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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

December 19, 2007

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on December 19, 2007, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

5 + + + + +

6 SAFETY RESEARCH PROGRAM SUBCOMMITTEE

7 + + + + +

8 MEETING

9 + + + + +

10 TUESDAY,

11 DECEMBER 18, 2007

12 + + + + +

13 ROCKVILLE, MARYLAND

14 The subcommittee met at the Nuclear Regulatory

15 Commission, Two White Flint North, Room T-2B1, 11545

16 Rockville Pike, at 10:00 a.m., DANA A. POWERS,

17 Chairman, presiding.

18 MEMBERS PRESENT:

19 DANA A. POWERS, Chair

20 SAID ABDEL-KHALIK, Member

21 J. SAM ARMIJO, Member

22 MARIO V. BONACA, Member

23 MICHAEL CORRADINI, Member

24 WILLIAM J. SHACK, Member

25 JOHN D. SIEBER, Member

1 ACRS CONSULTANT:

2 ASHOK THADANI

3 ACRS/ACNW STAFF:

4 HOSSEIN NOURBAKHSH

5 Designated Federal Official

6 PANELISTS:

7 JOHN AHEARNE

8 GARY HOLAHAN, NRO

9 TOM MILLER, DOE

10 ROBERT HILL, ANL

11 ALEX MARION, NEI

12 BRIAN SHERON, RES

13 NRC STAFF:

14 DON CARLSON, RES/DSA

15 SAMANTHA CRANE, RES/DE

16 DON DUBE, NRO/DSRA

17 DON HELTON, RES/DSA

18 JOCELYN MITCHELL, RES/DSA

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

2 (10:13 a.m.)

3 OPENING REMARKS AND OBJECTIVES

4 CHAIRMAN POWERS: The meeting will now
5 come to order. This is a meeting of the ACRS
6 Subcommittee on Safety Research Program. I am Dana
7 Powers, Chairman of the meeting. Members in
8 attendance are Said Abdel-Khalik, Sam Armijo, Mario
9 Bonaca, Mike Corradini, Jack Sieber, and Bill Shack.
10 Also in attendance is the ACRS consultant Ashok
11 Thadani.

12 The purpose of the meeting is to discuss
13 the scope of long-term research the agency needs to
14 consider. The Subcommittee will gather information,
15 analyze relevant issues and facts, and formulate
16 proposed positions and actions as appropriate for
17 deliberation by the full Committee. Dr. Hossein
18 Nourbakhsh is the designated federal official for the
19 meeting.

20 Rules for participation in today's meeting
21 have been announced as part of the notice of this
22 meeting previously published in the Federal Register
23 November 30th, 2007.

24 A transcript of the meeting is being kept
25 and will be made available, as stated in the Federal

1 Register notice. It is requested that speakers first
2 identify themselves, use one of the microphones, and
3 speak with sufficient clarity and volume so they can
4 be readily heard.
5 We have received no written comments or
6 requests for time to make oral statements from members
7 of the public regarding today's meeting.
8 What we are doing today is responding to
9 a request made by several members of the Commission to
10 develop comments on the long-term scope and nature of
11 research at the NRC.
12 In thinking about long-term research, I
13 harken back to the words of Brian Sheron. And I'm
14 very sympathetic to these words. Brian pointed out to
15 us that if this were 1987, instead of 2007, he could
16 come in here with discussions on how to dismantle the
17 nuclear industry.
18 DR. SHERON: Actually, it was 2002.
19 CHAIRMAN POWERS: You don't even need to
20 go back that far. And so the ability to forecast
21 exactly what the research program will be working on
22 is limited. My own interest is in how staff does its
23 work for the NRC, rather than the specific things.
24 But in that regard, Ashok Thadani has put
25 together a program for us on research in the long

term. Ashok comes to us with really amazing credentials.

I first met Ashok when he was over working in NRR and we were worried about the future in the form of the Clinch River Breeder Reactor and things like that. But Ashok subsequently moved from NRR to become the Director of the Research Program.

And so he has firsthand experience with NRC research and has also worked with the ACRS as our Deputy Director. So he has all the credentials we need to put together an appropriate program for us.

So at this point, I will just turn the meeting over to Ashok.

DR. THADANI: Well, thank you very much, Dana.

I. REMARKS BY MEMBERS OF THE PANEL

DR. THADANI: As Dana noted, this is an issue of great interest to the Commission. There was a staff requirements memorandum to the Committee asking the Committee that they provide advice to the Commission on specific long-term research that should be initiated by the Nuclear Regulatory Commission.

An important element of any long-term research is to make sure the Committee has heard from various parties who have knowledge and interests in

terms of what might be anticipated over the next 10 to 20 years.

The Committee decided the long term would be in the range of 10 to 20 years. And that issue can also be debated because I know there are different views on that. So I am certainly very, very pleased to see such a distinguished panel to help us out on this important subject.

Let me introduce the panel. I think everyone on the panel, starting with Brian Sheron, who is the Director of the Office of Nuclear Regulatory Research.

John Ahearne. We all know John. John used to be Commissioner and Chairman of the Nuclear Regulatory Commission and, of course, has been involved in many activities, including two I will point out when John chaired the early CSIS study that looked at the NRC processes back about a decade ago or so. And John also was involved in an earlier effort as a member of the expert panel to look at the role of research at NRC.

DR. AHEARNE: That was to look at NRC combined with DOE after the --

DR. THADANI: Yes, and combined with DOE. You're quite right. And so you know the NRC. You

1 know our functions. And you know its challenges and
2 so on. So I think your views will be of great
3 interest.
4 In particular, because of this forward
5 look into 20 years, your involvement with NERAC will
6 really, really bring some better understanding on our
7 part.
8 Tom Miller. Tom Miller, of course, was
9 well-known for a long time. Tom is Department of
10 Energy, responsible for the lightwater reactor program
11 there.
12 Gary Holahan. Gary I suspect all of you
13 know is the Deputy Director of the Office of New
14 Reactors. And I suspect he has a whole bunch of
15 challenges ahead that he has to deal with. I think
16 selective research can be of value to that
17 organization, I expect.
18 Alex Marion. Marion from Nuclear Energy
19 Institute will give us some strategic thinking in
20 terms of what the industry thinks the future is going
21 to hold. So the research will be of some real value
22 for the country as we go forward.
23 Robert Hill is from Argonne National
24 Laboratory. He is going to talk to us about GNEP and
25 some aspects of Generation-IV designs. And, again, I

1 think that would be of some value.

2 I asked Robert if he can also touch upon

3 GIF, the Generation-IV International Forum initiative,

4 as to what is happening in the context of

5 international initiatives.

6 With that, what I will do is to briefly go

7 through some background. Background very simply is

8 what is the objective of this effort and then what are

9 some of the assumptions. That may or may not be

10 appropriate but should be interesting in your views on

11 that.

12 The first one is given the Commission

13 request, should a portion of NRC research activities

14 be devoted to the development of the technical

15 infrastructure that may be needed in the 10-to-20-year

16 time frame?

17 There are two parts here that are

18 important on that part of the sentence:

19 infrastructure. By "infrastructure," what we mean is

20 people's expertise, people who are knowledgeable and

21 really understand those aspects of technologies and

22 that they have ability to do analysis. That means

23 they have analytical tools available to them.

24 And the third part of the infrastructure

25 would be access to some place where they may need to

1 do some experiments to verify certain models. I say
2 access because it could be national. It may be
3 international. Some of the facilities may not be
4 available in this country. And so that the
5 infrastructure is basically the real talent in a
6 technical area that might be of use to the agency.
7 The second part that is important there is
8 that might be needed in a 10-to-20-year time frame.
9 There might be different views as to why 10 to 20
10 years. Why not five to ten years? So any thoughts on
11 that would be useful.
12 And then the second aspect of this
13 objective is focused more on efficiency and
14 effectiveness; that is, the computing technology. The
15 power of computers is just going up and up and up.
16 Can one take many of these analysis tools,
17 convert them to much more user-friendly fashion, give
18 them to staff, for example, in the New Reactor
19 Organization? For example, you can simplify PRA
20 models. You can give that to 10 or 20 staff members
21 who have some knowledge of PRA. They may be able to
22 use these tools to do sensitivity studies to
23 understand things perhaps a little bit better.
24 To what extent can one take advantage of
25 this capability and simplify and provide information

1 to the reviewers now, technical reviewers in the line
2 organization so they can get their work done perhaps
3 in a more efficient and effective way?
4 The important considerations if one were
5 to move forward in this direction certainly would be
6 that whatever infrastructure is there, whatever tools
7 are developed, the objective is that they will support
8 timely decisions by the agency, critical timely
9 decisions by the agency. And that would define the
10 time line if one goes down this path. So when should
11 one get started to be there to have the tools in time
12 for appropriate decisions to be made?
13 I mean, it goes without saying that the
14 whole idea of infrastructure is that it provides sound
15 science and technology to the decision-making process.
16 Another element -- now, this is important.
17 And over the last 30 years, the agency and the
18 industry have moved more and more to try and
19 understand what the margins might be and try to work
20 towards cutting some margins as long as the end result
21 is still adequate level of safety is maintained.
22 So the focus should probably be to make
23 sure whatever infrastructure you have, that you
24 understand what reality is, try to understand realism.
25 My own experience tells me when you try to understand

1 what reality is, you end up needing more information
2 and not less information.
3 But if you keep that in mind that
4 realistic assessment is the goal, whatever margins are
5 added, that's fine. At least try and understand the
6 realistic outcome. Then that might be of some real
7 benefit as we go down the road.
8 So what should be the scope of this
9 long-term research the agency should, then, consider?
10 First, we all know that the lightwater reactors are
11 going to be around. They're going to be the dominant
12 process.
13 But it may be that there may be some
14 applications of non-lightwater reactors. The thought
15 here is that if one has to address the issue of
16 non-lightwater reactors, developing an appropriate
17 infrastructure may be a long-term process.
18 People have talked about it might take a
19 decade or so to develop an infrastructure to deal with
20 non-lightwater reactors. It may or may not take a
21 decade. It may take less. It may take longer. It
22 would depend on various parameters.
23 Should one seriously consider some sort of
24 non-lightwater reactor research? Should that be
25 initiated, undertaken over the next 2 or 3 years

1 because we see that there is a potential need in the
2 next 10 to 20 years?
3 The third element there applies to both
4 the lightwater reactors and the non-lightwater
5 reactors. The technology is moving on. I mean, there
6 have been tremendous advances. I've given some
7 examples here of some new materials, in fact, sensors,
8 nondestructive examination techniques, and so on,
9 which would very likely lead to enhancement in safety.
10 My own view is that they can also lead to
11 improvement in economics if they use the new
12 technology. The question is -- and wee can go through
13 and if we have time this afternoon -- I have a list
14 myself, but we can go through it -- are there some
15 areas where it would be beneficial to be engaged?
16 The NRC research focus always got to be on
17 safety. Vendors, designers have interests in
18 economics. NRC's focus presumably would be to see if,
19 in fact, these new technologies lead to simplification
20 in design and/or these new technologies had new
21 failure modes that one needs to understand. So
22 there's an aspect that if the NRC were to move down
23 this path the Commission would find some interest in.
24 So these are three we think fairly
25 important issues. And it would be very useful if we

1 can get some thoughts from you. Some of the
2 assumptions that largely are discussed among a few of
3 us here, that nuclear power in the U.S. will grow over
4 the next 20 years, lightwater reactor will be
5 dominant.
6 There may be a small part in the staff
7 workload in the non-lightwater reactor technology, but
8 the more challenging issue if one were to go down this
9 pathway would be -- it won't require long-term
10 research to develop safety requirements and support
11 future licensing decisions for non-lightwater
12 reactors.
13 Second, I briefly touched upon this, that
14 licensees are going to get more and more
15 sophisticated. They're going to try and get more and
16 understand what the expected outcome is going to be
17 from accidents and try to tear away at some of the
18 margins even further.
19 And these applications will probably be
20 more demanding than some of the earlier ones, which
21 were fairly straightforward, even if they have
22 significant margins. One would expect if it
23 continues, that the challenges to the staff might
24 significant in terms of being able to approve such
25 changes.

1 The third one is fairly straightforward.
2 Nuclear power will become ever more international.
3 NRC actually I think has done a great job. NRC has a
4 whole bunch of bilateral, multinational, or
5 international, the various programs ongoing for large
6 international, multinational design evaluation program
7 that Gary is involved in, Chairman Klein has been very
8 engaged in, various components of manufacturing
9 different parts, just the world we live in today. So
10 it's pretty clear one has to start thinking globally
11 when one talks about nuclear power in the next many
12 years.
13 Now, here is the down side. The view is
14 that when the nuclear power grows, it is not clear the
15 NRC will grow at the same rate. NRC has been growing
16 and will grow, but the rate of growth will be the
17 same. This is especially if you look at history,
18 there has always been a lag when the agency grows and
19 the demand comes in. And only then the agency
20 realizes it has to grow, but there is always a bit of
21 a lag.
22 The next assumption is that a lot of
23 talent has left the agency and a lot of talent is
24 going to leave the agency. If you look at the
25 demographics, it does appear that in the next five to

1 ten years, there will be significant loss of
2 additional capabilities in the NRC.
3 And also if nuclear power is really going
4 to grow in the way some people think, you will reach
5 competition for limited resources. And this might
6 lead the agency to be in the more challenging position
7 of having to deal with some of those large numbers of
8 applicants.
9 So these are some thoughts and assumptions
10 and some broad-level considerations. We thought what
11 would be best would be to try to get a picture not
12 only of what I put up if that makes sense. Maybe you
13 have some news that that's not that far from
14 considering. So we're very open. We really and truly
15 want your real views, both on these objectives and the
16 assumptions.
17 Now, the plan was that every panelist may
18 take like 10-15 minutes or whatever time, in that
19 range, to give some thoughts and then in the afternoon
20 to have some discussion period.
21 I have some backup charts. I put together
22 seven what I would call very specific questions. And
23 then if we have an opportunity, we can depending on
24 how this morning goes then come back and try and take
25 each issue by itself and have some discussion and see

1 where we end up before the end of the day.

2 With that, Brian?

3 DR. SHERON: Thanks. I apologize. I've

4 got an office Christmas party. I probably can come

5 back after 2:00 o'clock if you want.

6 DR. THADANI: Please. I think it would be

7 very good.

8 DR. SHERON: I would like to make a

9 presence at my office Christmas party with the staff.

10 I am going to tell you right now you have

11 taken on a very complex subject. There are so many

12 factors that are going to play into this. This is a

13 piechart which kind of shows where our budget goes

14 now. If you combined the '08 and '90 budget numbers,

15 which is about $135 million total, this is basically

16 how we divide it out. I've got some copies here I

17 guess. I don't know if I have enough.

18 Basically what you see there, user needs

19 drive about 67 percent of our research. And by "user

20 needs," I mean this is work we are doing to supply

21 offices, NRR, NRO, NMSS, FSME, NSIR, with products

22 that they have requested from us.

23 And this will include things like

24 international cooperative research because if they

25 have asked for, for example, a validated computer

1 code, if we need experimental information to validate
2 that, then that is considered part of the user need.
3 Agency-mandated programs. These are
4 programs like we prepare the abnormal occurrence
5 report that goes to Congress every year. We run the
6 generic issues program. We develop the SPAR models.
7 So it's those kind of programs that have been mandated
8 by the agency, as I call it, and assigned to the
9 Office of Research.
10 Long-term research, which is what you are
11 focused on, if you just want a little history, when
12 Chairman Klein first started here in July of 2006 --
13 and I had been the office director I think a whole two
14 months prior to that.
15 And so I think I had my first meeting with
16 him. And it was back. Actually, he had come and
17 visited me, I guess, in August, the office. But I had
18 my first real sit-down with him. It was probably in
19 October or so.
20 The first question he asked me is, one of
21 the things he says, "Well, what do you do about
22 long-range research?"
23 And I said, "Well, you know, we plan out
24 three years. That's our budgeting process. And, you
25 know, we're working on the budget for three years."

1 And he says, "No, no, no, no." He says,
2 "I'm talking 5, 10, 15 years from now." He says,
3 "What are you doing to get the agency prepared?"
4 And I kind of was like a deer in
5 headlights. And I said, "You know, well, we really
6 don't plan out that far and everything."
7 He said, "You know, well, we really need
8 to start thinking about, you know where the agency
9 needs to be 10 or 15 years from now, what
10 capabilities, what tools we'll need" and so forth.
11 And so I took that sort of as a request to take a hard
12 look at where we needed to be.
13 And I'm sure you've all seen we developed
14 a first cut at a long-range research plan. We
15 requested input, both from within the NRC as well as
16 from the ACRS and from external stakeholders. And
17 you're familiar with what we put together.
18 We had originally requested something, if
19 I remember, on the order of about $6 million and about
20 8 FTE to conduct that. And then we got into the
21 budget process. And before that made it up to the
22 Commission, it was completely zeroed out of the
23 agency's budget.
24 The Commission restored some of that. I
25 think it was around -- I've got the numbers here.

1 I'll find it here, but it was around 2.6 million I
2 think and about 2.4 FTE.
3 We have identified certain things in '09
4 that we would plan to fund with that money. I think
5 there were 800k and .4 FTE for characterizing and
6 evaluating promising sensor candidates for extended
7 into inspection monitoring, 700k and 1 FTE for the
8 development of an R&D facility for digital
9 instrumentation in human control and human-machine
10 interfaces. That was also a Commission SRM for us to
11 look into that.
12 There was 500k and .8 FTE for research
13 activities to review advanced fabrication techniques
14 for materials and reinforced concrete, 400k and .3 FTE
15 for development of MELCOR to be used for both level
16 2/3 as a PRA tool.
17 I did want to point out that with regard
18 to looking down the road, we have also -- I've got
19 some input from EPRI. This is a presentation they
20 made recently at a workshop at CSNI in December, which
21 was the role of research in a regulatory context.
22 There were three panels that were
23 convened. One was on research needed for the current
24 fleet of reactors. The second was for research needed
25 for what we call new reactors. And then a third was

1 research for the advanced reactors, the non-lightwater
2 reactors.
3 The areas that were identified by EPRI
4 that are on their kind of high-priority list were
5 material degradation, fuel performance, digital I&C
6 technology, and cable diagnostics and alternative
7 replacements.
8 And if you think about one of the big
9 things -- and, as a matter of fact, we had an
10 all-hands meeting yesterday and the Chairman came and
11 spoke. One of the first things he mentioned that was
12 high on his priority list was what I have termed "life
13 beyond 60" as a long-term research area. And that is
14 plants, as you know, have gotten license renewals for
15 an additional 20 years.
16 I think the first plant is probably going
17 to hit the end of their 40-year license in about 2
18 years, maybe Oyster Creek, I think. And then
19 successional plants will start hitting the end of
20 their 40-year term.
21 Some utility execs have come in and talked
22 to I know Luis Reyes and the like and said, you know,
23 "We have invested a lot of money in these plants so
24 that they can run beyond 40 years in terms of
25 replacement valves, motors, pumps, you name it."

1 They feel that, you know, with those
2 investments, they don't really see these plants being
3 able to have to shut down in 20 years but running
4 beyond 60. And so the real question is what is
5 needed, what are the technical issues that would have
6 to be addressed to allow these plants to run beyond 60
7 years.
8 And so we have started taking a hard look
9 at that. We have been working with the Department of
10 Energy. As a matter of fact, there's a workshop, a
11 three-day workshop, in February that's been scheduled
12 out at the Hyatt Regency in Bethesda to discuss this
13 very subject.
14 But if you really look at some of the
15 areas that EPRI identified, they are all related:
16 material degradation. You know, basically it's
17 cracking. This is what is plaguing the industry,
18 cracks and welds and so forth.
19 Being able to understand when and where
20 material is going to fail, it's going to crack and
21 degrade, and either go into a proactive replacement or
22 a repair process is something the industry is very
23 interested in.
24 You don't want to be on the right-hand
25 side of the bathtub curve, where you're shutting down

1 every day because you're finding more and more things
2 failing and breaking. So they're very interested in
3 understanding material behavior and what they need to
4 do to control it and predict it.
5 Fuel performance. They want to run these
6 plants to higher and higher burnups. They're running
7 right now -- one of the viewgraphs here says they're
8 actually running beyond the validated range of a lot
9 of computer codes. So there's going to be a real need
10 to get fuel performance data and to understand its
11 behavior, high burnups in order to allow the agency to
12 authorize them to run beyond the current limits.
13 Digital I&C. I'm a little questionable
14 about that one. I know there are going to be a lot of
15 replacements as the operating fleet as the analog
16 systems wear out. Given some of the experience Oconee
17 has had trying to install a digital I&C platform to
18 get it through the licensing process and particularly
19 with the QA and answering a lot of questions about
20 redundancy in diversity, our feeling is -- and my
21 branch chief in the I&C area is from industry. And
22 he's worked. And we have discussed this.
23 The feeling is that while they will
24 develop new platforms and everything so they can
25 replace outdated analog systems and the like, once

1 they have replaced them with digital, we're not sure
2 there are going to be any great sweeping changes in
3 this area.
4 The industry basically works on a
5 three-year cycle, which is if I don't see a return on
6 my investment in three years, I don't make it unless
7 it's something extraordinary.
8 And the feeling is that unless they see a
9 benefit, either in reduced down time or increased
10 megawatts, there's really no incentive for them to go
11 and develop more sophisticated digital systems if
12 they're not going to provide any kind of return on
13 investment.
14 As a matter of fact, Jim Dyer told us the
15 other day that in 2009, he expects to see a lot of the
16 PWRs coming in now for power uprates. And we're kind
17 of scratching our heads, at least I am, trying to
18 figure out how they're going to do that, especially if
19 they're not going to have a 50.46(a) ECCS rule in
20 place at that time.
21 But that is going to be a challenge
22 because these plants, as Ashok said, most of these
23 plants, are going to start pushing closer to the
24 limits.
25 Cable diagnostics. I think there are two

1 limiting factors that prevent a plant from going out
2 to a full 80 years, let's say, or something. One is
3 concrete, especially the concrete that may be used to
4 support the vessel, how does it behave the long term,
5 the properties of it under irradiation and high
6 temperature because that can't be replaced, really.
7 I think a vessel might even be able to be
8 replaced these days. You know, when you see pictures
9 of these where they cut a hole in containment and pull
10 a steam generator out, you know, other than it's
11 probably a lot more radioactive, I don't see why they
12 couldn't at some point replace a vessel.
13 But cables. I don't think anybody wants
14 to go through the headache of recabling an entire
15 plant. So we're kind of thinking that -- and if the
16 insulation starts to break down and not perform under
17 the environmental qualification, what do they do?
18 And so we're thinking remote sensors,
19 wireless. And so that's an area we are starting to
20 look into right now, is to understand what are the
21 safety implications of wireless transmission through
22 the plant? You know, why replace a cable if I could
23 just send a signal and pick it up somewhere?
24 So we see that. And I think EPRI has
25 identified that as well. So these are some of the

areas we have been focusing on. The other thing on advanced reactors, I know Ashok said they are in the out years. But they are not so much.

We have been interacting with some of the vendors. PBMR has told us they are coming in with a design certification application at the end of calendar year '09, which is not that far away.

Toshiba has said they are coming in with an application for certification of the 4S, the small, simplified, super simple, whatever it is, safe reactor.

PARTICIPANT: Nuclear battery.

DR. SHERON: Nuclear battery, yes, one they want to put in Galena, Alaska. It's about 30 megawatts. They said they are coming in at the end of '09 with a design certification.

We are working with DOE right now with NGNP. They're going to need to come in with a design certification package, probably somewhere between I guess the 2011-2013 time frame to meet Congress' mandated requirement that they put a plant on line by, I think, 2021.

We have had some interest from a company called Hyperion, which wants to do a preapplication of the hydride reactor. And I couldn't even tell you.

I've read about it once.

MEMBER SIEBER: What is it?

DR. SHERON: I'm sorry?

MEMBER SIEBER: What is it?

DR. SHERON: It's a design that actually Los Alamos I was told had come up with some time ago. And they want to commercialize it. I have seen a description of it, but it's -- I could get back to you or probably have staff that could explain it better than me.

And then we know that AREVA apparently has a gas-cooled design, but they haven't really come forward yet. But the expectation is -- and then there's also GNEP and whether or not there will be a liquid burner reactor.

But we have not put together, really, any of the tools that the regulatory offices, NRO, for example, would need to review these to the same level that we do with the lightwater reactor.

We don't have right now the sophisticated thermal hydraulic codes. I mean, there are codes that were developed for LMRs way back. Okay? And they are still obviously available and the like. But, for example, we don't have the severe accident codes.

There's a lot of policy questions. I am

1 sure with PBMR they are not talking about a
2 containment. They are talking about a confinement
3 that's a policy decision that's going to have to be
4 made.
5 There's a lot of questions about
6 in-service inspection for LMRs and stuff and how do
7 you inspect the welds in the vessel and so forth, do
8 you have to train the vessel.
9 So there's just a whole host of questions
10 that really need to be looked at. And right now our
11 funding levels, we have done very little on that.
12 For the advanced reactors, in '08, for
13 gas-cooled, we had about $3 million and 5 and a half
14 FTE and 100k and .3 FTE for the LMRs. In '09, I've
15 got about 6.3 million and 7.7 FTE for gas-cooled and
16 nothing for liquid metal in my budget now. And that
17 is about it. There is nothing for the gas-cooled in
18 the design certification review area either.
19 And then in '09, there is 500k and one FTE
20 for GNEP. So, you know, I think the point is that
21 from the standpoint of looking out 15 or 20 years, I
22 am more worried about just how are we going to deal
23 with these advanced designs that are going to be
24 coming in in a couple of years and not being able to
25 produce the tools.

