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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON NUCLEAR WASTE

NOVEMBER 27, 2001

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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON NUCLEAR WASTE (ACNW)

5 130TH MEETING

6 WORKSHOP ON RESEARCH NEEDS

7 + + + + +

8 TUESDAY,

9 NOVEMBER 27, 2001

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11 ROCKVILLE, MARYLAND

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14 The workshop met at the Nuclear Regulatory
15 Commission, Two White Flint North, Room T2B3,
16 11545 Rockville Pike, at 9:45 a.m., George M.
17 Hornberger, Chairman, presiding.

18

19 COMMITTEE MEMBERS PRESENT:

20 GEORGE M. HORNBERGER	Chairman
21 RAYMOND G. WYMER	Vice Chairman
22 B. JOHN GARRICK	Member
23 MILTON N. LEVENSON	Member
24 WILLIAM J. HINZE	ACNW Consultant

25

1 ACNW STAFF PRESENT:

2 RICHARD P. SAVIO

3 SHER BAHADUR

4 JOHN T. LARKINS

5

6 NRC STAFF PRESENT:

7 ASHOK C. THADANI

8 MARTIN J. VIRGILIO

9 TIMOTHY J. McCARTIN

10 WILLIAM R. OTT

11

12 ACRS MEMBER PRESENT:

13 MARIO V. BONACA

14

15 ALSO PRESENT:

16 KENNETH ROGERS, Private Consultant

17 MALCOLM KNAPP, Private Consultant

18 MICHAEL T. RYAN, Charleston Southern

19 University

20 WESLEY C. PATRICK, Southwest Research

21 Institute

22 BUDHI SAGAR, Southwest Research Institute

23 JOHN H. KESSLER, Electric Power Research

24 Institute

25 ANDY CAMPBELL

1 ALSO PRESENT: (cont'd)

2 JANE LONG

3 JOHN WILSON

4 JEFFREY POHLE

5 BILL REAMER

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1 I N D E X

2 AGENDA ITEM PAGE

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

(9:48 a.m.)

CHAIRMAN HORNBERGER: Good morning again, and welcome to the workshop portion of our 130th ACNW meeting.

Let's see. First, just an announcement to start off with. We had a written communication from Mel Silverburg related to the ACNW Research Needs Workshop. If anyone needs -- wants a copy of that, please see one of our staff members and we will make sure that they're available.

MR. LARKINS: That will be entered into the record also.

CHAIRMAN HORNBERGER: And it will be entered into the record. It will be part of the record. Thanks, John.

So we have -- I'll thank at the outset all of the -- our distinguished guests who have agreed to come here. We really appreciate this. I think I'm looking forward to an interesting session.

Just a bit of background perhaps. The ACNW I think it was three years ago became responsible for providing review comments on research at the Nuclear Regulatory Commission. And the ACNW has lots of things that it does, and overview of research is

1 only one of them.

2 We have -- the ACNW has heard from the
3 Office of Research, which is the body within the NRC
4 specifically charged with research. We have over this
5 past year, in fact, heard presentations from several
6 people on research being conducted under the auspices
7 of the Office of Research -- leach -- for example,
8 leaching of radionuclides from slag, aspects of
9 radionuclide transport, and hydrology.

10 The ACNW, however, also is engaged pretty
11 heavily in the NRC evaluation of the proposed Yucca
12 Mountain repository, and that work is overseen by the
13 Office of Nuclear Materials Safety and Safeguards,
14 NMSS, and a lot of that work is done by the Center for
15 Nuclear Waste Regulatory Analysis.

16 That is officially called technical
17 assistance. As an academic, I think of research as
18 being, for example, something that is done that
19 creates new knowledge and often leads to publications.
20 Let's say in my field it might be in the Journal of
21 Geophysical Research.

22 There's a fair bit of the technical
23 assistance that goes on at the Center for Nuclear
24 Waste Regulatory Analysis that results in such
25 publications. And so the ACNW, thinking that it walks

1 like a duck, and so forth and so forth, and quacks, we
2 have incorporated that -- those aspects of the Center,
3 the work done by the Center, and by the NMSS staff
4 under our review of research as well.
5 So we don't make a distinction as to
6 budgetary lines or anything else. What we're here to
7 do is to consider what the NRC should be doing as a
8 body and not just restricted to the budgetary
9 constraints.
10 We've periodically grappled not so much
11 with the specific review of individual research
12 projects, but we've tried to take an overview on the
13 scope of the work being done. Certainly, we look at
14 the quality of the work, but we -- much more the scope
15 of the work.
16 The other thing that we grapple with a lot
17 is that the Office of Research has a very modest
18 budget for research, and it's pretty clear that in
19 trying to get the most for the least one has to face
20 up to how one prioritizes. And so a lot of the
21 comments that the ACNW has made back to the Commission
22 has to do with making sure that appropriate
23 prioritization schemes are in place.
24 All right. So with sort of that
25 background as to what the ACNW has done in the past,

1 what we had envisioned coming out of this workshop,
2 what we hope to get out of this workshop are -- is
3 information that will help us advise the Commission.
4 That's our job.
5 And in fact the objective, as stated in
6 the paper in front of you, to develop insights as to
7 the information and technical tools that will be
8 needed for future NRC regulatory decisions --
9 decisions related to the management, storage, and
10 disposal of spent fuel and radioactive waste, and how
11 research can be used in making these decisions.
12 We've tried to organize the presentations
13 to a certain extent. I also -- I know how these
14 things go. I doubt that we'll be able to hold to the
15 specifics of this structure. But, nevertheless, the
16 overall structure is to look at the technical issues
17 associated with regulatory decisions and then move on
18 to the knowledge and technical tools that will be
19 needed for those future decisions, and then to talk
20 about what research is needed, and, finally, to
21 consider how one might come up with prioritization, to
22 make sure that the highest priorities really are being
23 addressed.
24 That's our hope, and my fondest hope is,
25 of course, that we will have some lively discussion

1 involving not just our panel members in the ACNW but
2 other interested people whom we can engage in the
3 audience.
4 With that, I think we'll move right into
5 our presentations. And, let's see, who -- do we know
6 -- is this schedule -- Dick, help me out. Is this
7 going to go -- do you have the names in order?
8 MR. SAVIO: In the order.
9 CHAIRMAN HORNBERGER: In the order?
10 MR. SAVIO: Yes.
11 CHAIRMAN HORNBERGER: So Ashok Thadani is
12 going to lead off. Is that right? Yes?
13 MR. THADANI: Would you like for me to be
14 in front, so you can actually look me straight in the
15 eye?
16 CHAIRMAN HORNBERGER: Yes, we want to look
17 at you.
18 (Laughter.)
19 MR. THADANI: Well, first, let me thank
20 you for inviting me to participate in this workshop.
21 As you well know, obviously, it's of great interest to
22 me and the Office of Research, the deliberations that
23 are going to take place over the next two days.
24 Clearly, it's -- the whole issue of management of
25 disposal of radioactive waste is a very critical

1 issue.

2 Over the last year or year and a half,
3 certainly the climate has changed in this country, and
4 I'll withhold what has happened since September 11th,
5 addressing that issue. But, nevertheless, the climate
6 has changed. There were those who were talking about
7 renaissance of nuclear power, potentially significant
8 number of nuclear powerplants being built.

9 But I think the public will demand and
10 deserves clear resolution of the issue of waste. I
11 think it will be an important issue in my view as to
12 what happens and whether we do, in fact, end up with
13 any new nuclear powerplants in this country.

14 Now, since I came to the Office of
15 Research, it was fairly clear to me that the trend of
16 declining -- continued declining resources had to be
17 arrested, and the desire, of course, was that it could
18 be reversed as a matter of fact. And this is
19 important to be able to maintain a strong technical
20 capability to support various regulatory decisions and
21 the independence of those regulatory decisions.

22 And in that regard, of course, we have
23 benefitted greatly from the advice and the reviews
24 done by this committee, the ACRS, and, more recently,
25 the expert panel that was headed by Dr. Rogers, who is

1 here, of course. Dr. Rogers noted in the report --
2 the panel report -- that research must have efficient
3 resources such that research is an unassailable source
4 of technical information and support for regulatory
5 decisions.
6 And in order to ensure that the role and
7 responsibilities of the Office of Research are better
8 recognized, we prepared a Commission paper -- it was
9 SECY 99-281 in December of 1999, which articulated the
10 vision of the Office of Research and the roles and
11 responsibilities of the office.
12 Now, you will hear -- both Jack Rosenthal
13 and Bill Ott are going to be participating in dialogue
14 during these two days. They will talk about technical
15 issues as well as the prioritization scheme that I
16 know is of particular interest to you. I'll touch
17 upon it, but there will be further discussion of that
18 issue.
19 Now, this is the articulation of the
20 vision as documented in the report I talked about, the
21 SECY report. I just want to highlight some points
22 here. We see our responsibility as not just
23 developing technical basis for issues that we know
24 about, but also responsibility to be probing/searching
25 to see if, in fact, there are some issues that are not

1 being addressed by the agency that deserve attention.

2 And yet another important element is to

3 look to future, over the horizon as the Chairman says,

4 to see what may be down the road and are we preparing

5 ourselves for that future. It is important because as

6 -- you know this as well or better than I do -- that

7 a lot of the research that perhaps needs to be

8 undertaken, it takes time.

9 And we certainly don't want to be what I

10 would call a bump in the road, so to speak, come in at

11 the last minute, identify issues that need to be

12 addressed, and say it's going to take us five years of

13 research to get some technical resolution. So it's

14 really critical for us to be -- that our thinking be

15 more forward-looking than perhaps we've been in the

16 recent past.

17 And our focus, by and large, is to ensure

18 that we generate sufficient information, data, and

19 methods, to be able to make realistic decisions. And

20 I'll come back to this issue of why is it important to

21 try and make realistic decisions.

22 While the offices -- NMSS and NRR --

23 certainly are mostly focused on what I would call

24 short-term challenges, it is our responsibility to be

25 looking ahead. As part of that, we certainly seek

1 views from various parties in terms of what the issues
2 might be and what is it that we should focus our
3 attention on. And certainly the distribution, the
4 wide distribution given to the radionuclide transport
5 research is an example of how we would like to conduct
6 our business.
7 Next slide, please.
8 There are just a few points there.
9 There's nothing new in this chart that I'm sure that
10 you don't know, but I'd like to make a few points. In
11 terms of the confirmatory research, by and large those
12 are areas where it takes a few months to maybe two
13 years kind of effort. And we're certainly focused, as
14 you know, on things like parameter uncertainty,
15 probabilistic considerations, and DND, and waste rad.
16 And you mentioned slag degradation in your remarks,
17 and areas such as that.
18 In terms of anticipatory research or the
19 longer term -- let me put it that way -- we've had
20 some interesting discussions about the choice of that
21 word "anticipatory." But in any case, we're certainly
22 looking at things like concrete durability, conceptual
23 model uncertainties, and so on.
24 The important issue, in my view, is that
25 we really need to be sensitive to protecting our

1 resources focused on anticipatory research. I could
2 go into example after example of how issues come up
3 and we're looking for resources, and we have a
4 tendency to go, what are we doing in our anticipatory
5 research? And let's see if we can't delay that
6 program.
7 That tends to add a certain amount of
8 inefficiency in the process, but that's the way much
9 of our business goes on. We are sensitive. We try
10 not to get there, but it's sometimes pretty difficult.
11 And as I said, our focus is on making sure
12 we have tools and models for realistic analysis. In
13 the end, when one has to make a decision, it's not to
14 imply that one must not be looking for margin, but it
15 is understandable margin that we're looking for in the
16 decisions that we make. And that's critical.
17 I think, again, we could -- my background
18 is, of course, in reactors, and I can tell you how at
19 one point when I first joined the agency I think there
20 were 24 branches reviewing applications. And each
21 technical reviewer in each branch wanted to have
22 certain margin that he or she thought was appropriate.
23 In the end, I'm not sure we know what we
24 have, how much -- or what we call "conservatism."
25 It's not clear to me that it's actual conservatism.

1 Sometimes, in fact, that may lead to unnecessary use
2 of resources or perhaps misunderstanding of what the
3 realistic expectation might be.
4 Next slide, please.
5 The radionuclide transport research
6 program plan, you have seen that plan. Only point I
7 want to make here is simply that this is sort of
8 trying to make sure we have some sound planning basis.
9 We have had input reviews, for example, from NMSS,
10 from NRR state programs, certainly from the public
11 through the website and the Federal Register notice.
12 Also, we have sought input from peers at
13 scientific and technical meetings. We certainly
14 expect this process to end sometime in January, and we
15 should be finalizing this plan by the end of January.
16 Well, where are we focused today? Again,
17 let me just briefly note that over the next few years
18 our focus is going to be largely on the issues
19 identified here. In terms of the source term,
20 certainly the chemical and physical form of
21 contaminants and their evolution over time, engineered
22 barriers, their performance, trying to understand
23 rates of releases from the isolation unit to the
24 environment.
25 Certainly, monitoring is necessary to

1 provide assurance of long-term performance, and this
2 is all because, again, we really do not have
3 sufficient data. Parameter uncertainties and
4 conceptual model uncertainties are, as I indicated
5 earlier, going to get significant attention.
6 And there is also, certainly, the question
7 that currently we don't really have a single tool for
8 systematically assessing some complex sites. So those
9 are areas that are getting our current attention.
10 What are some of the challenges? As I
11 indicated, my own -- this is a personal view, that it
12 is extremely important for us to resolve this issue of
13 waste disposal. I think there will be significant
14 public support if we were to resolve this issue for
15 new designs and new plants to be built here.
16 Nevertheless, we see a number of things
17 down the road, over the horizon in some cases,
18 certainly in terms of the transmutation of waste. We
19 would need to address this, as you know, considerable
20 interest. DOE seems to be marching on. They have
21 significant resources in their budget, and they are
22 looking to a multi-year effort here.
23 Currently, all we're doing in these areas
24 is just monitoring. We are not expending any
25 significant resources. Monitoring is done through

1 management keeping sort of track of what's going on,
2 perhaps attending a few meetings, and so on.
3 Certainly, there are going to be areas in
4 terms of low-level waste. I talked about the issues
5 of the need to monitor. Perhaps one can figure out
6 ways to get away from that.
7 Clearly, the potential vulnerabilities in
8 terms of security and safeguards, we'll need to
9 consider lessons learned, it seems to me, from the
10 September 11th event, just in terms of new
11 technologies and new designs that might be developed.
12 Early attention to such considerations I think would
13 lead to more efficient end results rather than not
14 considering such situations up front.
15 So if I had to summarize, what do I see as
16 some -- some important issues in my mind, certainly
17 long-term research resources I think need to be
18 protected. We need to continually focus on
19 distribution of our resources amongst the three arenas
20 that we work in in Research -- that is, reactors,
21 waste, and material arenas.
22 I admit that the prioritization scheme
23 that we had developed initially was probably somewhat
24 unreasonable in terms of how we should distribute our
25 resources. This year we have made some improvements

1 in that, and I think you'll hear about that some more.
2 I think it's -- I'm not convinced that we
3 are there yet. We need to work on it some more, and
4 we certainly seek your ideas/recommendations on how we
5 can improve that process.
6 An important issue also to me is to get a
7 sense from you to know whether you think we are
8 properly focused on issues you believe are important
9 today. I want to really acknowledge the thoughtful
10 letter that you sent in February of this year. I
11 think -- certainly, I thought it was a very good
12 letter. In fact, it was discussed at the expert panel
13 discussions, and there was a general view that that
14 was the direction the office should be considering.
15 And we had some -- we've had, as you know,
16 a very thorough evaluation of our programs in the
17 reactor arena, and it was a very clear focus on, are
18 we doing the right things in the office, given today's
19 knowledge and understanding? And it was of great
20 value to us in the office, but even equally important
21 I'm sure it was very important to the Commission to
22 get some independent views and thoughts in that area.
23 So I would seek your views in that
24 appropriate time to see if you think we're focused on
25 the right things.

1 An area that is consistent in my view with
2 the philosophy that was articulated in your letter,
3 one that we believe in, we agree with, is where you
4 need to be thinking about some alternatives, some
5 other ways. Other things need to be considered, and
6 this is the time to do it.
7 Now, the question is, obviously, of
8 resources. And given the -- some boundaries there,
9 what are the right things that the office should
10 really be looking at? That's going to be a focus of
11 our attention in the near term.
12 And, finally, it is critical for us as an
13 office. And ever since I'm come to Research we have
14 increased our cooperative agreements with both
15 domestic organizations, DOE, EPA, and others in this
16 country, including EPRI, as well as the international
17 community. I mean, these are common problems that we
18 all face, so it is essential that we form some teams,
19 leverage, or resources as we go forward.
20 So if I had to -- those are the key issues
21 in my mind. And, again, I want to thank you for
22 asking me to share some of my thoughts with you.
23 CHAIRMAN HORNBERGER: Thanks very much,
24 Ashok.
25 What I'm going to do is, because I would

1 like to maintain some semblance of a schedule, is we
2 are going to move on, and there will be some time for
3 discussion I think at the end of presentations.
4 Before we go on to the next one, I
5 neglected -- I had earlier introduced my colleagues
6 Milton Ray. And I wanted to make sure that I did
7 introduce John Garrick, whose plane did arrive from
8 Nashville as we had hoped. And also to welcome a new
9 member of the ACNW for today, Mario Bonaca, who is
10 with the ACRS but he is an honorary member of ACNW
11 today.
12 (Laughter.)
13 MEMBER GARRICK: So that means he really
14 fits in with us here.
15 (Laughter.)
16 CHAIRMAN HORNBERGER: Okay. And so next
17 we're going to hear the -- an NMSS perspective. Marty
18 Virgilio is going to have some comments.
19 MR. VIRGILIO: Good morning. It's a
20 pleasure to be here with the committee again, and also
21 with the invited guests, some of which I work with
22 today and some of which I worked with and for in
23 former years. So it's really a very good collection
24 of experts that you've pulled together today. And I
25 do want to give you a little perspective on NMSS

1 views.

