. And the ones in in budget
25 space you spend a lot of time on are the ones that

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1 come out low, you know, that you're making the
2 decision, is it in or is it out. And why spend a lot
3 of time on the things that you know are high or come
4 out high in the prioritization process because it
5 doesn't matter in the long run.

6 What really matters is where do you draw
7 the line when you're down into the low category ones,
8 so I think if the committee has views on the
9 complexity, we'd certainly be interested in that.

10 CHAIRMAN HORNBERGER: John Wilson.

11 MR. WILSON: Yes, just one more thing.
12 You're doing this for different activities from
13 increments or areas, which is one of the hard parts.
14 How do you just aggregate something into this
15 individual activities?

16 You could do it in a way that is another
17 form of making the thing incommensurate, the size,
18 shape can be completely different. And you start
19 ranking them and comparing them, it's sort of like if
20 you were doing the same thing with people. From one
21 group we take the individuals and we rank each of them
22 and we'll take the other group and lump them all
23 together and rank them. And oh by the way, they rank
24 higher because they're more productive.

25 CHAIRMAN HORNBERGER: There are all sorts

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1 of difficult issues and perhaps what we should do is
2 take a lunch break for an hour. Actually, I think we
3 can probably reconvene at one, okay, so if we could
4 start at one, that would be good. And people can
5 think over these difficulties over lunch.

6 (Whereupon, the above-entitled matter went
7 off the record at 12:08 p.m.)
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A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(1:03 p.m.)

CHAIRMAN HORNBERGER: We will reconvene the meeting for the afternoon session.

Again, we are on the -- now the prioritization of NRC-sponsored research. And we had heard from Jack Rosenthal about the procedure that the Office of Research goes through, and we have several other presentations this afternoon, hopefully to give us some other perspectives.

Again, the ACNW's view is always to figure out what good advice we can give to the Commission that may help the NRC, and it's with that idea that we are listening to everything that's being said here.

So John Kessler has yet a third hat now that he's going to put on to talk to us, as Research Manager I guess.

MR. KESSLER: Right. Okay. Next slide, please.

I would say that any talk about prioritization has to talk about, what are the criteria? I mean, certainly, that was the discussion we had right before lunch is that, how do these decisions -- how should they be made? And perhaps this is a little too strict, that what we heard just

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1 right before lunch in terms of filling out this form,
2 but nevertheless it's a nice thing to shoot at and
3 focus our thinking with. And it's a great focusing
4 tool.

5 So, certainly, the criteria for
6 prioritization must be clearly stated. And some of my
7 inputs, at least recommended inputs, to developing
8 criteria would be sort of -- it's a reiteration of
9 what I see on this same form. The highest value data
10 should be based on risk information, "value" meaning
11 high probability, high consequence, perhaps
12 significant uncertainty would be something that I
13 would say would be high value data. And anything that
14 could go directly at these issues would be something
15 that I would say would certainly be up at the top of
16 the list of criteria.

17 I've got costs there. We live in a real
18 world; cost has to be a consideration. And what I was
19 trying to point out about looking at scope versus
20 cost, there's a big interplay between these two, so
21 that you do try to look at the biggest bang for the
22 buck you can get.

23 Another criterion that we could think
24 about is, when is the information needed? Near-term
25 needs require short-term research. And, of course, if

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1 you're talking about the Yucca Mountain performance
2 confirmation program, we may have years and years to
3 do this.

4 And I think it's kind of amusing that when
5 I think of performance confirmation for Yucca
6 Mountain, I think of the long time that we used
7 confirmatory research NRC does for the short-term
8 stuff, which I find -- going to be interesting, and
9 we'll have to keep our definitions straight here as we
10 proceed.

11 I talk about something called
12 definitiveness. That is, do we have identifiable,
13 measurable parameters that are going to come out of
14 this that actually address these high value issues up
15 here? And are the desired results achieved in a
16 required amount of time?

17 That's -- there's some of these eight
18 steps that DOE proposed in their performance
19 confirmation program that really are these two issues.
20 And in the workshop we had at EPRI a couple weeks ago,
21 we tried to get into these ideas as to, what are those
22 identifiable and measurable parameters? And can you
23 actually measure them? Will they get you what you
24 want in the timeframe you think you've got?

25 And the last part is it supports

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1 development of or challenges existing regulations.
2 Again, I struggle myself with, what does this mean?
3 How is it really different than maybe some of what NRC
4 is now thinking of is their confirmatory research? To
5 me, a well thought out confirmatory research program
6 should, in a way, start challenging things and looking
7 forward to issues that are coming down the pike.

8 And I would bet that they really do, if
9 you take a look at some of those programs, that
10 there's going to be aspects of something that would be
11 more anticipatory within the confirmatory research
12 work.

13 So, are basic data available? Here's one
14 we heard this morning, and I think that I can almost
15 skip this now. The chemical thermodynamic database
16 was certainly one that was up higher on my list, which
17 is this idea that sparse data contribute to the
18 continuing hot versus cold controversy, that we may
19 have data down at lower temperatures, but because the
20 data is missing up at higher temperatures this
21 controversy about how important these coupled
22 processes are, and how uncertain they are, continues.

23 And that's why I asked the question I did
24 this morning about, well, should we just get rid of
25 the hot repository idea? Or, rather, should we try to

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1 develop perhaps a better chemical thermodynamic
2 database up at the higher temperatures to support
3 that? Maybe that's a naive view.

4 But again -- and, again, I don't know
5 exactly what NRC's role in all of this is, but I would
6 imagine that with the many research institutions
7 available to do it, there could be some cooperative
8 research being -- going on. I would imagine with this
9 kind of basic research there would be a lot of ways to
10 piggyback on other maybe DOE basic energy sciences
11 kind of research or whatever that would be getting at
12 this.

13 Well, we're back again to large scale
14 dispersion and fractured, porous media. It will be
15 another one where perhaps the data is or isn't there.
16 And long-term stability of oxide layers on nickel and
17 titanium alloys would be another one where certainly
18 TRB has already been looking at that. DOE has their
19 peer review panel chaired by Joe Payer that's looking
20 at this issue -- all really good examples of things
21 that need to be looked at, and I know that that is
22 part of the Center's program as well.

23 Basic data research is well suited to co-
24 funding opportunities, that if you're going to -- if
25 the NRC is going to enter into the realm of basic

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1 data, there are probably many opportunities out there
2 to co-fund.

3 I would still argue that PRAs are going to
4 be a main tool for prioritization, maybe not the only
5 thing you look at, but they will be a main tool. NRC
6 Research proposed PRA objectives, again, seem
7 appropriate to me. Conceptualization of the problem
8 and supporting data seems right. Sampling of complex
9 FEPs seems like it's the right thing to be doing.

10 Flexible database access -- I can
11 certainly understand, having -- trying to mess about
12 a bit with my simple code, trying to get to some of
13 this stuff is an important aspect of trying to get the
14 right questions answered that you even want to ask
15 using the code or something about it.

16 The importing/exporting reporting of data
17 results, yes, it sounds rather trivial and a boring
18 exercise. But I guess it's not when it comes down to
19 actually running through these issues.

20 Incorporating additional models -- yes, I
21 think this is important, that the shell for the
22 performance -- the TSPA has to be flexible enough that
23 if somebody wants to look at an alternative conceptual
24 model that maybe has different data needs and somewhat
25 different outputs, that you can actually handle that.

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