1 And so one of the things we're trying to
2 look at now is what kind of leverage we can get with
3 either what is being done overseas. We're
4 participating in a program called RAFAEL, which is a
5 European consortium looking at gas-cooled, trying to
6 see what we can get from that.
7 I know we want to interact with DOE
8 because we're convinced they've got all the money, but
9 there may be actually some work that they could do
10 that would support our independent capability and the
11 like.
12 So, you know, from a long-term -- the
13 other thing I did want to point out before I am taking
14 too much of my time here, when we define long-term
15 research, it's not from a standpoint of looking at it
16 as a huge budget. What we have defined it as is this
17 is the exploratory stage. What are the issues that
18 the agency needs to deal with.
19 And so when we talk about a long-term
20 research program, what we are looking at is let me
21 call it looking under the rocks. What are the digital
22 issues? And once we have identified them, for
23 example, if we have decided that wireless technology
24 is something that we really need to focus on and
25 understand better, I'm not going to keep it in a bin

1 called long-term research. I'm going to probably go
2 over to my user offices, you know, like NRO and NRR,
3 and make sure they're in agreement that this is an
4 important area that we need to focus on and start to
5 get information on. In other words, I will cultivate
6 a user.
7 And then I am going to move that program
8 into my baseline research program. It's not going to
9 be called this long-term or this -- it's I'm going to
10 budget it, and I am going to work on it.
11 So the long-term research program is
12 really in my mind what we use to identify what the
13 issues are, to focus, to say, "What do I need to work
14 on? What can I ignore?"
15 And once I have identified what I really
16 need to work on and I get buy-in from my user offices
17 that says, "Yes, we are going to need this information
18 down the road." I am going to start budgeting it into
19 my regular research program because, quite honestly,
20 when you put stuff through the NRC prioritization
21 process, you know, anything that has the term
22 "long-term" on it is going to fall off the edge.
23 Okay? So I've got to get it into -- let me call it
24 the baseline research program, where I have an
25 identified user, an identified product, and the like.

1 The other piece of the long-term research
2 is to identify the issues for the industry. Okay?
3 We're not going to solve all of the issues needed for
4 a plant to run beyond 60 years. That's not our job.
5 We do confirmatory research and the like.
6 But we need to identify the problems and
7 then tell the industry, "Here are the issues you are
8 going to have to deal with. Here is the information
9 you are going to have to submit and provide to us in
10 order to demonstrate safe operations, say, beyond 60
11 years.
12 So if it means better NDE techniques to
13 find cracking earlier, if it means getting more data
14 on high burnup to be able to be able to run with
15 higher burnup fuel, we will tell them that so that
16 they have plenty of time to prepare and to get that
17 information.
18 If they need to put more coupons in a
19 reactor so they can get irradiation data to make sure
20 that they're not going to bump up against some sort of
21 a PTS limit, then they need to do that now.
22 So that's really where we are with
23 long-term research. We're trying to focus on
24 identifying what the issues are. The long-term
25 research program, we intended to update it on an

1 annual basis.

2 We would go out to our external

3 stakeholders I think every other year and look for

4 updates, you know, what is new, what is different,

5 what should we focus on, is there anything that has

6 changed. And we will be coming back to the Committee,

7 obviously, with that on a probably yearly basis.

8 With that, I will yield the microphone.

9 DR. THADANI: Thank you, Brian.

10 Brian has to leave soon. So there are a

11 few minutes. If there are any questions for Brian,

12 this might be a good time.

13 MEMBER SIEBER: Yes. I have one. This is

14 probably a simpleminded question, but the way this

15 industry started out is that the very first reactors,

16 the very benign reactors, had lots of margin. And the

17 regulations were deterministic. And they had lots of

18 margin.

19 If you introduce new types of reactors,

20 one way to do it is to analyze all the PRAs and

21 everything, analyze all the accidents and where you

22 would place the margin.

23 The other way to do it was the way this

24 industry started out, which is the early reactors have

25 the margin built in, everything that was done by

1 bounding analysis, and you rely on redundancy and
2 defense-in-depth.
3 I sort of think that you are going to have
4 to use a combination of those. And the question is,
5 do we know what sophisticated things that we need to
6 do to handle the general class of advanced reactors
7 compared to things that we can solve and regulate by
8 just adding margin to it?
9 DR. SHERON: Well, that's one of the
10 things hopefully the research program is trying to
11 identify.
12 MEMBER SIEBER: Yes. I don't see it in
13 the documents that I have. Maybe it will.
14 DR. SHERON: Well, I think a lot of it is
15 we just haven't progressed that far because we haven't
16 had the resources to really look into these. One of
17 the things that would concern me, though, is that --
18 and Tom might be able to address this better -- DOE is
19 looking for commercial partners. In other words, this
20 is not a demonstration.
21 MEMBER SIEBER: Right.
22 DR. SHERON: And I would worry that the
23 industry would not participate if the costs, you know,
24 for example, to develop a new technology, a new
25 reactor type with this margin and because they

1 couldn't, you know, let me call it run it, you know,
2 push it as hard as they could, that it wasn't
3 profitable for them. And that would be a concern.
4 That's all because there's a balance there, you know,
5 unless DOE were to say, "Yes, we'll pick up the extra
6 bucks here."
7 MEMBER SIEBER: Well, is there a
8 possibility of some incentive like that? Because
9 that's the way the early industry started out.
10 DR. SHERON: That may evolve just from the
11 review process depending upon what the licensees can
12 provide to support their technical bases, the amount
13 of information and so forth.
14 You know, like with the gas-cooled
15 reactor, if you license another Part 52, you're
16 required to have a PRA. What kind of a database is
17 there to support a PRA? What kind of failure data do
18 you have on and, you know, what kind of margins, then,
19 do you put on the PRA to account for the fact that you
20 don't have a complete database like you have with
21 lightwater reactors?
22 MEMBER SIEBER: Of all of the elements of
23 uncertainty in a PRA, when you talk about gas-cooled
24 reactors or other types, molten salt or whatever,
25 those uncertainties are so big that they're basically

1 going to be covered by bounding analysis.

2 You know, you don't know much about the

3 parameters because your equipment, the summary

4 equipment, has not been built and operated. And you

5 don't know everything there is to know about the

6 modeling. The only thing I know for sure is the PRA

7 techniques done properly are probably better than

8 deterministic techniques for layer after layer of

9 protection.

10 Well, anyway, those are the kinds of

11 questions that go through my mind because I don't

12 think government by itself is going to be able to

13 sponsor new reactor types. Given the current

14 political situation, I don't think industry is going

15 to dive in there with something they're not sure that

16 they can license or that will be economic. So, you

17 know, it's sort of damned if you do and damned if you

18 don't.

19 MEMBER BONACA: Just a question. Isn't

20 there a risk that depending on user needs, you know,

21 certainly thinking long-term initially when you go to

22 users for their endorsement, isn't there a concern

23 that that problem may be very myopic and in short

24 eyesight?

25 Users typically are not concerned about

1 ten years. I mean, they have needs tomorrow. Isn't
2 there a risk that your long-term planning becomes
3 really a short-term problem?
4 DR. SHERON: Well, I mean, the long-term
5 planning if you want to call it that, I mean, I don't
6 see it as this is 20 years out. For example, with --
7 I was going through the numbers, for example. If you
8 assume that the first plant is going to hit its
9 40-year life in 2 years and they get a 20-year
10 extension, that means they can run up to 2029. Okay?
11 Most utilities have to plan probably about
12 15 years in advance for replacement generation, where,
13 you know, "Do I need another power plant?" and the
14 like.
15 So back off 15 years from that, and you're
16 at 2014, which is not that far away. So from the
17 standpoint of what's needed, they need to start
18 thinking about this now.
19 So, in other words, when I talk about
20 long-term research, I'm really probably thinking
21 within about the next five or six years. And I think
22 the regulatory offices, you know, Gary could probably
23 talk about this from NRO's standpoint. They're
24 looking in that time frame.
25 So I don't think it's that myopic. And

1 the issues that I have talked about are actually
2 issues that are facing the industry to some extent
3 today. They're just going to become more acute as the
4 plants age.
5 Material degradation and cracking is an
6 issue right now. You know, the concern is that it's
7 going to get worse, you know, as these plants age.
8 And what do we need to do more of? But we're still
9 worried about it now.
10 The digital I&C is an issue right now for
11 a lot of plants at Oconee with trying to replace their
12 protection system and the like. And that has been
13 going on since I was -- that was going on before, back
14 when I was in the NRR, and they're still reviewing it.
15 So there's a lot of technical issues and the like.
16 The life beyond 60, we're trying to get
17 ahead of that one. And we're working with DOE. As I
18 said, we've got a three-day workshop. And I would
19 hope that some of the committee members would want to
20 attend that.
21 I think there's a lot of interesting --
22 there are actually some issues that the industry has
23 raised that didn't even cross our minds. I think one
24 is potable water and stuff, which, you know, they're
25 worried about having adequate supplies of fresh water

1 to cool these plants and stuff.

2 So there are other issues that the

3 industry hopefully is thinking about that we haven't

4 even thought of. And, you know, that will help us.

5 MEMBER ABDEL-KHALIK: Well, that sort of

6 brings my question. I am sort of concerned about the

7 direction of information flow. You indicate that

8 research identifies the problems, then goes

9 essentially and convinces the customer, whether it's

10 NRR or NRO, that this is something that you guys will

11 need a few years down the road. And once you get

12 concurrence, you move that to your regular research

13 program to start working on it.

14 Would it be more logical if the

15 information flow was in the opposite direction?

16 DR. SHERON: Well, actually, it should be

17 a two-way flow.

18 MEMBER ABDEL-KHALIK: Well, yes, but there

19 has to be some information coming from the customer

20 telling you that, hey, we've thought about this.

21 We're the ones who are doing this. We know what we

22 expect a few years down the road. And we really need

23 information in this area, which we don't see as having

24 in the agency. Would you mind working on this?

25 Is this loop closed? Is there sort of

1 bidirectional information flow on this issue, problem
2 definition?
3 DR. SHERON: There will be. In other
4 words, we're just at the starting edge, you might say,
5 of this whole process with the life beyond 60.
6 MEMBER ABDEL-KHALIK: Well, not just that.
7 DR. SHERON: I understand. But yes, I
8 mean, the industry has to identify obviously what they
9 believe are the issues that they need to address.
10 They're going to identify the issues from
11 an economic standpoint because they need to look. And
12 they're going to say, can this plant run reliably and
13 profitably for the next 20 years? And if it can't,
14 they're probably not going to invest in it and the
15 like.
16 And they're going to look at issues that
17 maybe overlap with safety issues, but it's really
18 going to be, does the safety -- if it's a safety issue
19 as well as an economic issue, is it going to inhibit
20 the ability of that plant to earn money for the
21 utility?
22 The NRC is going to look at issues that
23 the industry may not think about or may not believe
24 that they have a problem. That's the two-way type of
25 flow. The industry will tell us the issues that they

1 are going to have to deal with to make sure that that
2 plant is going to be able to run safely and
3 efficiently for the next 20 or whatever years.
4 We take an independent look at those
5 issues. And we may come up with some of our own. And
6 typically what we do is we go back to the industry.
7 And we say, "Hey, you know, in addition to your
8 issues, we've got a couple here that we're worried
9 about."
10 The industry is either going to say, "No.
11 You're wrong. And here is why you're wrong" and you
12 don't have to worry about it or "Yeah, you've got a
13 point. We're going to have to go look at this. And
14 we'll get back to you."
15 MEMBER ABDEL-KHALIK: But who is doing
16 that?
17 CHAIRMAN POWERS: We'll have lots of time.
18 Said, we'll have lots of time for discussion in the
19 afternoon.
20 MEMBER ABDEL-KHALIK: All right.
21 CHAIRMAN POWERS: We need to move along.
22 DR. THADANI: Brian, just a quick, quick
23 question. Status. You mentioned a number of novel
24 designs, some lightwater reactor designs. The
25 agency's knowledge base is pretty thin. And a lot of

1 people in the industry seem to be walking away. So
2 we're losing a lot of knowledge as we speak.
3 Is there any effort underway to sort of
4 document what I would call state of knowledge? I
5 think that might be a useful starting point so you
6 know what the gaps are and where the challenges are.
7 DR. SHERON: Well, the biggest example, I
8 guess, is Sid Ball down at Oak Ridge, who is working
9 on gas-cooled reactors. I worked on Fort St. Vrain in
10 1979 for a short period. And I was working with Sid
11 at that time. He's still working on gas-cooled
12 reactors.
13 And we're actually trying to get him to
14 document. We have a contract with him to actually try
15 and document this information that he has and the
16 like.
17 The other thing we do obviously is we have
18 the rehired annuitant program, which I'm sure you're
19 familiar with that. So we don't lose a lot of
20 corporate knowledge.
21 When senior staff that have worked in
22 these areas announce they're going to retire and the
23 like, we can actually hire them back now. And the
24 main purpose is for them to transfer that knowledge,
25 either to write it down through some kind of a

1 document or to just pass it on through other means and
2 the like.
3 A really classic example was back when I
4 was in NRR. Paul Shewmanski before he retired wrote
5 a document on equipment qualification. I picked it
6 up, and it was basically a mind dump. It was just
7 everything that he knew about equipment qualification
8 and what you need to look for when you are doing a
9 review. And it was great.
10 You know, if you were a new employee and
11 you were coming in and you were assigned to be an
12 equipment qualification reviewer and you read this
13 thing, you would walk away from it when you were done
14 and say, "I know exactly where to focus on, what to
15 do."
16 So that is one of the things that we are
17 trying to do. We have some what we call the community
18 of practice. We have Web sites where people can
19 actually ask questions and chat back and forth with
20 some of the experts so new employees if they have a
21 question can get information.
22 We are trying to really do a mentoring
23 program where we link new employees up with senior
24 staff. And, actually, in their job description now is
25 the requirement that they are a mentor. And they try

1 and pass on knowledge to the new employees. And it
2 seems to be working.
3 We have the resource seminars, where we
4 bring in experts and we give them an opportunity to
5 pass on that knowledge to the staff, not just research
6 but to the agency staff. So we have just a number of
7 forums that we're using to try and pass on to capture
8 all of that knowledge.
9 The other thing we are doing is, you know,
10 we have a lot of reports that were generated over the
11 past 30 years or so, you know, technical reports,
12 NUREGs, and so forth.
13 A lot of them prior to ADAMS, you might
14 say, and the internet and all of that are in documents
15 that are just kind of laying around in people's
16 offices. A lot of people every time we move or have
17 to do something, you know, they're pitching.
18 We're trying to capture these and scan
19 them in so that that information that was generated
20 back, you know, '70s, whatever, in the '80s isn't
21 lost.
22 One of my old professors in graduate
23 school, Charlie Graves, used to always tell me. He
24 said, "Engineers tend to redesign things every 20
25 years." And he said, "The reason is because they

1 forget that it was designed 20 years ago because
2 nobody passed on that knowledge that said, 'Hey, we
3 already did this.'"
4 So we're trying to do that. So we're
5 trying to capture all of these documents, these
6 technical documents, you know, in electronic form so
7 they don't get pitched out the next time somebody has
8 to move or they decide to retire.
9 So I don't know. I hope that answers a
10 little bit of your question about what we're trying to
11 do. But it's a very serious issue with the agency.
12 Okay? And both the Commission and the EDO are very
13 supportive of knowledge management activities. It's
14 actually in our SES contracts if that helps.
15 DR. THADANI: Very good. Thank you very
16 much.
17 DR. AHEARNE: Okay. First let me say I am
18 here under false pretenses. It says NERAC. NERAC
19 doesn't exist anymore.
20 (Laughter.)
21 DR. AHEARNE: It disappeared. Now, over
22 the last eight months, there has been an effort to
23 re-form something called the Nuclear Advisory
24 Committee for NE, DOE. And I'm not sure whether it's
25 the problems of the General Counsel or the problems of

1 getting prospective members to agree to be special
2 government employees, but it has been taking months
3 and months and months.
4 So, Mike, the answer to the question you
5 were asked, I don't know what is happening.
6 MEMBER CORRADINI: Thanks for guessing.
7 DR. AHEARNE: In theory, I am still vice
8 chair of something.
9 (Laughter.)
10 MEMBER CORRADINI: Short memory of it.
11 DR. AHEARNE: And then the second, when
12 Ashok called me, I said, "Look, I don't live in this
13 world." And so I'm not like Brian obviously in
14 detail. Tom lives with it. All of these guys spend
15 their days thinking and worrying about this stuff.
16 Even Mike, who teaches all of this stuff. I don't.
17 So I'm going to give you a perhaps broader perspective
18 because it's about all I can do.
19 And I'll tell my colleagues here I'm not
20 going to talk as long as Brian did. So you will have
21 a chance.
22 (Laughter.)
23 MR. MARION: The best news I've heard all
24 morning.
25 (Laughter.)

1 DR. AHEARNE: Okay. The perspective I
2 will take is that I view the NRC and then the Research
3 as the leader of it to do something that goes with it
4 to provide the protection of public health and safety,
5 but it's to make the public understand and be
6 convinced that the NRC is protecting the public health
7 and safety.
8 And that turns out to mean that the
9 information that gets developed and the areas in which
10 people work have to take into account who is the user
11 of that information. And it's not just NRR, NRO, or
12 the industry. It's a lot of the people who are
13 skeptical or perhaps agnostic about nuclear power.
14 And I think that's something that has to be kept in
15 mind.
16 So, for example, I'll just go through the
17 things that we're thinking about. I was glad to hear
18 Brian saying most of these are on the agenda.
19 What has to be done to prepare for going
20 beyond 60 years? I hear a lot from the people who
21 have this general community of skeptics, can you
22 really trust the NRC to actually look carefully at
23 what is a degradation that is occurring and can you
24 trust the NRC in being able to say that a plant can go
25 80 years? Those are some of the things that research

1 should be looking at and what are the issues there.

2 The much higher burnup fuels. I know NE

3 has been pushing that for a long time. And that is

4 something obviously that fuel begins to fail that

5 causes a problem, again, out in the public.

6 There's a lot of interest through GNEP and

7 through the world on fast reactors. And one of the

8 issues that obviously comes up when you talk about

9 fast reactors is they're too expensive. Well, if you

10 can recall back when the lightwater reactor was viewed

11 as too expensive, some of the people -- and I think it

12 was started by John Taylor at EPRI -- looked at the

13 idea of going towards passive safety and eliminating

14 a lot of the active safety systems.

15 Well, there are some people beginning to

16 talk about going back to the EBR2 experiment that was

17 done and say, "Well, can't you, then, on a fast

18 reactor eliminate a lot of the active safety systems?"

19 And if you did, then the cost of that reactor would

20 come down a lot. So that is something the challenge

21 for the regulator to be able to say what has to be

22 shown that this would be safe.

23 The issues that constantly come up about

24 -- and, now, this is something that -- I realize part

25 of the problem is the research here office doesn't

1 handle everything. Low levels of radioactivity are
2 still a constant issue. The threshold question of
3 linear is obviously always raised.
4 And recently some more studies are
5 beginning to come out about increased leukemia and
6 cancer around nuclear power plants. These issues
7 don't go away. And it is blind if the NRC doesn't
8 realize that that is a major objection that keeps on
9 popping up. And it would be better if they knew more
10 about this area and worked on it.
11 The high-temperature materials. Hydrogen
12 production is talked about. You're going to need to
13 essentially get 50 percent higher temperature, which
14 has been a real challenge for the materials. And
15 that's an area of research where people should be
16 spending a lot of time on.
17 Well, I don't care whether you call it
18 reprocessing, regeneration, or reuse, whatever
19 terminology, but there are a lot of new approaches
20 being studied. DOE has been talking about UREX I,
21 UREX Plus 2, UREX Plus 3, UREX Plus 4. These are
22 waste streams that are going to come out of this.
23 And I realize part of the problem,
24 research has almost been kept away from the waste
25 management area. Remember, we worked on that.

1 DR. THADANI: Yes.

2 DR. AHEARNE: I don't think that's
3 appropriate. I think that, again, in the whole
4 concept, the NRC is responsible for providing
5 confidence in the public and research people have to
6 do the long-term thinking. And waste management is
7 still a major issue.

8 I think that research has to get ahead of
9 the issues of computerized control. If you drive a
10 modern car now, the car will tell you what is wrong
11 with it. And I think that as we go into more advanced
12 reactors, that is an approach that eventually is going
13 to come about. And I think that the NRC has to be
14 ahead of that.

15 The burner reactor that was mentioned.
16 Whether that ends up coming about, nevertheless, when
17 some of us looked at the problems that GNEP was
18 facing, one of the issues that didn't seem to be
19 getting enough focus/attention is these new facilities
20 are going to have to be licensed. And so someone has
21 to be really thinking about what are the challenges of
22 those new facilities.

23 Fusion is a topic that hasn't been talked
24 about very much for years, but there's this huge
25 project underway, ITER. And that is not going to be

1 built in the United States, but issues are going to be
2 as to the safety and the regulatory framework for a
3 fusion reactor.
4 There's the issue of working with NE, with
5 DOE. We all know that there is a problem about
6 conflict of interest and maintaining this barrier.
7 There have to be continued, though, better working
8 relationships because they're both trying to
9 accomplish the same thing.
10 I realize that NE's role is trying to
11 encourage the growth of nuclear power. NRC is not
12 trying to encourage the growth of nuclear power. It's
13 trying to make sure that the growth of nuclear power
14 is done safely and environmentally soundly. But those
15 two are not contradictory roles.
16 And then there is the question of
17 non-proliferation. Research really has to think about
18 when you're getting a whole bunch of new designs, new
19 reactors, and the world is growing rapidly in the use
20 of reactors, the non-proliferation issue is going to
21 still be there. It's bubbling underneath the surface
22 in many places.
23 Finally, the use of contractors. The
24 issue was brought up. People here in the NRC are
25 aging, like all of us. And the question about, are

1 you going to have the expertise there, that would be
2 a problem, even if there weren't a lot of new designs
3 coming in, a lot of new applications.
4 But with a flood of applications, the NRC
5 has the potential of being seen as the roadblock, the
6 obstacle for the growth of nuclear power. And I think
7 research has to think about one of the ways to access
8 the contract community is Argonne and other national
9 labs, a lot of very bright and knowledgeable people,
10 in some cases prevented from working on NRC issues
11 because they're working on DOE issues.
12 Well, man-power is a finite resource.
13 Knowledgeable man-power is an even more finite
14 resource. And that has to be used as best as
15 possible.
16 So that's my short summary that I was
17 thinking about. We can discuss some later.
18 DR. THADANI: Thank you, John.
19 CHAIRMAN POWERS: Let me ask you a quick
20 question on the non-proliferation. Are you aware of
21 anyone that has used fuel from a nuclear plant to go
22 to hard generation as a root to weapons-grade
23 material?
24 DR. AHEARNE: Of course, because if you
25 reprocess that fuel and you get the plutonium out of

1 it --

2 CHAIRMAN POWERS: Even with weapons

3 material, any material.

4 DR. AHEARNE: This is not a design of a

5 weapon that you could put on, make it a very --

6 CHAIRMAN POWERS: Sophisticated.

7 DR. AHEARNE: -- long-range nuclear

8 missile, weight-limited. However, you could still get

9 a pretty good explosion from that plutonium.

10 Of course, the other issue which is

11 constantly in the news, if you're going to make the

12 fuel itself, as we all know, you enrich it. Well, you

13 don't have to stop there.

14 DR. THADANI: I'm just thinking I know we

15 might start to lose people. Maybe we should take a

16 ten-minute break and come back.

17 MEMBER CORRADINI: Five, anything.

18 DR. THADANI: Well, let's say ten because

19 I don't think people will be back. After a ten-minute

20 break, we'll start with Tom.

21 (Whereupon, the foregoing matter went off

22 the record at 11:26 a.m. and went back on

23 the record at 11:34 a.m.)

24 CHAIRMAN POWERS: Let's come back into

25 session.

1 DR. THADANI: I understand Alex has a
2 commitment at 12:00 o'clock. So why don't we go to
3 Alex first? Then we'll go to Tom Miller.
4 MR. MARION: Okay. Thank you.
5 I am Alex Marion. I am the Executive
6 Director of Nuclear Operations and Engineering at the
7 Nuclear Energy Institute. And I am pleased to have
8 the opportunity to offer industry perspectives on
9 NRC's long-term research objectives and goals.
10 As background, I also participated on the
11 expert panel that Dr. Thadani referred to that was
12 chaired by former Commissioner Rogers in looking at
13 the role of NRC research.
14 One of the key recommendations that was
15 identified from that activity is still applicable
16 today. And that's for the NRC to strive to seek
17 additional opportunities for collaborative research,
18 collaborative from the standpoint of more industry
19 participation as well as collaboration with other
20 federal agencies, such as the Department of Energy.
21 I recognize pursuing such collaboration is
22 not going to proceed successfully without its
23 challenges, but I think in the environment that we
24 have today, where we are all struggling for resources,
25 it only makes sense to look for these opportunities so

1 that we can be more efficient, more effective, and
2 more focused as we go forward because fundamentally
3 assuring appropriate technical research to sustain the
4 current operating plants as well as develop new
5 technology I think is in everyone's best interest as
6 long as we maintain a focus on safety and do it in an
7 open manner such that the public is aware of the
8 actions and activities that are being pursued.
9 Brian Sheron mentioned a number of areas
10 where research will be needed to support basically
11 current plant activities as well as future plant
12 activities. He mentioned materials degradation. We,
13 of course, agree that that is fundamentally important.
14 The industry has put forth a significant
15 effort in understanding and identifying and
16 understanding known degradation mechanisms based upon
17 operating experience.
18 And we are working towards prioritizing
19 those gaps that we have identified in our knowledge
20 base relative to effective management of those
21 degradation mechanisms. And we have had some
22 preliminary discussions with the Office of Research on
23 potential opportunities for collaborative research.
24 I'm hoping that that progresses in a
25 successful manner because we're both interested in

1 making sure our programs in diagnostics are effective
2 in managing degradation today as well as into the
3 future. And along with that, in-service inspection,
4 diagnostic techniques, et cetera, are critically
5 important, especially from the standpoint of
6 nondestructive examination.
7 On digital technology, I must take issue.
8 And I am sorry Brian is not here, but I made a note to
9 follow up with him directly. I have to respectfully
10 disagree with Dr. Sheron's assessment on how the
11 industry deals with the application of new
12 technologies, especially with regard to the planning
13 horizon and incentives that he mentioned earlier in
14 his comments.
15 Fundamentally, if his premise was valid,
16 we would not have any utilities that had pursued
17 license renewal, nor will we have utilities that
18 submit applications to the NRC for new plants. And so
19 I submit that his premise is incorrect. And, as I
20 said, I will take that up with him individually.
21 Risk assessment --
22 MEMBER ARMIJO: Were you talking about the
23 three-year payback kind of concept?
24 MR. MARION: Yes, yes. That is just
25 incorrect.