2 My name is Marty Virgilio, for those of

3 you who don't know me, and I am the Director of the

4 Office of NMSS.

5 On the next slide, what I just wanted to

6 do is just lay out a little bit of background in terms

7 of where we are with regard to user needs and

8 anticipatory research. I think NMSS and Research

9 together have made significant progress over the past

10 several years in developing confirmatory research

11 programs for today's regulatory needs, since Ashok and

12 his staff and our staff have worked very well

13 together.

14 And I think when I look at the user need

15 process that's in effect today for support of our

16 today decisions, I see a very successful program where

17 except where we're limited by resources we really are

18 getting the support we need from Research to make the

19 decisions that we make today.

20 We have synchronized our operating plans,

21 and so we have deliverables. We know when they're

22 due, and we know what's expected. So we've defined

23 success, defined schedules, and I think that program

24 is working very well today.

25 Anticipatory research is another matter.

1 It's not that it's not working well today, but I think
2 it's an opportunity for us to make some significant
3 improvements. I think about anticipatory research, as
4 George spoke in his opening remarks, that goes beyond
5 today's existing regulatory programs. It's
6 anticipated what could be needed in the future and
7 acting on that.
8 Anticipatory research I think needs to
9 focus. It needs to be identified early on, and it
10 needs to be prioritized. So we are working on the
11 right things.
12 NMSS and Research and ACNW and other
13 stakeholders I think need to work together in this
14 process, and I look forward to the discussions today
15 and future discussions around anticipatory research.
16 In general, I'll go back and sort of underscore what
17 I just said. I think that we all need to play a
18 greater, more proactive role in anticipatory research
19 than we've done in the past.
20 I think we need to be more proactive in
21 providing input to Research on anticipatory projects
22 and achieving I think in the front end of the project
23 some notion of what we think success might be, and
24 then actively engaging in monitoring the results that
25 come out of the programs as they're being implemented,

1 and the final results of the projects.

2 In my short discussion today, I'm going to
3 give some broad views and some ideas where
4 anticipatory research could probe in support of maybe
5 some future needs. These are not I think well
6 developed or mature in thought. They are more to put
7 suggestions and ideas before you to stimulate your
8 thinking and your input. And it follows along the
9 lines of some of the areas where Ashok has suggested
10 that we anticipate and explore. So I think they are
11 very complementary presentations.

12 On the next slide, I just wanted to go
13 into the area of low-level waste disposal and provide
14 some thoughts there. The citing of low-level waste
15 disposal facilities, as you well know, is at a
16 standstill, primarily due to public opposition and not
17 really the technical issues. Anticipatory research on
18 environmental monitoring and economical waste packages
19 I think might improve NRC's regulatory programs and,
20 therefore, improve public confidence and reduce
21 opposition to low-level waste disposal.

22 Improved techniques for monitoring and
23 detecting radionuclides in the environment could be
24 used to improve our understanding for estimating
25 transport in the geosphere and provide assurances to

1 the public that releases are well understood and are
2 well within safety limits.
3 Anticipatory research could be used to
4 also support economical container designs that provide
5 high confidence for containment of radionuclides, on
6 the order of 300 years or more. This is not for us to
7 design the container, but I think to scope and
8 characterize what the needs might be.
9 I think we would also see some potential
10 benefits from research that would support development
11 of regulatory criteria for assured isolation, waste
12 management facilities, and also for alternates, maybe
13 shallow land disposal of greater than Class C waste.
14 On the next slide, I want to talk a little
15 bit about decommissioning and materials regulation, so
16 think about that broader title as I go through some of
17 the talking points here.
18 Similar to low-level waste disposal I
19 think license termination under restricted release
20 could benefit from some improvements in our techniques
21 and instrumentation for monitoring and detecting
22 radionuclides in the geosphere. Additional
23 anticipatory research could help us understand
24 alternatives for institutional controls, which is a
25 real stumbling block for us today.

1 We've been working trying to get
2 cooperative arrangements, memorandum of understanding
3 with DOE and for institutional controls, and that's --
4 we're not making much progress in that area. So I do
5 see that institutional controls are going to be a
6 significant issue for us in decommissioning some of
7 our sites in the future.
8 What Research can do in this area is help
9 us understand better what passive and active controls
10 might be most effective for some of the conditions
11 that we deal with, what active and passive controls
12 might help us in understanding and controlling
13 transport in various environmental settings and
14 characterizing the source term.
15 How can the human interfere, or how can
16 the human activity change the transport or the source
17 term? These are some issues that I think might help
18 us in the area of institutional controls.
19 Ashok mentioned entombment. I think
20 that's another area where we could benefit from
21 anticipatory research, understanding -- and I think
22 Ashok mentioned concrete grouts, how they perform in
23 the longer term. I think it's an area worth
24 considering.
25 Now draw the line on site decommissioning

1 -- and I just wanted to speak for a minute about
2 materials regulation. We believe, to the extent
3 permissible or supportable, by the information that we
4 have available we ought to be using risk information
5 in making our decisions. Both risk assessments and
6 risk management techniques I think need to be part of
7 anticipatory research.
8 We've done a lot of work in the reactor
9 arena, and I think we're just starting to do some
10 meaningful work today in the waste and materials
11 arena. I think we've had Lawrence Kokiko on the staff
12 come over and brief you on where we are with our case
13 studies and some of the efforts that we've been doing
14 around developing safety goals in the waste and
15 materials arena.
16 I think this is pretty exciting work, and
17 I really look forward to future interactions with you
18 not only in developing these tools but also looking
19 out into the future and seeing how we could apply
20 them, how we could make a difference.
21 I think here anticipatory research could
22 be used to help improve the methods that we're just
23 now formulating about risk analysis in these areas.
24 I think it's important to recognize the strengths and
25 limitations of the approaches we have in health

1 physics today.

2 Understanding the radiation effects on man

3 continue to evolve. And I know Research has been

4 engaged in anticipatory work in this area, and I think

5 we need to continue these efforts to better understand

6 how the program is evolving, how our knowledge is

7 evolving, and how that evolving knowledge could change

8 our regulatory programs.

9 On high-level waste, our regulations

10 require us to have a performance confirmation plan

11 that means -- that would help us have increased

12 confidence in the decisionmaking that we're going to

13 be making about a repository.

14 The performance confirmation program I

15 think could involve anticipatory research, testing,

16 and monitoring on extremely long time scales. We're

17 talking about thinking on the order of hundreds of

18 years down the road. That's truly anticipatory

19 research.

20 Accelerated tests could be evaluated over

21 the extended performance confirmation period and could

22 be used to help us provide more realistic

23 extrapolations of test results and improved methods

24 for estimating corrosion rates and other things about

25 the waste packages.

1 We're dealing with slow processes in the
2 geologic systems and releases of spent fuel and
3 information along these lines. Anticipatory research
4 in these areas I think would be very helpful. I think
5 we also need to establish and continue to look forward
6 to, how are we going to monitor performance? What
7 kind of performance indicators might we have for this
8 elongated period of performance confirmation? And I
9 think that's an area where we could do some more
10 anticipatory work.
11 Looking down the road, I think there are
12 other potential topics for high-level research. Ashok
13 touched upon safeguards issues and security issues.
14 I think about remote sensing techniques that would
15 help us understand or provide information on the
16 integrity of the physical protection systems is an
17 area that might be worthy of exploration. So that's
18 how you bring safeguards into this I think on an
19 anticipatory, long-term scale.
20 We've got -- we've had a number of delays
21 in the high-level waste program for a variety of
22 reasons. We may, in fact, be looking at having our
23 casks -- storage casks stand for longer periods of
24 time or have to stand for longer periods of time than
25 we originally anticipated. So I think here might be

1 another opportunity for some anticipatory research,
2 looking at and probing at what new materials might be
3 best for long-term surface storage.
4 Recently, we've also had a number of
5 discussions and a renewed interest about advanced
6 reactors. One of the areas that I don't know that
7 we've put enough emphasis on is the back end of the
8 process about what are kind of -- what are the fuels
9 that are going to be used associated with these
10 advanced reactors, and how best to -- and safely store
11 those fuels over the long term, both on the surface
12 and in the repository. So these are yet other areas
13 where I think we might be able to do some exploratory
14 or some anticipatory research.
15 This is really the -- what I wanted to do
16 is just put some ideas out on the table, just
17 stimulate some thoughts for discussion. And these
18 pretty much conclude the prepared remarks that I had.
19 Again, I think I want to stress where I
20 started off, that I think there is a strong need for
21 us to work in partnership -- both the line
22 organization, ACNW, and Research -- around
23 anticipatory research in a much stronger way than we
24 have in the past, and to get to where I think we are
25 today with regard to the user need process, where I

1 think that is working very well. And I think what
2 we'll do through this process is maximize the benefits
3 from anticipatory research.
4 Something that we've talked about between
5 the staffs -- and I know we've had a lot of discussion
6 about -- the end of the day, when it comes to
7 anticipatory research, I think what we want to say is
8 that was money well spent, whether we actually found
9 something that we actually needed to change or really
10 confirmed the path that we are on. Either way, I
11 think that could be viewed as money well spent, and
12 that's where I want to see our programs. And that's
13 where I think we're headed today.
14 So I look forward to the conference. I
15 look forward to the advice that comes from this group,
16 and I wish you success. Thanks.
17 CHAIRMAN HORNBERGER: Thanks very much,
18 Marty.
19 I find myself delinquent again. I forgot
20 to introduce Bill Hinze, a former ACNW member and a
21 consultant with us today, also a participant on our
22 group. So I think I've covered everyone now.
23 (Laughter.)
24 Okay. Next we're going to hear from
25 former commissioner Ken Rogers. For those of you who

1 don't know, Ken chaired a group -- a committee about
2 a year ago looking at NRC research. So Ken has lots
3 and lots of insights into research at NRC.
4 MR. ROGERS: Thank you very much. You
5 know, I have to remind you that I don't really have
6 any detailed technical knowledge of the specialty
7 areas that we're really focusing on in connection with
8 radionuclide transport and such issues, although I
9 certainly have been interested in them for many years.
10 So my remarks are going to be more of a
11 general nature. I hope they have some value.
12 First, the draft report "Radionuclide
13 Transport and the Environment" produced by the
14 Radiation Protection, Environmental Risk, and Waste
15 Management Branch of RES is a very comprehensive plan
16 which appears to have touched on a great number of
17 issues of generic as well as special interest in
18 dealing with nuclear waste that calls for further
19 study.
20 The plan reflects a great deal of careful
21 thought and scholarship. I really was quite pleased
22 with it. I hadn't seen anything like that before, in
23 my view, in past years in -- with regard to research
24 -- a research program in this area under RES.
25 If I had to choose a simple phrase to

1 characterize the plan, it would be, "Requirements for
2 establishing a realistic basis for the regulation of
3 nuclear waste." It seems to me that that is the --
4 that's the overarching view that just permeates that
5 whole plan. Virtually every subject discussed in the
6 plan is examined for its degree of realism. That is,
7 the extent to which it is understood on the basis of
8 established, quantitative, factual knowledge and
9 experience rather than shaky facts conflated with an
10 attempt at conservativism.
11 I was very interested in the discussions
12 earlier this morning on how involved you are with
13 defining conservativism. I think it's terribly
14 important, and I was really pleased to hear that
15 focus.
16 I found the approach in the report
17 refreshing and stimulating. However, at the risk of
18 appearing to quibble over language, I have to take
19 issue with the wording in the appendix in the
20 performance goal cited in A2.2 of the plan, which
21 concludes with the statement -- I'm quoting now --
22 "NRC will make its decisions more realistic by
23 eliminating excessive conservativism."
24 Eliminating conservatism does not
25 necessarily result in more realism. But insisting

1 that risk information, research results, and
2 operational experience are the bases for regulation
3 can result in the elimination of excessive
4 conservativism. The distinction, while seemingly
5 trivial, is, in fact, very important.
6 And what brings this to mind is the
7 experience in the reactor area where we found, not
8 surprisingly I suppose, the safest and best running
9 nuclear powerplants, when we compare almost identical
10 units with those which were the least expensive to
11 run.
12 So if one draws the conclusion, then, that
13 the way to get to a safe plant is to reduce costs,
14 you're going to be in real trouble.
15 (Laughter.)
16 And I'd keep that in mind here with
17 respect to this question of eliminating
18 conservativism, that you don't eliminate
19 conservativisms. What you do is become more realistic
20 and they'll go away if they're not appropriate.
21 I certainly am mindful of the comments
22 that Milt Levenson made this morning that, you know,
23 we're not against conservative approaches. Of course
24 not. It's just that when you don't know and you just
25 inflate something that -- and then cobble it together

1 with something else which has been done exactly the
2 same way, that you get led into a never neverland that
3 really leaves you on very unsure basis.
4 So I think that it's very important to get
5 the cart -- get the horse before the cart and not the
6 other way around. Realism, as it has been defined in
7 -- by Ashok Thadani and in research, I think is -- is
8 the proper meaning of realism at NRC.
9 I think that there has been a confusion
10 sometimes that realistic meant less economically
11 demanding. No, that might come about, but don't try
12 to get that way, get there that way. Realism has to
13 be most soundly based. That's, to me, what realism
14 has to mean. You know, best data, best validation,
15 best use of experience, rather than something else.
16 Given the draft plan as it is, the next
17 step is to develop a basis for prioritizing all the
18 possible studies and works described in that plan,
19 because it's very apparent to me, and I'm sure to
20 everyone, that it cannot be fully underwritten by NRC
21 which this year is budgeting 11 FTEs and $2.8 million
22 in fiscal 2002 for this general -- in this general
23 area. That's just simply, you know, nowhere near
24 enough to do the job. On the other hand, it's a plan
25 and a very important and interesting one.

1 I would suggest that high priority should
2 be assigned to those projects that can be undertaken
3 with a high degree of leverage of NRC funds. It's
4 obvious, but I'll just remind you that there are
5 really two reasons for this.
6 It seems to me that jointly supported
7 projects are likely to have undergone a highly
8 rigorous examination of their generic importance. And
9 an NRC dollar, when contributed to a joint project,
10 simply buys much more than a solely NRC supported
11 project of the same dollar value. That's obvious, of
12 course.
13 But I think the other point that is
14 perhaps -- that they may get greater scrutiny and
15 examination from the standpoint of their generic
16 value. And I think that's very important,
17 particularly in this area where we're doing a little
18 ballet all the time to dance away from doing research
19 in research that is applicable to Yucca Mountain
20 versus doing research which is generally applicable
21 that also might be of interest to Yucca Mountain.
22 And it seems to me that the -- combining
23 resources and multiple support is a way to help to
24 deal with that issue.
25 Also of high priority, it seems to me, are

1 projects which stimulate other entities to continue
2 and extend the work, maybe not through direct
3 collaboration but to start something which then gets
4 picked up by others and carries -- is carried forward.
5 And this may be of particular importance in the low-
6 level waste area, which some time ago NRC more or less
7 handed over to the states, which by and large have had
8 difficulty in funding relevant research into new
9 issues.
10 With NRC leadership in low-level waste
11 issues such as we heard about just a few moments ago
12 from Marty, greater states involvement in low-level
13 research might increase. It's not going to provide
14 them with money, but maybe they will see the real
15 value of carrying something a little bit further for
16 their own purposes in low-level waste disposal.
17 The various research issues related to
18 engineered barriers to radionuclide transport would
19 fall into that category, it would seem to me,
20 particularly the effective performance lifetimes of
21 barriers -- very important -- noted in the research
22 plan as a significant area for study that really needs
23 attention.
24 I note that the prioritization rating
25 factor scheme that RES does -- has proposed does, in

1 fact, take into account external
2 participation/leverage. That's in there. It's
3 mentioned in there. But I'm going to come back to the
4 prioritization scheme a little bit later.
5 The research plan repeatedly stresses the
6 need for improved conceptual bases for the models used
7 in analysis. It seems to me that this is really very
8 important. The particular -- it's particularly
9 important in establishing the clarity of the basis for
10 regulatory -- future regulatory decisions, when
11 they're made that the public can understand the basis
12 on which the decision was made, that this -- that the
13 model is in some way -- at least can be understood,
14 what its limitations and applicabilities are, clear
15 statement of the underlying assumptions on which a
16 model is constructed, what is included, and what is
17 omitted in the model.
18 You know, very often you hear about what's
19 in there, but not necessarily what was left out, which
20 could ultimately be extremely important.
21 What the basis is for the numerical
22 parameters that are built into these computer models
23 and their quantitative uncertainties which
24 characterize the model, what quantitative
25 sensitivities are associated with those uncertainties,

1 what is the permissible range of input data for which
2 the model is expected to yield valid results, and how
3 well the model performs when compared to the results
4 of actual measurements.
5 I'm not telling you anything new that all
6 of us didn't learn as graduate students. And yet we
7 tend to somehow rather forget some of these things in
8 the great attention to detail that has to go into
9 finally arriving at some kind of regulatory decision.
10 And it seems to me that -- that these
11 considerations really take on great importance in
12 performance assessments in which the uncertainties
13 directly relate to certain margins. When you really
14 come down to the performance assessments, you've got
15 to know what those margins are and what they -- how
16 they relate to safety.
17 And it would seem to me that a very useful
18 activity -- I didn't put it in my little remarks here,
19 but -- would be for somehow NRC Research, together
20 with others, to develop some kind of a -- a method of
21 forcing the display of these -- the applicability of
22 all of the data, all of the parameters, all of the
23 assumptions, that go into the use of any conceptual
24 model, that it's all got to be there.
25 You don't have to go and chase it down and

1 pull it out. By the time it gets used, it should be
2 very clear what those are. So that one can understand
3 the limitations and -- and either derive confidence or
4 a lack of confidence from them.
5 And that leads me to the very important
6 observation that the ACNW made not so long ago, in
7 already pointing out the importance of developing
8 relatively simple risk models based on the dominant
9 contributors to risk, the great value in the
10 intellectual exercise of such an activity. Greater
11 understanding of the results of more complex models is
12 achieved, and ultimately higher confidence in those
13 results.
14 We all know this, but, you know, somehow
15 it gets forgotten. We get seduced by the beautiful
16 complexity of a huge computer program that's got a
17 million lines of code in it and has been worked on by
18 hundreds of people over the years. But trying to come
19 to grips in a simple way with what the really
20 important features of that complex model are requires
21 another approach.
22 You know, it's what we used to call the
23 back of the envelope calculation that every
24 experimental physicist had to do before they started
25 taking data, or, you know, you wouldn't know where you

1 were going.