1 MEMBER ARMIJO: I don't think he meant --

2 MR. MARION: It's possible I could have

3 misinterpreted --

4 MEMBER ARMIJO: Yes.

5 MR. MARION: -- the point, but I don't

6 think so. Application of risk analysis is extremely

7 important. We have had a tremendous amount of

8 positive constructive collaboration with the NRC in

9 the area of fire risk and research in that area. And

10 I think that needs to grow. We need to develop that

11 and use that as a benchmark for further activities.

12 Dr. Thadani mentioned the importance of

13 leveraging computer technology and that capability.

14 I think we need to take a look at what kind of

15 computer modeling analytical techniques are we going

16 to need in the future.

17 But fundamentally today we have a

18 situation where the fuel vendors have a computer

19 model, the industry has computer models, the NRC has

20 computer models that do similar analysis.

21 We can't afford to operate that way going

22 forward into the future. And we have got computer

23 technology that we are all using today, all of us, the

24 vendors, the industry, and the NRC. And we have had

25 sufficient operating experience with those computer

1 methods. We ought to seek an opportunity to get
2 together and collaborate so we have one computer
3 software program that we're all confident and as we go
4 forward.
5 I understand the principle of independence
6 on the part of the NRC, but there are some areas where
7 we can gain significant efficiencies and improvement.
8 And I submit that that is one because what happens
9 over time, the owner of the software in terms of the
10 original developer will fight that product and try to
11 continue use of that product to the grave. And that
12 doesn't serve any of us well. So that's something
13 that we're going to be discussing with the NRC in the
14 future.
15 Fuel performance, of course, is another
16 important area. Brian touched on that, and we agree.
17 He mentioned license renewal and the fact
18 that there is this workshop in February. We support
19 that completely. There are utilities that are
20 starting to consider license renewal beyond 60 years.
21 And I hope we don't necessarily, if you will, reinvent
22 the wheel.
23 We have a stable license renewal process
24 in terms of seeking NRC approval. We have up to this
25 point established reasonably effective aging

1 management programs to support license renewal in that
2 additional 20-year term. We use that as a foundation
3 going forward beyond the 60 years, instead of creating
4 a new one.
5 We have a good, excellent foundation to
6 build on. And I suggest we do so as we go forward.
7 And that will be raised at the workshop in February.
8 That essentially completes the comments
9 that I wanted to make. And I do apologize, but I do
10 have a 12:00 o'clock appointment. I will be returning
11 after lunch to participate in the discussion. And I
12 thank you for the opportunity.
13 DR. THADANI: Thank you, Alex.
14 Any questions for Alex?
15 CHAIRMAN POWERS: I think we'll chat with
16 Alex later, when he comes back later.
17 DR. THADANI: Tom?
18 MR. MILLER: Thank you.
19 My name is Tom Miller, Office of Nuclear
20 Energy within DOE. My focus has been on lightwater
21 reactors. And that's really what I wanted to talk
22 from, that focus, today.
23 I was glad Ashok put up several of the
24 preliminary assumptions and assumptions on the board
25 earlier because I felt like it was important to lay

1 some groundwork with you on where we see things coming
2 from.
3 We expect that the industry and
4 policy-makers are going to continue to push nuclear
5 energy as an energy security climate change solution.
6 And, therefore, there is going to be a continued call
7 for expanded use of nuclear energy. I expect, even
8 with an administration change, it will still be a
9 push.
10 It is our belief lightwater reactor
11 technology, existing lightwater reactors and new ALWRs
12 will be the dominant reactor technology for the
13 commercial nuclear power deployment. And you can pick
14 a date. Some people say as late as 2050. But it's
15 going to be for the foreseeable future and within the
16 guidelines of your long-term deployment or research
17 program.
18 Brian mentioned the gas reactor and the
19 congressional mandate to have one in place by 2021.
20 Expectations I think by the industry would be that's
21 great. That's a demonstration unit. It's
22 commercially. But one is really to become
23 commercially feasible for them. We would expect that
24 there would be at least some five years of operation
25 before the industry is going to really want to deploy

1 them on a commercial basis.

2 There's been a lot of talk about climate
3 change and the need to increase non-emitting
4 technology generation. And, no matter what percentage
5 of generation that you look at, nuclear is going to be
6 a major component.

7 And even if you expected nuclear to
8 maintain a 20 percent generation, you're talking about
9 200 gigawatts of generation in 2050. That's adding
10 100 new plants on the line and if you don't license
11 renewal again an additional 100 megawatts.

12 So we see the life after 60 we call a
13 second license renewal as a very important aspect of
14 energy security for the country. And if you propose
15 that nuclear should provide more than 20 percent, then
16 you're just adding an additional new plants on the
17 line and then pressure to look at further extension of
18 plants.

19 It's our belief that there's going to be
20 some R&D required to establish the underlying
21 technical basis, economic basis, and to understand the
22 potential effects of reductions in safety margins as
23 these plants age. I'll get into a little bit more of
24 what we are talking about for the future in a little
25 bit.

1 New plant deployment. We think for the
2 foreseeable future, the existing identified designs
3 will be what the utilities pursue: GE's ABWR on the
4 ESBWR, AP-1000, AREVA's EPR, and MHI's APWR.
5 Several of those are in the design
6 certification process. Another one is expected. But
7 these technologies are pretty well-known. Our
8 expectations are that they be minimum or a little
9 confirmatory R&D required.
10 However, there are some beliefs that as
11 small reactors are pursued as part of GNEP, that there
12 will be small LWR reactor certifications coming
13 forward, concepts like IRIS. There is another new
14 concept that we heard about just last week called
15 NuScale. And then because of their integral reactor
16 designs, we would expect that there would be a
17 significant amount of confirmatory research involved
18 in those.
19 I don't know what the time frames are, but
20 we understand that -- well, IRIS has been in
21 preapplication design certification discussions for a
22 while. And I understand this newer concept, which is
23 based on an INL reactor design that came out under the
24 NERI program, that they will be coming in in the near
25 future, over the next couple of years.

1 Some comments about implementation of R&D.
2 It has been mentioned, but I think we will have to do
3 a better job of coordinating and collaborating on R&D
4 to leverage our meager resources, limited resources;
5 minimize any duplicative activities, tests, or
6 experiments; and maximize the use of test facilities.
7 The workshop has been mentioned. We are
8 working with staff on RES, both from the Office of
9 Nuclear Energy and the Office of Science, to put that
10 workshop together. We see this as a very valuable
11 input to our R&D program. We are planning. We also
12 see it as a very valuable input to RES as to what they
13 need to be looking at.
14 At least at a working level, we agreed
15 that there is a potential for collaborative research
16 with RES and the Office of Nuclear Energy and the
17 Office of Science. It is now getting down to what is
18 it we have to do and how to collaborate. And that is
19 yet to be determined.
20 Although we have some near-term examples
21 of how we have done that in the recent past, many may
22 not know this, but the Department's Nuclear Energy
23 Plan Optimization program, NEPO program, back in 2000
24 to 2005 had several activities in which we
25 collaborated, one in particular being the annealing

1 demonstration project up at Marble Hill, where we
2 collaborated and were able to obtain test data on the
3 facility as it was heated up at that temperature. It
4 was a good show of how we collaborated to get the test
5 data for our own purposes.
6 Another opportunity happened under the
7 Nuclear Power 2010 program, where we were doing some
8 testing out at the Oregon State University Apex
9 facility for the AP-1000 certification. And we did a
10 test program coordinating some air entrainment
11 experiments between RES and ourselves and
12 Westinghouse. So the examples are there. We just
13 need to do a better job at working together to find
14 out where it is and what it is we collaborate on.
15 We are working, NE is working, with the
16 industry and the laboratory community and RES on what
17 is going to be required in research terms for
18 lightwater reactors in the future.
19 Idaho National Laboratory and their
20 utility advisory board and EPRI have worked and pulled
21 together a strategic plan for lightwater research for
22 the department we just received at the end of
23 November. We will be making this available to those
24 that are interested.
25 This plan at least identifies in a

1 preliminary sense areas that we feel that it was
2 necessary. And it looks at extending plant life
3 beyond 60 years and looking at improving performance
4 of the plants. That is existing plants.
5 Sustained expansion of or deployment of
6 lightwater reactors. The plan also includes some
7 areas of infrastructure enhancement or development
8 that support both of those two other objectives.
9 Areas of interest I think that we have in
10 research. Component life extension improved lifetime
11 prediction. We think there are issues involving
12 degradation and corrosion of structural and vessel
13 materials, structural steels and structural concrete.
14 Brian mentioned, you know, reactor vessel supports.
15 These areas need to be looked at for life beyond 60.
16 Things such as why do inconel and other
17 high-temperature alloys continue to crack. We believe
18 that there is an opportunity for the Office of Science
19 and some of their fundamental research to be tapped to
20 help us address these issues.
21 Integrated material performance and under
22 various chemistry regimes. We think that is an area
23 that needs to be looked at a lot closer as we age the
24 plants.
25 Identify a potential environmental

1 precursor for degradation to improve predictions of
2 component life. Improvements to in-service inspection
3 diagnostics, maintenance and repair techniques. This
4 has been mentioned by both Brian and Alex.
5 I will bring this up, but it has been in
6 our plan for transition to state-of-the-art digital
7 technology. One of the main reasons this has come up
8 in our discussions with industry representatives,
9 utility management, has come from the perspective of
10 not reducing margins or improving performance as much
11 as it is from obsolescence. You can't get the parts
12 and pieces for the components.
13 And if you start looking at movement to a
14 digital technology, computerized technology, the rate
15 of improvement in those technologies is a lot shorter
16 than it was for analog technology. And, therefore,
17 the obsolescence of those might be happening in a
18 shorter period of duration.
19 So we need to establish a mechanism to be
20 able to upgrade to some of the latest technologies.
21 It's obvious in the digital I&C area in a easier
22 manner than it happens today. And we have that as
23 part of a collaborative program that we're planning.
24 Advances in fuel. I would start from the
25 perspective of advancing fuel reliability of existing

1 fuels, particularly trying to resolve some of the clad
2 degradation issues, and then a move toward a higher
3 burnup fuel. I think that way we can support
4 industry's goal to observe defects by 2010 in fuel and
5 then take the fuel to higher performance levels.
6 Again, higher performance levels, we need
7 to look at new fuel designs, new clad materials.
8 There are some issues that need to be developed there
9 and the corresponding research that RES would do to
10 look at those.
11 Another area of our R&D plan we believe is
12 important, and it has some -- as has been mentioned,
13 an expanded use of probabilistic risk methods and
14 tools, improved safety and understanding of safety
15 margins. We believe advanced simulation in modeling
16 techniques, improvements in there is important.
17 One of the areas that, in particular, were
18 brought up were having the ability to do fuel
19 pin-to-pin safety margin analysis. And, in
20 particular, one area that came up was just because of
21 bypass flow and things like that that it became an
22 issue. And it didn't have the capability to do that.
23 Seismic design safety margins. I think
24 recent earthquake in Japan has kind of raised that
25 issue up again. Plus, some of the new work on new

1 plants has raised seismic as a potential area that
2 needs to be looked at.
3 It was mentioned earlier advanced
4 fabrication, construction, inspection methods for new
5 ALWRs. There is a portion in the industry to do
6 modular construction, shorten the construction period,
7 minimize the construction period. Can we do that
8 effectively, efficiently and still maintain the
9 inspection to assure safety of the plant as built is
10 an area that has been brought up by the industry for
11 us to consider.
12 Other improvements in advanced lightwater
13 reactors has been raised as an item in hopes that we
14 would continue to improve lightwater reactor
15 technology. In addition, some other I'll say not
16 necessarily nuclear but other areas, alternative
17 cooling technologies, industry has raised a specter of
18 what if they start to reduce the cooling water flows
19 so that we can utilize for these plants as we go to
20 relicense.
21 The drought in Georgia and some of the low
22 lake water levels sort of raise the specter up. In
23 particular, one utility executive said that's probably
24 his topic issue right now as far as how to place and
25 where to place plants, new plants.

1 And, correspondingly, what are the
2 implications to safety of those alternate cooling
3 technologies? Process heat applications and other
4 performance improvements is another subject we're
5 looking at.
6 There is an infrastructure focus in our
7 plan and related to workforce and identifying critical
8 skills needed for nuclear, not only for new plants but
9 existing plants and what, if anything, the Department
10 should be doing.
11 That is an open item. It's something we
12 feel like is important to look at. I think from
13 everyone's perspective, we don't have as many people
14 coming in to the industry as we did before.
15 We have more people leaving than have the
16 experience and knowledge base and somehow several
17 other methods we talked about, but this is a subject
18 we're looking at.
19 I think there is another area that deals
20 with the limited infrastructure in the United States
21 and how we look at and how we evaluate additional
22 foreign content that's in the plants to date or will
23 be in the plants coming up in the future. I think
24 there are additional challenges that might be there.
25 Laboratory facilities for experiments,

1 tests we think needs to be evaluated again. In some
2 of our I'll say more recent fuel-related projects, we
3 have run into some issues on post-irradiation
4 examination of components that cause us to step back
5 and look at it. And I believe that probably some of
6 the other facilities as we move into looking at new
7 types of plants, it's going to be an issue. And we're
8 willing to continue talking with the RES about that.
9 One area that I mentioned at the break, I
10 was asked if we were losing manpower. And I said,
11 "Absolutely." We're having people retire. I had a
12 good young materials engineer leave me just recently
13 and go to the industry. I think for her overall
14 career, it was good, but for me, it was terrible. And
15 I said I blame myself for that because I suggested she
16 do an internship at the utility.
17 (Laughter.)
18 MR. MILLER: But I found when she came
19 back, she had a very good appreciation and
20 understanding of what utility life was like, what
21 activities they go through. And it was something that
22 she as growing in DOE had not experienced.
23 I think that is a good way for some of the
24 knowledge and some of the experience to be transferred
25 to some of the young folks. I won't say put them out

in the industry. From RES, maybe they need to spend time at the laboratory working some projects in their areas of expertise and understand what the laboratories are doing and how they get things done.

That would be a recommendation I would make. And at that, I'll end my discussions and wait for more detailed discussions this afternoon.

DR. THADANI: Thank you, Tom.

MEMBER ARMIJO: Tom, you mentioned the fuel R&D, new fuel cladding, and new correlation CO_2. But the U.S. has a really poor infrastructure for fuel R&D in that we have no test reactors, maybe ATR. I don't know if that is really going to be available and adequate. And we have very limited hot cell facilities in this country.

And for research in the nuclear industry, you're going to need a sound infrastructure to do this kind of research. Is this a priority within DOE? Has this issue been considered a kind of a by the way issue or is this something that's of concern? I know industry doesn't have anything cooking, at least. And certainly NRC can't do it.

MR. MILLER: Yes. I think within NE, it's a concern. Beyond NE I'm not sure it's a concern because you have competing priorities with EM trying

1 to shut down nuclear and decontaminate nuclear
2 facilities. And you want to expand nuclear energy of
3 particular research.
4 MEMBER ARMIJO: I know it's not a
5 glamorous area, but it's an important area.
6 MR. MILLER: One thing that's going on
7 right now is NE is exploring and I guess trying to
8 progress ATR to a users' facility; therefore, you
9 know, open it up to these kinds of experimentations
10 and testing. In doing so, I mean, they're going to
11 need to also have the hot cells.
12 One of the things that we ran into is a
13 problem with the post-radiation examination and on the
14 hot cell, we didn't have the equipment in there that
15 we needed right away.
16 So it will be a focus for us in this fuel
17 area. That's about all I can answer right now.
18 DR. THADANI: Tom, do you know, for the
19 lightwater reactors, we have learned enormous things,
20 like from the operating experience of the reactor
21 operation.
22 What strikes me is after the Three Mile
23 Island accident, we needed to understand small breaks
24 better than we did. And we were trying to figure out,
25 what do we do, where do we go. We realized we really

1 didn't have an experimental capability to run some
2 tests to see if we're really interested in small
3 breaks.
4 With these new passive reactors, we don't
5 have operational experience. Presumably in this
6 country, they will go in operation in five to ten
7 years' time frame. And you know we are going to learn
8 lessons from operation.
9 I didn't hear you say anything about what
10 infrastructure you think should be in place or should
11 be considered to make sure that the country is
12 prepared if there are events that take place in the
13 process, prepared to say, "We understand that and can
14 deal with that." Are we really prepared? I didn't
15 hear you say anything in that regard.
16 MR. MILLER: I don't think I have an
17 answer for you to be honest with you.
18 DR. THADANI: It's about to be considered.
19 I think these plants will operate from five to ten
20 years from now. We have an opportunity to think about
21 what might be appropriate.
22 MR. MILLER: What might be appropriate and
23 what test facilities have been created to try and
24 maintain them viable, Oregon State University has what
25 they call an apex test facility, which is, what is it,

1 a quarter-scale, full-pressure, full-temperature
2 circulation of the AP-1000. And we have used it.
3 Well, it was designed and put in place for
4 the AP-600 certification. And we updated it when
5 Westinghouse came in for the certification of the
6 AP-1000. They used it, and we have used it since
7 then.
8 Oregon also has a scale model of this new
9 concept, this new scale concept that they want to use.
10 And I'm not sure of the status of some of the
11 facilities at Purdue, but these are some of the test
12 facilities at universities. Okay. But it is some of
13 the test facilities that if there were questions that
14 we would want to go back to and use as a minimum.
15 That's a good point.
16 DR. THADANI: Gary?
17 MR. HOLAHAN: Well, thank you for inviting
18 me to participate. I am going to speak about new
19 reactors. And I think the first thing I will do is to
20 talk about the fact that there are new reactors and
21 there are new reactors.
22 Last week we got our fourth application
23 for a combined license. And we anticipate a lot more.
24 So we're looking at in the next few years probably 22
25 applications for 31 or 32 units.

1 Those are all lightwater reactors that
2 have a lot of interesting features, but they are not
3 what you would call advanced reactors. Every one is
4 a lightwater reactor. And most of them have pretty
5 conventional features.
6 I think probably the important thing to
7 say is when we are talking about new reactors, doing
8 research during the licensing process is a bad idea.
9 We were currently looking at about 24 months for early
10 site permits, 30 months for technical review of a
11 combined license, and 42 months for design
12 certification.
13 I think if there are technical issues
14 requiring research, they really ought to be done
15 during, actually before design certifications because
16 even a 42-month design certification doesn't lend
17 itself to a developing, putting in place a research
18 program, getting the results, understanding them,
19 having some peer review and some consensus on what
20 they mean. The entire design certification would have
21 gone by while that process was developing.
22 So I guess my first thought is when we
23 talk about new reactors, this next generation of new
24 reactors is really based on the research activities
25 that were put together in the 1990s. And most of the

1 facilities that were just mentioned are 1990s
2 activities that took place, particularly for the
3 passive designs. And I think that's the right model.
4 If you have fundamental research issues
5 that are opened, you're not ready to go into the
6 licensing process. That's begging for a process
7 that's sort of uncertain with respect to both time and
8 outcome. And I think neither the NRC nor the industry
9 is interested in sort of experimenting its way through
10 the next generation of reactors.
11 If I apply this logic to the advanced
12 non-lightwater reactors, it means you have to do the
13 research, you have to understand the issues in some
14 sort of long-term research concept.
15 And I won't adopt Brian's definition and
16 his distinction here because I think to me long-term
17 research is anything that's not near-term or
18 short-term research. And whether it has a user need
19 or not I think is a peculiarity of the NRC's budget
20 process. You can call a rooster a hen, but you still
21 can't get eggs. Okay? So in my mind, not all of this
22 is helpful terminology. So I think that there needs
23 to be a research program to support long-term reactor
24 concepts.
25 My second thought is a time versus

technology thought. And that is time frames of even 5 but certainly 10 and 20 years scare people because the uncertainties are rather large.

But I think the range of technologies that people will look at over the next 10, 20, 30, or even 50 years is a lot more predictable than the time frame.

So if we said we wanted a long-term research program to cover the range of technologies of interest, I think that's a little less scary than saying we are going to develop a program that's going to cover the next 10 or 20 years.

Even though we are currently in the lightwater business, we get discussions with entities that are interested in non-lightwater reactors.

And it's pretty clear that liquid metal and gas-cooled are two interesting technologies to people. High temperature is interesting for its efficiency and also for hydrogen production and those sorts of topics.

So I think those are pretty obvious areas. So I think you can develop a long-term research program by forcing yourself to define what technologies you are going to build that research program around and not worry so much about whether

1 it's a 3, 5, 10, or 20-year issue.

2 There is a current peculiarity also in the

3 NRC program in which the Office of New Reactors is

4 responsible for lightwater reactors. And the Office

5 of Research is responsible for prelicensing activities

6 on non-lightwater reactors. So to a certain extent,

7 the Office of Research is its own customer on

8 non-lightwater reactors.

9 Now, that is an issue that we are

10 rethinking. It has been discussed somewhat. It's the

11 subject of a February Commission meeting. And there

12 are some papers under development. And I think the

13 Office of New Reactors and the Office of Research are

14 rethinking our roles in this area.

15 Probably the Office of New Reactors is

16 going to turn out to be the customer and Research is

17 going to take a more traditional research program role

18 with respect to the non-lightwater reactors. And that

19 may help in having the customer and the supplier

20 relationship sort of a little clarified.

21 I would like to make --

22 CHAIRMAN POWERS: The applicant needs to

23 brought into this process, too.

24 MR. HOLAHAN: Yes, right.

25 CHAIRMAN POWERS: I mean, you have to

1 communicate to him --

2 MR. HOLAHAN: Yes.

3 CHAIRMAN POWERS: -- what he is expected

4 to bring to the table.

5 MR. HOLAHAN: Absolutely.

6 CHAIRMAN POWERS: Is there a formal

7 process for -- I guess there isn't because you are

8 still deciding who is responsible for --

9 MR. HOLAHAN: Yes. There's an informal

10 process. I mean, both the Office of New Reactors and

11 the Office of Research do get contacted by people who

12 are interested in advanced technologies.

13 But in the non-lightwater area, I mean, we

14 have a more formal program. We send a letter out

15 every year, saying, "What are your goals? When do you

16 intend to send in an application? What kind of

17 application?"

18 So we have a more structured program for

19 finding out what is going on and getting prepared for

20 it. It can be a little difficult. You know, people

21 have their proprietary considerations, but we can

22 usually work with those concepts.

23 My last point I'm going to get to who does

24 the research question, but I want to hold off on that

25 just a moment. In this area; that is, long-term

1 research planning, we often run into the plans versus
2 planning program. And I was once told that it was
3 General Eisenhower who said that planning was
4 essential but plans were useless.
5 I think his point was you have to do the
6 planning process. You have got to know where you're
7 going. And it's essential. But when you get into a
8 battle, it is not going to go according to plan.
9 You've got to be prepared to throw that plan away and
10 move forward as best you can.
11 Well, I think in the long-term research
12 question, we get into the planned versus planning
13 problem. That is, any plan we produce today is
14 probably going to be wrong. It's not going to be
15 exactly the way the world turns out. I think you have
16 got to sort of get over that problem and say that's
17 not a good reason for not planning.
18 We have to have planning for a long-term
19 research program, even though things are not going to
20 go that way, some of the things we plan for won't turn
21 out, some of the money that is spent will never be
22 done in a useful way. But if you're going to have a
23 long-term program, it's got to be that sort of
24 exploratory in a sense that there's no guaranteed
25 return on those investments.

1 Brian is right. The research program will
2 see some skepticism on the part of the Commission and
3 the OMB and the Congress because it can't guarantee
4 its usefulness in that way. But I think you have to
5 face up to that issue. You have got to lay out the
6 issues and make the decision-makers make their
7 decisions in a well-informed way, make them part of
8 the process, not outside the process. So I think we
9 are in favor of planning for long-term research, even
10 though it can't be done in any really perfect, 100
11 percent guaranteed fashion.
12 In that sense, I think ultimately -- and
13 this is something that our interest in the long-term
14 research program has -- we would like to see not just
15 a list of tasks. We would like to see a vision, a
16 strategy, and a program for long-term research
17 activities on advanced reactors. And I think it's got
18 to get to the point where the Commission buys in on
19 those thoughts.
20 I used to be an advisor to a chairman
21 during the period when some research was being cut.
22 And I can tell you that research was cut, in part,
23 because it wasn't at all clear what it would lead to.
24 I think to get Commission, certainly OMB
25 agreement, there needs to be a much clearer idea about

1 where the research program is going and what it might
2 achieve and the down side of not doing it.
3 Ashok asked me to talk about a yellow
4 piece of paper, which is not yellow because it is old,
5 although it is fairly old. I kept it in my desk for
6 a while. And then Ashok borrowed it.
7 But the fact is I'm not sure how many of
8 these thoughts are mine and how many are his because
9 we have discussed it over a number of years. And that
10 is a piece of paper that says, "Why do research?" And
11 I think if you don't understand why you're doing
12 research, you can't possibly have a long-term research
13 plan that makes any sense.
14 So this is part of the vision thought.
15 Why would you want to do research? The first one
16 says, "Acquire tools for independent analysis." And
17 the idea of independence and Dr. Ahearne's comments
18 about the public and others need confidence in what
19 the NRC does and says. And I think that is an
20 important element of it.
21 The second one is to identify area as high
22 safety significance and large uncertainty and those
23 that are amenable to change. And so you've got to
24 have all of those characteristics. You can't afford
25 to spend money on topics that are not important or

1 topics that are really important but are
2 well-understood.
3 But also you have to understand that when
4 you spend a dollar, you have to change the
5 uncertainty. So there may be topics for which the
6 topic is important and the uncertainties are large and
7 spending a lot of money on it doesn't accomplish
8 anything, which makes me a little suspicious about the
9 LNT issue. I wonder about whether a linear
10 non-threshold issue will ever be solved with a lot of
11 dollars.
12 So for me that's one of the elements about
13 whether to go forward with that topic. It can be
14 important. The uncertainties can be large. But
15 you've got to think that I'm going to accomplish
16 something with the dollars.
17 Third thought is research informs and
18 educates the staff on safety issues. It simply makes
19 better regulators out of the staff.
20 The fourth is to explore beyond design
21 basis events. And I think that issue is less
22 important now than it was in the past, but we went
23 through the first generation of plants, where the
24 utilities, the vendors, and all of their supporting
25 research programs were design basis-oriented.