2 What are the important things that govern

3 this? What do you really think is going to come out

4 of it? How do you develop a kind of common sense

5 approach to looking at, you know, detailed numerical

6 printouts of huge computer programs?

7 And so I don't see any explicit mention of

8 this type of work in the RES plan, and it seems to me

9 it would be very good to include it in some way. That

10 somehow there's a complementarity here that really

11 should be addressed.

12 RES has developed prioritization rating

13 factors for work -- for the work carried out under

14 this plan from their reactor safety-based

15 prioritization scheme, with weighting factors and

16 basic considerations largely carried over from

17 reactors to waste. I know ACNW has commented about

18 the need to prioritize, and I guess this was the first

19 cut at trying to do that, take over what was done for

20 reactor safety into the waste area.

21 It isn't clear to me that this is the best

22 way to establish a prioritization system for waste

23 safety research, although it might be a starting

24 point. I'd prefer not to start that way and see

25 whether you get there some other way.

1 But it's been done, and I think it perhaps
2 suggests that this needs another look, that the
3 prioritization rating scheme for waste disposal is
4 really, conceptually it seems to me, quite different
5 from what you would -- how you would address reactor
6 safety.
7 The issues -- really, there are some that
8 are very vital in reactor safety that really aren't
9 all that important in waste. The thing that comes to
10 mind to me is human -- some of the human factors
11 considerations in running a safe nuclear powerplant
12 probably are not easily translated over into how to
13 deal with low-level waste, for instance. It's a
14 different kind of animal.
15 So it will be very important in reactor
16 safety, probably not important very much at all in
17 waste disposal.
18 Not surprisingly, the plan doesn't put
19 price tags in either FTEs or dollars on the various
20 activities that are listed. So it's difficult to
21 identify the low hanging fruit that easily and
22 relatively inexpensively could be harvested. I think
23 those things should be identified. These are things
24 we might be able to get -- very useful -- out of this
25 program right away with not an awful lot of additional

1 expenditure.

2 And also missing are easy ways to identify

3 possible synergisms among the various studies. Where

4 could you combine things? Where would a study here

5 and a study there actually complement each other in an

6 extent that leads to a sum that's greater than the --

7 a whole that's greater than the sum of the parts.

8 And I think that one should very carefully

9 try to go through that plan and try to identify

10 possible synergistic activities. But these are all

11 future steps that can be taken readily with the help

12 of experts such as have been assembled in this

13 workshop, omitting myself.

14 So that's what I -- the little bit I have

15 to say to you right now.

16 CHAIRMAN HORNBERGER: Thanks very much,

17 Ken. That's very useful.

18 Probably everybody is aware that the

19 Office of Research has put out the draft plan for

20 radionuclide transport, and Ken has obviously read

21 that very carefully. It's out for public comment

22 right now. So they are very useful comments, Ken.

23 Next we have Mal Knapp, consultant.

24 That's a new -- new title.

25 (Laughter.)

1 At least since we've seen you last, Mal.

2 MR. KNAPP: Yes. Well, I was sort of

3 under the impression that that's kind of the career

4 path that you follow after you leave the NRC.

5 (Laughter.)

6 So I didn't want to deviate.

7 (Laughter.)

8 One thing that I think you'll find, partly

9 in what I say now and partly in what I'll say later,

10 that although I've come at it from a little bit

11 different approach here and there, that many of the

12 things that you just heard from Ken Rogers you're

13 going to find that I tend to agree with.

14 The questions that I wrote down to address

15 this morning were: what issues will be the subject of

16 future decisions? Where is work needed to provide

17 necessary information for decisions? And where will

18 work provide a significantly improved and more

19 realistic decision?

20 That first question, what issues will be

21 the subject of future decisions, causes me to ask,

22 well, what are the future decisions likely to be? And

23 reminding you that this is my perspective on this, and

24 that your mileage may differ, I have what I think will

25 be three decisions that are pretty likely in the

1 future.

2 And the first is I'm talking about, say,
3 the next five to 10 years, whether to license Yucca
4 Mountain, whether to license private fuel storage, and
5 -- and something that may be a little broader than
6 what the ACNW has really worked with in the past, but
7 nonetheless I think very much falls within the
8 concerns associated with spent fuel and waste
9 management as well as storage and disposal, what to do
10 about spent fuel pools.

11 I think, in my mind, these are the three
12 big areas where decisions will have to be made. Now,
13 I don't want to take anything away from the things
14 that you've heard Marty say, and I think he has
15 provided a good perspective on such things as low-
16 level waste and decommissioning. And there I think
17 may well be issues yet associated with some of the
18 uranium recovery work.

19 But from my perspective, these are areas
20 where major decisions with major issues are not as
21 likely to spring up, at least over the next five to 10
22 years. Now, obviously, if there were a dramatic
23 change, say, in what they're going to do at Barnwell,
24 I might come in with an entirely different sheet.

25 But given that those are the future

1 decisions that I'm anticipating, let me talk about
2 some of the issues that I think might well come up.
3 And I'm speaking broadly here.
4 One of the questions that I think we will
5 need to address, and I'll talk more about it in a
6 moment or two -- you'll also notice that I say "we" on
7 occasion, so that although I am retired sometimes I'm
8 not as retired as I'd like to think.
9 (Laughter.)
10 But I think something that the NRC will
11 need to consider is the quality of the application
12 that DOE will bring in on a high-level waste facility.
13 I think another issue that will be important, but I
14 think, frankly, maybe less than application quality,
15 will be transportation associated with getting the
16 waste facility, and, of course, as a result of
17 September 11th terrorism.
18 And I have a few thoughts on terrorism and
19 threat that I will share, but I've asked Marty to pay
20 careful attention here. It's not my intent to stray
21 into areas that we really shouldn't discuss publicly,
22 but I may by accident.
23 The next question of whether to license
24 private fuel storage -- again, in my view, the
25 principal issues that will have to be dealt with will

1 be transportation and terrorism or threat. And with
2 respect to the question of what to do about spent fuel
3 pools, September 11th is what put that on my agenda.
4 If we can go on and talk a little more,
5 where do I think work is necessary as opposed to where
6 I think work will provide improvements? Again, with
7 necessary work, I turn immediately to terrorism. Now,
8 I don't know what's going on within the NRC at this
9 point, and I don't really want to speculate too much.
10 But I would suspect that work has been -- is going on
11 and will go on to reevaluate the design basis threat
12 as a result of what happened September 11th.
13 And once that threat has been evaluated,
14 then I think that work will need to be done in a
15 couple of ways. I think one needs to talk about the
16 probability that that threat would, in fact, be
17 successful from several viewpoints and how to alter
18 that probability of success. And I think one should
19 then look at the consequences of the threat being
20 successful or partially successful and how those
21 consequences can be mitigated.
22 And I'm talking, again, about all of the
23 areas we've just discussed. We talked not only about
24 the possibility of threat associated with
25 transportation but threat against any of the

1 facilities that I mentioned earlier. The threat may
2 turn out to be the same or it may be different. And
3 I don't know, but I think that it will be a basis for
4 having to do additional work, as I said, on
5 probability and consequences.
6 Having said that, let me turn to where
7 perhaps the first of these areas might be examined and
8 I talk about spent fuel pools. This is where I think
9 with respect to improved and more realistic decisions
10 -- with respect to spent fuel pools, I think that it
11 would probably be a good idea to look for new
12 paradigms.
13 Now, one, for example, that comes to mind
14 -- certainly, in my experience, the way one ran a
15 spent fuel pool, you wanted to safely get the spent
16 fuel out of the reactor, into the pool. Once you had
17 it into the pool, you obviously wanted to let it
18 remain there to decay a good, long time, say five
19 years, before you did anything with it. And with the
20 exception of filling up the pool, you really had no
21 rush. That paradigm may have to be changed.
22 I was at a meeting several weeks ago that
23 really had very little to do with nuclear safety. But
24 as soon as people found out what I did for a living,
25 the question I was immediately asked is, what are we

1 going to do about spent fuel pools? And I found it
2 interesting that a number of people in the public
3 simply brought that forward on their own.
4 That's not to say necessarily that there
5 are great technical issues, but that there are going
6 to be issues associated with pools and the NRC is
7 going to have to make some decisions. When I talk
8 about the new paradigms, I'm thinking about people who
9 are concerned about how long the fuel should remain in
10 the pool.
11 At one point, I would have said, well,
12 there's no rush. Today, we may have to say this --
13 that fuel should be removed from the pool promptly.
14 That could suggest research. If you wanted to remove
15 it in, say, less than five years, suppose you wanted
16 to remove it in one-tenth of that time, say six
17 months. Is that possible? How would you go about it?
18 What are the hazards associated with, say, moving it
19 into dry cask storage after six months? Just --
20 that's just one possibility.
21 But I think there will have to be a
22 reexamination of exactly what one has to do to store
23 spent fuel, in a pool or to store it dry. There are
24 additional considerations I just don't want to really
25 bring forward in the meeting, but I think they can be

1 examined, and I think research can definitely
2 contribute to how some of those decisions might come
3 out.
4 With respect to Yucca Mountain, I
5 mentioned earlier the quality of the application.
6 Now, questions have recently been raised about the
7 quality of the technical work at Yucca Mountain. And
8 DOE has met with the NRC, they have the message, and
9 they are going to take the necessary steps to ensure
10 quality.
11 Unfortunately, that happened when I was
12 the Division Director in Waste Management in 1994. It
13 happened again, I believe at least twice, before I
14 retired. I have to say that I am somewhat skeptical
15 as to whether DOE will succeed this time. I have no
16 doubts that they will do the best they can, but their
17 track record of being able to be responsive to this is
18 something which may go beyond the capabilities of that
19 program in some way we don't understand.
20 And that leads to the question: what
21 would the NRC do with a high-level waste application
22 where the quality was limited? Another reason to
23 wonder about the quality, we have to recognize that
24 they've been looking at that site now for about 14
25 years.

1 Now, I'm not going to assert that there
2 won't be any breakthroughs over the next few years,
3 but the fact is much of the data has been taken.
4 Unless they extend the license application submittal
5 decades, most of what they have to base it on is
6 already there. That's a sweeping generalization, and
7 I'm sure that you can identify a number of areas where
8 that's not true.
9 But I think we need to recognize that
10 there is a very real possibility that the quality of
11 that application is not going to be as sound as either
12 NRC or DOE would like. To my mind, that suggests
13 research perhaps on how to deal with that reduced
14 quality.
15 Now, the easy answer, of course, for the
16 agency would be to simply have the application, under
17 those circumstances, fail the acceptance review. But
18 if you consider that one of the goals is to reduce the
19 regulatory burden, and I'm talking about the public as
20 well as the Department of Energy, is it worthwhile to
21 consider whether there are ways that less than high-
22 quality data and technical work could be examined and
23 could be treated so as to still be able to make
24 decisions, perhaps with greater uncertainty -- forgive
25 me, but perhaps with more conservatism.

1 But I just don't know. And it may be that
2 there is no way that research can, in fact, improve
3 this situation, and it may be that the problem that
4 I'm describing is one for the attorneys, not for the
5 scientists.
6 But I would be inclined to at least probe
7 in that area a little bit and ask, is there something
8 that could be done so that in the event that the
9 application is of less than high quality that the
10 agency could be more responsive to it?
11 The next item that I have, and you see I
12 have a question mark after it, is transportation. I
13 have it up there because I believe that transportation
14 is going to be a major issue in at least two of the
15 areas, the spent fuel storage and high-level waste
16 storage disposal at Yucca. And I just ask myself, is
17 there anything that can be done?
18 My sense has been that often we have --
19 it's not fair to say that we've taken a brute force
20 approach, but it has not been particularly high tech.
21 Things are changing. If we consider the threat to
22 transportation, obviously, the threat has changed.
23 But also, the way that this country responds to threat
24 and anticipates threat is going to change.
25 Further, I think there are a variety of

1 technical advances associated with information,
2 information gathering, that I'm not certain have, in
3 fact, been considered with respect to transportation.
4 And so I think an area where technical work might be
5 considered would be recognizing that it is a very
6 different ballgame than it was five years ago, and
7 will probably be very different five years from now.
8 And research into trying to forecast what
9 that ballgame might be like, and ask how we could be
10 more effective, ask how perhaps greater information
11 could make things safer, is something worth
12 considering.
13 At the same time, although probably at a
14 lower priority, I would look with respect to
15 transportation at incident response. Again, this is
16 going to be a significant issue. Again, have we, in
17 the last five years, looked at all of the changes that
18 might be made, all of the opportunities associated
19 with the incident response? Again, I think this is an
20 area where information gathering, information sharing,
21 could have -- result in improved response for
22 transportation accidents.
23 Those are just a few thoughts. They are
24 from my perspective. And that's really all I have at
25 this point, although there are a couple of thoughts on

1 prioritization and other things that I'll talk about
2 a little later today.
3 Thank you.
4 CHAIRMAN HORNBERGER: Thank you, Mal.
5 Very good.
6 Finally, for this portion of the session
7 we have John Kessler from Lawrence Livermore Lab --
8 (Laughter.)
9 -- or California anyway.
10 (Laughter.)
11 MR. KESSLER: All right. I did a bit of
12 anticipatory research of my own, and recognizing that
13 as I was the last speaker behind these particular
14 speakers, I am going to try to keep this short.
15 Next slide, please.
16 I tried to follow the general questions
17 here in terms of what I've put together. But in terms
18 of spent fuel issues subject to regulatory decisions,
19 I want to preface it by saying that what I look at as
20 the spent fuel side is more -- probably more than low-
21 level waste. So you'll have to bear with me there.
22 But certainly, the industry recognizes that while we
23 support Yucca Mountain, it's going to be a long time
24 coming under the best of circumstances.
25 And the number one issue for us is going

1 to have to do with technical bases for storage of not
2 only higher burnup fuel but also independent spent
3 fuel, storage installation, license extensions, and
4 license extension issues. Those things need to come
5 first. No matter what happens with Yucca Mountain, we
6 need to have good bases for storage of fuel,
7 especially higher burnup fuel.
8 The current situation is that NRC has
9 licenses for rather limited burnups now, limited in
10 the sense of what's now coming out of the reactors,
11 and there needs to be some work done. NRC is actively
12 looking at that with industry, but I just want to
13 highlight this as the -- as a number one issue in
14 terms of spent fuel research that we would like to see
15 progress on probably even more so than Yucca Mountain
16 in terms of what needs to be done first.
17 So for the -- number one, it's the storage
18 of high burnup fuel. That is, it must demonstrate
19 that all fuel can be stored safely while final
20 solutions are developed. Not only the lower level
21 burnups for -- up to mid level, but the higher burnup
22 stuff that's now coming out of the reactors.
23 In fact, the limits on burnup are such
24 that I'd say the majority of the fuel now coming out
25 of the reactors exceeds the burnup limits for the

1 current suite of storage systems out there. So this
2 is a very pressing issue.
3 The majority -- I just said that here.
4 The burnups now are higher than the ISFSI licenses or
5 the Certificate of Compliance allow.
6 The next one is we've got a lot of stuff
7 that's already in storage, and those storage license
8 limits are 20 years, which back in the mid '80s seemed
9 like plenty of time before something like Yucca
10 Mountain would be on board. Well, we're reaching the
11 end of some of those. In fact, the first one will
12 come up in 2006, so we need to clearly distinguish
13 issues associated with longer term ISFSI degradation
14 from the original licensing bases.
15 That is, there were a lot of technical
16 bases that were set down, established, agreed upon, to
17 get those things in storage for the first 20 years.
18 We need to distinguish just the research that's
19 involved with, what are the long-term aging mechanisms
20 that maybe weren't considered or part of the technical
21 bases for the first 20-year application?
22 Things have been considered like cladding
23 creep. It's not really a consideration now in terms
24 of the original technical bases, probably not
25 important beyond a few months to a few -- whoops --

1 years years -- in the sense that we feel that cladding
2 creep is probably over, and that it's not going to
3 contribute significantly and it probably isn't an
4 issue for long-term storage.
5 And evaluating the integrity of the cask
6 system components may be more important. I believe
7 that was alluded to a little bit earlier.
8 Next viewgraph, please.
9 Okay. Now into general disposal issues.
10 I echo earlier comments by quite a few of you that the
11 appropriate use of total system performance
12 assessments and other information in decisionmaking is
13 something that can be the subject of research. While
14 it may be mainly up to DOE, NRC should provide some
15 guidance as to, you know, what is it that makes sense
16 in terms of using that information in decisionmaking?
17 Well, the NRC guidance has got to be based
18 on an adequate understanding of information
19 limitations and where judgment becomes important.
20 This is identifying how one uses judgment, how one
21 uses data, to make decisions about very long-term
22 performance.
23 The nature of reasonable expectation at
24 each step of repository development really needs to be
25 thought through. There is likely to be a research

1 component here. What added data needs and modeling
2 are required to advance to the next stage? And along
3 those lines, certainly we feel at EPRI that
4 performance confirmation is a very important research
5 topic that helps one establish maybe the data needs
6 and can stage those data needs as we go through.
7 And EPRI hosted a workshop on the idea of
8 performance confirmation. We talked a little bit
9 about this issue then.
10 Next.
11 Getting down to the particular topic here,
12 source term and radionuclide transport issues, I'm
13 going to whiz through these right now and revisit them
14 somewhat later on. Inventory issues, I would say that
15 those are lower priority for spent fuel, if I think in
16 terms of, you know, the uncertainties that are there
17 and how much variability, although certainly there are
18 some big question marks for inventory of defense fuel
19 that might require some research there. But it's
20 certainly higher for the other wastes, thinking of
21 low-level waste, decommissioning waste, things like
22 that.
23 Chemical conditions in the engineered
24 barrier system, I think that's clearly understood to
25 be something of importance that's fairly uncertain.

1 That certainly is something that can be amenable to
2 research far and wide.
3 Role of diffusion and sorption in the
4 engineered barrier system, I'll talk a little bit
5 later about the idea that it seems like there's a lot
6 of -- how would I say -- importance being placed on
7 diffusion, and I would say that's only because we have
8 a limited ability to model it realistically or
9 understand that. And I'll talk a little bit more
10 about that later.
11 And sorption within the engineered barrier
12 system itself may actually be of importance if we can
13 establish a decent technical basis to do that.
14 Fracture/matrix interaction, both use --
15 especially in the unsaturated zone, but especially the
16 saturated zone, could, if we had some more supporting
17 research, dramatically change the case or the relative
18 importance of those particular barriers, at least for
19 the Yucca Mountain system.
20 Matrix sorption also, which these two are
21 really linked, are again areas of -- amenable to
22 research that could make a significant difference to
23 our understanding of the relative importance of the
24 system. And that would really be almost -- many
25 systems, not just Yucca Mountain. So it's sort of up

1 to NRC to decide whether this is an NRC Research or an
2 NMSS activity.
3 Now, here is a pretty Yucca Mountain
4 specific one for the Tephra part. But Tephra and
5 common dust resuspension and radionuclide distribution
6 is something that is certainly making the top of the
7 list right now for the volcanism consequences, the
8 Tephra part. But, in addition, our revised model for
9 our biosphere for the normal release, just due to
10 irrigation of crops, is that dust resuspension or dust
11 inhalation is our dominant pathway for most of the
12 actinides, even for not the volcanism scenario.
13 Lower priority might be neptunium and
14 uranium solubility. When we did our sensitivities, we
15 just didn't see that those were big hitters, even
16 though there's been a lot of press attached to them.
17 And I'll talk about that a little bit in one of the
18 later talks.
19 Colloid-aided transport, I think that
20 we're -- we could nail that lid on that coffin a
21 little bit tighter, certainly with some more R&D. But
22 even with the analysis that's done that I would argue
23 sort of maximizes the potential for colloid-aided
24 transport, we are not showing it up in terms of risk
25 space as being hugely important.

1 Sorption in the alluvium -- again, I'll
2 get back to why I feel that's of secondary importance,
3 and there are certainly lots more.
4 And in terms of additional work needed to
5 provide regulatory decision bases, evaluate NRC spent
6 fuel storage guidance from a more risk-informed
7 perspective. This was developed, I would say, mostly
8 in the era before NRC started talking and trying to
9 internalize risk-informed thinking.
10 And some of the guidance -- I'm thinking
11 in particular some of the interim staff guidance for
12 spent fuel storage -- may be aimed at lower risk
13 aspects. I would encourage NRC to look at that, think
14 about whether there is an opportunity for some
15 research in some of those areas to identify what level
16 of risk those -- that guidance is for.
17 And some of the guides seem rather
18 conservative based on available information. I'm
19 thinking particularly of the source term ISG-5 that's
20 -- talks about what an applicant needs to assume in
21 terms of things coming out of a package for normal
22 release in accident conditions.
23 Continue forming the bases to support
24 storage and disposal of higher burnup fuel.
25 Additional research may allow for future flexibility

1 and approaches. What do I mean there? There are
2 approaches that are available for high burnup. They
3 are not very pleasant from an economic standpoint,
4 causes additional transportation requirements because
5 we may have to derate packages and the like.
6 And some additional research -- and here's
7 an opportunity where EPRI and others are already
8 working with NRC Research in this area -- is something
9 that could be of high benefit.
10 Advanced capabilities to conduct more
11 realistic performance assessments -- yes, I'll jump on
12 that wagon, too. It's really impossible to properly
13 prioritize. Certainly, we can prioritize, but we
14 can't properly prioritize research needs without a
15 more realistic performance assessment. It's got to be
16 based on currently-available information.
17 But we've got questions about if not
18 conservative or what we generally understand to be
19 conservative -- and I'm sorry, I missed the discussion
20 about that this morning -- then how to get a best
21 estimate. It's not easy, and it's going to cost a lot
22 of money sometimes to get to a best estimate. And
23 that needs to be thought through in terms of what
24 might be done for research.
25 It may also require a greater flexibility

1 on the use of expert judgment. There may be cases
2 where it's just going to be really hard to get to
3 these best estimate cases. How might one use best --
4 the proper mix of data that you can collect with
5 expert judgment to get at something you may feel is a
6 more realistic performance assessment in the end.
7 And from the recent expert panel report
8 that Ken Rogers chaired, certainly we like the idea
9 where they say research should be doing more work on
10 the utilization of PRA results and in developing
11 improved PRA methods.
12 For additional work to facilitate improved
13 regulatory decisions, continue supporting joint
14 research on higher burnup fuel, improve understanding
15 of material degradation trends with burnup is
16 certainly a key to that aspect.
17 There's a good example of cooperation
18 between reactor and storage needs with NRC. We've got
19 NRR, NMSS, and Research all involved with that. I
20 think it's a shining example of how cooperation, both
21 within NRC and between NRC, DOE, and industry, in
22 terms of actually co-funding particular projects, is
23 going rather well.
24 And the technical bases for decisions are
25 still different between NRR and NMSS -- for example,

1 the allowable oxide thickness on cladding. Well, they
2 came from two different approaches. They came up with
3 two different answers, and yet it's an example of
4 where NRC needs to think through the entire fuel cycle
5 there to come up with a common approach that would
6 help.
7 Next.
8 Developing approaches to get -- to get to
9 a realistic TSPA is the additional work that needs to
10 be done. Developing an understandable TSPA -- I think
11 that I'm echoing what I believe Ken Rogers just talked
12 about. The current attempts aren't playing very well.
13 Come up with some sort of simplified performance
14 assessment.
15 We need to decide on the stories to tell
16 with performance assessment. There's a billion things
17 we could be doing with those PA codes. What is it
18 that you want to show, and does the code show it? Can
19 you get it to show it? Is there something else you
20 need to be doing, either within the code or outside of
21 the code, to tell the stories that need to be told?
22 Clearly identify data used and assumptions
23 made. We all tend to get rather parochial when we
24 develop these models and forget to do this quite
25 often. In fact, in one of my later talks I'm going to

1 compliment the Center's research proposal where they
2 actually do try to do this before they identify what
3 research needs to be done in a particular area.
4 Continue exploring the role of natural
5 analogs. What we're concerned about is that not all
6 of the important FEPs -- highly uncertain ones, highly
7 sensitive in terms of the results -- features, events,
8 and processes here will be amenable to performance
9 confirmation. You may not be able to get the data.
10 You may not be able to measure it.
11 What is it you're going to use? Perhaps
12 natural analogs is one of those techniques, and more
13 could be thought about in terms of how one uses
14 natural analog information.
15 That ends that section. Thanks.
16 CHAIRMAN HORNBERGER: Thanks very much,
17 John.
18 Because we're on the record, of course, I
19 should point out that everybody knows that John
20 Kessler is with EPRI. I'm from the University of
21 Virginia, and at the high-level waste conference John
22 made the mistake of introducing me as from Virginia
23 Tech.
24 (Laughter.)
25 MR. KESSLER: Some year I'll live it down.

1 CHAIRMAN HORNBERGER: So I was just trying
2 to get back at John a little bit.
3 (Laughter.)
4 What I think I'd like to do now is take
5 some time to basically have some -- we have some time
6 to offer questions to some of our presenters from this
7 session. We didn't schedule a lot of time for this,
8 but I think that it's worthwhile for us to take some
9 time to do that.
10 I don't know if Ashok and Marty want to
11 join us at the table for this discussion.
12 Does anybody have any questions? John, do
13 you have anything that you want to pose to any of our
14 presenters, or comments you want to make?
15 MEMBER GARRICK: Well, perhaps.
16 (Laughter.)
17 One of the things that came to my mind as
18 I was hearing from Ashok and the NRC people was a
19 couple of -- a couple of thoughts here as to how to
20 maybe enhance the public confidence in what we're all
21 doing. And one of the things that comes to my mind at
22 least is something that Ken Rogers touched on, and I
23 would put it in the context of greater exposure of the
24 NRC decisionmaking process.
25 This committee has long advocated that

1 what really should be the basis for our decisionmaking
2 is the evidence that can be presented for the
3 different alternatives that are under consideration.
4 And I think sometimes there is the thought on the
5 outside that the decisions are made in the absence of
6 the consideration of alternatives, and sometimes even
7 in the absence of the consideration of real evidence.
8 So one of the things that may be important
9 here and may even be a research topic is, how can we
10 better display not only the evidence that is behind
11 the decision, but also the alternatives that were
12 considered in the process. And I was anxious to see
13 if anybody from the NRC wanted to comment on that.
14 MR. THADANI: I believe Marty had to
15 leave, so I will at least give you my views on this
16 subject. I'm in total agreement with some of the
17 comments that were made in the last hour about what is
18 behind the so-called conservative decisions.
19 I was at a workshop last June with the
20 role of research in the regulatory context, and it was
21 sponsored by Nuclear Energy Agency in Paris and
22 included top decisionmakers, researchers, and other
23 interested organizations. From NRC, Chairman Meserve
24 participated, and I did from Research perspective, and
25 so on.

1 And there was interesting discussion of
2 this issue of conservative, and the comment was made
3 -- and I think -- I don't mean to imply this is done
4 all the time, but sometimes we hide ignorance behind
5 the statements of, "I will make a conservative
6 decision." Obviously, that's not done regularly. But
7 it has happened, and I think it is essential, it seems
8 to me, to do exactly what John is saying; that is, to
9 lay out the bases.
10 And the Advisory Committee on Reactor
11 Safeguards -- Safety sent a letter to the Chairman not
12 too long ago recommending that the NRC Research
13 develop some thoughts, principles, for formal
14 decisionmaking. And I hate to admit this, but it --
15 when we used our prioritization scheme, it came out
16 somewhat lower than the way we drew the line as to
17 areas we should be pursuing.
18 We'll consider it again this year. It's
19 clearly an area where I do think it will improve
20 public confidence if we do a better job really laying
21 out how we make some decisions. Having said that, as
22 you know, the agency is doing a number of things to
23 make sure its decisionmaking process is better
24 understood.
25 And, in particular, we have more meetings

1 with various stakeholders, public meetings, where
2 alternatives are, in fact, discussed. There's a great
3 deal of give and take, and I would say better
4 understanding of the decisions that are being made
5 today as compared to perhaps some time ago.
6 But, again, like you, John, I also believe
7 that we should be disciplined, and for all significant
8 decisions at least we ought to have a clear
9 articulation of what went into that decisionmaking.
10 And we in the Office of Research will look at it again
11 to see how we can help in that process.
12 MEMBER GARRICK: Yes. I only want to make
13 one other comment. As George Hornberger pointed out,
14 that my absence this morning allowed the meeting to go
15 very quickly --
16 (Laughter.)
17 -- on the subject of conservatism. So I
18 didn't mean to have that kind of reputation. But what
19 this committee has strongly -- long advocated is not
20 that we are against conservatism. We, in fact, think
21 that the regulatory process should be conservative.
22 What we are very much in favor of, though, is knowing
23 what that level of -- what the level of conservatism
24 is.
25 And in order for us to do that, we need to

1 calibrate from some sort of reference or baseline that
2 is developed by the experts as constituting what they
3 think will really happen. Then, the regulators have
4 a basis for deciding how -- what the margins ought to
5 be. And in that context, we're very supportive of a
6 certain amount of conservatism.
7 CHAIRMAN HORNBERGER: Bill, got anything?
8 MEMBER HINZE: Well, one thing that I
9 would like to ask about is going back to Commissioner
10 Rogers' comments about leverage. I think that's very
11 important because it sets the right tone in these days
12 of modest resources. And I sense that in the nuclear
13 reactor field that this has been a tradition, that
14 there is a lot of evidence, a lot of examples of this
15 kind of thing.
16 And I wonder if that -- if that -- if
17 we've seen much of that in the waste area. John has
18 talked about some of that. But, for example, when we
19 talk about radionuclide transport in the environment
20 we think about ground water and we -- that comes to
21 mind immediately. And the -- I think the acknowledged
22 groundwater -- largest reservoir of groundwater
23 expertise in the country is in the U.S. Geological
24 Survey and -- outside of academia, George, of course.
25 (Laughter.)

1 Well, and I just wonder if -- how one --
2 if Commissioner Rogers or anyone else has given any
3 ideas on how this synergism between agencies and
4 groups can really be affected in the waste area. I
5 think EPRI is a good example, but I think if we're
6 going to get the leewards that we're talking about,
7 especially in the radionuclide transport and the
8 environment, that we have to go beyond that. And we
9 have to get some better ideas. We have to get some
10 new ideas, and that, of course, brings to mind
11 competitive research, proposals, the use of academia.
12 CHAIRMAN HORNBERGER: Any responses?
13 MR. THADANI: Let me at least --
14 CHAIRMAN HORNBERGER: It's a tough
15 question.
16 MR. THADANI: I can only address part of
17 your comment, and I'm hoping that Bill Ott later on
18 will share with you some details.
19 As John noted, we have some cooperative
20 efforts with EPRI plus other organizations in the area
21 of high burnup fuel, in the area of cladding behavior
22 if you go beyond 20 years of license period, perhaps
23 as long as a hundred years. We are looking at
24 structural issues on cask.
25 And we're working with both domestic

1 organizations -- and that includes EPRI as well as the
2 international community -- it's the so-called package
3 performance effort -- to leverage our resources.
4 In terms of trying to get to the point of
5 developing analytical tools to deal with some complex
6 issues, we have an agreement -- and I think -- I'm
7 trying to remember what it's called. It's a
8 multimedia -- Bill, if you can address that. And
9 participants in that program are many of the U.S.
10 agencies.
11 The idea was exactly that that Dr. Rogers
12 pointed -- there was a synergism issue. When you're
13 developing these models, there can be various
14 applications. There may be different interests. And
15 if we can identify those up front and integrate our
16 thinking, we will end up with a better tool and a more
17 effective tool. And I don't remember the number of
18 organizations involved, but there are several
19 organizations. The concept is that.
20 CHAIRMAN HORNBERGER: We had a
21 presentation on the MOU, and so I don't want to invite
22 Bill to give us a long --
23 MR. THADANI: Okay.
24 CHAIRMAN HORNBERGER: -- exposition of it.
25 But there is a memorandum of understanding with --

1 including the USGS and USTA on multimedia. But I
2 think Bill was asking a broader question rather than
3 a -- to get a list of the things that are currently
4 underway.
5 MEMBER HINZE: I guess what I'm really
6 getting at is that one would have to take a very
7 proactive stance to get something like this going.
8 It's not going to happen without some real effort.
9 And if the NRC wishes to save money and have a broader
10 base of people to be active in a research area, it
11 seems to me that you really have to go out and search
12 these opportunities and develop them. It's not going
13 to happen without some serious effort.
14 MR. ROGERS: Can I just say something
15 about it?
16 CHAIRMAN HORNBERGER: Ken?
17 MR. ROGERS: I think that this is the time
18 to start doing that sort of thing. I think that the
19 climate for cooperative efforts in the past was really
20 quite different from what it is today.
21 There was this total, I thought,
22 preoccupation with the possibility that a decision
23 would be contaminated if it involved in some way some
24 other organization that had some possible connection
25 with what the decision was, and that to avoid that

1 just cut them off, do everything yourself.

2 And that just isn't possible today. It

3 just simply is not possible. The resources are not

4 there.

5 So the thinking, I think, is very

6 different. I think one of the reasons why that hasn't

7 happened in the past as much was because of this kind

8 of legal worry about a decision being upset in some --

9 in a court or someplace because somehow it was

10 contaminated by a self-interest -- the self-interest

11 of a party that was somehow rather involved.

12 My feeling is that that's -- that that's

13 not as serious a concern today as it was. It's always

14 a concern. It'll never go away. But it used to be

15 absolute showstopper on almost everything. And, of

16 course, this reinforces the insularity of the

17 organization, which is what you want to break down.

18 So I think that this is the time to do that.

19 My other guess is that -- that in the

20 reactor area everything was better organized in the --

21 within the licensees. And there was just a lot more

22 money, more power, more sophistication in many ways.

23 When you start dealing with some of these issues, say

24 in low-level waste, I don't know about high-level

25 waste, but in low-level waste you're talking with

1 totally different kinds of organizations that don't
2 have the kinds of history or resources to offer.
3 And some really new, creative thinking has
4 to go into how to -- how to bring those things
5 together in a way that produces some new results. It
6 is a real challenge, I think.
7 MEMBER HINZE: I think, too, that it has
8 to be emphasized that this is not only a resource
9 leverage, but it is an expertise leverage, which may
10 in the long run be the more important aspect of it.
11 CHAIRMAN HORNBERGER: Yes. Absolutely.
12 Let's go to the other end and start back. Mario?
13 MR. BONACA: Well, just -- I just was
14 reflecting on, first of all, I mean, I am here to
15 learn more than anything else, because I don't have
16 much expertise in nuclear waste.
17 But one thing that struck me was somewhat
18 of a different focus between the presentation of Mr.
19 Knapp, which really was -- I believe is on target, it
20 seems to me, and speaks about certain issues that are
21 somewhat different from the ones that are being
22 presented by EPRI, which may be an obstacle to the
23 level of cooperation we would like to have or
24 collaboration among the organizations.
25 Clearly, it seems to me that the EPRI

activities presented focus on immediate needs of licensees in discharging the fuel and looking at higher burnup fuel and issues of that nature. And the one presented in the previous presentation had to do with not only quality of application but transportation issues to -- to a repository, terrorism -- which is really beyond what the industry may be focusing on.