1 If we required a double-ended guillotine
2 rupture, they would do research to show how it
3 behaved. If we didn't require a core melt or an
4 ex-vessel phenomenon, then it wasn't in the industry
5 research program. So it was left to the NRC to
6 explore those topics. And I think that is a very
7 important reason for a research program.
8 As we moved into this upcoming generation
9 of reactors, requiring more information on the
10 probabilistic risk assessments, I think hiding behind
11 the design basis issue is not so easy. But I think,
12 even in the future, it will be for NRC to confirm that
13 the design basis works as it should and to explore
14 beyond design basis capabilities. So that's one thing
15 that probably a research program with an NRC emphasis
16 ought to do beyond an industry program.
17 The fifth is to confirm engineering
18 judgments for areas of high safety significance.
19 There will always be areas in which judgments are
20 necessary because you just don't have the information,
21 and I think that's all the more reason why we should
22 be clear about saying how judgments are made in the
23 regulatory process.
24 Engineering judgment is okay, especially
25 if you have experienced people and they can quote what

1 experience they're basing it on. But you would like
2 to be able to confirm that those judgments are the
3 right things to do.
4 Now, if that's the list of why you do
5 things, it didn't say anything about, really, who
6 should do them. And I think when the first generation
7 of reactors was done, the separation between the NRC
8 and the Department of Energy didn't exist or at least
9 we were kind of on the tail end of that activity.
10 And so the distinction between an NRC
11 research program and an Energy research program, like
12 LOFT. for example -- was LOFT an NRC program or a
13 Department of Energy program? Well, at the time there
14 was no distinction. And I think both the regulators
15 and the DOE promoters of nuclear energy were very
16 interested in the program. And it wasn't like you got
17 paid 10 percent per year and 90 percent for there. It
18 just wasn't like that.
19 So who does it? It's kind of an outcome
20 of the independent regulator. And if you look at the
21 current generation, the next generation that we're
22 looking at, the passive designs, the AP-600, AP-1000,
23 ESBWR, and even some of the earlier GE designs, the
24 largely research for those was done by the vendor with
25 DOE support in many cases, with the NRC kind of

1 tagging on maybe 10 percent on the end and doing a few
2 extra experiments.
3 But even though the NRC had an independent
4 program, it almost never had independent facilities to
5 do those programs. And I think that is a fine model.
6 I think independence in my mind is more intellectual
7 than it is a nuts and bolts issue.
8 If you have people with a different point
9 of view with a different reason for doing the analysis
10 who have full access to the information, full access
11 to how the experiment was set up and what the results
12 are, I think you can be perfectly independent with one
13 facility and even one experiment supporting both the
14 developer and the independent regulator.
15 So I am less concerned about the
16 independence of the facility than the intellectual
17 independence of the people using the information,
18 which says as you go into a long-term research
19 program, to me -- and I think what we ought to be
20 looking for is a single integrated program that says
21 you're generating enough information for the
22 developer, the supporters of the program, the
23 independent regulator, and the other stakeholders, who
24 need to be convinced that this is the sensible thing
25 to do. And to me that says you ought to have one

1 long-term research program, which has many elements to
2 it, but it needs to be one integrated thought about
3 how long-term research is done.
4 I guess that's the end of my thoughts.
5 DR. THADANI: Thank you. Thanks, Gary.
6 Any questions?
7 CHAIRMAN POWERS: A quick one, Gary.
8 MR. HOLAHAN: Yes?
9 CHAIRMAN POWERS: You spoke to the
10 independence of facilities. How about the
11 independence of models?
12 MR. HOLAHAN: Well, I guess in the past,
13 we have had independent models. I guess I am a little
14 undecided on that subject. If I go back to current
15 examples, probabilistic risk assessment, the NRC has
16 models and the industry has models. We spent some
17 part of the last ten years talking about how can we
18 get to the point where there's just one model.
19 I think I don't have a problem when we are
20 talking about a large model. Certainly if we're
21 talking about doing things like CFD, you know, no one
22 is going to insist on developing an entirely new CFD
23 code. I think that, even if you don't do your own
24 model, there is certainly enough room to critique or
25 criticize how the model is used.

1 I guess I probably want to approach the
2 issue on a case-by-case basis. There are probably
3 some topics for which a completely separate approach
4 to the problem might be worthwhile. But in most
5 cases, you know, I think if the model can be exercised
6 or be discussed in a way that addresses features of
7 that model that can look at different things, whether
8 it's through a sensitivity analysis or different
9 modules in an overall model, I think those are all
10 possible.
11 So I wouldn't want to go at this
12 dogmatically to say the NRC always and forever needs
13 independent and different models. The thing I
14 wouldn't want to lose is the fact that it's possible
15 that sometimes the way an issue is approached, the way
16 the model was developed will begin to convince people
17 that the answers are right.
18 And every time I have seen a research
19 program that compared calculations from one model
20 versus another, the differences between models are
21 always bigger than the uncertainties ascribed to the
22 models, which says the model uncertainty is really
23 larger than people recognize.
24 So I think you have to be open to that
25 somehow. But there may be cases in which the industry

1 has more than one model. And so for the staff to have
2 a third model it seems to me it does not necessarily
3 have this independent role.
4 So I think I would go back to just it's
5 independence in thinking that I am most interested in.
6 And whether it is a model or an experiment, I think
7 you have got to approach it on a case-by-case basis to
8 see whether you are comfortable with a diversity of
9 views that can be recognized.
10 DR. THADANI: Thank you.
11 Robert?
12 MR. HILL: Yes. I did have handouts here.
13 Let me go through very quickly.
14 I was asked to comment on the non-LWR
15 research issues. And, in particular, I am going to go
16 very quickly through research and a high-level
17 overview of what we are going to be doing in the GNEP
18 program. And I'm going to talk about some
19 recommendations for NRC long-term research based on
20 that.
21 For the GNEP, I think the second figure in
22 the package I handed out shows the closed fuel cycle.
23 And I am going to be recapping a lot of what you have
24 heard from the other presenters in the previous
25 presentations in my talk. I think there is the

1 recognition that LWRs are going to be the dominant
2 power producers and they will be the dominant part of
3 the fuel cycle, which is the main power-producing
4 reactors.
5 However, if we go to a closed fuel cycle,
6 we will have several new technologies beyond that.
7 And that is in the center of this diagram, which is a
8 separations technology, a fuels technology for the
9 recycle fuels, and a new type of reactor that is using
10 the recycle fuels. And those are really the three
11 main areas of research that are going on within the
12 GNEP program, are those three technologies.
13 And as far as what the focus is within
14 GNEP for those three technologies, it's obviously not
15 just the safety issues but other issues. On the
16 advanced separations, the issue there is the improved
17 waste management.
18 So they are worried about things like low
19 separation losses and technologies that can be very
20 efficient to be done, also inexpensively to do the
21 separations.
22 There are proliferation issues, as raised
23 by the previous speakers. And some of the items there
24 are looking at technologies that don't have separated
25 plutonium and also looking at advanced safeguards

1 technologies.

2 For the advanced fuels, these are new fuel
3 forms with recycle materials. So there's a lot of
4 testing of the fuels that's going on in the program
5 and demonstration of what can work with the recycle
6 fuels.

7 For the advanced reactors, there is a
8 focus on fast reactors. This is the type of reactor
9 you need to do the repeated recycle within the closed
10 fuel cycle.

11 There is a lot of research devoted to cost
12 reduction features, and there is a variety of
13 features. I could give a whole set of comments on
14 that, but I will answer questions this afternoon as
15 they arise on that.

16 From the safety perspective, several of
17 the items with these advanced reactor concepts is less
18 reliance on active safety and control systems?
19 There's more of a passive safety approach similar to
20 what was done in the newer generation of lightwater
21 reactors, but there's also been a lot of thought of
22 how to prevent regression into severe accidents and
23 how to mitigate any consequences as they do arise. So
24 those are both things that have been thought of. And
25 there is research ongoing on those issues.

Now, also within the GNEP program, there are two cross-cutting areas of research that are of specific interest to the safety issues for these non-LWR technologies. There's a modeling and simulation cross-cut, and there's a regulatory cross-cut. I'm going to spend a little bit more time on those two areas.

For the advanced modeling and simulation, there is work in the GNEP program across the different technologies that are being looked at. For the separations technology, a lot of the work on the advanced simulation is just having a modeling tool and optimizing the plant layout based on that modeling tool.

For the fuels, there are a lot of challenging issues with the fuel performance and how we model this. They are trying to get some of the more basic physics captured and have more predictive models for the fuel. That is something that is going to take many years. You're looking at ten years before you're getting very useful models for predicting the fuel behavior.

This is very important as we are talking about new fuels to help focus and because, as we talked about from the previous questions, there's a

very limited fuels testing capability. So we want to try to supplement this with simulation to try to limit the number of tests and make them more useful as we do the testing of the advanced fuels.

MEMBER ARMIJO: Are you addressing both metal fuel and oxide fuel?

MR. HILL: Yes. I will talk about that in a minute. For the fast reactors, those are the two primary candidates.

For the reactors, really, we have always used predictive tools for reactors as really the backbone for the reactor design and analysis. So using these tools is not something new. However, with modern computers, we have a lot more computing capacity than we had in the past. And we're looking at techniques to improve the fidelity to get better accuracy and also to do more modeling of the physics and less just calibration to experiment than was done in the past.

In particular, for fast reactors, I think in the next five years, you will have some major strides in the thermal modeling compared to where we were in the previous generation of liquid metal designs with much better modeling and much more physics-based modeling, where you can predict what

1 will happen, both for different types of designs and
2 for different off-normal conditions.
3 So these new modeling and simulation tools
4 are both useful for design optimization, which is a
5 lot of what they are being developed for. But they
6 are also useful for assessing what the uncertainties
7 are and what the behavior will be in off-normal
8 conditions, which is important, obviously, for the
9 safety analysis.
10 I am going to skip the next one. It is
11 just talking about how for the reactor area, there are
12 a lot of different fields that we are trying to
13 capture in this modeling and simulation. It is a very
14 broad area. We are trying to do better reactor
15 simulation.
16 Now, there is within the GNEP program a
17 cross-cut that's looking at regulatory issues. And
18 the reason this is a cross-cut is there are regulatory
19 issues for a separations plant if you would build it.
20 There are regulatory issues related to fuel
21 fabrication and performance and regulatory issues
22 related to the reactor.
23 These are just some of the activities that
24 are starting within the program. It is trying to look
25 at what the guidelines might be for some of these

1 advanced technologies and also what is the status of
2 the current technology for that. So I think the
3 outcomes and the output from this work will be very
4 useful as the NRC considers what is needed for their
5 internal program.
6 And the next slide there, I really just
7 wanted to go to the second bullet of this, which is a
8 very important point, which is the regulatory
9 framework for fast reactors and reprocessing
10 facilities has not been exercised in a long time. And
11 in some cases, it never has been exercised.
12 So this is something where there is a lot
13 of work, there is a lot of speculation on what the
14 criteria will be, and it is going to be very important
15 that there is a lot of interaction between the NRC and
16 the people who are trying to develop these concepts on
17 what the appropriate criteria area.
18 That was sort of a quick, trying not to
19 make everybody late for lunch, overview of what the
20 research is that is going on within GNEP. What I am
21 going to talk about now are some of the
22 recommendations on the topic that was asked, which was
23 what would you see, then, as useful for an NRC program
24 on long-term research.
25 All of these are issues that have been

1 mentioned in previous talks, and this is sort of a
2 recapping of these issues and maybe a little bit
3 different spin based on the non-LWR technologies.
4 The first item is the knowledge base.
5 There needs to be an in-house capability within the
6 regulatory agency. And this capability needs to be
7 very broad. The first part of the bullets here is I
8 am trying to give an idea of how broad the interest is
9 and what the possible applications are of advanced
10 technology.
11 We're talking about different kinds of
12 chemical separations. There are both advanced aqueous
13 processes and dry chemical processes that are being
14 looked at for future application.
15 There is a variety of fuel forms. Besides
16 the oxide -- and fast reactor oxide behaves very
17 differently than LWR oxide fuel -- there is metal fuel
18 that we are also looking for our fast reactors. And
19 in the gas reactor technology with the Generation-IV
20 program, there is TRISO fuel, which is coated particle
21 fuel. And even there, they've got different kernels
22 that are within the coated particles that they're
23 looking at depending on the particular application.
24 There is a variety of different coolants
25 that are being looked at. The main ones that are

1 being looked at for the advanced technologies are
2 sodium, helium, and heavy metals. And these coolants
3 tend to operate in different regimes. For the sodium,
4 your single phase, liquid phase, and you tend to
5 operate at low pressures; whereas, for the gas, your
6 single gas phase, but you're operating at very high
7 pressure compared to LWR systems. So there are
8 different coolants operating in different operating
9 regimes.
10 And, really, to do the regulatory issue
11 here, you need to be looking not just obviously at the
12 normal operating conditions of these systems but how
13 they will respond to off-normal conditions, which
14 takes a deeper level of understanding of what is going
15 on than just the standard operating conditions.
16 So there needs to be this broad knowledge
17 base, and there needs to be this in-house capability
18 to do this. And we face the same challenge within the
19 DOE programs that were talked about here, which is
20 limited human resources and expertise within these.
21 And this is a real issue of human resources and how we
22 have the people who have this capability and knowledge
23 to be able to address this wide range of systems.
24 The last item I have here is there is this
25 real issue of as we go to a more risk-informed basis

1 on the safety, how do we handle systems where there is
2 less experience with the systems.
3 You can do a PSA, and you can make some
4 engineering judgment on what the failure mechanisms
5 are and the probabilities of them are, but how does
6 this need to be done in a safety and a regulatory
7 environment as we're looking at systems where I don't
8 have the experience base, I can't point to pumps that
9 I have run for 20-40 years of this precise design and
10 how they will fail?
11 The second area, then, is safety
12 assessment tools. And this is the discussion that was
13 just had with Gary's talk, which was, you know, do I
14 need an independent analyst or do I need an
15 independent tool or do I need totally independent
16 capability with the testing also?
17 And, as I state here, the traditional
18 approach was to have independent tools. I am not sure
19 that this is advisable as we go forward. We're going
20 to be doing a lot of work within the research program
21 on the development of advanced methods. And I think
22 at least some of those should be applicable for the
23 safety analysis also and very useful.
24 And this goes back very closely, then, to
25 the first one, which is the knowledge base because I

1 agree totally that you need the independent
2 intellectual approach to it from the regulatory body
3 to where you can assess whether these tools are useful
4 or not. And in general they will probably have to be
5 adapted for the specific issues that you are going to
6 have looking at the safety cases.
7 From the NRC perspective, this is both to
8 develop what the standards are going to be and then to
9 look at the specific applications that will be brought
10 in by the applicant.
11 A key issue on this is validation and how
12 do we validate these tools because the tools are
13 modeling very different physics than were modeled for
14 the LWR safety issues. I've got a little bit on that
15 on the next slide there.
16 With modern computing, we are going to be
17 doing a lot more reliance on the simulation and the
18 results of the simulation with probably more limited
19 testing, both because of better computing power and
20 lack of facilities to do the testing. And, therefore,
21 it's going to be very important to validate how well
22 these tools are modeling the basic physics of what is
23 going on.
24 I think you are going to get somewhat into
25 some new regimes. Instead of testing very specific

1 design configurations, you will be testing the physics
2 and the modeling of the physics of what is going on.
3 We are doing that. And we are starting to develop
4 testing plans within the program for the advanced
5 safety methods.
6 One issue that is very important is that
7 we have a lot of data historically. And that data is
8 not all well-documented. And one issue we are going
9 through now is preserving the existing knowledge and
10 the testing knowledge for these advanced technologies.
11 And any early identification of gaps in the validation
12 basis will be very important.
13 One other issue as we go into these
14 advanced simulation methods is we are working very
15 hard to make sure that the uncertainty assessment and
16 the uncertainty propagation are included in these
17 methods from day one and that we don't just develop a
18 best estimate method and then later have to guess what
19 the uncertainties are in that method.
20 Now, this is well done already and well
21 understood for certain fields. Like for reactor
22 physics, we have fairly good estimates of what the
23 errors are in the nuclear data. We have very
24 formalized techniques of how to propagate that into
25 the predictions. It's less well-specified for other

1 areas, like CFD, how you account for the
2 uncertainties.
3 There is work going on in this field. And
4 we are trying to make sure that it is applied in the
5 new methods that are being developed. I think we will
6 have something in the next five years that is much
7 better both for the fidelity of the thermal
8 calculations but also for how we do the uncertainty
9 evaluation for those.
10 The third area for the NRC, the first two,
11 again, were the knowledge base and the assessment
12 tool. The third area is the regulation development.
13 There is a lot of speculation among the people who are
14 looking at these advanced designs on what the criteria
15 are going to be. In order to do a lot of the work
16 that is being done out there, you have to make some
17 assumptions on what the design criteria are going to
18 be. And this is one of the key roles obviously in the
19 NRC to establish what the design criteria are for
20 advanced non-LWR systems.
21 Some of the areas that need to be done on
22 our what are the proper shutdown limits are going to
23 be the heat removal requirements and the containment
24 approach and technical limits.
25 And these really are key issues for some

1 of the advanced designs because, for instance, the
2 liquid metal designs rely a lot on inherent feedbacks
3 and reactivity feedbacks, which are very related to
4 what the shutdown issues are and those where, for
5 instance, the gas reactor concepts have a very large
6 heat removal and a very large heat retention
7 capability within the system with their low-powered
8 incidence. So the heat removal requirements become
9 very important for those designs.
10 And some way to translate what is in the
11 existing body of regulations and capture the essence
12 of the safety criteria for the LWR and how it will
13 then be applied to the advanced systems I think is
14 going to be needed by everybody in the long run.
15 This work obviously -- I put these in the
16 order for this. This follows very carefully, then,
17 from the knowledge base and the safety assessment
18 tools. Both of those things are needed, I think, to
19 be able to set what the design criteria are going to
20 be and what makes sense for these advanced systems.
21 So, to summarize, then, within the GNEP
22 program, we are looking at three different areas of
23 technology. We are looking at advanced chemical
24 separations; advanced fuels; and advanced reactor
25 concepts, particularly fast reactors in GNEP and the

1 gas reactor in the GEN-IV program.

2 Some of the key issues that were

3 identified in our presentation were this in-house

4 knowledge base, safety assessment tools, and

5 regulatory practices and procedures.

6 I think as those three areas are

7 concentrated on in the long-term research program, the

8 specific issues, what technologies do we need to test,

9 what more detailed testing analysis needs to be done,

10 will fall out from those three areas as the concepts

11 that are being pursued become more clear five, ten

12 years from now and as where the gaps are become more

13 clear, the specific issues will fall out. There is no

14 one issue I can point out today and say, "This is the

15 key safety issue." I think they will come out as the

16 focus in the long-term research is on these three

17 areas.

18 Another important role that I was asked to

19 talk about is international collaboration. There are

20 really two different contexts in which international

21 collaboration is being pursued. There are several

22 international agreements within the GNEP program. And

23 those are on developments both of the separations

24 technology and the advanced reactor technology.

25 We have agreements, and we are doing

1 active work with the Japanese, in particular, on fast
2 reactor technology. We are having discussions also
3 with the Russians and the French. And that will be
4 both the technology for the reactors and the advanced
5 simulation methods for the reactors.
6 The other context in which there is
7 international collaboration is the Generation-IV
8 international forum. There's been a lot of work over
9 many years to set up the international agreements
10 there such that you have an international agreement to
11 do and to share research and development results
12 within that context.
13 There is a lot of ongoing work there on
14 gas reactor materials because one of the main issues
15 there is the high-temperature materials within the
16 system and also on the fuels within the system for the
17 TRISO fuels.
18 Within the Generation-IV international
19 forum context, there is also work on fast reactors.
20 It has a lot of the same character as the work that's
21 within GNEP but a little bit broader context of the
22 parties that are involved within the Generation-IV
23 program. And I can answer more specific questions
24 after lunch this afternoon on the details for the
25 international collaboration.

1 DR. THADANI: Thank you very much, Robert.
2 Any clarification questions?
3 (No response.)
4 DR. THADANI: So we will take a break
5 until 1:45.
6 CHAIRMAN POWERS: Well, you're more
7 generous than I was going to be. I was going to say
8 1:30.
9 PARTICIPANT: He is in charge.
10 (Laughter.)
11 DR. THADANI: I would recommend 1:45.
12 CHAIRMAN POWERS: All right. 1:45.
13 (Whereupon, a luncheon recess was taken
14 at 12:47 p.m.)
15 CHAIRMAN POWERS: Okay. Let's come back
16 into the session, and I'll promptly turn it back to
17 Ashok.
18 DR. THADANI: Robert sort of, I thought,
19 felt compelled to rush through his presentation.
20 CHAIRMAN POWERS: Oh, I don't know why
21 you'd think that.
22 DR. THADANI: I think it's only fair that
23 we see if Robert has any areas he wants to emphasize,
24 go back to. And also I suspect there's a lot of
25 interest and there's questions probably in this area.

1 So if you don't mind, we'll go to you.

2 MR. HILL: Yes. First of all, I just

3 wanted to highlight sort of the different time frames.

4 Because I know there was discussion over what things

5 were of interest and what time frame.

6 The current GNEP plans talk a lot about

7 facilities in the 2020 time frame which would need

8 licensing then and soon. 2010 time frame.

9 The technologies for that would be the

10 separations technology. And there would be issues with

11 licensing issues for that. And then for the reactor

12 technology and that time frame, it would definitely be

13 sodium cooled reactor. We're looking at both metal

14 and oxide fuel options for the sodium cooled fast

15 reactor. And that would be in that type of time

16 frame, the technology that you're talking about, for

17 the reactor specifically to use the recycled fuels.

18 And the initial reactor probably would be

19 testing those fuels. It would probably start up on a

20 more conventional fuel because we just don't have the

21 experience yet with the recycled fuels.

22 The other reactor technology non-LWR

23 that's out and being looked at as what's also talked

24 about as in the NGNP. That's the gas reactor. A

25 similar means, the ultimate approach with that is to

1 go to very high temperature for hydrogen production
2 and then they back off for the initial application to
3 more of a -- but still, much higher temperature than
4 the other technologies we're interested in. And they
5 have a variety of fuels, the TRISO fuel options that
6 they're looking at for that reactor.
7 And as far as I know, and Tim you can
8 correct me if I'm wrong, they're looking at both
9 pebble bed and the prismatic options within the GNEP
10 program so there isn't any firm decision on that yet
11 at this point.
12 DR. AHEARNE: You also have fuel
13 fabrication facilities.
14 MR. HILL: Fuel fabrication facilities?
15 Yes. But again for the 2020 time frame for the initial
16 start of facilities, you'll probably be starting up on
17 a more conventional fuel and then you'll be doing
18 testing early on of these recycled
19 fuels so that the fuel fabrication, the new part where
20 you're doing other recycled materials a little bit
21 farther on. So trying to get a handle on here as a
22 little bit what the time frames are for the different
23 applications.
24 MEMBER ARMIJO: On the LMR, we decided
25 whether it's pool type, loop type do you have a

1 reactor design decision?

2 MR. HILL: Yes. There is no decision.

3 There are four industry teams that we're working with

4 at the moment in GNEP. And both are being considered

5 among those four teams.

6 MEMBER ARMIJO: Okay.

7 MR. HILL: In general what you'll see is

8 each country has a preference replica of what it's got

9 the more experience with. Now in the U.S. we've got

10 experience both with pool designs and loop designs.

11 MEMBER ARMIJO: We haven't decided yet?

12 MR. HILL: It has not been decided.

13 CHAIRMAN POWERS: Anybody have any good

14 experience with loop designs?

15 MR. HILL: FFTF was a loop design.

16 MEMBER ARMIJO: And steam generators are

17 probably a weakness in both systems. Any work on

18 that?

19 MR. HILL: Steam generators have been

20 where there's been a lot of leaks in the past. Now

21 there really has been a lot of progress made in the

22 demonstration reactors that have run. And I think

23 today that you would have better experience than you

24 have in those previous reactors.

25 DR. AHEARNE: You're not talking about

1 Monju and Phoenix, are you?

2 MR. HILL: Monju the leak wasn't in the

3 steam generator.

4 DR. AHEARNE: But you're saying good

5 experience.

6 MR. HILL: Well, the BN-600 has had much

7 better experience then.

8 DR. AHEARNE: Okay.

9 MR. HILL: Super-Phoenix -- Phoenix had

10 good experience with steam generators. And EBR-2 had

11 good experience with steam generators. FFTF didn't

12 have a steam generators.

13 MEMBER ARMIJO: FBRs had great steam

14 generators.

15 MR. HILL: Yes. Exactly. But to be able

16 to make that design economic -- so that's what they're

17 looking at now. But they had great experience.

18 I think you could do better today than

19 what was done in the past. We are looking at options,

20 though. There's a lot of work going on both in

21 generation for and in GNEP on a super critical carbon

22 dioxide Brayton cycle as an alternative to the

23 conventional steam cycle for use with sodium systems.

24 And that's a promising feature for the future. Now

25 that's probably not going to be available for plants

of the 2020 time frame, but there's a lot of research going on on that. It eliminates any issues of sodium water interactions, sodium C02, you have to worry about which is a different set of interactions. But it's a little bit less problematic than the sodium water is.