I'm just -- I was just reflecting. I don't know if there is any point there, but that some collaboration may be somewhat difficult at this stage because the RES is looking at the -- at a longer focus I think, and maybe these issues that -- that Mr. Knapp presented, and they may be somewhat different from what the industry is focusing on right now. That may be -- that was an observation.

CHAIRMAN HORNBERGER: Mal, did you have something you wanted to say?

MR. KNAPP: I think I might agree in part and perhaps disagree in part. Again, while I don't claim at this moment to know immediately what's going on, I think that probably the transportation and the spent fuel issues are going to be of immediate and pressing need in industry.

Again, I don't want to speak for them, but

1 that would be my guess. And so I would say of the
2 things that I've brought up, there will probably be
3 some areas or parts of areas where there could
4 certainly be leverage and extensive cooperation and
5 others, exactly as you have said, where there would
6 probably be limited interest in industry, very much
7 because of the short term here.
8 MEMBER HINZE: I wouldn't want to give the
9 impression that we're not interested in
10 transportation.
11 (Laughter.)
12 But certainly we're involved in
13 participating, mostly from the outside, but also on
14 some panels -- on, say, NRC's modal study for
15 transportation risks, things like that -- we do
16 participate in that area.
17 Right now, we are taking a look at the
18 work that has already been done in terms of
19 transportation and storage hazards, as they relate to
20 terrorism, to see -- we feel that a lot of the
21 regulations that NRC has already imposed probably
22 bounds many of the terrorism scenarios that could be
23 considered.
24 We're looking to see whether that's really
25 true by seeing what's -- what do we know, what's

1 already been known, and then try to define from there
2 what we think will be the research needs that may
3 result from maybe other terrorism scenarios that
4 haven't been currently thought of.
5 The little that I know on the reactor side
6 of the house, they are doing much the same, looking to
7 see what has already been done, applying it to perhaps
8 some scenarios that hadn't been thought of before, to
9 see whether -- that that work does or doesn't bound
10 it, and what does need to be done. I'm sure that NRC
11 is doing that as well.
12 MR. BONACA: I was more reflecting on that
13 particular line you have on new paradigms, and that
14 really struck me as something that would be, you know,
15 a possibility in today's environment. And you have to
16 look for something --
17 MR. THADANI: If I may comment --
18 MR. BONACA: -- reflected on before.
19 MR. THADANI: I think Mal has identified
20 some issues that need to be thought through, some
21 interesting points that I think you have brought out.
22 But I do want to make sure that we are giving you
23 enough information and background in terms of, what is
24 the Office of Research doing in terms of collaborating
25 with others to take advantage of the infrastructure

1 issues, the expertise facilities, and certainly
2 includes training considerations.
3 But let me make sure that you don't -- I'm
4 not misinforming you. First of all, there is no
5 alternative. I agree with issue resources going down.
6 We've got to become more creative on how can you get
7 what you want. And, clearly, making sure we're
8 focused on the right things, risk-informing what we
9 do, and paying attention to what is really more
10 important from the point of view of safety. And the
11 issue of public confidence I think is critical.
12 Secondly, then looking to areas which are
13 appropriate for research, then making sure we get out,
14 we try and understand what's going on. We have -- to
15 that extent, we have a significant number of
16 agreements. I think we have 84 bilateral or
17 multilateral agreements, and we have on the order of
18 in the twenties domestic agreements.
19 Dr. Rogers is exactly correct.
20 Environment has changed. We have -- I have signed an
21 agreement with EPRI, and that agreement has fairly
22 broad scope, and that includes the following
23 consideration. That Electric Power Research Institute
24 and Nuclear Regulatory Commission research
25 organization may well collaborate in doing joint

1 experimental work.

2 The independence of decision would come

3 once we take the data, EPRI will take the data, and we

4 will do with it what we believe is appropriate with

5 our analytical tools, and so on.

6 So I want to be sure that if -- if you

7 would like, we can come back and we can brief you on

8 where we are in terms of collaboration with other

9 organizations, where we think there may be mutual

10 interest. And if there are any hard spots, we will

11 certainly share those as well with you.

12 Just wanted to make that comment. In case

13 you are planning to address it in your letter, I just

14 want to be sure that we've given you enough

15 information.

16 CHAIRMAN HORNBERGER: Fine. Thank you.

17 I also -- just a point of clarification,

18 I should point out that in our instructions for this

19 meeting we recognize that we can talk about a wide

20 range of potential research topics. We know this, and

21 I certainly don't want to overly constrain people, but

22 to try to focus, at least a little bit because in

23 these workshops what we like to do is get into

24 technical nitty-gritty to as great an extent as

25 possible, we gave directions to try to focus, to the

1 extent reasonable, on radionuclide transport and
2 source term.
3 And so some people have taken that to
4 heart, and I wouldn't, Mario, read too much into
5 disparities you may hear in what people have said.
6 Milt?
7 MEMBER LEVENSON: Well, let me ask you a
8 question, first. Does it -- as a disciple of John's,
9 I have a long list of questions. How much time should
10 I take?
11 (Laughter.)
12 CHAIRMAN HORNBERGER: You have five
13 minutes.
14 MEMBER LEVENSON: I'll talk fast.
15 (Laughter.)
16 MEMBER GARRICK: For the purpose of the
17 recorder, we probably need to distinguish the Johns
18 here. I think the Johns that were referred to by Bill
19 and by somebody over here was John Kessler.
20 MEMBER LEVENSON: My comment was to John
21 Garrick.
22 MEMBER GARRICK: Yes. Protect the
23 innocent.
24 (Laughter.)
25 MEMBER LEVENSON: Well, none of the other

1 Johns are old enough to possibly be --

2 (Laughter.)

3 CHAIRMAN HORNBERGER: Okay. You've used

4 two of your minutes.

5 (Laughter.)

6 MEMBER LEVENSON: I really have several

7 comments. One was the discussion about future

8 reactors I think has a potential impact on our

9 priority for research, because for all of the reactors

10 that have been licensed and approved to date, ultimate

11 waste disposal wasn't at issue.

12 For a new reactor design coming up, it's

13 going to be a major issue, and I think we need to

14 reassign the priorities and recognize that waste

15 disposal is now critical to reactor licensing, which

16 has never been the case in the past.

17 Secondly, I think that there was a comment

18 made about greater than Class C waste. In an era

19 where we want to move into risk-informed performance-

20 based, I think the old categories of Class A, B, C,

21 and greater than C have really no significance because

22 concentration of a material is irrelevant. And I can

23 have one-tenth of a curie of something that's greater

24 than Class C and a million curies of something that's

25 Class B, and, obviously, the greater than Class C is

1 not the bigger risk.

2 So we have to recognize, if we want to

3 move into a risk-informed future, that the old

4 classifications just don't fit.

5 The third one is in the ratio -- in the

6 subject of fission product transport. Historically,

7 that has been primarily water-related colloid

8 solubilities, etcetera.

9 I think we need to reassess transport for

10 two reasons. One, the question of things like

11 volcanism for Yucca Mountain. But perhaps more

12 importantly is the whole issue of terrorist attacks.

13 If there are terrorist attacks, what will be most

14 important is airborne transport, and I think that's an

15 area that's been sadly neglected. It wasn't ever all

16 that important, so we could make a conservative guess

17 and let it go at that. I think we need to be able to

18 understand for real what are the potential risks of

19 transport by air.

20 Since I've got a half a minute left, I'm

21 going to make one comment on conservatism. In another

22 incarnation, I've recently participated in source

23 reconstruction operation using the NCRP screening

24 criteria, which are very elaborate and very reviewed.

25 It turned out to be probably close to meaningless.

1 There were 50 or 60 isotopes involved.
2 Because different degrees of conservatism had been
3 used on the different isotopes, the screening criteria
4 picked out the half a dozen that are most important
5 and what ought to be focused on, and they were the
6 wrong ones. Some of the really most serious ones were
7 screened out as something you shouldn't consider, and
8 that's really a major risk that arises from
9 inconsistent conservatisms.
10 It isn't that the conservatism per se is
11 bad. It's that it can lead you to ignoring things
12 that are more important.
13 CHAIRMAN HORNBERGER: Milt, I really
14 didn't want to constrain you too much. Do you have
15 other things that you need to address now?
16 MEMBER LEVENSON: No.
17 CHAIRMAN HORNBERGER: You just talked
18 quickly? Okay.
19 Ray?
20 VICE CHAIRMAN WYMER: As usual, he who
21 talks last has nothing to say.
22 (Laughter.)
23 But I have one comment. As Milt said, in
24 another incarnation I was involved pretty deeply in
25 institutional management, institutional controls. And

1 I think that's an 800-pound gorilla that's lying
2 waiting to spring on us as soon as we get around to
3 it. And we're getting around to it pretty rapidly.
4 And I was interested to hear Marty
5 Virgilio bring that up. And since he's not here, I've
6 got to ask for a little bit more clarification on --
7 and I have some ideas, too -- but on what the research
8 needs might be related to institutional controls. I'd
9 just to hear what the current thinking is of the
10 research people.
11 MR. THADANI: Well, I'm going to ask for
12 help on that one. We have -- if you are interested,
13 I would certainly want to ask Bill to address that.
14 But this is an issue that clearly deserves some
15 attention from Research. It was an issue that was
16 discussed at some length, not exhaustively certainly,
17 at the last nuclear safety research conference that
18 the Office of Research sponsors. It was last month.
19 And there were different -- radically
20 different views expressed by the participants; on one
21 hand, the strong need for institutional controls, on
22 the other hand a view or other strongly-held view that
23 institutional controls don't work. You've got to look
24 for something else.
25 So it seems to me that, given that

1 background, it's clear to me that Research needs to
2 start thinking about this issue and develop some
3 plans. And we've sort of briefly touched upon it in
4 the plan that you've seen, but it's an area that we
5 need to do some more thinking about. But Bill Ott may
6 want to add to what I'm saying.
7 MR. OTT: I think Tim will try and give
8 you some perspectives from Marty. We have not focused
9 on this a lot yet. We are keeping track of what the
10 Department of Energy is doing. They went -- the
11 National Academy had a fairly major study done on
12 institutional controls. That study came out saying
13 they had a major problem, and I think we're trying to
14 follow what they're doing.
15 I think we did touch on it in the plan,
16 but not to an extensive degree. I think right now
17 what we're trying to do is follow what DOE is doing.
18 MR. McCARTIN: Yes. Just briefly, in
19 terms of -- the institutional controls we put forward
20 for primarily decommissioning, and we have restricted
21 release, and certainly the question of the durability
22 of the controls.
23 But also, one of the things that -- part
24 of the thinking for research would be that for
25 decommissioning you have a lot of very different types

1 of settings, both source term and geological. And the
2 question would be, it may not be a situation where one
3 size fits all, here are my suite of institutional
4 controls. But, rather, depending on the
5 radionuclides, the nature of the source term, the
6 geologic setting, there may be certain things that
7 human activities could effect release of the
8 radionuclides more so than other areas.
9 And are there things that you could do,
10 from an institutional control standpoint, that would
11 make more sense at site A for radionuclides X and Y
12 versus other ones. And the concept was forward-
13 thinking, gee, are there things we need to be more
14 worried about and where controls would be more
15 appropriate.
16 VICE CHAIRMAN WYMER: Now, considering the
17 rate at which this problem is rising to the surface,
18 it seems to me that it would be a very good idea to
19 get your thinking long about now.
20 MR. KESSLER: It leads me to ask, is NRC
21 -- NRC is certainly not alone in having to worry about
22 institutional controls. I think EPA's got that issue
23 in spades for cleanup there. And certainly there are
24 other institutions worldwide that may be actually
25 having a few research dollars to do something.

1 I would encourage NRC to consider talking
2 to their sister agencies in broader perspective to see
3 if there are some opportunities to get a joint program
4 going.
5 CHAIRMAN HORNBERGER: Okay. So let's see,
6 I'm really last, so --
7 (Laughter.)
8 One of the things that I noted in -- on
9 several of Marty's slides was that he had listed
10 instrumentation and monitoring, instrumentation
11 development and monitoring. And we're talking about,
12 of course, the NRC primarily and issues that will be
13 important for regulatory decisions.
14 And I just wanted to toss it out to the
15 rest of the speakers this morning, do you also see
16 instrumentation development and monitoring as
17 important for regulatory decisions? And should NRC be
18 doing more of that kind of work? John?
19 MR. KESSLER: One of the things that came
20 up in EPRI's performance confirmation workshop a
21 couple weeks ago was the idea that if you're going to
22 put forth a candidate activity for performance
23 confirmation, you have to be able to know that you can
24 define what it is you want to measure and that you can
25 actually measure it, and you can measure it in the

1 amount of time that is the right amount of time,
2 whatever time that is that's available.
3 And part of that is certainly the idea of
4 developing techniques by which you can measure what
5 you want to measure after you've defined that. So
6 that it's -- I would agree that it's an important
7 component of our research.
8 MEMBER LEVENSON: But it's not so clear
9 that it's the NRC component. I mean, if we look at
10 the reactor field, it's very clear that you need all
11 kinds of instrumentation to monitor everything that's
12 going on. But it's not NRC's role to develop that
13 instrumentation. Since NRC doesn't own or operate,
14 say, a repository, is it their responsibility?
15 MR. KESSLER: Well, I see the Center doing
16 what EPRI does all the time. It was -- I think it
17 goes back to one of Ken Rogers -- says that projects
18 that stimulate others to pick up the work, EPRI does
19 that all the time. I see the Center doing that from
20 time to time. And this is one where the Center is
21 doing that.
22 They are looking at one particular
23 technique of looking at ways you can measure corrosion
24 of alloy 22 in situ, where they're not going to get
25 all the way down the road. DOE will need to pick that

1 up and go with it, but they've got a good start.
2 That's the kind of thing that I think that NRC could
3 also contribute to.
4 CHAIRMAN HORNBERGER: Yes. I think that's
5 probably a point worth our keeping in front of us, the
6 point that John just made, and that is this whole idea
7 of stimulating work that needs to be done. And I
8 think that probably falls into this -- what has been
9 called by NRC anticipatory research. There's a bit of
10 creativity involved when you do these kind of things.
11 Bill, did you have something?
12 MEMBER HINZE: Yes, I'd like to come off
13 the wall and --
14 CHAIRMAN HORNBERGER: Why?
15 (Laughter.)
16 MEMBER HINZE: Well, as we've heard this
17 morning, it's important to be consistent.
18 (Laughter.)
19 As I think about this word "future
20 regulatory" or these words "future regulatory
21 decisions," I wonder if we shouldn't be concerned
22 about CFR 60, CFR 63, going into the future. This
23 country is going to have to face the problem, either
24 on a technical basis or on a political basis, that
25 we're going to need another repository at some time.

1 And that repository likely will be in an
2 environment quite different than the current candidate
3 site. In other words, it may be east of the
4 Mississippi where the hydrologic and meteorological
5 and climatic conditions -- as well as many other
6 conditions will be somewhat different.
7 If I recall Mel's discussion with this
8 committee several years ago about how 60 was put
9 together, it was put together certainly with a -- and
10 I'm not putting words in his mouth, he can speak for
11 himself, but was on an ad hoc basis because there was
12 a lack of information in many areas. And it was also
13 designed more or less for comparison of the three
14 sites that were then candidates. That approximates
15 the truth.
16 63 is a different matter. That's aimed at
17 Yucca Mountain. The Nuclear Regulatory Commission I
18 think really has to look forward to the possibility of
19 another repository and what that will mean in terms of
20 a new CFR on the topic and what information is going
21 to be needed.
22 If you're going to really look into the
23 future, and if you want to come off the wall with me,
24 I think you're going to have to do this.
25 CHAIRMAN HORNBERGER: That's off the wall.

1 (Laughter.)

2 I think what I would like to do, seeing

3 what the hour is, I would like to take now a one-hour

4 break for lunch. And I would like to reconvene at

5 five minutes to 1:00, and we will then start the

6 second part of our session where we'll talk about the

7 knowledge and technical tools needed to address some

8 of these issues.

9 Thank you.

10 (Whereupon, at 11:53 a.m., the

11 proceedings in the foregoing matter went

12 off the record for a lunch break.)

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A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

(12:59 p.m.)

CHAIRMAN HORNBERGER: Okay, we are going to continue on with our workshop topic and the topic for this afternoon, "Knowledge and Technical Tools Needed for Future Decisions" and we have several presenters and then we have some panelists who are going to comment somewhat, I think, on the presentations, but knowing the panelists, it will also be somewhat free form. They will not feel constrained to offer comments only on what they've heard.

So it looks like we're scheduled to have a tag team here. First, Wes Patrick and Budhi Sagar from the Center are up. And I don't know how you want to do it?

Budhi's going to do it.

MR. SAGAR: Well, obviously Wes didn't want any blame for this.

(Laughter.)