The Japanese are looking at, they've gone back to a double tube steam generator design. And their latest one is a double tube, not with a detecting fluid, but just as an extra barrier. Just double tube with no extra detection.

MEMBER ARMIJO: It's simpler.

MR. HILL: Just as an extra barrier.

I know that the previous work by GE and I think by Tosbiha also still is looking at straight helical coil just single tube. And they think they can make it work and work reliability. But that's going to need to be demonstrated.

And there was work done actually after '95 with some testing on various steam generators and electromagnetic pumps also. That's another issue: electromagnetic versus mechanical pumps.

MEMBER ARMIJO: Right.

MR. HILL: Both are out there in the current designs.

1 CHAIRMAN POWERS: The NRC has sponsored
2 two phenomena identification and granting exercises in
3 connection with the gas pooled reactor, one focused
4 strictly on the TRISO fuel, the other one focused more
5 broadly on the accident analysis. Do you have any
6 thoughts on those? Were they adequate identification
7 of safety issues to consider overly conservative? I
8 mean, what are your thoughts?
9 MR. HILL: Yes. I'm not personally aware
10 of either of those. I can contact the right people
11 and let them know that you've requested some feedback
12 on them.
13 CHAIRMAN POWERS: Okay. Yes. It would be
14 useful to find out because right now there's an
15 example of a fairly proactive step that the Agency had
16 taken.
17 MR. HILL: Right.
18 CHAIRMAN POWERS: And I know for certain
19 that the analysis of the issues that are associated
20 with fission product released from the fuel is
21 unequivocally excellent. That would be of interest.
22 MR. HILL: Okay. I will pass that request
23 on to the GEN-IV leaders, and that particularly from
24 the ACRS Subcommittee they requested some feedback on
25 that.

1 CHAIRMAN POWERS: Please.

2 MR. HILL: One other comment I wanted to
3 make then, that's sort of the technologies and the
4 different time frames that you're talking about. So
5 depending on what the time frame is you're looking at
6 for the long term research, that that's sort of in the
7 10 to 20 years. The longer terms, there are options
8 being looked at in GEN-IV, such as the lead-cooled
9 fast reactor. That would be a possibility for a
10 subsequent generation beyond that. And then the even
11 higher temperatures for the gas-cooled system would be
12 for the longer term.

13 I wanted to talk a little bit more about
14 the simulation methods, and I wanted to make it clear
15 that we've taken a serious start in the GNEP program
16 on advanced simulation methods. There's a lot of
17 advances in computing since the last time. Nobody's
18 built a fast reactor since about the 1990s time frame.
19 There's a lot of advances in computing since then.
20 There's a lot of advances in CFD. And there's a lot of
21 advances in just having much better integrated design
22 tools. All of these need to be brought up to date and
23 applied to these advanced reactor designs.

24 We have truly mixed teams of computer
25 scientists and engineers that are now working together

1 and working effectively together on trying to apply
2 these tools nd getting the most out of the modern
3 techniques. And I think \you really will see some
4 higher fidelity, better user interface, much better
5 methods available. And I think you'll start to see
6 that on the reactor side in the next five years
7 assuming any reasonable funding level for this work.
8 And I think those will be out in the five year time
9 frame and available.
10 CHAIRMAN POWERS: I mean, you hit right to
11 the heart of our interest here.
12 DR. THADANI: My understanding is that for
13 years Pratt & Whitney for their jet engines have
14 advanced CFD codes, tied into CAD/CAM. So both from
15 a design perspective as well as a perspective of
16 somebody who wants to say what if I change to this,
17 what might it do, so on and so forth.
18 It appears to me that the nuclear side may
19 be a little bit behind times.
20 MR. HILL: Yes. I think that's accurate.
21 And I think this is going to be something that the NRC
22 has to struggle with. Because the safety issues are
23 different for nuclear systems then for these other
24 types of systems, but there are these advances tools.
25 And how do I correctly account for the advances that

1 I have there and the better fidelity and the more
2 predictability I can get there than I used to be able
3 to get in the past with what's going on while still
4 maintaining the correct level of safety for these
5 systems.
6 MEMBER ABDEL-KHALIK: The better
7 predictability, does that come from enhanced
8 validation based on experimentation or what?
9 MR. HILL: It's a combination of better
10 modeling the physics and enhanced experimentation.
11 Let me give an example from an LMR, one on liquid
12 metal reactor, one I'm very familiar with.
13 Back when they developed the tools about
14 20 years ago we really could only do two dimensional
15 modeling. So some of the issues about swirl and what
16 happened with wire rod were just taken into account
17 with what they called eddy diffusivity factors. Now
18 we're coming up with methods that remove that. You
19 don't have this knob that gets you within channel,
20 subchannel mixing, but you directly model or you have
21 a very fine model that generates those factors for
22 you. Instead of having to do the experiment to
23 generate those factors for you.
24 So the better predictability is partly
25 just from a better modeling of the physics of what's

1 going on, that that's for that area. Now in other
2 areas where we have a fairly robust experimental base,
3 for instance on the physics prediction, let's say what
4 the power events to use within the reactor, there we
5 have a fairly robust experimental base. There we go
6 to better validation techniques to wrap in the
7 modeling uncertainties with what we know from integral
8 experiments to get better levels of uncertainty.
9 So it's really a combination of better
10 methods and better validation.
11 MEMBER ABDEL-KHALIK: Well, what I'm
12 struggling with, you know, throughout the day here is
13 the boundary between the responsibility of the
14 developer/promoter/vendor and the regulator. In order
15 for you to come up with a credible design based on
16 economic constraints, you really have to have the
17 research base to support your design. And the question
18 is is that the starting point for the regulator?
19 MR. HILL: I think it will become that as
20 you develop a new generation of tools in the next five
21 years, which is what the designers are going to be
22 basing some of their technology changes on. Yes, I
23 think that's the best place to start. And then they
24 will be used and adjusted slightly differently by the
25 regulator for the issues that need to be looked at for

1 safety.

2 MEMBER ABDEL-KHALIK: I mean, if that is

3 the case, then the incremental additional research

4 that the regulator would have to do would be

5 relatively minimal.

6 MEMBER ARMIJO: Unless the designers have

7 made a big mistake.

8 MEMBER ABDEL-KHALIK: Right.

9 MEMBER ARMIJO: Well, that's happened.

10 MR. HILL: Well, it my be incremental in

11 the sense that the extra additional onto those tools

12 that needs to be done. But it's not incremental in

13 that you can't just start up and start and starting

14 using the tool and the next day you're able to get

15 good and useful results out of it. It takes time.

16 I mean, I'm having to train people on fast

17 reactor analyses methods, which is not taught very

18 well in schools today, and it takes years from when

19 they start to when they're able to know and have a

20 good enough feel on the results to where they can get

21 good calculations and good analysis.

22 So the timing issue, it's a little bit

23 more incremental but as far as what capability needs

24 to be added, you may be correct.

25 MEMBER ABDEL-KHALIK: But the idea of

1 intellectual independence that Gary Holahan was
2 talking about implies that, okay, you have the basic
3 data that support the methods that you have developed
4 and validated and the regulator can start from the
5 same basic data and can either take your tools and
6 recheck the validation or go through the whole process
7 of developing new tools, albeit using the same
8 supporting data. And that's what I mean about, you
9 know, the same starting point without jeopardizes the
10 so called this intellectual independence.
11 MR. HILL: I agree.
12 MEMBER SHACK: The question that you need
13 to do that in order to maintain intellectual
14 independence is that it certainly would do it. But,
15 you know, is that the only way to do it? You know, is
16 it necessary? That's not so clear.
17 DR. THADANI: No. There are several
18 documents written about what are good attributes for
19 a strong regulator of nuclear power. IAEA has
20 actually standards, if you will, for what a good
21 regulator is.
22 Public confidence that John talked about
23 is a very strong element into those attributes that
24 you look for in a strong regulator.
25 Most people agree, most organizations

1 would agree that you should have some capability for
2 independent judgment of what is put in the front. To
3 have confidence in that independent judgment, you
4 certainly need very competent people. To have
5 competent people they can't just be ones who review
6 other people's work. That's not enough. That's an
7 attribute, but it's not sufficient.
8 So there's this issue of truly
9 understanding safety by having done something, by
10 having been involved in something rather than spending
11 lifetime reviewing others.
12 So these documents, IAEA and other
13 documents recommend strongly certain things: That you
14 should have capability for independent assessment; you
15 should have adequate resources. It's a larger list.
16 There are other issues.
17 If you come to an agreement that I'm
18 willing to use a tool that you have developed, chances
19 of success are better if the regulator has had a say
20 in terms of understanding your experimental support,
21 the types of experiments that were done and probably
22 QA issues and other things that would come up in
23 hearings down the road.
24 So from that perspective, I said this
25 earlier, long term research collaboration has to be

1 really, really early between the industry and the NRC
2 to have confidence to be able to go to hearings and so
3 on and say "No, by gosh, I just didn't accept what the
4 utility or the license gave it to me. I was involved.
5 I watched, I saw these experiments. I saw what was
6 going on." Otherwise you expose yourself, I think,
7 during the hearing process to some potentially
8 significant challenges.
9 So it's a workable system if you get
10 involved early. I forget who used the words about
11 "early integrated long-term research." I forget who
12 said that. But day one you need to sit down and make
13 sure you're tracking plenty.
14 Good. I am glad Brian is back.
15 DR. SHERON: And I only had iced tea.
16 DR. THADANI: This is your Christmas
17 party, come on.
18 DR. AHEARNE: Could I ask a question.
19 DR. THADANI: Please, John.
20 DR. AHEARNE: Do you have any comments on
21 the recent National Academy study on GNEP?
22 MR. HILL: No.
23 DR. AHEARNE: I'll talk to you in the
24 hall, outside this room.
25 CHAIRMAN POWERS: This study is the one

that claimed that we didn't need to pursue these advanced reactor options?

DR. AHEARNE: Yes.

CHAIRMAN POWERS: Yes.

MEMBER CORRADINI: Right. I think the conclusion was don't go commercial just this quickly. I think that was the key negative conclusion. Is that a fair way to say it?

CHAIRMAN POWERS: Do I detect spin going on?

MEMBER CORRADINI: No. No.

MEMBER SHACK: Since he's one of the guilty parties--

MR. HILL: I think actually one thing I would say is I don't think the NES report had at all a negative opinion or not proceeding with the research and development

DR. AHEARNE: Right. Right. It was strong on the research.

MR. HILL: And what's what we're talking about today is the research and development. The issue where we really got into was on the commercial deployment and the rate of deployment.

DR. AHEARNE: And whether it was ready for it.

1 MR. HILL: That's all part of that. It's
2 all wrapped together. Yes.
3 DR. THADANI: Just on that, I put up my
4 question number one which really we have been talking
5 about for the past 20 minutes or so, basically.
6 DR. AHEARNE: Needed infrastructure for
7 what?
8 DR. THADANI: Is there infrastructure
9 needed if the Commission has to deal with some non-
10 light water reactors of science coming in for
11 approval. And that infrastructure is when those expert
12 staffs, that's fundamental to all of this. But
13 expertise comes at a cost.
14 DR. AHEARNE: But if you don't develop it,
15 there's even a larger cost.
16 DR. THADANI: That you don't like.
17 DR. AHEARNE: If you don't develop it,
18 it's an even larger cost?
19 DR. THADANI: Yes. Yes.
20 CHAIRMAN POWERS: It seems to me that if
21 it's needed, is it needed such that we need to start
22 on developing it now.
23 DR. THADANI: Yes.
24 CHAIRMAN POWERS: If not now, is it five
25 years from now?

1 DR. AHEARNE: Yes. What's the right --

2 CHAIRMAN POWERS: I mean, the thesis that
3 I look down was the advice we got from Holahan, and to
4 some extent I think we got it also from Alex Marion
5 which you don't want to be doing research during a
6 licensing process itself.

7 DR. AHEARNE: Right. Right.

8 CHAIRMAN POWERS: And so I guess my
9 question is -- I would change your question to be do
10 we need to start developing this infrastructure now.
11 And is that infrastructure just models, models and
12 facilities, models, facilities and expertise. That's
13 how I would spin it.

14 DR. THADANI: Particularly, as I mentioned
15 earlier, I mean my general understanding is that it
16 takes a lot time, it takes years to be able to get to
17 a point of having a certain level of confidence, but
18 you're prepared, you're ready. People have thrown
19 numbers around like it takes a decade. So experience
20 tells me sometimes it takes longer in some areas.

21 CHAIRMAN POWERS: I think it depends on
22 the area. You take a light water reactor fuel guy, it
23 isn't that much of a stretch to be an LMR fuel guy and
24 not that much of a stretch to be a -- I find almost no
25 overlap between fast reactor fuel and LWR.

1 MEMBER ARMIJO: Right. Right.

2 CHAIRMAN POWERS: You know, I find no

3 overlap.

4 MEMBER ARMIJO: I don't think it's a

5 cliff. I mean, there's people as these technologies

6 are becoming more likely to be deployed, it's easy to

7 take an experienced people, let's say, just evolve

8 into your advanced reactor fuels.

9 I don't know about systems. Systems are

10 probably more complicated. But for some of the

11 technologies it's an easy.

12 DR. THADANI: This is sort of -- I would

13 say this is more in a context of systems. Well, two

14 parts -- it seems to me two parts are important. One

15 is in selected areas and the NRC has at least started

16 with this. Say we want to confirm certain selected

17 areas of what the industry claims, and we'll go off

18 and do our thing to confirm if those claims are okay.

19 The second part, in my words, is the

20 regulatory agency would probably want to poke and

21 probe in some areas where the industry's not likely to

22 look.

23 CHAIRMAN POWERS: Right.

24 DR. THADANI: Which generally means the

25 industry probably does not want to look to the point

1 of failure.

2 CHAIRMAN POWERS: You're right.

3 DR. THADANI: It's a success oriented

4 approach to thing, which means I think someone said

5 here, beyond design-based accidents, severe accident

6 considerations. It's very difficult for NRC to push

7 the industry to do certain things which are not

8 explicitly called for by the requirements. On the

9 other hand --

10 MEMBER SHACK: When we're dealing with new

11 reactors, we can have new requirements.

12 DR. THADANI: Are they going to be to

13 obtain it?

14 MEMBER SHACK: And do we have to license

15 every reactor that somebody brings to us?

16 DR. THADANI: That's right.

17 MEMBER SHACK: You know, if the guy walks

18 in with his wood -- reactor, do we tell him to go

19 home?

20 DR. THADANI: If there's a utility

21 involved, NRC has to review it, right?

22 MEMBER CORRADINI: If there's a potential

23 customer involved, yes.

24 DR. THADANI: Well, it's more than

25 potential now because priorities being with the upper

1 resources, they want a letter from a utility, right?
2 MEMBER CORRADINI: But I guess I wanted to
3 ask Brian a question, because --
4 CHAIRMAN POWERS: What's the answer?
5 MEMBER CORRADINI: Oh, I'm sorry.
6 DR. SHERON: Well, I was just going to
7 object and say that, you know -- and I've had this
8 discussion with the Commissioners periodically. I
9 guess since I took this job, which is now over a year
10 and a half ago I guess, you probably almost from the
11 get-go I started lobbying for the fact that we would
12 not be ready for these advanced reactors. So when
13 you're saying when should we have started this
14 research for the non-light water reactors, my
15 contention would probably have been about three years
16 ago.
17 There are some parts of it that I don't
18 think are going to be a big problem. Both the gas-
19 cooled and the liquid metal reactor are single phase
20 coolants, okay. So you're not dealing with any of
21 these two phase problems that you have with the codes,
22 for example like with RELAP and TRACE and all that.
23 And I don't know if you know, but when I
24 started my career in '73 up at the Atomic Energy
25 Commission, I worked for three years on the Clinch

1 River Breeder. On the thermal hydraulics, I was the
2 project manager for development of the DEMO code,
3 which was the Westinghouse code for the reactor. So
4 I'm fairly familiar with LMR behavior and stuff.
5 And there are some areas that are a lot
6 simpler, okay. As I said, the single phase fluid, the
7 heat transfer and all that; it's a fairly
8 straightforward calculation. You know, again, you're
9 not dealing with a very compressible fluid. So to
10 some extent you don't even have to solve the momentum
11 equation.
12 When you get into the things that make it
13 different, for example when you have a steam generator
14 that has sodium on one side and water on another, you
15 open up a whole new pile of accidents.
16 That's probably one of the door alarms.
17 You know, because obviously when sodium to
18 air it burns, when it's exposed to water it explodes.
19 So there's a whole new area there with pressure pulses
20 and everything that I think really I'm not sure how
21 much we know about it.
22 I know when you get, as you said, beyond
23 design-basis to the HCDA type accident and transient
24 overpower where you have a whole different accident,
25 I'm not sure how much we really know about that.

1 Gas-cooled reactors are different, you
2 know the pebble bed. You know, they're coming in
3 saying you can't melt the fuel. We can't come up with
4 an accident that melts the fuel.
5 DR. THADANI: As long as there's no air,
6 no moisture.
7 DR. SHERON: Yes.
8 DR. AHEARNE: And no cracks.
9 DR. SHERON: And no cracks, right. Or no
10 airplanes. And I won't go any further.
11 But it does rise a whole set of policy
12 questions, okay. And if a license is going to come in
13 under Part 52, then they have to do a PRA which
14 doesn't stop at the design-base. So there is an nexus
15 to -- or at least some link to say you need to have
16 some understanding of how this plant behaves beyond
17 the design-base in order to do the risk assessment.
18 The Commission has taken a position, at
19 least previously when I spoke with them, that given
20 all the light water reactors that were saying they
21 were going to come in with an application and had
22 licensees right in tow with customers, the guidance I
23 was getting was that unless the non-light water
24 vendors have a customer in tow, we're really not going
25 to put them at the top of the list. In other words,

1 they can come in and they can submit all the design
2 certification reviews they want, but the priorities
3 are going to be we're going to work with the people
4 that have customers.
5 And originally, you know, when I would
6 talk to Westinghouse, the PBMR part of Westinghouse
7 that would come, you know they would always say that
8 they had interested utilities. They never had a
9 customer in tow. But now Toshiba, for example,
10 supposedly has the city of Galena, Alaska, although
11 I'm not really sure they understand what they're
12 getting into or the costs of doing a review. But
13 that's pat of the whole issue is that, you know, maybe
14 we don't need to be ready right now if the agency is
15 just not going to entertain these applications because
16 of resources. In other words, even if they came in we
17 may say, you know, you're not going to -- and, you
18 know, I've had Westinghouse had the PBMR people sort
19 of say, "Well, you know, if you guys don't review it,
20 you're going to close down this technology to the U.S.
21 You know, we're just not going to pursue it here;"
22 that kind of stuff. And I basically tell them is, I
23 said you know, let me show you what the 17th floor and
24 the 18th floor is over in that building is. You know,
25 you need to go over and talk to them, and the like.

1 But that's really where the Commission is
2 right now I think. And that is that they're looking
3 at -- you know, even with the light water reactors,
4 they're basically telling people is that unless you
5 come in with a commitment. And to some extent they're
6 really saying is, you know, to prioritize you, we're
7 going to prioritize you based on whose put the money
8 up front to order long lead equipment, you know the
9 big fortunes and everything. Because that's
10 demonstrating more of a commitment than just somebody
11 that comes in and says I want to get the license in
12 hand, I want to get the certification in hand and then
13 I'll decide later if I want to go, and like.
14 So anyway, I just wanted to pass that on
15 that that's sort of in the priority. But I think for
16 non-light water reactors there's a whole bunch of
17 areas I think that we've learned about since we first
18 worked on these things back in the '80s. There's
19 material questions that I think are going to come up.
20 And I think that's a lot of NDE questions that you
21 have to figure out, especially for the LMRs and stuff.
22 And then also the, as I said earlier, the PRAs, you
23 know, what database do you have.
24 I remember Clinch River actually did a PRA
25 back in the early '70s and they were coming up with

1 ten to the minus 14 as a core melt. And they were
2 coming into the NRC. And I remember at the time the
3 NRC was, you know, after they picked themselves up off
4 the floor laughing --
5 DR. THADANI: I can tell you this came to
6 me.
7 DR. SHERON: Yes.
8 DR. THADANI: And what do you think is the
9 likelihood of failure to SCRAM? And we had this long
10 discussion about that. And I think it was then
11 recognized that those earlier studies considered only
12 random failures. The common cause failures were
13 excluded.
14 DR. AHEARNE: It seems to me --
15 DR. THADANI: Yes?
16 DR. AHEARNE: Okay. Go ahead.
17 DR. SHERON: I'm done. I'm done.
18 DR. THADANI: Go ahead.
19 DR. AHEARNE: I want to pick up a question
20 that Mike had asked. I don't see how you can expect
21 to get a utility to be putting up saying we're
22 interested in any of these advance designs.
23 Now I just coming off the utility board,
24 and we look at what I would say the pragmatic reality.
25 And an advanced design reactor with all the wondrous

1 description of this, is not something that you're
2 immediately going to go for. But on the other hand, I
3 think the NRC has had an experience. I can think back
4 when there was a suggestion well maybe Candu could be
5 licensed. And it turned out at the time, the NRC had
6 no codes to apply to it, they had no experience in
7 doing that. And that concluding would take about four
8 years just to begin to go through that.
9 So I think that if we really -- or you,
10 really see the likelihood of some of these more
11 advanced designs coming down, you've got to get
12 prepared for it. And that means you've got to educate
13 people. you've got to work on look at what kind of
14 codes are going to be needed. And then look around the
15 world to see what kind of experimental facilities are
16 available that you might have to use.
17 MEMBER ABDEL-KHALIK: If I may just follow
18 on that, something you said. You indicated that you
19 expect to have some sort of advanced within five
20 years. It's a very short period of time. Is the NRC
21 cognizant of what you're going to have five years from
22 now? Have they been involved at all in the definition
23 of what needs to be there five years from now? Have
24 they identified any holes in whatever you will have
25 five years from now that they need to work on today so

1 that five years from now they will have not only your
2 tools, but the tools to fill the holes that you might
3 have?
4 MR. HILL: They have not been really
5 involved in the development tool --
6 MEMBER ABDEL-KHALIK: Why not?
7 DR. SHERON: Because we have no resources.
8 MR. MARION: Well that gets to the
9 question, that's a point that I was going to raise,
10 that in some of these areas specifically with
11 analytical tools that are being developed under GNEP,
12 the NRC has to make a conscious decision at some point
13 to get involved to understand those tools because
14 ultimately they're going to be applicable.
15 MEMBER ABDEL-KHALIK: Right.
16 MR. MARION: And the challenges make that
17 decision in some point in time, then get the staff
18 involved to understand that technology so that when it
19 is submitted for regulatory approval, you have the
20 expertise here to do a credible review. That seems to
21 me the question.
22 From a utility point of view, you're
23 absolutely correct. They're not going to look at
24 anything new. They're going to look at existing plants
25 or existing designs that are out there that are proven

1 that they can license. You know, that's the reality
2 of the way industry looks at these things.
3 It's not going to say that they're not
4 going to support some new reactor in the future. But
5 right now they're going to look at what's already out
6 there on an international scale.
7 MEMBER ABDEL-KHALIK: The answer to that
8 question I posed, you said they haven't done that
9 because we don't have the resources. So maybe the
10 very first question we need to address is where do we
11 start? What are the resources needed and how do you
12 secure those resources?
13 DR. THADANI: Number one, where do we
14 think the gaps are? What information may be needed at
15 what time? Second, what resources do you have, what
16 you can practically do? Don't constrain yourself up
17 front by saying, you know, I'm not going to have
18 resources, I'm not going to bother thinking.
19 The idea, it seems to me at least, would
20 be to do as good a job as you can of what you see
21 future challenges might be, what would it take to be
22 ready to license these designs. Go to the Commission.
23 Say "Commission, these are the resources that we think
24 would be needed on this time scale." And the
25 Commission may come back "We support you, we'll go to

1 Congress." And assuming Congress says okay, then
2 you're all right.
3 But it's quite likely the Commission would
4 say "Well, no. You still have to go prioritize some
5 of this stuff. You have to come in with X amount."
6 I think where we are now, we're just
7 trying to say what those challenges are and what would
8 it take before you jump. I wouldn't jump into
9 resources issue until later. Do the best job you can
10 technically saying what you think would be needed so
11 the agency is really prepared.
12 MEMBER ABDEL-KHALIK: To define those
13 challenges, to identify the holes, we have to know the
14 landscape.
15 DR. THADANI: Yes.
16 MEMBER ABDEL-KHALIK: And that was the
17 basic question I was asking. Why hasn't the NRC been
18 involved in sort of finding out what the landscape is
19 all about?
20 DR. THADANI: I think, Brian, doesn't the
21 resources --
22 DR. SHERON: Well, you said we don't know
23 what the landscape is. I'm not sure exactly what
24 you're --
25 MEMBER ABDEL-KHALIK: Well, he's saying,

1 you know he's given super duper tools five years from
2 now. Do you know what those tools are?
3 DR. SHERON: No, we don't. Because, first
4 off, we don't have an applicant.
5 Second is that I don't have a mechanism to
6 go and basically get that information from him. All
7 right?
8 We are putting together a Commission
9 paper, which will go up I think in January as a
10 combination with NRO and Research. And it addresses
11 that very issue that you're going in. And that is that
12 we're trying to give the Commission a picture of the
13 advanced reactor landscape as we know it today.
14 As a matter of fact, you probably ought to
15 listen to that meeting. Because in the morning it's
16 going to be a two part meeting. In the morning they're
17 going to bring in all of the vendors that are talking
18 about design certifications. They're going to bring in
19 representatives from PBMR, representatives from
20 Toshiba. I even think for maybe the IRIS reactor. And
21 I think DOE, which we kind of look at as the
22 ringleader, if you want to call it that, in terms of
23 developing these advances reactors and the like. And
24 the reason is is we want these vendors to tell the
25 Commission and we want the Commission to have the

1 opportunity to quiz them exactly how serious are they.

2 You know, that's another part of the

3 equation is how serious are you? I mean, it's nice to

4 come in and say we want this, we want that and

5 everything. And I'm not going to go off and devote a

6 whole pile of staff and money, okay, for something

7 that's never going to materialize.

8 So we do have to get some feel. For

9 example, with GNEP, okay, I mean even the Commission

10 is very skeptical. We just see it -- you know, one

11 day it's on the top of the pile, the next day it's at

12 the bottom. You know, we're not ready to go off and

13 chase that until we get a better read from DOE on what

14 the long-term commitment is on that.

15 In the afternoon both NRO and Research are

16 going to report to the Commission. And I'm not going

17 to go in there and tell them, you know, I need this or

18 I need that and pull my pockets inside out. But

19 basically we will tell them to what level we will be

20 ready to support the Regulatory Office with what tools

21 we have.

22 And as was said earlier, okay, it may be -

23 - I mean we've licensed plants before, it's a little

24 tougher if you don't have all the tools. You make

25 more conservative decisions a lot of times. But it'll

1 basically kind of define what we can provide the
2 regulator on what time scale and then, you know, what
3 the licensee is going to have to provide in order to
4 provide the assurance that the plant can be designed
5 and operated safely. And we'll go from there and see
6 what the Commission does.
7 But you got to remember when you're
8 talking about, gee, how can we have resources, okay,
9 NRC's budgets are not set on any logic. Well, I
10 apologize, but I mean it's true. The Chairman just
11 told us yesterday. You know, he says in years that
12 are divisible by two, it's not too logic; in years
13 that are divisible by four, it's even less logical.
14 The '09 budget, for example, we got cut by
15 OMB $211 million on the passback and 641 FTE was the
16 passbacks, was the cuts we got. That put the FTE
17 ceiling below where we are now. Okay. We actually
18 had to lose people to reach the '09 levels, okay.
19 The Commission went back and got a $813
20 million and the 641 FTE. We just found out the other
21 day we got the 641 FTE, but we only $100 million. So
22 now the agency is struggling to figure out how do I
23 take a $83 million cut in my '09 budget, $61 million
24 of it is fee recoverable and the rest of is out of the
25 treasury, okay?

1 So we may not even be doing work on some
2 light water reactors. And I don't know how they're
3 going to allocate those cuts. But resources are a very
4 important thing in this whole process.
5 And the other thing is it's not just
6 money. You have to have people that can manage the
7 money. It's not just a matter of saying, you know,
8 give me dollars and I'll shovel it out and stuff. I
9 really need to have competent project managers that
10 know how to write and know what the work that is
11 needed and know how to interpret it and know how it
12 meshes and fits in. And that's a very important part
13 of the process.
14 So just throwing money at it really
15 doesn't solve or get you what you want, okay?
16 And I've estimated, for example, right now
17 the Office of Research has 243 FTE, that's my
18 allocation for 2008. And I think that's my number also
19 for 2009. I'm presuming somewhere down the road that
20 the agency is supposed to go from 3400 where it is
21 now, up to over 4000 that the demands on the Office of
22 Research would go up proportionately. So I'm
23 presuming at some point all the FTE, you know my
24 staffing would rise to maybe 280/275 people. Now, is
25 that enough to handle any additional work like

advanced reactors versus are most of the demands going to come in for support from the light water reactors? And that I don't know yet.

Anyway, there's just so many factors in this equation and it's really hard to -- I mean, you're sailing the wall and fine one day, and the next day you find out your budget's been wiped out.

MEMBER ARMIJO: Well, these are moving targets. And the only credible customer is the Government. It's only in the U.S. It's only DOE will build an LMR and only DOE will build a gas reactor. And until the government has established a reliable plan and commitment to build those, I don't know how you can really lay out a sensible plan to do the regulatory research to support that. It's interesting, but what can you do with it?

DR. THADANI: The 2005 Energy Bill, yes that's when it was, said that DOE and NRC needed to come back and tell us about licensing strategy of gas-cooled reactors.

MEMBER CORRADINI: We're going to hear about that in a Subcommittee meeting in February.

DR. SHERON: And that's moving along.

MEMBER CORRADINI: Yes.

DR. SHERON: We're planning. We should

1 meet the August '08 date. And basically it says that,
2 you know --
3 MEMBER ARMIJO: You licensed a gas
4 reactor.
5 DR. SHERON: Yes, we did. We will proceed
6 with Part 52. And I think what the plan is to risk-
7 inform some parts of the Part 50 regulations as pat of
8 it. Okay. But the real key is going to be whether,
9 you know Part 52 requires the submittal of a fairly
10 complete design. And the question is is DOE going to
11 have a fairly complete design on the time scale that
12 they need to submit in order to meet the startup date,
13 you might say, at '20/21. And I think that's going to
14 be the critical part of it.
15 We've estimated like a four year review
16 time once the application is on. But, you know, the
17 Commission has gone out and told the industry in no
18 uncertain terms that if you want to get these licenses
19 on a predictable time scale, you have to have a
20 quality complete submittal. And that's the real
21 question is is DOE going to have any kind of a
22 complete design for a gas-cooled reactor that will
23 pass the Part 52 test.
24 DR. THADANI: Shall we, moving along.
25 This one has to do -- we've discussed this

1 also for the classes in technologies. This relates to
2 both things like advanced monitoring system,
3 predicting potential failures that might come about,
4 keeping track of buried piping and things of that
5 sort. To just have a much better idea of what's going
6 on, and including cables. Cables. Actually, there is
7 an interagency group, or has been for a while, and a
8 great deal of research has been done. I don't mean
9 nuclear. There's a great deal of research trying to
10 understand cable fires, cable failures and such.
11 There's a lot of technology available that can tell
12 you likely places for failures, types of leakages you
13 might get and so on.
14 DR. AHEARNE: That's an example that has
15 been around for almost 40 years.
16 DR. THADANI: Yes. Yes. And so that's one
17 side is the prior technology. But the other side is,
18 of course, technological advances as then might relate
19 to software, models including -- has grown a great
20 deal.
21 With that sort of background, are there
22 things that you think research should be looking at
23 over the next several years?
24 My personal view is if you pay attention
25 to this, I think you probably do two things. You

1 enhance safety and I think things also become more
2 economically from an industry perspective. You have
3 a better idea of what's going on, you can take better
4 preventive actions and so on.
5 MR. MARION: If I understand -- this is
6 Alex Marion.
7 If I understand the scope here, this is
8 probably an area that is ripe for collaboration with
9 industry and other industries that applied more
10 advance forms of science and technology. And I think
11 everyone is watching what's going on with digital INC.
12 You know, it's an embarrassment because I know of one
13 utility that has a number of non-nuclear plants and
14 nuclear plants in Calvert County, Maryland. Twelve
15 years ago they upgraded their non-nuclear facility
16 control rooms to digital. Twelve years ago. And
17 they're not even thinking about it on the large scale
18 for the nuclear facilities. And the question is, you
19 know at some point we have to look at what were the
20 barriers created that prevented us from staying
21 abreast of that technology. Because the U.S. lags the
22 world. Okay. And what are we going to learn from
23 this experience so we don't fall into that trap again
24 with newer technology as it develops?
25 I mean, those are the kinds of things that

1 really need to be addressed at a policy level.
2 Because everyone in this country is watching what's
3 going on with our efforts with the staff on digital
4 upgrades. And we're committed to make it successful,
5 but it's going to take a while. And, hopefully, we'll
6 get there and we can use that as a stepping stone to
7 do a better job with other technologies.
8 And in the digital world, you know what is
9 licensed today is probably going to be a different
10 product that has to be relicensed three to five years
11 from now because the technology is improving so fast.
12 CHAIRMAN POWERS: Well certainly non-
13 nuclear digital systems were they commercial off-the-
14 shelf systems?
15 MR. MARION: Yes. They were demonstrated
16 systems that were used in other industries. Yes. But
17 they met some of the electrical standards, but not
18 necessarily the electrical standards that are adopted
19 by the Nuclear Regulatory Commission.
20 DR. THADANI: See, Alex, it seems to me I
21 only put safety here. Because -- economics are
22 involved. From regulators perspective for new
23 technology, you want to be sure you understand what
24 the failure modes might be and whatever it takes to
25 gain some level of confidence in that. And if I look

1 back to research that NRC did to understand aging of
2 components and so on, I think that really is and you
3 can see a lot of confidence to uphold this license
4 renewal. And in the same way if the agency
5 selectively focuses on some key advanced technologies
6 that the industry is likely to utilize, it might solve
7 the problem. Because ultimately you want which carry
8 here now, they need to have confidence so they can
9 move quickly to approve the use of such technologies.
10 What are some of the important areas that
11 the industry might be looking at that perhaps Research
12 at NRC should get started on?
13 MR. MARION: I think -- well, I don't know
14 if we're collaborating or not, but the industry is
15 putting a tremendous amount of resources in
16 nonhistorical examination. And that's another area of
17 the collaboration.
18 And also nominal inspection techniques for
19 unavailable like systems. And when you get into to
20 start thinking about license renewal for an additional
21 20 years, the obvious question comes up
22 of what confidence do you have that the rebar in our
23 concrete structure is still adequate and sufficient.
24 So some diagnostic technique has to be available for
25 that. And I think there are a number of things that

1 can be done in a collaborative manner. Because the
2 thing about it is when the way I look at research
3 there are some fundamental principles that need to be
4 confirmed. But then the marketplace has to step in
5 play.
6 And when you think about the industry and
7 where we are on this threshold of expansion, there is
8 going to be a marketplace out there to develop new
9 techniques as long as the principles have been
10 established. Because those vendors are going to
11 recognize the importance of new probes for NDE, et
12 cetera, as we go forward. That's the kind of thing
13 that really needs to get laid out. And I think that's
14 extremely important.
15 Cable diagnostics, I'm not really sure
16 that we can do much more because in the real industry
17 in terms of the electrical distribution industry,
18 they've done a tremendous amount of testing and
19 investigation of diagnostic techniques on cables used
20 in underground systems. And there isn't a solution to
21 the problem today. Okay. And they've invested
22 millions and millions of dollars in research and can't
23 come up with an effective repeatable diagnostic
24 technique.
25 So anyway, I only made that comment because I'm

1 an electrical engineer.

2 CHAIRMAN POWERS: Yes. But it's really

3 important that you identify whether it is --

4 DR. SHERON: If I can interject on the

5 digital part --

6 COURT REPORTER: Excuse me. Is somebody

7 using a BlackBerry or something? Because that

8 interferes on the microphones and I can't really hear

9 very well. If you could turn it off or just avoid the

10 microphones.

11 DR. SHERON: You know, you all know Mike

12 Mayfield and I can tell you what he said at one point,

13 and that was he said that if the industry -- in other

14 words, one of the things we're looking for in digital

15 is the diversity and separation, okay, and the like.

16 He said, you know, if somebody for example developed

17 a digital protection system that had two channels that

18 were designed and constructed by different companies

19 and whatever, you know, and the logic -- he said we'd

20 be happy. He says but the trouble is the industry

21 starts putting common connections between -- basically

22 in the platforms and everything. And the more they do

23 that, the more questions get raised about the common

24 mode failure, you know.

25 So to some extent this is kind of a self-

1 inflicted wound from the standpoint of the industry.
2 And when we asked the questions about well how do you
3 assure you're not going to have a common mode failure
4 or whatever, in other words what programming error,
5 all right, and you could shutdown wipe both trains,
6 and that's what worries everyone. And that's why we -
7 -
8 MEMBER BONACA: Foreign designs have the
9 advantage of having more redundant systems --
10 DR. SHERON: And some of them are actually
11 putting in, for example I think in Finland when we
12 asked, they said you know, well we have the digital.
13 Well, they've got analog backup.
14 MEMBER BONACA: That's right. More
15 redundant failure. It's like four times then German
16 design where then you can focus better on the issue of
17 common cause and they're designed for that.
18 DR. SHERON: But when we asked the
19 questions, I mean I sit on the CSNI. And when I go
20 over there and I even asked folks over there, I said
21 what have you done on digital. And it's basically
22 nothing because from a PRA standpoint they don't know
23 how to model a digital system in a PRA because it's
24 not a random failure, okay? If there's a programming
25 error, it's there, it's going to happen every time.

1 And so they struggled with well how do I represent
2 that in a PRA. And as a matter of fact, we've got a
3 whole group over there that's trying to figure this
4 one out.
5 So when you say, you know, well you know
6 our primary purpose is safety, and it is, okay, and
7 when the industry comes in with these new digital
8 systems that have all these common connections and
9 everything we asked the question how safe is it.
10 Well, they can't give us a risk answer because they
11 don't have a risk assessment, okay? You know, and you
12 say well how do you know you're not going to have a
13 common mode and, you know, their arms go above the
14 head and everything.
15 We are finding that there are, even though
16 they say they're isolated from the rest of the world,
17 they are still connections. We say can a hacker get
18 in there? Because somebody could do something, you
19 know. And while these systems may have been used
20 successfully in non-nuclear plants, you got to
21 remember if one of these systems fails in a non-
22 nuclear plant, like a boiler or something, well maybe
23 it'd melt a tube or something but it's not going to
24 make the *Washington Post*. It's a lot different than
25 if it screws up in a nuclear plant, and that's part of

1 the logic.

2 DR. THADANI: Well, ABWR had an analog

3 backup, too.

4 MEMBER BONACA: Yes. And in addition to

5 that, I mean if you look at the typical design it was

6 based on the four redundant trains and it was designed

7 for common cause. So therefore you could back in to a

8 digital system more easily because you had provisions

9 of separation, the redundance took care of that and

10 it's for designs if you already have two trains.

11 Maybe South Texas can do better.

12 DR. SHERON: Well, we have a whole digital

13 research plan, digital INC research plan. And I think

14 -- I don't know if it's been briefed to the Committee.

15 But you know what the scope is of what we're looking

16 at and everything.

17 CHAIRMAN POWERS: They held that briefing.

18 WE never got the Mayfield quote you go, which was --

19 I mean, it seems to me that's the biggest problem with

20 these digital systems is that you let digital

21 engineers work on them and they are insistent on

22 putting in more features. They make them progressively

23 more and more complicated. And especially for safety

24 systems, it seems like that's not necessary.

25 MEMBER SHACK: Should be doing it the

1 other way.

2 CHAIRMAN POWERS: Should be going the

3 other way, exactly. That when you add in features you

4 get into this complication of what are the

5 requirements and things like that. And if what would

6 in fact satisfy Mike, and I have tremendous faith in

7 Mike's safety judgment, is two independent systems not

8 connected together, I think you've solved the problem

9 right there. I think that solves the problem.

10 And then the only other hurdle to go over

11 is that you would like to use commercial off-the-shelf

12 equipment. And that has a --

13 DR. SHERON: Yes. But that's where I go

14 back and I say part of this is a self-inflicted wound.

15 CHAIRMAN POWERS: Yes.

16 DR. SHERON: It's not the wrong way.

17 MEMBER SHACK: I think it's a safety

18 policy, it's a philosophy, it's a defense-in-depth to

19 structural kind of thing --

20 DR. SHERON: Yes.

21 MEMBER SHACK: -- that the interim staff

22 guidance does address, basically.

23 DR. SHERON: Or they could put in an

24 analog backup.

25 MEMBER SHACK: Well, that's another way to

1 get --

2 DR. SHERON: We're not telling them how to

3 do, okay? We're just telling them what the

4 performance measures are.

5 MEMBER SIEBER: Well, if you just back up

6 the protection system, you know that's 90 percent of

7 it.

8 MEMBER SHACK: But I mean there are still

9 issues that are addressable by research. I mean,

10 that's not one, I don't think.

11 DR. THADANI: There's a whole bunch of

12 other issues.

13 MEMBER SHACK: Right. There's a bunch of

14 other issues.

15 MEMBER SIEBER: If you look at the cost of

16 the protection system versus the cost of everything

17 else, the protection system you can afford to put that

18 in as analog or hard wired without driving the cost of

19 your control room out of sight.

20 DR. THADANI: Okay, Alex. Moving on. We

21 were talking about the non-light water reactors it's

22 the sense that we've learned everything that we can

23 learn about light water reactors. Why is there a need

24 for any further research in light water reactor

25 technology?

1 Now we have certified passive designs. We
2 don't have any operating experience, as I said earlier
3 and I believe if history is any teacher, we learned a
4 great deal about light water reactors from operating
5 experience. Things happened, things we didn't expect.
6 I would think when passive design plants
7 come into operation six, seven, eight, ten years from
8 now in this country, I suspect there may well be
9 events. And earlier I used the example of small break
10 LOCAs which became an issue and we had to scrounge
11 around and find a way to be able to do some
12 experiments in small break LOCAs as well.
13 Does the agency need to do something such
14 that in five to ten years from now and if plants start
15 operation and if events were to occur, would the
16 agency be prepared to say we understand what these
17 events are all about, I can go do A,B,C to deal with
18 what I saw here and there? Is there a need for such
19 consideration for long-term research on passive
20 designs? And if there is, what should be the makeup
21 of that? That's the issue.
22 DR. AHEARNE: Well I think that, as I
23 mentioned earlier, I think it's not just like water
24 passive systems we have to do it, yes.
25 MEMBER BONACA: But I think you need --

1 that's not long term, in my judgment. You need it now.
2 DR. AHEARNE: Yes.
3 MEMBER BONACA: I mean, we are reviewing
4 ESBWRs. We have approved the AP-1000.
5 MEMBER SHACK: Yes.
6 DR. THADANI: The designs have been
7 certified. The Agency ignores all it used to know
8 about safety, and that's why the word "confirm" is
9 there. Because often times to me that's confirmatory
10 research. I used my base judgment or I got a decision.
11 But, in case, I think I want to go to Research and say
12 do some work, confirm that what I did was in fact --
13 MEMBER SIEBER: Well, I think in a passive
14 plant that's a pretty good idea. Because the portions
15 that drive the safety systems are small compared to a
16 1000 horse power someplace pumping it here. You know,
17 you know that it's going to go only for the horse
18 power behind it. But when you're relying on gravity
19 and bouncy and all kinds of things, you're relying
20 totally on the calculations.
21 DR. THADANI: And particularly because you
22 have power flow paths and are there aging effects,
23 corrosion products building up? In these passive
24 designs you really need to know where the water is
25 going.

1 MEMBER SIEBER: Yes.

2 DR. THADANI: And how much.

3 MEMBER SIEBER: Yes.

4 MEMBER BONACA: Yes. The point I was
5 making earlier is that confirmatory research from what
6 I understand, it characterize the NRC's research to,
7 in fact, confirm that certain approvals they provided
8 for safety evaluation is supportable. Wouldn't it be
9 more or less the discretion of the designers as they
10 implement these new designs would in fact do this
11 research. It would not be confirmatory, it would be
12 however provided by the vendor, performed by the
13 vendor.

14 I don't deny the need for the research.
15 I'm only trying to understand if there is a long-term
16 research the NRC should conduct.

17 DR. THADANI: This is the infrastructure
18 issue again. Do you have in place some capability such
19 that if you see some off normal offensive occurring,
20 are you prepared to deal with that.

21 MEMBER BONACA: I understand.

22 MEMBER SHACK: Although rather than those
23 passive systems, I mean I got a 100 reactors out
24 there. I would guess that the biggest challenge I'm
25 going to have as they continue to operate, is they're

1 going to want to cut margin because that's the
2 cheapest way to get kilowatts.
3 DR. THADANI: Yes. There is an issue I
4 want to go into as well.
5 MEMBER SHACK: And I think I would -- if
6 I was seeing a need for long-term research in LWRs, I
7 think they're going to become much more sophisticated
8 in their analysis techniques getting everything they
9 can get and you're going to be less and less capable
10 of deciding whether -- you've seen them do that.
11 DR. THADANI: I am in total agreement. So
12 that's going to happen.
13 MEMBER BONACA: We've seen it with
14 several of the power uprates recently. I mean, they
15 are getting more complicated different kind of fuels,
16 all the issues we have raised in the recent
17 application reviews in Susquehanna.
18 CHAIRMAN POWERS: Let me ask this question
19 combining what Bill said and what the slide says is --
20 we have a member who is not with us that insists very
21 much that with passive plants that you have to have
22 all hide test facilities.And that suppose we go ahead
23 and we do certify yet another passive plant whose
24 plants do get constructed and we know that at least
25 one of the applications coming in here is an advanced

1 plant, does the NRC need full height test facilities
2 to look at requests to yet further erode the margin
3 based on very sophisticated CFD kinds of analysis,
4 which the same member claims have an inherent
5 deficiency and need experimental confirmation?
6 MEMBER ARMIJO: I mean we're in the midst
7 of reviewing the ESBWR, for example. Does the Agency
8 know that there are no stability problems associated
9 with the ESBWR?
10 DR. SHERON: Mr. Holly is not here. I
11 mean, I'm not actively involved in the review of ESBWR
12 or --
13 CHAIRMAN POWERS: Stability in what sense?
14 Nuclear stability?
15 MEMBER ARMIJO: Right. Coupled neutronic
16 thermal hydraulic stability. You're operating under
17 the natural circulation line.
18 DR. SHERON: Well, I mean the licensee has
19 computer codes. We have computer codes.
20 MEMBER SIEBER: You're talking about a lot
21 of the reactors are critical that are running?
22 MEMBER ARMIJO: Right.
23 CHAIRMAN POWERS: I would think with --
24 MEMBER SIEBER: It depends on what regime
25 you're in.

1 CHAIRMAN POWERS: Well, I'm sure that.

2 MEMBER SIEBER: They appeared in an

3 accident situation, you can forget about it.

4 DR. SHERON: But, again, I would argue

5 that in the past we have -- if the Agency believes

6 that there are unanswered questions that require

7 experimental data from integral facilities, typically

8 the licensee is held accountable to produce that data.

9 MEMBER SIEBER: Yes.

10 DR. SHERON: What NRC has historically

11 done is their own confirmatory testing. And typically

12 what we do is we will address issues such as facility

13 scale if there are questions.

14 Most of the time no one's going to build

15 the full scale facility, obviously it's way too

16 expensive. So you have compromises.

17 If you remember on AP-600, Westinghouse

18 first came in and they said well we're going to run a

19 facility over in Italy. And that was a full height

20 facility, all right. But it was also horribly one

21 dimensional and had horrible heat losses because of

22 the surface areas. And there were a lot of questions

23 that came up about that -- I'm sorry. I take that

24 back. They started out with the Apex facility. I'm

25 sorry. They started out with the Apex facility in

1 University of Oregon, which was I call the short fact
2 facility. It didn't times fails, or whatever, and it
3 was low pressure. And we went through the assessment.
4 I was in Research at the time. And I remember talking
5 to Tom Murley. And I said there are a lot of phenomena
6 that occurred in AP-600 while the reactor is at a much
7 higher pressure than the Apex facility. And I said
8 that I didn't really think that Apex was going to
9 cover the full spectrum of events.
10 NRR in turn went back to Westinghouse and
11 said you guys got a problem. So Westinghouse went off
12 and said all right. So they went off and they got a
13 contract to run the SPES facility, which was the full
14 height facility, full pressure but, as I said, very
15 one dimensional. So it introduced a whole new set
16 of scale and distortions, okay, that were totally
17 different from Apex.
18 So I had short/fat and tall/skinny.
19 We looked around, and as a matter of fact
20 it was Larry Hochreiter from Westinghouse who even
21 suggested, he says have you guys looked at the ROSA
22 facility in Japan? And we went over and we looked.
23 And Japan was more willing to want to use the facility
24 because they were trying to find a use for it. And so
25 we modified it so we could run our own set of

1 experiments, okay. And it was sort of a cross between
2 the new facilities, if you want.
3 So now I had three facilities in three
4 different scales. And the logic was is that, you know
5 under the assumption that I could understand scaling
6 distortions, go through my code validation, it
7 provided me with enough assurance that I can rely on
8 my codes to tell me how well the AP-600 was going to
9 perform.
10 When we got to AP-1000, okay, the agency
11 went through another assessment and decided what
12 aspects were different. And we concluded that we
13 didn't need to go through that whole thing again.
14 Okay. In other words, the codes were still validated
15 but there were some parts that needed, you know,
16 further refinement or investigation.
17 When they went through it for the ESBWR,
18 the conclusion was is that we didn't really need to
19 build an independent facility to do that testing.
20 There was enough confidence in the computer codes.
21 And I apologize, I wasn't part of that
22 assessment and there are people that are, but that was
23 the logic that was used.
24 MEMBER SIEBER: They questioned if they
25 did the full height.

1 DR. SHERON: Yes. Yes. But we didn't see
2 a need for the NRC to have to go off and --
3 MEMBER SIEBER: And you should have.
4 DR. SHERON: Right.
5 CHAIRMAN POWERS: A question. I don't
6 think the AP would want the 600 licensing, and I guess
7 I'm reading through the ESBWR. The question I think
8 I'm asking now is you're going to get some AP-1000s
9 built, and they're going to run -- you're going to
10 give them a license for 50 years. Over the course of
11 that 40 years it's not unreasonable to assume that
12 they'll come in and say, gee, we would like to change
13 our licensing basis because we've got a little more
14 out. And we've run this computer code. And it says
15 it's safe to do so.
16 The question I'm asking is does there need
17 to be the capability to independently check that at
18 the NRC with a full height test facility, which one of
19 the members of the ACRS really thinks that that --
20 DR. SHERON: Likes the idea.
21 CHAIRMAN POWERS: Yes. Well, I like to
22 blame to him. And he's very blamable, by the way. Or
23 is a more ad hoc approach because it's very difficult
24 to anticipate what issue is going to come up and what
25 kind of an experiment you would actually need, the

1 best or more cost effective approach to take? I don't
2 know the answer. I mean, I don't have a prejudice
3 either way.
4 DR. SHERON: Well, I have a very strong
5 opinion because we just went through this exercise
6 over in the CSNI because there's a lot of European
7 facilities that are struggling with the same question.
8 Okay. And the conclusion that was reached out of the
9 CSNI was that, yes, we would like to maintain
10 infrastructure facilities, but only if there is a
11 meaningful course of work for them to do. In other
12 words, you don't want to have this facility sitting
13 here and you're doing nothing but dreaming up things
14 for it to do to keep it busy while you're waiting for
15 that event to happen that you want to really use it
16 for. Because you got to remember, you know I mean
17 even though somebody may be running tests, then
18 someone's got to analyze them, which means you got all
19 this -- and so all of a sudden you're talking millions
20 of dollars every year to support a facility. And
21 somebody is going to say why are you doing this?
22 Okay. You're waiting around for this thing to happen
23 that may never happen and you're just spending.
24 And so the whole logic was that we really
25 don't -- we can't afford that luxury, okay.