I'm by myself and after lunch too. I'd like to make a couple of introductory remarks before I begin my presentation. First of all, I did take the instructions you gave us in the agenda very seriously, so still just focused on the radionuclide transport and source term topic, not that the other topics

1 discussed this morning are not important. We think
2 they are important.
3 And secondly, I did consult with the staff
4 at the Center in preparing these vu-graphs, so it's
5 just not my views. There are other people who have
6 had experience that have input to these topics that I
7 wold bring to you. But I would like to say that we
8 have not gone through any scientific or systematic
9 study of prioritizing these topics. These are more ad
10 hoc topics I asked the staff to tell me what, based on
11 their experience, what the topics that were most
12 important for research. And when I say research, we
13 mean some long-term.
14 I have personal difficulty in classifying
15 research just anticipatory and confirmatory. To me,
16 it's very difficult to put them in one box or another.
17 But my point of view is that if something takes 3, 5,
18 7, 10 years that's research, which ever form you want
19 to put it in.
20 (Slide change.)
21 MR. SAGAR: To define research all I mean
22 or we mean is that it's some combination of laboratory
23 experiments, field investigations and computational
24 analyses together to solve some problems. I will not
25 go into whether this is generic research applicable to

1 all sites or facilities or not. It's scientific work,
2 that's what all this amounts to. It would apply to
3 multiple science, even though some of the examples I
4 would present at Yucca Mountain, about 80 percent of
5 the work we do at the Center is related to Yucca
6 Mountain, so obviously that is the background we come
7 from, at least in the examples that would be
8 reflected.
9 We are also not making any distinction
10 between who sponsors it. I know it's an issue at the
11 NRC whether it is RES, Office of Research that
12 sponsors it and assets the work. To us, it doesn't
13 matter who pays the bills so long as work gets done.
14 So we're not getting into that organizational issue
15 here.
16 CHAIRMAN HORNBERGER: Thanks for doing
17 that Budhi, and I surely hope you don't get into
18 trouble for being honest with us.
19 (Laughter.)
20 MR. SAGAR: I hope, and also who conducts
21 it. I heard this morning and I think we supported
22 that, the regulator, even NRC, from my international
23 experience as a lot more associates than the other
24 regulators in other countries, Europe, for example,
25 it's still very limited resources. And if you can

1 leverage it, as someone said this morning, it's great.
2 If you can do that, it's great.
3 Of course, there are legal issues some
4 times. If the Applicant joins into the research, your
5 research could be questioned on the legal ground,
6 whether there's a conflict of interest or not. So of
7 course, the lawyers, would have to get involved at
8 some point to say whether something can be done or
9 not. But again, we don't make any distinction on who
10 sponsors or conducts the research.
11 Well, what are the objections of research?
12 Of course, risk significant is the most important
13 foundation on which you're going to choose what topics
14 to research, so identification of risk significant
15 features, even some processes. That covers a
16 multitude of sins here.
17 Any process, any event, any feature of the
18 geologic setting that might impact the bottom line
19 risk assessment is a topic, appropriate topic for
20 research; any structure system and components I'm
21 bringing into the design issues which may also have
22 long-term research associated with them; the interface
23 between natural and engineered systems, there will be
24 some topics of research in this area.
25 Even though Dr. Rogers this morning said

1 he didn't think human factors were important in
2 repository, having started some work in the last year
3 or two which may be naivety on our part because we
4 started it very late, but we found that for the
5 preclosure safety, the human factors and the
6 reliability of software would be extremely important,
7 that any catastrophe that might happen would probably
8 have an underlying reason related to human factors and
9 that the repository ought to be looked at from that
10 point of view which hasn't been done much. So maybe
11 at the end of two or three years, we would say gee,
12 not much needs to be done and if it exists, we do some
13 review from which the opinion we found was this was
14 important.
15 To obtain conceptual understanding, again
16 this has been said this morning. Of course,
17 conceptual means any foundation of your models has to
18 be correctly understood. The more realistic you can
19 make it, the better you understand it, the more
20 confidence you will have in your bottom line results.
21 More realistic, I say more rather than
22 simply realistic because I personally believe that
23 it's impossible to tell when a model is realistic.
24 You can, as you keep working on it, as you understand
25 more and more the realism improves, but there's always

1 something that you don't understand either because you
2 simplified something or because the scales are
3 different between your measurement and what you put in
4 the models. So there's always approximations
5 involved.
6 And simplified models, as we heard, and we
7 agree with it, they are important to understand and to
8 even do some analysis that you cannot always go to the
9 detailed level physically realistic, physics
10 demonstrated as realistic models but that you must
11 understand what those simplifications do to your
12 results.
13 So the simplified model, they're the
14 support for those models and then the main purpose of
15 research, of course, is at any point when we make a
16 decision, we think we know what we are doing. Even
17 the uncertainty bounds are assumed to be known or
18 estimated, but there are always anomalous phenomena
19 which this is the unknown kind of things where in
20 research you try to design experiments, try to design
21 studies which would detect those, if there are any.
22 And of course, in addition to the
23 conceptual understanding, the better definition of
24 model parameters is important because most of our
25 estimates for long term performance are based on

models and most of the models are parametric. And how those parameters are defined, how well we know those parameters is important. Reduce the number of assumptions which is my way of saying make them less conservative by using actual data, if you have them.

And I again believe that the conservative assumptions cannot be completely removed from the analysis and then again as was discussed this morning, understand what that does to your analysis, what safety margin it builds up. I completely agree that if you do not -- if you're not consistent or if you do not understand the conservative assumptions that you make, that some of the important effects would be masked, that your sensitivity analysis would be faulty, that any importance you determine may not be correct, so you have to keep open mind. You have to figure out what assumptions you made.

And then in simplified models, I basically think of them as lumping various parameters and you have to understand what that does to your results.

The one topic in terms of radionuclide transport and I'm merely thinking of in geologic media, not in the atmosphere in terms of the, for example, the volcanism scenario where it is transported through atmosphere is -- that comes for

1 most as I talk to people is how do we characterize
2 heterogeneity in the field if you have is you have a
3 hundred square kilometers in area and maybe 500 meters
4 in depth, that kind of real estate. How do you
5 characterize field heterogeneity. And there are two
6 aspects to it, how do you measure things.
7 We all talk about fractures and falls and
8 those discrete geologic features, but while physically
9 one can locate them, even the three dimension geometry
10 of these features is almost difficult or very
11 difficult to determine and to measure their, for
12 example, hydrologic properties or transport
13 properties, there are no good methods. This might
14 take five years. This might take 10 years to do, but
15 that is something one needs to look at.
16 And then most of the data bases that I
17 have looked at would tell you the hydraulic
18 conductivity is X or 5. But they will not tell you
19 well what volume of rock does that apply? The
20 associated scale summation are rarely mentioned in
21 data bases. In fact, sometimes they are difficult to
22 figure out from the test where that scale is. But
23 that's an important area of research and once you have
24 figured out that scale, how this is input into a
25 model, whether you need upscaling or downscaling based

1 on your measurements is another theoretical study that
2 I think needs to get done.
3 The preferential transport paths, we all
4 know those are important for transport and safety
5 issues and uncertainties, of course, the stochastic
6 description of these properties. I must say that some
7 of the research that has been sponsored by NRC in the
8 past including a dissenter and elsewhere including in
9 Arizona and Tucson, in Las Crusas many years ago for
10 unsaturated flow, in my opinion, is an outstanding
11 example of trying to do research on this topic. And
12 I think that's probably one topic that will may take
13 50 years to figure out reasonably well, but that ought
14 to be continued.
15 (Slide change.)
16 MR. SAGAR: This is a simple example, let
17 me do some simulations on Yucca Mountain where the
18 middle layer that you see, the paintbrush stuff which
19 is supposed to be not as fractured as the other, the
20 layers at the top, the Topapah Springs and the Diablo
21 Canyon, but yet because of the heterogeneity, you see
22 discrete -- these are particle tracks that are shown
23 here in white. You see they're discrete paths of
24 higher flow rates. So the heterogeneity definition
25 becomes important, even if you are looking at average

1 fluxes. You still have to bring in some amounts, some
2 description of heterogeneity.
3 The other process that plays a major role
4 in transport are the retention processes and this
5 includes, of course, the absorption, the ion exchange,
6 etcetera and that as most hydrologists know, we
7 started out with assuming simple equilibrium models
8 with K_Ds as coefficients in the flow and transport
9 equation. The field, I think, has progressed quite a
10 bit.
11 Again, NRC two researchers participating
12 in an international project sponsored by the Nuclear
13 Agency in Paris which is looking at mechanistic
14 modeling and comparing the results of the mechanistic
15 modeling, different types of mechanistic modeling with
16 actual field data, I think it's an excellent way of
17 trying to learn what more can be done in this
18 particular area.
19 But nonreversible line exchange need to be
20 studied. I'm not again -- let me emphasize, I'm not
21 saying these things need to be necessarily resolved
22 before we make a decision, these are long-term
23 research topics to improve the knowledge base that we
24 have today. They are not totally unknowns at this
25 point.

1 Thermodynamic data, the last bullet on
2 this slide is another one I want to emphasize because
3 most of the mechanistic modeling, whatever we end up
4 using, and these are process level models I'm talking
5 about, then we will, of course, have the task of
6 simplifying these mechanistic models to input into the
7 performance assessment. The thermodynamic data which
8 are nuclide-specific would need to be collected.
9 Again, NEA is a good example where they
10 are at least looking at all the literature that exists
11 anywhere to try to summarize what we know about
12 thermodynamic data. That is the first step, I think,
13 after which you can decide what other experiments we
14 need to do.
15 Another example, again, this is not site
16 specific, but essentially showing how the K_D even if
17 we used the K_D approach could be related to the
18 geochemical conditions at a site, for example, for
19 neptunium, plutonium plotted here as function of pH
20 and inorganic carbon. True mechanistic modeling. The
21 idea here was we did detailed level of modeling, the
22 best we know to date, not that this is the ultimate in
23 mechanistic modeling, but then simplify it through
24 these curves to input to the performance assessment
25 models. That's one way of trying to go from very

1 detailed models to simplified models.

2 John Kessler said this morning he didn't

3 think colloid was important. That's probably true

4 with the existing knowledge with the sensitivity

5 analysis we have done so far, but that doesn't mean --

6 I still believe it's a less understood topic even --

7 that was your Ph.D. wasn't it, John?

8 MR. KESSLER: Yes.

9 MR. SAGAR: He probably has more authority

10 than I have. But to most people I have spoken to tell

11 me that this is still a very poorly understood topic

12 and there is a potential for it affecting the risk

13 that we estimate that that detail of research at the

14 longer time frame research needs to get done,

15 including how the colloids are generated, whether

16 they're stable or not, whether they will be filtered

17 through the porous media as they move and retardation

18 of these colloids.

19 I'm trying to finish this in 15 minutes.

20 Those are the instructions.

21 (Laughter.)

22 (Slide change.)

23 MR. SAGAR: And again, my example shows

24 you the effect of colloids on transport where the

25 vertical axis shows you the retardation factor and the

1 horizonal axis shows the K_D value and as you include
2 the colloids which are the flatter curves, what is
3 showing is that the retardation factor can decrease
4 quite a bit which means the delay that we expect
5 normally in the radionuclide transport would be less,
6 if they were transported by colloids in the field.
7 (Slide change.)
8 MR. SAGAR: Among the source term, the
9 most important topic that the staff at the Center
10 thinks is the study of evolution of in-package
11 environment. This may not apply so much to low level
12 waste or to apply so much to decommissioning, but
13 certainly to high level waste where the dissolution
14 rates of spent fuel and even gas that is formed
15 depends a lot on what the chemistry is as a function
16 of time within the waste package, depending upon the
17 flow rate of water into the waste package, the
18 corrosion products and how that changes the chemistry
19 and the rates of corrosion. So those are again things
20 that need to be studied, we believe, experimentally to
21 come to some conclusion as to how, at least, bound
22 them if we don't know realistically what might happen
23 at this point.
24 And then the waste dissolution rate,
25 again, mechanistically with different pH values and

1 redox conditions. The secondary mineral phases that
2 affect the dissolutions, especially with the high
3 burn-up fuel. I think you brought up that topic this
4 morning in another context.
5 Another example I'm showing here is the
6 evolution of in-package chemistry where the different
7 curves here show how the pH varies for different type
8 of spent fuels as a function of time. This is of
9 course, model generated, assuming certain flux rates,
10 assuming certain other conditions, based on a lot of
11 assumptions. So I wouldn't call it a realistic
12 simulation at all, but this is trying to get some
13 sense of how the pH might evolve as time goes on and
14 as the pH evolves, so does the source stream that
15 needs to be factored in.
16 (Slide change.)
17 MR. SAGAR: The fuel cladding which is
18 again an issue and again that might bring you up to
19 whether you should be conservative or not because, for
20 example, in the NRC models for Yucca Mountain, we
21 don't give any credit to cladding. We view cladding
22 as if it doesn't exist. The DOE, on the other side,
23 does take quite a bit of credit for cladding and if
24 that's the case, then of course, as a regulator you
25 have to have such knowledge to check whether that

1 cladding does exist and that DOE is assuming is
2 appropriate or not. And stress corrosion cracking
3 study again is needed for this, if that credit is to
4 be allowed, but that is again a research topic.
5 Unzipping of cladding, under wet and dry conditions is
6 another topic that we believe has not been studied and
7 needs to be looked at.
8 My example again shows you that the
9 fracture, stress corrosion cracking, the stress, the
10 crack propagation rate could be much higher than we
11 would normally see under passive conditions.
12 (Slide change.)
13 MR. SAGAR: My last topic is the one
14 related to performance confirmation and other safety
15 questions. I think John Kessler answered this
16 morning, his answer was perfect, I think, from my
17 point of view, which is that as a regulator, you do
18 have to worry about whether are indeed reliable
19 instruments to do the monitoring or not, even though
20 it is DOE's job, of course, to figure that out, but as
21 a regulator, the data that comes out of it is supposed
22 to tell you something and those instrumentations,
23 those instruments have lost for 20 years, for 30
24 years, 40 years, whatever number of years, because I
25 don't know if you can go into that high radiation

1 environment and change those things once they fail,
2 first, and secondly, whether the instruments will
3 survive that kind of severe environment or not. Now
4 when we were discussing this topic I was told that
5 some of this work could be borrowed from space
6 research. While that may be true, but again, we need
7 to take a look. I don't think we have really paid
8 attention.
9 At the Center we did a small project to
10 see how one might monitor the corrosion rates which
11 means the corrosion potential, actually, is what we
12 were trying to measure as a function of time. And
13 that's again to start some ideas flowing and then
14 perhaps the DOE will pick it up and run with those
15 ideas.
16 Long-term monitoring of flow and water
17 chemistry is important and the instrumentation is not
18 totally clear how or what the instruments tell you,
19 how do you analyze those data? How do you draw any
20 conclusions out of those? That's not a given. We
21 think it's a simple topic, but when we started
22 thinking about it, we found it not so easy to figure
23 it out.
24 And in the context of performance
25 confirmation and this was discussed at the workshop

1 two weeks ago at EPRI, what are the performance
2 indicators that you would use and if those performance
3 indicators exceed certain value or below certain
4 value, what actions would they call for?
5 The performance indicator definition could
6 be a research topic because it's not quite clear what
7 you would measure and how do you correlate those
8 measurements to how the safety of the system is
9 judged.
10 Then there are other questions like for
11 the long term, what the percolation rates are. We
12 have -- even paleohydrology study may be of interest
13 here, but certainly actual measurements at site would
14 be much better for providing some confidence.
15 Do or do not preferential flow paths exist
16 in the chlorine-36 issue and why does that happen?
17 What's the explanation? Can you predict it for the
18 future, therefore, estimate it for the future? The
19 stability of the drifts is another issue which
20 supposedly should be simple from rock mechanics point
21 of view, but my boss tells me it's not so simple.
22 (Laughter.)
23 NRC assumes these -- or DOE assumes these
24 drifts will be stable for 10,000 years. Well, there's
25 no historical evidence of that. How do you convince

1 people the drifts will be stable, if they will be.

2 Monitoring of trace elements, because

3 those issues recently have come up that might affect

4 the life of C-22 containers and coupling of processes

5 is another big issue. In the simplified models you

6 obviously cannot have fully coupled processes playing

7 a role, therefore, there is some research which tells

8 you how the various coupler processes might be

9 simplified so that the factors aren't lost when you do

10 the performance assessment.

11 That's about my last line. So in summary,

12 these topics, as I said, are ad hoc in the sense I

13 have no systematic basis of saying well, these are the

14 only topics. There definitely could be others, I

15 believe, but these are based primarily on the

16 experience we have had in the past. I have been in

17 this program for too long, actually.

18 (Laughter.)

19 I stopped counting after 15 years, but the

20 rest of the staff at the Center for the last 10 years,

21 so thank you for giving me the opportunity.

22 CHAIRMAN HORNBERGER: Thank you, Budhi.

23 What we're going to do is take a half hour and I'll

24 get to you in just a minute. So what I was going to

25 suggest is we'll take questions up until a half hour

1 and rather than me doing it formally and going around
2 asking, I'll try to just be traffic director and if
3 Members and guests could just indicate to me with a
4 wave of the hand and all, I'll try to direct traffic.
5 Milt, you're first.
6 MEMBER LEVENSON: One for clarification.
7 The figure you have on colloids, is that based on data
8 or is that a parametric analysis?
9 MR. SAGAR: That's the parametric
10 analysis. We would like to get some data though.
11 That's the point of the research issue.
12 CHAIRMAN HORNBERGER: Other questions?
13 MEMBER GARRICK: The things you talked
14 about are well within the bounds of your guidelines of
15 talking about the transport and what have you, but you
16 didn't say anything hardly about the issue of the
17 chemical and physical properties of the waste itself.
18 Does that mean that there are no issues there?
19 MR. SAGAR: I wouldn't say that. I would
20 say that we at the Center have had very little
21 experience in actually doing experiments on waste
22 form, simply because they are very expensive, but I'm
23 sure the high burn-up fuel has issues on what nuclides
24 and inventory of nuclides in the spent fuel. There
25 are issues we know about in the glass waste form. I

1 wouldn't go that far to say there are not issues. I
2 just haven't identified them.
3 MEMBER GARRICK: Okay.
4 CHAIRMAN HORNBERGER: Others? Budhi, how
5 would you characterize the list of ideas that you gave
6 us? How much of the work that is currently going on
7 at the Center covers some of these topics?
8 MR. SAGAR: Most of the topics we are
9 working on one aspect or another, but are not
10 necessarily in a quote unquote research mode. We do
11 have the mission at the Center which is to assist in
12 the licensing actions. Longer term research is
13 therefore harder to justify in that framework. I was
14 merely bringing this up, for example, the
15 heterogeneity issue where you might have a fuel site
16 where you collect data under controlled conditions for
17 whatever number of years, do the analysis, change the
18 experiment according, try to understand the basic
19 phenomena.
20 We are not doing that. We are doing some
21 small scale lab experiments on certain things. I have
22 pleaded with NRC to have a niche at the site for us to
23 go there and actually do some Institute experiments,
24 but there is some programmatic problems with doing
25 that, so we are doing some work, but not to the extent

1 that could solve the problems.

2 MR. PATRICK: If I could just add a couple

3 of things to that, I'd also say that I believe without

4 exception there are one or more agreements in the

5 issue resolution process with DOE, so DOE is also

6 pursuing those topics and with the -- and I'd be hard

7 pressed to find -- colloids may be one or two others -

8 - these also reflect our experience so far in through

9 performance assessment, examining how these contribute

10 to risk.

11 Most of these, because they are in the

12 research realm, and I guess that's the third point I'd

13 make. We're talking about areas where we see

14 opportunities to reduce uncertainties or to increase

15 the understanding upon which some of those risk

16 judgments are made and the calculations are founded.

17 MEMBER HINZE: Budhi, I'd like to ask a

18 question about coupled processes. This was a very

19 significant item of discussion several years ago. The

20 low thermal loading has not in any way decreased my

21 concern about the coupled processes. Coupled

22 processes are inherent certainly to the high level

23 waste problem, but to all of the other waste problems

24 that we have.

25 I have the sense though that these

1 nonlinear processes that we end up with as a result of
2 coupled processes have not advanced very far and we --
3 there seems to be a limited amount that's being done.
4 Is that true and if so, why isn't more
5 work being done and if more work could be done, what
6 kind of work do you think should be done?
7 MR. SAGAR: Well, I can express my
8 personal opinion. It's obviously a very broad topic.
9 I personally think that not a whole lot of work is
10 being done or can be done is because they are
11 difficult to study any time you couple let's say the
12 thermal, the hydrologic and chemical processes
13 experimentally or even in the field sites, the
14 instrumentation itself, it's not known. Any scale of
15 experimentation it's a very difficult -- we have seen
16 this, the bulkhead is moved, it starts leaking from
17 somewhere, the heterogeneities are not known. What do
18 you do with such a test. You can't interpret it.
19 So I think that's the main reason is the
20 difficulty and interpretation. I think it surely has
21 progressed quite a bit. I think the data, the actual
22 experimental and field data is what is lacking to
23 check those theories or hypotheses plus I do believe
24 that in the end as engineers, we do have to figure out
25 how to linearize the nonlinear processes best, how to

1 decouple the coupled processes, to simplify the model
2 and to be able to really do this sensitivity analysis.
3 To me that's the important step that needs to be done.
4 MEMBER HINZE: Natural analogs would also
5 seem to be a way that one could, if one could
6 deconvolve the results that one ends up with in
7 natural analogs and geoscientists do this all the
8 time. It would seem that this would be a fertile
9 area.
10 Perhaps this is an area in which some
11 competitive research, RFPs, might draw some things out
12 of the woodwork that wold start to give us a little
13 more confidence that we have a handle on these coupled
14 processes.
15 I still think that this is a weak point
16 and it's something that we shouldn't be just
17 relegating to longer term research. These problems
18 are important in some of the decommissioning of the
19 tailing sites and so forth.
20 MR. SAGAR: I agree with you, but partly.
21 I have spent quite a bit of time looking at natural
22 analogs and I think they have to be by their very
23 nature longer term projects because to be deconvolved,
24 you have to first characterize those natural analog
25 sites reasonably well and that requires resources.

1 That requires time and if you do half job which is not
2 just going and do bullet holes and say well I can
3 deconvolve, I don't think you can.
4 MEMBER HINZE: I agree with you. I failed
5 to express myself well. It's a long-term problem in
6 terms of getting at it, but the problems are right
7 with us today. That's what I wanted to -- that's what
8 I mean.
9 CHAIRMAN HORNBERGER: Okay, thank you very
10 much, Budhi.
11 MR. SAGAR: Thank you, sir.
12 CHAIRMAN HORNBERGER: Mal, you're going to
13 put on a different hat.
14 MR. KNAPP: In some ways, this is in part
15 a continuation of some of the things that I said this
16 morning and I'd like to make a couple of caveats with
17 respect to radionuclide transport and source term
18 work, I have to defer to what I think is some
19 outstanding work that's been done by the Center and by
20 the staff.
21 I think it's well documented in the
22 technical portions of the IRSRs. I do have a few
23 views on that that I will share, but I'm going to ask
24 your indulgence while I speak about one or two other
25 things that I think might be worth considering as

1 research is pursued and one that will come up
2 tomorrow.
3 The first thought that I wanted to talk
4 about briefly was the topic of the pursuit of flaws
5 and I'll explain a little more what I mean about that
6 in a minute and a little bit about prioritization and
7 then I will talk about some views on radionuclide
8 transport and source term.
9 When I talk about the pursuit of flaws,
10 it's something that crossed my mind more than once at
11 the NRC and one that may very well apply to research.
12 In my years at the Agency, I was never particularly
13 interested in developing a system that got an A. But
14 I was keenly interested in a system which never got an
15 F and so I was less interested in achieving
16 outstanding performance than I was in a system which
17 was robust against virtually anything that uncertainty
18 or unknowns could throw at it.
19 With that in mind, I wonder if research
20 done by the NRC might not on occasion take what I
21 might call a contrarian approach. Somebody once said
22 when everything appears to be going in one direction
23 that's a signal it's time to take a good hard look in
24 the other direction.
25 For example, when I did my graduate work

1 and I suspect that's probably true of a number of
2 people around the table, I started with something very
3 simplistic. I was intending to model the blast
4 furnace, but I did stuff in a small lab on very simple
5 well understood materials and I developed some
6 understanding of that, but the ability to translate
7 that into the blast furnace was obviously work that
8 was going to take another decade or two or three.
9 I sometimes wonder if we would be looking
10 for flaws and looking for the potential for Fs if
11 maybe it wouldn't be worthwhile to start with some
12 systems that are very complex, watch how they behave
13 and if you've seen this behavior then try to simplify
14 them using something like say a dichotomous search, to
15 ask what aspects of this complex system were, in fact,
16 contributors to the misbehavior.
17 I would assert and this is literally an
18 unsorted assertion, that maybe an avenue for research
19 again, perhaps anticipatory research might be less to
20 understand what was going on and more to simply try to
21 observe failures and then once a failure is observed
22 then try to bear in and become more simple to pursue
23 the understanding. It's just a thought for
24 discussion.
25 I'd like to talk a little bit about

1 prioritization processes because that was a feature of
2 the radionuclide transport program plan. And I just
3 had a couple of thoughts. As I read it, the current
4 system that's used in research is shown on the slide
5 with a number of contributors to prioritization,
6 credibility and agency support, safety significance,
7 so forth, down to unnecessary burden reduction or
8 reduction of unnecessary burden and what the
9 contributors might be.
10 If one presumes that research and the
11 Agency will continue with this sort of a
12 prioritization scheme, I did have one or two questions
13 that came to mind. With respect to whether or not a
14 project was credible or had Agency support or what its
15 safety significance was, while I don't want to take
16 anything away from safety significance, I remember
17 Edison's statement "what use is a newborn baby?"
18 One of the problems that I had in NMSS
19 years ago, was that I was very uncomfortable with
20 attempting to support anticipatory research because I
21 was looking at a very small window, one or two years
22 out into the future and so I might question whether
23 seeking what was obviously a safety significant
24 problem or seeking agency support might not move the
25 research into topics that are a little more short term

1 a little more essential to confirmatory research and
2 so I might ask whether those are really things that
3 should be used.
4 I also asked the question in
5 prioritization about what I'll call rewards. If we
6 can talk about risk, I'm just talking about the
7 inverse. What I see in the prioritization system is
8 something that leads to identification of an area as
9 an area worth doing work in, but I didn't really
10 necessarily see an effort to say take a particular
11 research project and ask if this project is
12 successful, what would be the impact of that success
13 on this significant area and while we're at it, what's
14 the probability of success of that particular avenue
15 of research? Now that may be implicit in some of the
16 things under the prioritization process, but they
17 didn't jump out at me.
18 And if I'm going to be contrary, I'll also
19 go against a number of things that Bruce said earlier
20 today in terms of leverage. While I think leverage is
21 certainly important and I particularly agree with Ken
22 Rogers' view that a program which is supported by
23 everybody will probably be subject to more scrutiny
24 which I think is a good idea, I also worry
25 fundamentally about the cost. We should be asking at

1 least in part of the questions what's the cost to the
2 NRC? If it's leveraged, that's good. But if the
3 basic cost to the NRC is high, that's still something
4 to think about.
5 So I guess what I'm headed toward is if
6 research continues with this system that they're using
7 now, it would seem to me that it could profitably be
8 considered whether there might be some modifications.
9 Perhaps one of the two of the factors could receive a
10 lower weighting than a couple of other factors. The
11 ones I've mentioned or others perhaps might get
12 greater consideration than I think they're getting
13 now.
14 As an alternative, of course, we have
15 performance assessment and I mean performance
16 assessment with respect to waste matters, not just to
17 include the TSPA or the TPA and the high level waste
18 program, but performance assessment which has been
19 done on low level waste and I know that in the not too
20 distance past there's a pretty significant program.
21 Perhaps the results of that program or reapplication
22 of it could be considered as a basis for deciding what
23 are some areas for research might be fruitful.
24 But if you want to talk about the high
25 level waste program, the TPA was just finished. I

1 think you've heard at least a bit about it in August,
2 published in August and of course, that's identified
3 a number of areas such as the ones that I have behind
4 me where at least research or significant influential
5 parameters have been identified and those are
6 certainly some areas that I would probably look at in
7 looking at what on the list of the current research
8 program plan could be attacked.
9 And of course, I'd be very interested in
10 how that performance assessment or any might be
11 flawed. I think that was discussed a bit. While, of
12 course, I'd be interested in whether or not the code
13 would work and whether or not the abstractions were
14 right, I'm also interested in whether the fundamental
15 models underlying the entire concept is, in fact, well
16 understood and I'll get to that in a minute because
17 that's something I worry about in transport and in
18 source term.
19 Another thing that is just a side bar on
20 this that troubles me a little bit is that I seem to
21 be seeing more and more comments that read something
22 like the performance assessment tells us this or the
23 TSP tells us that and I sometimes wonder if we haven't
24 created a complex code in our own image which we are
25 now -- we don't really understand what's going on in

1 the code, but it tells this, so it must be right. I
2 think there was discussion this morning about well,
3 shouldn't we have some simpler models which
4 essentially do about the same thing which we can
5 understand. I think that's a very good idea. I am
6 concerned about the possibility that some of these
7 codes may have flaws in them which are too
8 sophisticated for any of us to see, but nonetheless,
9 point us in the wrong direction. I worry about that.
10 But if you're going to use performance
11 assessment to figure out where research might be done,
12 again, I return to some of the questions I asked a
13 moment or two ago about the current research process.
14 Performance assessment has identified a number of
15 influential parameters and I'd consider them, but then
16 I'd go back and ask some more questions. How
17 influential is that parameter? What kind of research
18 might the NRC do on it? If that particular project is
19 successful, what would its impact on that parameter
20 be? What's the probability that it will succeed? And
21 again, how much will it cost?
22 Anyway, I appreciate your indulging me for
23 a couple of thoughts on prioritization and what I'd
24 like to do now is to say a few words about
25 radionuclide transport.

1 I think that the program plan, I saw it,
2 I believe it's very comprehensive. While I certainly
3 wouldn't call myself an expert in the area, I can say
4 that nothing came to my mind that I thought should be
5 considered which was not reflected somewhere in the
6 plans, so I think it does deal with again, as far as
7 I can tell, just about everything one might want to
8 consider.
9 On the other hand, I think as Ken Rogers
10 said this morning, it's now time to cull out something
11 that can be done with the resources available, using
12 some of the prioritization schemes that I mentioned or
13 what you will be discussing tomorrow in terms of
14 prioritization.
15 And I also heard Budhi say some thoughts
16 about mechanistic modeling and that sort of leads me
17 to the first bullet that I have here. One of the
18 things that I'm troubled about is whether we, in fact,
19 have a fundamental understanding of retardation. And
20 I don't know.
21 I can tell you that we understand it one
22 heck of a lot better than we did 20 years ago when I
23 got into the business, but do we really understand it
24 well enough, recognizing that we are extrapolating the
25 results for 300, 3000 times the intervals that we're

1 actually look at them, maybe 10,000 in some cases.
2 And when I talk about the fundamental understanding,
3 what I worry about is in a number of these areas and
4 I noticed it in looking at the surface complexation
5 models recently. They're good models. They make good
6 intuitive sense. They fit the data, but I wonder if
7 we can say more about them than that. Is the only
8 thing that we can say is that they are intuitively
9 sound and that we can select parameters within them to
10 fit the data? What independent lines of study have we
11 to confirm that those are, in fact, the applicable
12 mechanisms? Or are there other models out there which
13 also make good intuitive sense, but where parameters
14 may be selected that fit the data, and yet the two
15 models perhaps a 1,000 or 10,000 years from now might
16 lead to different results. And I'm not sure. I don't
17 mean to particularly pick on that particular set of
18 models, but I just ask myself how well do we really
19 understand these things and to what extent are they
20 simply things which are intellectually satisfying, but
21 may yet not be fully descriptive. So Budhi's comment
22 earlier on mechanistic modeling was one that I
23 heartily endorse.
24 Another area that is of interest to me, I
25 guess what I'll call predecessor and companion

1 effects. What I mean is that once radionuclides are
2 released, say from any facility, high level waste
3 facility, they are going to have been preceded
4 probably by heaven knows what and you folks can write
5 it up better than I can, very possibly changes in
6 oxygen as a result of having created the repository,
7 leftovers from corrosion of titanium drip shield,
8 leftovers from alloy 22, leftovers from the stainless.
9 I see these things as a bow wave as one
10 does chromatography through the entire system and to
11 what extent will these predecessors or could the
12 predecessors affect radionuclide transport to the
13 point that some of the tests that are done to date, in
14 fact, really don't bear on what they will see. They
15 may bear on what's there now, but do they bear on what
16 will be there?
17 And likewise, I wonder about companions.
18 And I'm just talking about other species which one
19 might not look at. Are there other say decay products
20 from radionuclides which could alter the way that
21 chemical processes work, but which we've ignored
22 because after all, they're benign. Or are there other
23 things that will travel along with them and obviously,
24 this is not a discontinuous set. There will be a
25 continuum of a variety of materials and species that

1 can travel. That's not to say that work is not being
2 done in the area. I just haven't seen it and that's
3 something that I would ask whether or not that kind of
4 work might be done.
5 If you want to get a little bit more
6 specific, one of the things that I noted from Ken
7 Rogers' panel is that Jan Long mentioned that -- to
8 her understanding we did not yet have a conceptual
9 model that explained chlorine 36 at depth. If that
10 continues to be the case that's certainly something
11 I'm curious about and I'd like to know if there is a
12 model.
13 Likewise, there are specifics on
14 radionuclide transport that again come from the TPA
15 that Tim McCartin and the Center folks and others ably
16 did. They identified key radionuclides. They
17 identified absorption in the alluvium. I know the
18 question was raised as to whether that was necessarily
19 a high priority, but these are just some of the things
20 that jumped out at me in terms of transport from my
21 perspective.
22 Let me move on and talk a little bit about
23 the source term. And I return to the same concerns
24 about fundamental understanding, from the same
25 perspective about extrapolation of results far into

1 the future.

2 I worry about accelerated testing and I
3 think the Center has worried about that. Perhaps
4 there's some accelerated testing that has not been
5 done because we don't really understand it. I know
6 that when I did accelerate testing in industry, we did
7 it for shorter terms. We developed models where in
8 the case of the work that I did, we actually, if we
9 waited around long enough could validate the things.
10 But for that reason we did it empirically and a lot of
11 the accelerated testing really had an empirical basis,
12 was not well understood.

13 I asked myself are some of the accelerated
14 tests that are done here equally based on picking up
15 from these empirical tests that have been done in the
16 past and how well do we really understand the
17 fundamental differences in what we are accelerating
18 the tests for. And of course, there are things that
19 you ask about what, in fact, if you test spent fuel or
20 waste form today, what are you doing to give you
21 confidence that it's like the spent fuel or waste form
22 that you might have 1,000 years from now after it's
23 been subjected to the passage of time, radiation and
24 all the other things that occur.