1 DR. AHEARNE: Well, it's more than just a
2 luxury, though. Because you say you're waiting
3 around, it may never happen. But you are then still
4 building some expert knowledge. You're learning how to
5 examine new designs, new approaches. That point may
6 not come up, but you pointed out you're going to be
7 losing people, you're going to be losing expertise.
8 So --
9 DR. SHERON: Semi-scale across the agency
10 in about 1977/78 dollars, about $7 million a year.
11 Okay. LOFT I think back in those days was running at
12 about 40 or 50 million a year. So translate that into
13 2007 dollars, and -- I don't want to go to the
14 Commission and say I need $20 million to run an
15 integral loop.
16 DR. AHEARNE: Yes.
17 DR. SHERON: And I can't tell them what
18 I'm doing it for.
19 DR. AHEARNE: Let me make a few comments.
20 The world has changed since I chaired the Commission,
21 I realize that. But nevertheless I found that when we
22 really had a very strong argument, even though we had
23 been told you couldn't get the money, by me going
24 personally to the Deputy Director of OMB and spending
25 an hour arguing with him and finally getting him to

1 agree, and personally going to the Appropriations
2 Committees and arguing to get them to agree we were
3 able to get money that we were told we could never
4 get.
5 So it depends on how important you can
6 make the case.
7 DR. THADANI: This Chairman has -- this is
8 now being recorded, so -- anyway. This Chairman has
9 also -- he's willing to go and fight for resources if
10 a proper case is made. And I think he is -- I
11 believe, current Commission, he is interested in this
12 whole general subject matter. And they seem to be
13 anxious to get some reasonable set of recommendations
14 that they can have confidence in. And they seem to
15 indicate they're willing to go to make the case for
16 resources if this country is really ready to build --
17 what was it? A 100 more reactors or maybe even 200 in
18 the next 20/30 years. There has to be an investment
19 to make it really happen.
20 DR. SHERON: But should it be industry
21 make that investment rather than the NRC?
22 DR. THADANI: Oh, I agree.
23 DR. SHERON: We worked on AP-600. But,
24 you know, you're going to have an EPR, you're going to
25 have an ESBWR. Should I have facilities for all of

1 those? In which case now I'm probably -- you know, and
2 then I've got Tosbiha, you know, Advanced PWR.
3 DR. THADANI: For Research has to make
4 some --
5 DR. SHERON: Maybe DOE should really take
6 on that issue. They got a lot bigger budget than we
7 do. All right.
8 MEMBER CORRADINI: And they're not here
9 either.
10 DR. SHERON: Right. That's part of my
11 logic. But I'm just suggesting that -- if somebody
12 gave me a lot of money right now and said go build a
13 facility, I'd probably say should I build a facility
14 where I can test gas-cooled reactor technology or LMR,
15 for example? Do I need a close loop test facility to
16 understand LMRs or gas-cooled reactors.
17 You know, I've even tried to -- Farouk
18 Altaweil, and I said, you know, we want so many
19 experiments and so many facilities. We have data we
20 haven't even analyzed yet.
21 CHAIRMAN POWERS: You're losing that data
22 faster than --
23 DR. SHERON: You know, when you look at
24 all the facilities that were run both pre and post TMI
25 And the kind of transients, I mean we've reached a

1 point where we couldn't think of any -- for example
2 with LOFT, okay, I can remember we reached a point
3 where we said we're done with it. Then we went over to
4 CSNI and we got a three year reprieve through a
5 cooperative program. And after three years the
6 international community couldn't think of anything
7 else to run in LOFT and the like.
8 Semi-scale was the same way. We just ran
9 out of stuff to run. We'd run every kind of transient
10 we could think of for code validation.
11 The MIST facility which simulated the BMW
12 design, you know, after BMW built it and we took it
13 over and ran it and everything, we ran out of stuff.
14 So, you know, a lot of it is we kind of
15 reached a saturation point. And ROSA is still around
16 and we're still running some stuff over ROSA right
17 now. As a matter of fact, when I came to Research I
18 was shocked that it was still around, but it is.
19 CHAIRMAN POWERS: I mean, you bring up one
20 of the issues that I have with -- that I don't quite
21 understand about thermal hydraulic facilities is that
22 when I build a facility and maintain it, ten years
23 later I have computer codes that are asking different
24 kinds of questions and I don't have the capability or
25 the instrumentation or something in that existing

1 facility to answer those questions.

2 DR. SHERON: That was the answer I got

3 from Farouk when I asked him, I said why are we still

4 running the ROSA facility. He said well for code. I

5 said well we ran tests on that a long time ago. And he

6 says, oh, yes, but we didn't have the right

7 instrumentation. So now we're instrumenting it right

8 so we can get the data. And I said okay,

9 So I mean we're trying to do that, okay.

10 But to some extent here I'm a little skeptical. You

11 know, I mean we were working on thermal hydraulic code

12 since -- going on 40 years now. You know, I keep

13 asking Farouk, I said I really want to see a

14 comparison of Zion with a LOCA calculation today

15 versus the best estimate LOCA we did in 1979. And I'd

16 like to see how different they really are in terms of

17 what are predicted capability. Because I really

18 think, quite honestly, I mean at some point, yes, you

19 got to keep the capability and everything. But to

20 some extent I wonder whether the codes are really

21 turning into the lumpy mattress where you push it here

22 and it pops up there, push it there and it pops up

23 here.

24 And we reach a level of sophistication and

25 accuracy that's totally adequate for regulatory

1 purposes. Okay. And do I need to focus my resources
2 on other safety issues, which I think are really going
3 to be the ones are material issues. You know, worrying
4 about what's going to crack next and do I have an
5 inspection program that's going to find it before it
6 comes up and bites me.
7 MEMBER ARMIJO: Brian, you mentioned and
8 that brings something up that I've been thinking
9 about.
10 In some areas in materials in the BWR in
11 particular they've instituted a new water chemistry,
12 the hydrogen water chemistry.
13 DR. SHERON: Right.
14 MEMBER ARMIJO: And, you know, the
15 question I ask is this a permanent fix to the IGSCC
16 and IASCC or is this just it'll last for a certain
17 time and then things will start cracking again. And
18 what should the Commission do to confirm -- or the
19 industry, somebody, to confirm that yes, this is it.
20 This is the magic bullet that will stop cracking on
21 things that haven't already started to crack and maybe
22 even stop cracking on things that have already started
23 to crack.
24 It seems to me that we left that
25 unfinished, and that applies to other mitigation

1 techniques, weld overlay, induction heating stress
2 improvement, all of these things are they really
3 permanent fixes or are they just a patch for the --
4 DR. SHERON: I don't know. When the
5 industry came back and they said, you know, we're
6 going to fix the vessel heads by replacing them with
7 Inconel 690.
8 MEMBER ARMIJO: Yes.
9 DR. SHERON: And they came in and they
10 said oh you guys don't need these inspection
11 requirements anymore because we're putting in the --
12 and we went uh-uh, you know. You know, you told us 30
13 years ago Inconel 600 wasn't going to crack and it was
14 the toughest stuff going and 30 years later we're
15 suffering. Okay.
16 We said we agree 690 is tougher, okay?
17 But you're not going to get out of doing inspections
18 altogether. You still have to do inspections. Maybe
19 not as frequently, but you need to monitor.
20 And I think that's the same thing is that
21 we don't know whether that's the magic bullet. It's
22 probably going to help. And all we have to do is
23 really say can we back off on our inspection frequency
24 and if so, how much and still be safe.
25 MEMBER ARMIJO: If you did enough research

1 or the industry? Too bad that Alex left because I
2 think this is really an industry responsibility.
3 DR. SHERON: Yes.
4 MEMBER ARMIJO: If they really would do
5 the necessary research to demonstrate that this really
6 works even under the worst conditions of poor
7 fabrication or marginal material, then they could come
8 back and request with confidence some relief on
9 certain inspections.
10 MEMBER BONACA: Yes. And there has been
11 issues of physical inspections.
12 MEMBER ARMIJO: Yes.
13 MEMBER BONACA: For example, in license
14 renewal we found more and more exceptions taken by
15 licensees because they can now get rid of inspection
16 physically that the BWR review people would recommend.
17 So there are those issues there that we're wrestling
18 with.
19 MEMBER SIEBER: But they've been doing
20 that through the first license, too. You know,
21 there's a fair amount, 20/30 percent. The fact is that
22 you can't get the whole --
23 DR. THADANI: Well, before we take our
24 break in a few minutes, this next issue is Dana
25 Powers. So, Dana, why don't you --

1 CHAIRMAN POWERS: The question, this
2 really has to do with how line organizations do their
3 work as opposed to what they're working on. And the
4 question that I -- what I see is a vastly growing
5 computational resources capability. Have lots of
6 people coming in, new hires coming in that expect to
7 have at their desk certain kinds of software. Now,
8 they couldn't solve the momentum equation if you
9 begged them to, but they certainly know that they're
10 computer kids, they're capable of doing -- and
11 already, the infinite element analysis like Abacus
12 codes and things like that that they just kind of
13 expect to have available to them to do their work.
14 And so the question was if in fact we
15 forecast a growth with the nuclear industry but not a
16 concomitant growth in the NRC staff and if you can see
17 that the number of licensing actions per plant is
18 about the same as now, you conclude that the people in
19 NRR or NRO, wherever they are, are going to have to be
20 more productive. And the only way I can see they
21 become productive is in fact through technology. What
22 kinds of technology should RES be developing for this
23 future era? And so I said should we expect that in 20
24 years someone like NRR would have at their desk the
25 TRACE code and they could run a thermal hydraulic

1 analysis for a plant without calling up RES to get
2 help to do it? Should they be able to run a PRA for
3 a plant without calling RES up to do it?
4 In other words, should RES make these
5 tools user friendly with the intention of having them
6 on the line organization's desk to do their work very
7 quickly and without the intercession of expertise from
8 RES? And that's essentially the question I'm asking
9 is what kinds of things does the line organization
10 need to have available to them to do the work in the
11 future, recognizing that the guy that authorized that
12 line organization is probably five years out of school
13 and has never been in a nuclear power plant before in
14 his life?
15 MEMBER SIEBER: You're talking about
16 resident inspectors.
17 CHAIRMAN POWERS: No. I'm really talking
18 about NRR.
19 MEMBER SIEBER: Okay.
20 DR. THADANI: And NRO.
21 CHAIRMAN POWERS: And NRO.
22 DR. THADANI: Yes.
23 CHAIRMAN POWERS: I think there's another
24 set of questions at the licensing organization, but I
25 wanted to start with NRR.

1 DR. AHEARNE: How would you do the QA?

2 CHAIRMAN POWERS: The QA --

3 DR. AHEARNE: In other words, you've given

4 this neophyte this large amount of capability for

5 independent assessment. All right. He or she does that

6 assessment.

7 CHAIRMAN POWERS: Yes.

8 DR. AHEARNE: Who checks?

9 CHAIRMAN POWERS: What does he do? He

10 comes up and he says yes. What the license has told

11 me is correct and his calculations have been

12 elaborately QA checked.

13 DR. AHEARNE: And rarely they said they're

14 wrong. And so I now go to the back and tell them

15 they're wrong --

16 CHAIRMAN POWERS: I mean the ordinary

17 course of events would be, gee, we get a different

18 result here, please explain this. And they would

19 issue an RAI asking for additional information.

20 DR. AHEARNE: They work independently.

21 It's a little troubling.

22 CHAIRMAN POWERS: For instance, I mean

23 what I'm most acutely familiar with is source term

24 analyses which have for historical reasons always been

25 done completely independently by the staff. And if

1 they come up and they gee, we calculate your 24.4 rem
2 at the site boundary --
3 DR. AHEARNE: Yes. But you used the word
4 "we." At the beginning of that discussion you had an
5 individual in an office.
6 CHAIRMAN POWERS: Yes. Right. It's done
7 by an individual. I mean Jay Lee over in NRR actually
8 does it. And he uses his own code called TRENDS or
9 something like that. And I guess Rad Tread, not
10 TRENDS. Rad Tread. And when he comes up with an
11 answer that's different, they go back to the licensees
12 and find out. If they can't resolve it, then his
13 number -- but typically they say, oh, the size
14 distribution or something is different.
15 DR. AHEARNE: But he's more experienced.
16 CHAIRMAN POWERS: He's very experienced.
17 Very experienced. The guy that replaces him, which is
18 coming pretty quick, is not going to be so
19 experienced.
20 MEMBER BONACA: Let me give you an
21 example, has been SPAR. Now SPAR clearly has not --
22 as it hasn't been developed to the extent of some of
23 the other tools, but there is an advantage there in
24 the fact that you have a consistent application of the
25 same inputs or assumptions in it from model-to-model.

1 And while the utility PRAs have made different
2 assumptions, they got their certain inputs, sequences
3 have not been modeled and so on and so forth.
4 So here you have an example of a code that
5 may not be as sophisticated as the one of the
6 utility's, but it is consistently applied.
7 MEMBER SIEBER: But it could be
8 consistently wrong, couldn't it?
9 MEMBER BONACA: Well, no. Because they've
10 been benchmarking them to the utility codes. On the
11 other hand, the level of scope and the -- it's
12 identically understood from SPAR to SPAR wherever they
13 apply it. And once you have that you can improve it,
14 refine it as is being done now. And, you know, it
15 could be a very powerful tool for verification.
16 MEMBER CORRADINI: I guess, could I go
17 back to not SPAR, but the other one you're talking
18 about which is thermal hydraulic hydroxide fuel. I
19 think Dana's point, at least my impression of it is in
20 some sense it's an ability to train the new individual
21 as well as not just do independent assessment.
22 Because some of these folks aren't going to know, have
23 been in the plant or have been in a situation. And
24 this is their way in some sense to get to learn more
25 about the phenomena by actually going through the

1 calculations themselves. At least that's my
2 interpretation of part of what you're after,
3 particularly when you get a newer individual that's
4 not knowing the details of --
5 CHAIRMAN POWERS: Well, yes, that's one of
6 the ancillary benefits, I'm sure. The question in my
7 mind is how much of this do we think they're going to
8 have to have in 20 years? And I'm presuming that we
9 have light water reactors, some of them are passive
10 but half of them at least, maybe two-thirds of them,
11 are just like the existing reactors. Do we continue
12 to operate in the same fashion?
13 Like right now if you want a thermal
14 hydraulics fuel calculation for Susquehanna, you
15 probably call up the RES and say put together a deck
16 and run some calculations for me. Certainly other
17 kinds of analyses that sort of thing is done. And how
18 much of it do you want to just be able to have the
19 line organization able to do fairly routinely, which
20 means it has to have a lot of the user friendly
21 interfaces and things like that, good support
22 documentation, probably an expert system associated
23 with it for -- you know, a help file sort of a
24 capability.
25 MEMBER BONACA: I had used the SPAR as an

1 example only because I do think that in ten years
2 there will be almost no decision being made without an
3 evaluation with PRA, too.
4 MEMBER SHACK: Well, I think if you looked
5 at analyses capability, the two tools that most people
6 will be using will probably be a PRA tool and a
7 thermal hydraulics tool.
8 MEMBER BONACA: Sure.
9 MEMBER SHACK: You know, those are the two
10 leading candidates for giving people that capability.
11 CHAIRMAN POWERS: What? PRAISE will be--
12 MEMBER SHACK: That's probably still a
13 special one.
14 MEMBER CORRADINI: What?
15 MEMBER SHACK: PRAISE, probabilistic
16 fracture mechanics.
17 MEMBER CORRADINI: Oh. Oh.
18 MEMBER SHACK: You're going to need some
19 tools if you do that. I know what the answer is.
20 DR. SHERON: I would like to point out
21 that, you know, NRR does have the capability to run
22 the codes. And we've provided that to them. You
23 know, we will provide them with input decks in terms
24 of preparation of the deck and everything, and we will
25 work with them to assist them if they run into

1 trouble. But they have -- we've provided them with the
2 codes and they have the capability to perform those
3 calculations.
4 CHAIRMAN POWERS: Right now the way they
5 do it, the line is conceptually not any different than
6 having RES run it in that we call a specialist guy to
7 run it.
8 DR. SHERON: Yes. I mean, I would not
9 expect and I would not want somebody, as you said,
10 five years out of school or something that really
11 doesn't understand
12 MEMBER SHACK: Twenty years.
13 DR. SHERON: Yes.
14 MEMBER SHACK: Twenty years, it's a long
15 time.
16 DR. SHERON: I'm not looking out 20 years
17 from now. Okay? You know, I'm thinking more in the
18 terms of five years from now.
19 CHAIRMAN POWERS: It's still going to have
20 TRACE, it's not going to have --
21 DR. SHERON: I mean, first off, they're
22 going to be 20 years from now. I mean, if you look at
23 how the computing capabilities have changed in the
24 past five years, okay, and stuff. I mean, I don't
25 know if you know, Research is supposed to move up to

1 a building in Rockville, 21 Church Street. And we've
2 been estimating now just I've got to build one of
3 these little nuclear batteries next to the building
4 just to power the computing.
5 If you look at the amperage and stuff that
6 we're requiring and the backup batteries, okay, we're
7 looking at floor loadings. All right? They're
8 talking about we got to put batteries somewhere, these
9 lead acid batteries, the backup for these computing
10 systems that we need to run these advanced codes.
11 Because we do have -- yes, I mean we do have the
12 computing capability up there. But, you know, where
13 we're going to be 20 years from now, Lord only knows.
14 I mean, this stuff will all be in our hand.
15 DR. THADANI: Well, Brian, while you were
16 gone -- your comment that you made this morning --
17 DR. SHERON: On what? In terms of?
18 DR. THADANI: You know, your vision that
19 you talked about this morning that you look ahead
20 three years because of the level of confidence you
21 have in terms of --
22 DR. SHERON: No. I just said that the
23 budgeting process looks ahead three years. I mean we
24 -- all right.
25 DR. THADANI: It was a point that was

1 made --

2 DR. SHERON: All right. We're going to

3 start the 2010 budget process now and I said the

4 industry has historically had a three year planning

5 horizon, at least that's what it used to be from the

6 standpoint of when they need to return in their

7 investment. Okay. I said that it's kind of hard to

8 look beyond that because, first of all, you know it's

9 not only that I don't know what my budget is going to

10 be and the like, but I also have to see where the

11 industry is going.

12 DR. THADANI: Alex said he's going to give

13 you a call.

14 DR. SHERON: Yes. And that's the biggest

15 thing, is to find out where the industry is going.

16 Okay. What are they focusing on? What are they

17 worrying about? And to try and draw that out from

18 them sometimes is not an easy thing. And then to

19 determine --

20 DR. AHEARNE: His main concern was a few

21 year time frame --

22 DR. SHERON: Well, I'm not sure it's

23 needed it, but --

24 DR. THADANI: I think Gary had the same

25 point also.

1 CHAIRMAN POWERS: I'm just concerned about
2 time frame. I think I'm worried about an exactly,
3 what you say, Brian, is the industry going to a more
4 technically sophisticated kind of application to
5 further erode the margin between where they operate
6 now and where the regulatory limits are. Because
7 they've done all the easy stuff. And so to get
8 further, you have to become more technically
9 sophisticated, more realistic and things like that.
10 And if so, do you want that analyses to continue to be
11 a burden to RES, you want more of that to move out
12 into the line organization. And if it moves out of the
13 line organization, what kinds of tools and
14 capabilities are they going to need to have?
15 DR. SHERON: Well, and you know we've
16 developed a tool for that. You know, it's a margin
17 assessment tool and Mirela Gavrilas has developed
18 that, and the like. And we've been developing for
19 about the past three or four years. You know, it's a
20 very structured way of assessing margins.
21 And, you know I've gone to NRR because I
22 said, you know, you know you guys want to use this,
23 okay, I mean we've developed the tool. And as a matter
24 of fact, when I was in NRR Research came over and I
25 said fine, let's apply it on a pilot application. And

1 I could never get -- you know and then I went to
2 Research and I checked and I said did we ever do that?
3 And they said well NRR never came up with a pilot.
4 And I called up Jim Wiggins just several
5 months ago. And I said "You guys want this thing or
6 not?" And the message I'm sort of getting is that
7 it's for a license amendment they don't really see a
8 need for it because, first off, it's not an easy tool
9 to use. You know, and when you're saying okay, for
10 the average license amendment you got 40 staff hours,
11 that's the benchmark, I guess, for an average one.
12 You know, the staff is not going to go off and spend
13 another 80 hours trying to do some margin assessment
14 on a license amendment. Okay. Because first off, the
15 licensee is going to scream bloody murder because
16 they're getting charged for it. It's going to delay
17 the thing, okay.
18 And the other thing is that they're saying
19 it doesn't matter. Okay? As long as they meet the
20 Commission's rules and regulations, that plan -- that
21 license amendment is acceptable and the plant is safe.
22 Okay.
23 In other words, you know, I always tell
24 people, I said you know you've got adequate protection
25 here, you got the licensing requirements here and you

1 got safety where the plant operate is up here. We let
2 them come down to that licensing line as close as they
3 want. Okay. When they drop below it, okay, we make
4 them come back into compliance. All right. And how
5 long it takes to come back into compliance usually
6 depends on how close they get to that adequate
7 protection line. You know, if you're way down here,
8 okay, it's okay. You shut the plant down or whatever,
9 or you come back into compliance real quick. If you
10 drop a little bit below it, you know, okay yes you
11 find
12 you can put some compensatory measures in place and a
13 couple of months from now you can come back in
14 compliance.
15 But where I see the tool, this margin
16 assessment tool being useful is in assessing
17 regulation changes. And so, for example, I've already
18 proposed to CSNI to do a study to apply it against the
19 5046A rule and say okay, we're proposing to change the
20 margins in 5041 to allow -- you know, we're going to
21 change the break size and all this other stuff. How am
22 I effecting the margins, the safety margins.
23 And so to me the use of that margin
24 assessment tool is probably if it has any application,
25 it's going to be in assessing regulations and whether

1 or not and how I change the regulation. Okay. And so
2 we've got that study going on that we're trying to
3 work internationally through CSNI through a working
4 group. And Merila's-- well, she's working on the
5 committee. I think the Swiss or the Sweds are heading
6 up that group. But there is going to be a meeting here
7 of that group in January. And you might want to have
8 somebody sit in on that because they're going to be
9 talking about applying it to the LOCA as a trial.
10 So anyway, you know, we do have tools that
11 we're trying to develop to assess margins. But you got
12 to remember that the regulators are -- when you're
13 doing license amendments and you're cranking out 1500
14 a year, you're trying to do it in a -- it's a
15 production mode, you know. And you don't want to get
16 into deep heavy duty analyses.
17 As a matter of fact, most licensees just
18 want to come in and say, you know, hey here's a
19 license amendment. You already approved three of these
20 or ten of these before, approve this one.
21 MEMBER SHACK: Well, I mean partly I would
22 argue that the first question you asked is would this
23 tool be useful. Now if it takes them 40 hours to do
24 it now, you know with a little bit of research maybe
25 you can get it down so we can do it in an hour. You

1 know, the real first question is is whether the tool
2 will be useful. And one of your arguments, again,
3 coming back to my -- you know, you say it's going to
4 go all the way down to the licensing basis. Well,
5 he's going to compute that he goes all the way down to
6 the license basis.
7 DR. SHERON: Right.
8 MEMBER SHACK: The question is whether you
9 believe it.
10 DR. SHERON: Right.
11 MEMBER SHACK: And do you trust his
12 analysis or do you have a tool that's as capable as
13 his of saying yes you did get to the licensing basis?
14 DR. SHERON: Yes.
15 MEMBER SHACK: I'm a little worried, you
16 know when he's talking over here, you know he's
17 talking about a tool that DOE's developing. And I can
18 sort of see, yes, I can over and hand that to the NRC
19 and we can argue whether the NRC then needs to develop
20 an independent tool. A licensee or a vendor develops
21 a capability, he isn't going to be so happy about
22 handing it over to the NRC. So I think it's going to
23 be a different sort of thing and a different kind of
24 decision that you're going to have to make.
25 I mean, personally I'd grab that DOE tool

early on here before it gets locked up in proprietary and become involved with it as we've discussed before. But, you know, when we're dealing with existing reactors and commercial worlds, independent assessment is going to be a tricker bit. You know, how do you maintain that independent view? You know, at a bare minimum you have to convince the guy to hand you the code, I think, so you can at least play with it yourself.

MEMBER BONACA: As to why I think it becomes so important as we go forward. Because originally, you know, these power plants, many of them will realize that their five percent above when you run them. So you knew they had margin. You had a little leeway for all sorts of -- now you're starting on better sharpening their pencils to shave off margins. And, you know, where it's going to end, I don't know. But, again, the points that was made before in the recent application is a good example where we just go with the margin there, the main locations.

MEMBER SIEBER: Well, you've got to be a little bit careful. I take it to margin is described as a distribution as opposed to a single point. And when you do that, you have two distributions. You may

1 not know whether they cross and that there is some
2 probability that you're going to fail in a
3 catastrophic way. And so you got to be careful how
4 you use that margin tool.
5 CHAIRMAN POWERS: Well, I had promised to
6 break at 3:30. And so I will -- five minutes late,
7 and we'll resume at ten of.
8 (Whereupon, at 3:36 p.m. a recess until
9 3:56 p.m.)
10 CHAIRMAN POWERS: Let's go back into
11 session.
12 MEMBER ABDEL-KHALIK: If we can go back to
13 issue four on the previous slide? There is a comment
14 that I wanted to make. If you were to provide a young
15 engineer with five years of experience with tools of
16 this type, that would fundamentally change the nature
17 of their work because the way in the limited time I
18 have been on ACRS, I view the work the government
19 engineers do.
20 It's sort of like pattern recognition,
21 just like students doing homework. They try to find
22 a problem that is pretty close to it. They match it
23 and change a few numbers. And that is their job;
24 whereas, if you give them tools of this type, the
25 nature of their work, the way they approach their

1 work, would be completely different.