25 I'm also worried about scaling effects.

1 And when I talk about scaling effects what I'm asking
2 is are the samples which are being tested today, in
3 fact, equivalent to what one will see in the
4 repository when this is a working industrial sized
5 process. I think about particularly the container and
6 I think about the differences and again, you folks
7 know the materials I'm sure better than I, but you
8 know what's important: composition, processing and
9 you get the properties. I worry about the processing
10 of one of these containers and I ask myself will there
11 -- is there a possibility things will be introduced in
12 the processing of a large-scale container we might not
13 see in the test today?
14 Some of the times I have found processing
15 of lots of material introduces perhaps small amounts
16 of impurities, but these small amounts of impurities
17 can have a very large impact on the properties and on
18 the material that's being worked. And so perhaps I'd
19 ask if you were to process alloy 22, what does our
20 experience show in how it -- what are the things that
21 might happen to it? I know some work has been done
22 and been considered. Has it been fully considered?
23 I'm just not real sure.
24 So I'd be interested in whether or not
25 moving up to that scale or perhaps having something

1 tested constructed at that scale would give us some
2 information that would be useful. And again, it's
3 just a fundamental understanding of these things. Do
4 we have enough to extrapolate into the future?
5 If you want to get a little more specific,
6 I'm worried about alloy 22. And I'm not really sure
7 I can tell you why. It's almost intuitive. Maybe
8 it's that I've known 316 for a lot longer and maybe
9 it's because spent fuel has been around longer and
10 because I've got more experience with Borosilicate
11 glass and that may just be it. It may just be that I
12 don't know that much about it and that I'm uncertain,
13 but I still worry about it a little bit and I wish I
14 knew more.
15 I know the Center has identified stress
16 corrosion cracking in alkaline environments. That's
17 something I'd like to know a little more about. Other
18 things have popped up that just -- I'm curious about.
19 You folks had a presentation, I think, the 28th of
20 August when Ray Wymer noted that one of the processes
21 on corrosion looked as a result of the temperature
22 dependence, I think is what might be diffusion
23 controlled. Well, Lord, if it's diffusion controlled,
24 what will be done other than maybe measure diffusion
25 coefficients? That's where I get back to my concern

1 about the fundamental understanding of how these
2 things go on.
3 I'm just -- I wish I was more comfortable
4 with alloy 22 and I guess what I would do of the
5 various things that are out there, that's something
6 I'd mess around with a little bit simply because I'm
7 just not that comfortable with it. Now Wes and Budhi
8 and others may very well tell you that it's a very
9 well understood material and that if I were more into
10 it I wouldn't have these worries and if they were, I'd
11 certainly defer to them, but that's something that
12 does have me a bit bothered.
13 So those are a few of the thoughts that I
14 have. I was a little general, but hopefully I've
15 gotten down to at least a few specifics that might
16 merit further discussion.
17 CHAIRMAN HORNBERGER: Thank you. John?
18 MEMBER GARRICK: Yes. Malcolm, you have
19 articulated some very interesting and thought-
20 provoking ideas and we appreciate them a great deal.
21 There is one theme to what you're saying that I just
22 want to comment on and get your reaction to and that
23 theme is basically that there's a lot of things here
24 that we don't understand to the level of satisfaction
25 that would bring one great comfort. And so the

1 question is how well do we understand things like
2 retardation?
3 Isn't the real question though not so much
4 how well do we understand it, but how well do we need
5 to understand it if we take into account what we don't
6 understand? That's kind of the foundation of risk
7 assessment. And I worry about getting on to a line of
8 thinking that we've got this long list of things and
9 we are uncomfortable about our level of understanding
10 of them and really, the best way to deal with it is to
11 go down the list one by one and gain that level of
12 understanding to where you have arrived at the comfort
13 zone.
14 One of the things that we've discovered by
15 the use of the risk assessment thought process is that
16 in the end, we have found out that many things we
17 don't need to understand very well, as long as we have
18 some real sense of the bounds that are involved. We
19 can have seven orders of magnitude of uncertainty in
20 the frequency of occurrence of an earthquake of a
21 certain magnitude, as long as it doesn't contribute
22 much to the core melt frequency, for example.
23 So that's the one thing I'd like to get
24 your reaction to.
25 MR. KNAPP: And I would agree with you

1 completely. I think the question that I would ask and
2 you've just given a good example, I could care whether
3 there are seven orders of magnitude uncertainty in the
4 prediction of an earthquake if we have confidence that
5 the number is small enough that that seven orders of
6 magnitude does not hurt us.
7 MEMBER GARRICK: Yes.
8 MR. KNAPP: Have we enough understanding,
9 enough - -and perhaps we don't need understanding.
10 Have we confidence in that number? That's where I
11 would say if we're comfortable that -- if we are
12 comfortable that seven orders of magnitude is not
13 going to have an impact on the repository, then I'd
14 say fine.
15 I certainly did not mean to suggest that
16 yes, if we had the world's budget and two or three
17 lifetimes, it would be nice to know all of this in
18 detail, but absolutely. The place where I'm looking
19 for understanding would be in those areas which we
20 already believe to have a significant influence on the
21 repository and any time we can throw out some of that
22 as a result of other -- something that gives us
23 confidence that we don't need to look at this
24 particular piece or that piece, I agree
25 wholeheartedly.

1 MEMBER GARRICK: See, this touches on the
2 whole issue of good science versus adequate science.
3 MR. KNAPP: Right.
4 MEMBER GARRICK: Yeah.
5 MR. KNAPP: My real question is more if --
6 one of the reasons I was interested in waste packages
7 is obviously DOE places a great deal of reliance on it
8 and so the question I would ask is well do we
9 understand those tests well enough that we believe
10 that reliance -- are we comfortable extrapolating. If
11 we are comfortable extrapolating without understanding
12 particular areas, I certainly wouldn't push it just
13 for the sake of understanding.
14 MEMBER GARRICK: Thank you.
15 CHAIRMAN HORNBERGER: Ray?
16 VICE CHAIRMAN WYMER: For the benefit of
17 those who weren't exposed to my wisdom at that August
18 meeting, I'd like to point out that I wasn't speaking
19 for many deep understanding of the corrosion of alloy
20 22, but only from the point of view that the
21 activation energy for the corrosion is based on the
22 temperature dependence was right in the ballpark of
23 what is normally considered to be diffusion-controlled
24 reactions whereas a chemical reactions generally are
25 a factor of 5 higher, 3 to 5 higher.

1 MR. KNAPP: And I would agree entirely.
2 It's simply that when you see that, to me, certain
3 alarm bells go off and you ask, well, does this tell
4 us it's diffusion-controlled or does it tell us
5 perhaps it's chemistry-controlled, but perhaps they're
6 competing chemistry processes, one of which goes up
7 and one of which goes down. It just causes me to sort
8 of ask myself, do we really understand what's going
9 on, given that step.
10 VICE CHAIRMAN WYMER: Well, it does me
11 too, Mal.
12 MR. KNAPP: That was basically my concern,
13 do we really know why this is the case.
14 VICE CHAIRMAN WYMER: Same way if affected
15 me.
16 CHAIRMAN HORNBERGER: Michael, did you
17 have a -- okay. Other questions?
18 MEMBER LEVENSON: Clarification. You
19 referred to it would be nice to have a model or
20 concept to explain the chlorine 36 at depth. Has it
21 been established for sure that there is chlorine 36 at
22 depth? I thought that was still a very much open
23 question.
24 MR. KNAPP: That's a good question and I'm
25 going to have to admit my ignorance. My only thought

is given that it's there, I'd feel a lot more comfortable if there was a satisfying model that explained it. If it is not there or if it had already been explained, then I wouldn't ask that it be pursued.

MEMBER LEVENSON: As far as I know, it's not been confirmed that it's there. That was the context of my question.

MEMBER GARRICK: One lab thinks it is and another lab thinks it isn't.

CHAIRMAN HORNBERGER: Andy?

MR. CAMPBELL: The chlorine 36 is there. The real issue is the ratio of the chlorine 36 to the stable --

(Laughter.)

Both labs are coming up with similar numbers for chlorine 36, but different numbers for the much larger amount of the stable isotope of chloride and that's where those chlorine 36 ratios differ between those two labs. In fact, it's a similar amount of chlorine 36 in both sets of analyses.

CHAIRMAN HORNBERGER: Other questions or comments? Thank you, Mal.

John, John Kessler is going to be our next presenter.

1 MEMBER LEVENSON: Still with EPRI?

2 CHAIRMAN HORNBERGER: Still with EPRI. As

3 far as I know.

4 MR. KESSLER: I also attempted to follow

5 the general theme here and focus a bit more this time

6 on source term and radionuclide transport, but my

7 comments will go everywhere and I have the same caveat

8 as Budhi. I don't care whether it's NMSS or research,

9 it's all research that might be something that NRC

10 would wish to consider, so you'll have to bear that in

11 mind as we go through.

12 CHAIRMAN HORNBERGER: And you certainly

13 won't get into any trouble for saying that.

14 MR. KESSLER: Yes, exactly. Okay, so what

15 did I look at to make the comments here? Basically,

16 all the stuff that Dick so nicely sent to us, the ACNW

17 letters, the expert panel report on the role and

18 direction of NRC research, the NRC research draft plan

19 for radionuclide transport, the Center's May 2001

20 research plan report and then some work that we've

21 done on top of it.

22 Okay, so I'm going to start with the

23 advice from the panel of experts. I think their

24 advice was fundamentally sound, sounded like good

25 stuff to me: analytical hierarchy program by research

1 needs to better account for waste research,
2 absolutely. The high level waste program needs to
3 have a long term anticipatory research program.
4 Sounds good to me, but let's figure out
5 what that means. I'm still having my trouble wrapping
6 my arms around what this anticipatory research thing.
7 Can we distinguish it from the others? I think that
8 was something that Budhi expressed concern about as
9 well. I think we can. I really think that there's
10 some aspects to anticipatory research that can be
11 distinguished, but let's do that.
12 Research should be doing more work on the
13 utilization of PRA results and developing improved PRA
14 methods. Again, I would agree.
15 NRC needs to be doing work on secondary
16 phases. Yes. It may be falling in the cracks between
17 NMSS and research responsibilities. I leave that to
18 NRC to figure it out. But it does seem to be that
19 sort of in between kind of subject where secondary
20 phases could conceivably be quite important.
21 And the draft NRC research plan for
22 radionuclide and transport and the Center both include
23 it and I only note that to make sure, to ask the
24 question are they fully coordinated with each other on
25 what aspects of that problem they're working on.

1 Certainly, we encourage expanded use of
2 collaborative R & D. Sorry, I'm going to be a broken
3 record on this, but it's certainly our bread and
4 butter. We do a lot of it. It works well for our
5 extremely limited budget. I'm probably one of the
6 less collaborative guys at EPRI in terms of the amount
7 of collaborative R & D that's done. I'm going to
8 point to one success story here that I alluded to this
9 morning.
10 Sorry, Ashok isn't here, but this is the
11 dry cask storage characterization project where I'm
12 the EPRI project manager, Roger Kenneally is the NRC
13 research project manager and we've got DOE-EM and DOE-
14 RW that all kicked in some money. What did we do? We
15 reopened the cask that was in storage for 14 years to
16 look for some signs of aging. It was one of the sort
17 of lead casks out there. This took a lot of money.
18 None of us had it by ourselves, so we
19 jointly funded work that was limited to data
20 collection here. And this was discussed earlier.
21 They did an interpretation. We all go off and do our
22 own interpretation. But we're all very careful and I
23 really think that in practice we are careful about
24 making sure that when we work these things through,
25 we're trying to define what data we're looking at and

1 interpretations will be left for another day.

2 I would just say that having suffered

3 through the process of getting this thing, this

4 agreement set, that a cooperative agreement with a

5 nonfederal organization should be made easier, please.

6 (Laughter.)

7 It just -- I think that we've made some

8 progress by going through these, but it is tough to

9 establish the ground rules by which one co-funds work.

10 Let's see, the NRC research, draft

11 research program plan -- I'm going to skip to

12 radionuclide transport and the environment. I think

13 the overall philosophy that they use is sound for the

14 plan. For example, they say conduct research that

15 will support credible, realistic and defensible

16 estimates of risk to the public. Sure sounds like

17 music to me. It's a tall order, but I think that they

18 can do a lot to do that.

19 Incorporate the best scientific

20 information on uncertainties and risks. Again, sounds

21 like the right words. They also say

22 oversimplification of models lead to underestimates

23 and overestimates of risk. And both are deemed

24 unacceptable. That also sounds good.

25 And maintaining an awareness of the latest

1 scientific and technological developments. This is
2 sort of the, the exploratory research for the future
3 technologies. And that also sounds like it's an
4 important component to what they do. Teasing this out
5 of what they do is perhaps something that could be
6 done better.
7 Okay, I'm going to start to be
8 controversial here just to prove a point or just to --
9 not to prove a point because God knows, we can't prove
10 anything, but to elucidate a point, let's put it that
11 way.
12 This is some recent work of EPRI here with
13 our performance assessment of dose rate which looks
14 like it got cut off there, versus time, where again,
15 this is for one particular branch, where we looked at
16 let's move -- this is the maximum likelihood Wet
17 Branch, just one where we actually get some invection
18 through our part of the repository. It says
19 accessible environment out in front of the alluvium
20 and we had two kilometers of alluvium out at the back
21 end. What we see is that if we move it out two
22 kilometers ahead and lose all that sorption and all
23 that delay, well, at least on a log scale here, we
24 just don't see much. And why don't we see much when
25 others see more? And I would argue it's because we

1 take a lot more credit for fracture matrix interaction
2 and other processes in the saturated zone that the
3 others don't.
4 Now maybe we've taken too much credit.
5 Fine. All I'm saying is is that your research
6 priority here is an example of where it might be
7 affected by your understanding of another system, in
8 this case fracture matrix interaction in the saturated
9 zone which I would argue is a much more important
10 thing to get right.
11 So if we can -- if I can say that we've
12 done a more realistic job, one would say that you need
13 to be more realistic as possible and if not, it
14 affects the relative features of processes
15 performance. That's the point I want to make here in
16 terms of trying to decide what you want to go after
17 here.
18 But this is what leads me to not be so
19 excited about studying sorption in the alluvium. It's
20 because I'm more excited about taking proper credit
21 for fracture matrix interaction in the saturation
22 zone.
23 Okay, while we certainly all advocate the
24 idea of trying to make our PRAs more realistic, that's
25 just not enough. First of all, as I alluded to this

1 morning, they're very difficult to put together, a
2 realistic PRA in some areas and one that Budhi talked
3 about and I think that they're making strides at
4 trying to get some way down that road is in-package
5 chemistry. It governs corrosion and waste form
6 degradation and solubility limits, in-package
7 sorption, all that stuff. Well, I don't know if that
8 falls within the NMSS or the research program, but I
9 imagine it's one of these overlap issues that could be
10 defined.
11 Our favorite one, whipping boy, these days
12 is diffusion from the waste forms surfaced through the
13 container internals through the container wall, down
14 the pedestal, through the invert to the nearest
15 flowing fracture. That is a complicated system and
16 what DOE has been doing is modeling it in my mind on
17 the whole seems very conservative.
18 You could probably come up with some
19 nonconservative scenarios in there, but I would argue
20 on the whole it's extraordinarily conservative, how
21 they models this, almost to the point where they've
22 got diffusion as a dominant release mechanism from the
23 EBS. Well, if I had diffusion as a dominant release
24 mechanism from the EBS I might care a whole lot about
25 the solubility limits of certain things because that's

1 sort or my driver to force my diffusion out of the
2 EBS.
3 If it's not, well, maybe I don't care any
4 more or don't care that much about solubility limits.
5 I care more about the actual infection through than I
6 care about maybe the degradation rate of the fuel and
7 even then I wouldn't argue. But I'm just saying
8 getting this model right may affect what you say is
9 important and is a really tough problem to be
10 realistic.
11 Transverse dispersion in a fractured media
12 across many kilometers, gee, I'm glad Jane is here, is
13 something that I don't know if there's much field data
14 out there for a fractured porous media system. I mean
15 they've done a lot like Bordon and nice porous media
16 and found not much going on, but I think that the
17 situation is probably different and especially over
18 the time scales of importance.
19 Whether you care about transverse
20 dispersion or not when we are forced to think about
21 3,000 acre feet per year is another issue from a
22 regulatory standpoint, but if not, it could be
23 important.
24 So all of this is going to require
25 multiple approaches. Again, I argue for the use of

1 expert judgment in elicitation. I don't want to say
2 that we want to replace collecting data with expert
3 judgment, but let's be realistic here. We are not
4 going to be able to collect all the data we'd like to
5 collect when it's time to make decisions. And
6 somehow, we need to think through and have a better
7 process for using expert judgment in such situations
8 for maybe where we have limited data. How are we
9 going to do that?
10 Long term R & D and performance
11 confirmation. Again, that's out there. It's
12 something where we should have reasonably high
13 confidence as we proceed to the next stage of
14 repository development, but long term R & D in a
15 performance confirmation program should help us manage
16 the data uncertainties that may be out there as we
17 proceed into the next stage.
18 And certainly, we talked a lot about how
19 that falls into the whole program of how you proceed
20 in our performance confirmation workshop. A summary
21 report from the panel, I think, is out on the back
22 table, if you haven't got one where we talked about
23 that.
24 And then natural analogs is again another
25 one where if you can look at what's out there, it

1 might help you provide even a better PRA or some sort
2 of independent understanding as to what's going on.
3 Okay, on to -- these are some random
4 comments on the proposed NRC research R & D plan.
5 I'll get back to this point again. There's no clear
6 distinction between regulatory needs and exploratory
7 research in the proposal. Can the exploratory
8 elements be identified? And are they inextricably --
9 or are they inextricably linked to the regulatory
10 needs. I think we heard the argument earlier today
11 that they probably are somewhat mixed up. Well, fine.
12 But I really do feel that the exploratory component
13 could be highlighted and that should help in decision
14 making as to whether it gets funded or whether it
15 doesn't get funded.
16 I'm picking on Biosphere merely as an
17 example of the kind of detail that one would go into,
18 not that biosphere is more important than any other
19 aspect of what's in the plan.
20 There was some discussion about working
21 toward benchmarking RESRAD when they said well,
22 there's lots of extent biosphere model codes out
23 there. I know we're funding our own, that would do
24 just as well and I'm wondering why RESRAD -- my guess
25 is that there's regulatory reasons, but again, it

1 would be nice if there was some discussion as to why
2 that's there.
3 Work on radionuclide distribution and
4 resuspension factors for tephra and dust is now
5 critical. I talked about that again this morning.
6 It's the predominant importance for extrusive igneous
7 activity. Certainly, that's within NMSS. In our
8 biosphere model, the dominant pathway for normal
9 release is dust inhalation for most of the actinides,
10 and again, now for that, where it's more generic, I
11 don't know whether that's a research, NRC research or
12 an NMSS sort of activity.
13 Switching now to the Center's R & D plan,
14 May of 2001, I just want to say I'm really impressed
15 with the Center staff capabilities. They're quite
16 good. Their work is very often innovative and I would
17 argue ahead of DOE and that is especially in the use
18 of natural analog information. They're out there
19 looking at sites in innovative ways to evaluate or
20 test the assumptions that DOE is making on processes
21 that are really hard to get at necessarily in the lab
22 and I think that's very creative.
23 Many of the KTI, key technical issue
24 sections begin with assumptions about sensitivities
25 that they use to prioritize their work. That's great.