2 And to me that would be a very valuable

3 thing to come out of this process.

4 DR. SHERON: Well, you know we do that a

5 little bit right now in the sense that a lot of the

6 staff, the younger staff, that do the code analyses,

7 you know, we're getting them from universities that

8 have contracts with the NRC; for example, Penn State,

9 M.I.T., whatever.

10 They're coming out with full knowledge on

11 how to run these computer codes because they ran them

12 when they were in grad school through their professors

13 and the like. And we're trying to scop them up as

14 fast as we can.

15 And we're getting topnotch people. You

16 know, Joe Staudemeier came out of Penn State. He came

17 in. He knew exactly what he was doing, you know, with

18 the code. And Joe Kelly, who came from the labs, he

19 knows.

20 So I have a lot of confidence that we have

21 topnotch staff that are just not coming in and, you

22 know, going through the motions. I mean, they fully

23 understand these thermal hydraulic codes. You know,

24 they understand them. They know when they run them.

25 They know when they're getting good results and bad

1 results, you know.

2 So we're getting quality people out of the

3 universities. And part of it is that synergy, as I

4 said, you know, where we have contracts with the

5 universities, you know. And they're training the grad

6 students for us. You know, when they're ready to

7 graduate, we try and go in there and woo them to come

8 and work for us.

9 DR. THADANI: What we need here, what you

10 really need is NRO and NRR because they are the ones

11 who have to really say, "Yes, indeed, we think there

12 is significant value in this. And we would support

13 them."

14 DR. THADANI: The point -- and I go back.

15 I left NRR, what, about 10-11 years ago to go to

16 Research. At the time I was Associate Director of

17 NRR.

18 And I was, I remain today a very strong

19 believer that the reviewers in some branches should

20 have access to some analysis tools because I think you

21 get a better understanding of issues.

22 If you don't do any analysis yourself,

23 even some -- suppose there are questions and John has

24 legitimate concerns about their knowledge of the tool

25 itself. But let's say you are just doing some

1 sensitivity studies. You get a much better
2 understanding of areas of emphasis and so on.
3 I hate to think that if you just ask
4 people to go review somebody's work, you're
5 potentially destroying some curiosity as well. You
6 want people to be curious. You want them to ask
7 questions, not go back to look at the last set of
8 questions asked on the last application. That's not
9 what I mean. But you want them to really have their
10 own activity, to show up in these activities.
11 And if you give them more tools -- and I
12 agree they could be abused. I recognize that. On the
13 other hand, you can also end up with, really, I think
14 more effective, you know, results from the agency.
15 MEMBER SIEBER: Well, there are a couple
16 of questions that come out of that. If you expand the
17 scope of work for reviewers, you're going to need more
18 reviewers and probably less of your expert types.
19 On the other hand, when you distribute
20 this work to the reviewers, you're going to lose a
21 nominal consistency across the board. So those are
22 things that you would consider when you were making
23 the decision as to whether you wanted to do that or
24 not.
25 DR. AHEARNE: In the back of the question,

1 20 years from now, there is an issue of what will the
2 material being submitted by the applicants look like.
3 MEMBER SIEBER: It's going to be a lot
4 different than that.
5 DR. AHEARNE: Right. I mean, I would
6 assume --
7 MEMBER SIEBER: It's going to be more
8 sophisticated.
9 DR. AHEARNE: I would assume it would be
10 much more sophisticated. They will also have been
11 either developing new tools, new codes, new methods of
12 analysis. And I would expect that the applications
13 would be all electronic.
14 MEMBER SIEBER: I imagine that is true,
15 too. And just to codify your point, look at how it
16 has changed over the last 30 years, the sophistication
17 of applications. I noticed a big difference.
18 And you're going to get more and more
19 sophisticated as people start to eat away at the
20 margin because you're going to have to be more
21 exacting, better calculations, and better tools,
22 better arguments.
23 DR. AHEARNE: And if there really are as
24 many new applicants as some are forecasting, you're
25 going to get applications from people who have never

1 applied before.

2 MEMBER SIEBER: Yes.

3 DR. AHEARNE: And so you also have some

4 mixture of the quality because of that.

5 DR. SHERON: A lot of the margin, though,

6 is going to come from areas that are not where you

7 just do an analysis. I mean, a lot of the stuff comes

8 in. I want to change my ISI inspection requirements.

9 I want to inspect a different way or I want to change

10 my frequency. There's no margin and the like. That's

11 a tough one. I mean, that's not something you can --

12 MEMBER SIEBER: Well, you do that almost

13 by feel or some statistical analysis of the

14 probability of finding the failures.

15 DR. SHERON: But, I mean, for example, we

16 changed the ECCS code back in, what was it, '90 or '89

17 or '88, what I call statistical loading.

18 You know, Westinghouse was the only one

19 that took advantage of it. The other vendors, you

20 know, didn't because they didn't need the margins.

21 MEMBER SIEBER: That's right.

22 Westinghouse was always the one that was --

23 DR. SHERON: Yes. B&W was far away from

24 22. They just didn't help that many.

25 MEMBER SIEBER: You may find that in your

1 revised incumbent space, too. Just one vendor is
2 going to pay for it.
3 DR. THADANI: All right. Moving on. And
4 I think we had some discussion of this, centers of
5 excellence and somewhat negative experience that
6 brought us back. But I would think the Committee
7 would certainly want to at least give it some thought
8 and see where --
9 MEMBER ARMIJO: Was that supposed to be
10 discussed?
11 CHAIRMAN POWERS: The question that you
12 posed at the beginning, where you said define areas
13 where there are unique agents and needs for long
14 involvement, that is the future of our report.
15 Right now we have it written down. It
16 says, "Gee, the agency will for the foreseeable
17 future, which we kind of define as 20 years. Need
18 expertise in the area of fuels, neutronics, and PRA."
19 Those are the ones we wrote down.
20 We went on and said they have ongoing
21 challenges in the area of materials and thermal
22 hydraulics. Okay? The other research activities that
23 we identify, we still get at particular issues that
24 they are confronting now presumably get solved.
25 One of those was digital I&C. You know,

1 presumably that gets solved and you don't have an
2 ongoing need. That may be incorrect because the
3 digital I&C world refuses to remain very constant.
4 And certainly we had had the issue of
5 wireless transmissions through the plants come up.
6 And I presume over the next 20 years, there will be
7 others. So maybe we're wrong about digital I&C, but
8 in the area of fuels, neutronics, and PRA, PRA because
9 the agency is tied to this regulatory system to get
10 the information, so they never get out of that
11 business, fuels and neutronics because our reactors
12 don't run without fuel and the agency is pretty much
13 looked at as being in an area that will have an
14 expertise in fuels and neutronics, no matter what. I
15 mean, it's not just the public. It's the other
16 government agencies that look to NRC to have an
17 expertise in those areas.
18 So the question comes up that I pose, have
19 we identified the right subset as enduring needs for
20 the technical capabilities that the NRC needs to have
21 in its research program, almost regardless of what
22 applications come in?
23 DR. THADANI: On my list, I added seismic.
24 CHAIRMAN POWERS: Seismic because of the
25 --

1 DR. THADANI: Things have happened that
2 there are questions raised about whether we have by
3 way of ground motion models hazards. Are there issues
4 of instrumentation in the right places? There is some
5 interest in things coming out of the Japanese
6 experience.
7 Is there a core someplace that you can say
8 really has a good capability to take information and
9 assess it and come back and say, "Yes. We" --
10 CHAIRMAN POWERS: I mean, seismic is a
11 very interesting issue because i's the vulnerability
12 of all these advanced plans.
13 DR. THADANI: Yes, yes.
14 CHAIRMAN POWERS: The reason I have been
15 reluctant to call that a core competency is because
16 there's a belief on my part, no matter -- perhaps
17 erroneous, but it's a belief on my part. The agency
18 has a seismic issue come up.
19 There are about 11,000 body shops in
20 California in Berkeley Laboratory that they could call
21 up and say, "Send me your best guy and help me out
22 here" and be confident that that person was not
23 conflicted with a licensee.
24 DR. THADANI: If you paid them, say,
25 $50,000 a year, you'll have a place at the table and

1 they will listen to you.

2 CHAIRMAN POWERS: Yes. Well --

3 DR. THADANI: Give you some --

4 MEMBER SHACK: I think Dana's bigger point

5 is that seismic is a widely -- you know, neutronics

6 only matters to us.

7 DR. THADANI: Yes.

8 MEMBER SHACK: Seismic matters --

9 DR. THADANI: Fuels is us.

10 MEMBER SHACK: Fuels is us. Seismic --

11 DR. THADANI: I agree. I agree.

12 MEMBER SHACK: -- the whole world worries

13 about.

14 CHAIRMAN POWERS: And the breakthrough is

15 in understanding and whatnot are likely to come

16 someplace else. And the breakthroughs in

17 understanding in neutronics are going to be within the

18 nuclear industry and things like that. That's how I

19 went about the plan.

20 I mean, I agree with you. To my mind, the

21 agency is hooked into some serious seismic work with

22 these advanced plans because when they come in and

23 say, "I have a 10^{-8} CDF," I break into laughter

24 because I know they can't survive a 10^{-6} earthquake

25 with 90 percent probability because that's an

1 earthquake that's undesignable because of the
2 uncertainty in seismic things.
3 DR. THADANI: Hearing that, there might be
4 some interesting insights coming. Brian probably
5 knows more than I do, but the Japanese are responsive
6 to various --
7 CHAIRMAN POWERS: Yes. I will put in some
8 advertising on this and substantiate my point here
9 that there do seem to be some active investigations of
10 that earthquake.
11 DR. THADANI: Yes.
12 CHAIRMAN POWERS: And the American Nuclear
13 Society is sponsoring a panel discussion of the
14 factual observations at its June meeting and a paper
15 session on it at its winter meeting on it.
16 The panel will be made up of four
17 contracting firms, seismic engineering firms, that
18 have looked at it, presumably will prepare, will just
19 observe what is expected. And my understanding is
20 that that's surprisingly large discrepancies between
21 what we expected based on the IEEE and what was
22 actually observed.
23 DR. SHERON: I would just say that I think
24 I wouldn't say seismic but I would say the ologies
25 were fundamental --

1 CHAIRMAN POWERS: Theologies?

2 (Laughter.)

3 DR. SHERON: No, not theologies. What

4 Jack Rosenthal told me a long time ago when I was in

5 C3 reactor systems, he came in my office one day. He

6 said, "This agency doesn't need any more engineers and

7 scientists. We need more priests and rabbis."

8 (Laughter.)

9 DR. AHEARNE: You already had some?

10 DR. SHERON: Apparently. But I would

11 agree that seismic issues as long as I have been in

12 the agency continue to rear their head. As you said,

13 there are a lot of people on the West Coast. Okay?

14 And they're all studying earthquakes. And they're

15 learning new things.

16 And so, for example, we can mark out

17 GSI-199, which is to reevaluate the seismicity down by

18 the New Madrid area and everything. What does that

19 mean? Okay. Do we have to take any action with the

20 operating plant? So these issues continually come up

21 and the like.

22 The groundwater issue with the tritium, my

23 staff has been -- I have been getting e-mails from the

24 regions. They're just in love with my staff because

25 they're the only guys who understand groundwater and

1 can talk about how tritium migrates and why it is or
2 isn't a problem. You know, I'm kind of thankful that
3 we had the expertise that could support the regions.
4 DR. THADANI: But it's leaving soon.
5 DR. SHERON: What?
6 DR. THADANI: It's leaving soon.
7 DR. SHERON: But I'm just saying that
8 these kind of issues just continually -- you know,
9 especially as plants get older, as these buried pipes
10 leak, these are issues that we have to deal with.
11 MEMBER SHACK: I mean, you do have a
12 seismic program that seems to be trying to stay aware
13 effectively of developments. You know, it seems to me
14 active and at all focused that way that if you're not
15 actually doing the research itself, they're certainly
16 staying abreast of whatever is going on out there.
17 DR. THADANI: You notice one of the charts
18 we used earlier about current capability and where
19 it's likely to be in a matter of a few years? That's
20 the issue. A whole bunch of technology is going to
21 leave the agency.
22 CHAIRMAN POWERS: If I could just
23 interject? If somebody could talk to me about that
24 tritium experience you have? I think that's something
25 we might want to highlight in our research report,

1 your ability to respond to that.

2 DR. SHERON: Yes. Do you know Bill Ott?

3 CHAIRMAN POWERS: Bill?

4 DR. SHERON: Ott. I can have him call you

5 or --

6 CHAIRMAN POWERS: If you would, I mean,

7 just pointing out your capabilities?

8 DR. SHERON: Yes. Actually, that's an

9 area of concern because most of that branch has been

10 involved in decommissioning. And that was an area

11 that got whacked in the budget.

12 It may be that that branch is going to get

13 broken up because I just don't have work for it

14 because FSME pulled back the decommissioning funds.

15 They're not going to have user needs, and they're not

16 going to have a need for the work. I don't have any

17 work to give them.

18 DR. THADANI: You can talk to John. Next

19 to you, he can talk to the Commission, saying, "You

20 should move research to research organizations." You

21 have that, John?

22 DR. SHERON: But I'll have Bill give you

23 a call.

24 CHAIRMAN POWERS: Thank you.

25 DR. THADANI: All right. I'll put up the

1 next one. It's again a personal thinking that
2 Chairman Klein has given lots of speeches, saying that
3 for future reactors, we have to think really globally.
4 Manufacturers are all over the world.
5 And he has said -- I am just quoting him
6 from his public statements -- that that the
7 international community should come together and work
8 towards common safety principles.
9 My sense is that for lightwater reactors
10 and giving the timing and so on, it's probably not a
11 practical consideration. On the other hand, if we're
12 really talking 10 to 20 years from now, some
13 non-lightwater reactor science, research has an
14 initiative of technology-neutral framework, for
15 example, that sort of approach, which is fairly
16 high-level safety principles, can key countries come
17 together, countries that design and sell reactors, if
18 you will? Can they come together to develop from
19 regulators' perspective now what are some high-level
20 safety principles that these designs should satisfy?
21 There are three tiers to this. So this is
22 high-level safety principles; light technology-neutral
23 framework; but then you get to technology-specific
24 considerations, where you would need more standards
25 and guidance and things of that sort. Can that be

1 done internationally? It's not clear. IAEA would
2 certainly say yes.
3 Then the third part is we sort of talked
4 about a little bit this morning when we talked about
5 industry's tools, regulator's tools, and somebody
6 else's tools. Does it make sense for the
7 international community to agree and say, "Well, let's
8 take our different tools and see if we can't do some
9 verification and validation of these tools?" to say,
10 "Yes. We're sort of in the same ballpark. We're not
11 too far off"?
12 So what I do in France, I do some work
13 using code X, but you can have some certain level of
14 confidence. And you may not want to repeat what I do.
15 So should research organizations be
16 thinking about such things and saying, "You know, yes.
17 Maybe at some pace we can begin some dialogue"? My
18 motivation in this was I have been supporting NRC in
19 multinational design evaluation program.
20 That program, three phases, first phase
21 was the EPR at Finland. Three countries, Finland,
22 France, and U.S., identified selected areas and said,
23 "We'll sort of review together and learn from one
24 another, see what comes up."
25 Phase 2 took it one step further. The

1 charter of phase 2 was to see beyond what was done on
2 phase one what areas the multinational group -- in
3 this case it's ten countries -- are there areas where
4 they can least understand what their requirements are?
5 Are there areas where cooperation could go forward and
6 even to the extent of just using one's countries
7 results or whatever work they had done? And it also
8 had the longer-term perspective of if you go to
9 Generation-IV, can we establish common safety
10 requirements?
11 The thinking in the Commission, Gary just
12 told me the Commission pretty much has agreed on the
13 next set of areas of cooperation between a subset of
14 the ten countries.
15 When the Commission has not yet come back
16 to the staff with a clear guidance, it's just this
17 area. So the thought process here is, can research be
18 doing something such that after Commission approval
19 they can perhaps say in five or ten years from now,
20 "We think we would be able to go get this common
21 understanding and maybe even convergence of safety
22 requirements"?
23 Remember, this doesn't have anything to do
24 with the issue of licensing process and individual
25 country decisions. It stays purely on the technical

1 side.

2 If I read the Chairman's speeches, I sense

3 that he would like to see the agency get there. But

4 it's a complicated, tough process. Fortunately,

5 research has done a lot of work on the project. It

6 can be a starting point. I know some countries

7 wouldn't agree.

8 So the point here was to get there ten

9 years from now, can we get started on some activities

10 in the next few years, three years so that in ten

11 years or so, we have a chance of success or failure,

12 for that matter? It just didn't work. We tried it.

13 It didn't work. That's the top here. And I wish the

14 regulatory side of the house was here.

15 For your information, Gary and I have

16 known each other a long, long time. We have discussed

17 some of these issues. And his sense, as I read it, is

18 that maybe for non-lightwater reactors, but he also

19 has some concerns about considering this for

20 lightwater reactors, for obvious reasons.

21 So, with that background, I am looking for

22 some views the Committee might want to consider.

23 DR. AHEARNE: What would be the long-term

24 advantage?

25 DR. THADANI: That's a constant.

1 Long-term advantage would be, of course, U.S.-designed
2 plants can be bought by country X without what seems
3 to be happening now, which is, "Well, we have
4 questions about your requirements. Why is it for" --
5 DR. AHEARNE: Okay. What you are saying
6 is that you would like to set up an internationally
7 agreed licensing set of standards. The only way you
8 are going to do that is it's going to have to be
9 sufficiently flexible so that the country that adopts
10 a tougher standard can find it in there and a country
11 that wants a weaker standard can also use it.
12 As you know, for many years, the standard
13 was the NRC's regulations.
14 DR. THADANI: Yes. Was. Was.
15 DR. AHEARNE: And if a plant met the NRC's
16 regulations, then most countries would accept it as
17 being acceptable.
18 DR. THADANI: Right. Here is the
19 situation. If you look on the multinational design
20 evaluation program, one of the questions was what are
21 your requirements, both deterministic and
22 probabilistic? Now, I'll just use that as an example.
23 And we can go to QA and other things.
24 But what at least from the countries that
25 participated in the exercise, by and large, I would

1 say, the deterministic requirements were pretty
2 similar, by and large. But there were differences in
3 all of those considerations, particularly when the NRC
4 in their design certification stated that the designs
5 have to meet the core damage frequency of 10^{-4} for the
6 reactor.
7 What you find in the expectations of the
8 countries that participate in this exercise is that
9 the core damage frequency should be 10^{-5} per reactor
10 year or less.
11 See, the difference is this, my personal
12 view again. Our requirement as laid out appears to --
13 DR. AHEARNE: I see that part.
14 DR. THADANI: But when you go to the
15 designs themselves, there is another slot in the 10^{-5}.
16 But estimated core damage frequency is less than 10^{-5}.
17 DR. AHEARNE: For example, one of the
18 things that comes to mind, right now, as we all know,
19 there is a big emphasis in the U.S. regulatory world
20 for what do you do about terrorist attacks. I don't
21 pick up that same attitude in some of the other
22 countries.
23 MEMBER SIEBER: I mean, some European
24 countries, it's even worse.
25 DR. THADANI: Yes. I was going to say I

1 don't know how much we can say.

2 DR. AHEARNE: I didn't detect in the

3 discussions with my Japanese colleagues the same

4 level.

5 MEMBER CORRADINI: So are you saying,

6 John, it might be easy to get a minimum set of

7 standards?

8 DR. AHEARNE: Yes.

9 MEMBER CORRADINI: It may be necessary but

10 not sufficient.

11 DR. AHEARNE: Right, yes. That's fine.

12 I think that's what I'm trying to say.

13 DR. THADANI: But I don't know about that.

14 I agree with --

15 MEMBER SIEBER: Europeans, for example.

16 DR. AHEARNE: And I also haven't seen that

17 much in the Russian standards either.

18 MEMBER BONACA: What I thought is, you

19 know, you want to match the differences to the past 20

20 years that have been caused by commercial things. I

21 mean, you know very well that there have been ways of

22 introducing technical requirements as a means of

23 excluding somebody from the table. Okay? It is a

24 common thing.

25 I would like to ask, you know, what

1 specifically you make of that. But do you believe
2 that country X will ever buy any ESBWR? They will try
3 to sell a design and --
4 MEMBER SIEBER: They will get pulled by
5 the U.K.
6 MEMBER CORRADINI: No, they won't. No,
7 not even then.
8 DR. THADANI: As long as you understand --
9 MEMBER BONACA: So there are issues like
10 that, too, with that.
11 CHAIRMAN POWERS: Ashok, let me ask you
12 this question. Finland, who just bought an EPR, is
13 trying to construct and even contemplating buying a
14 couple of more. And so, I mean, that's a market.
15 It's a market which I don't believe any U.S. firm
16 chose to bid on.
17 DR. THADANI: No, no.
18 MEMBER ARMIJO: The first one, yes, was
19 open.
20 DR. THADANI: The first one was open.
21 MEMBER ARMIJO: The first one was open.
22 There were ABWR --
23 CHAIRMAN POWERS: The AP-1000 did not.
24 DR. THADANI: I know.
25 CHAIRMAN POWERS: And so my question is,

1 why did the AP-1000 not choose to bid? And was it
2 because of the safety requirements? You know, were
3 the safety requirements sufficiently different in
4 Finland to preclude AP-1000 from bidding on it?
5 DR. THADANI: You know, I don't know for
6 sure, but some probably, some factors. I don't know.
7 Finnish requirements are pretty stiff,
8 pretty stiff requirements, more so than some of our
9 requirements in this country. The other thing is the
10 Finnish are at a very theoretical stage of just
11 requirements, not the implementation of the
12 requirements because people do different things.
13 The other issue certainly has been -- John
14 has raised it -- security issue. The Finnish prepared
15 a rule which on paper looks very challenging. The
16 aircraft of certain size, certain velocity, the plant
17 has to be able to withstand that.
18 CHAIRMAN POWERS: Right.
19 DR. THADANI: I personally don't know what
20 factors draw Westinghouse to not fight for that, you
21 know, potential sale to Finland. But the Finns have
22 pretty -- I have seen. They have even probabilistic
23 standards tougher than 10^{-5} core damage frequency.
24 MEMBER SIEBER: Security issues.
25 DR. THADANI: That's the reason I can't

1 say too much.

2 MEMBER SIEBER: We shouldn't get into

3 detail, but I understand it.

4 DR. THADANI: Yes. I'd better stop.

5 MEMBER CORRADINI: There's a different

6 coach.

7 DR. AHEARNE: Ashok, when you have

8 validation-verification, are you talking about

9 baselining codes one country to other?

10 DR. THADANI: Yes.

11 DR. AHEARNE: That takes care of the

12 validation. Verification requires experimental data.

13 DR. THADANI: Yes, yes. If the countries

14 agree to go down this path, they will have to set up

15 standard exercises. They will have to have

16 experimental facilities there. It's not a cheap

17 process.

18 CHAIRMAN POWERS: It's a big deal.

19 DR. THADANI: It's a big deal, yes.

20 MEMBER ARMIJO: And that's gets back to

21 John's original question. What do you get for all of

22 this effort? I don't see a prize at the end. I think

23 the commercial issues should be left to the commercial

24 guys.

25 DR. THADANI: No. You see, I think it's

1 a cost-sharing issue. I think in the end, you can
2 have increased confidence in your own tools. And you
3 may actually find that you were wrong. I'll give you
4 an example. I'll give you an example.
5 About six years ago, there was an
6 exercise, standard exercise. I was in France,
7 presentation being given by nine countries. And it
8 was amazing, actually amazing, that nine countries
9 resolved on this particular front. They were not too
10 bad. They were not too far off. I mean, there were
11 differences, but generally I was sitting. I was very
12 surprised.
13 The thing was the tenth country that
14 actually did the experiment put up the data. Guess
15 what? Nine were wrong. Okay? And so there may well
16 be some benefit to having this international
17 cooperative effort.
18 MEMBER ARMIJO: On specific issues,
19 specific problems, I can see where it is very
20 valuable, but just across the board --
21 DR. THADANI: They do it on pieces. You
22 see, that's what CSNI does basically. There are a
23 whole bunch of standard problems. They're up to like
24 50-something, something like that, a whole bunch of
25 standard problems. It depends on what countries want

1 to participate in that for that piece.

2 And part of this exercise is to go back,

3 step back, and look at some of that work and see, did

4 we learn, really.

5 MEMBER BONACA: Well, I mean, one

6 advantage, of course, would be the one of recouping

7 some credibility maybe in part of the lot. I mean, I

8 have heard things, people claiming that the U.S.

9 plants are as bad as the Russian plants. This was

10 like 10-15 years ago.

11 You know, those are flat statements that

12 clearly have no basis in many ways. And it would help

13 in trying to correct some because that translates

14 itself into opinion and then the advantage of the

15 market.

16 So there would be some advantage in that.

17 I'm not sure there would be an advantage from a

18 service standpoint. It would be more like reputation,

19 credibility, and all that kind of thing, which are

20 important, too, in the long run.

21 MR. HILL: One thing, I don't know if

22 everybody is aware of it, but there is some of this

23 already going on for non-LWR systems. In the IAEA

24 context, we're already participating in a benchmark

25 which is a natural circulation test that was done in

1 Monju before it shut down.

2 And there is another one with IAEA going

3 on, which is on shutdown experiments in Phoenix that

4 are going to take place next year. And both of these

5 are validation and verification because they are both

6 many different countries' calculations and a

7 comparison of them, but they have an experiment that

8 is being compared to where they have actual data.

9 DR. THADANI: This is working with IAEA?

10 MR. HILL: Correct.

11 DR. THADANI: In fact, that is an

12 interesting point you make. And in the context of

13 this issue, there has always been this question of

14 when can we benefit from, what is the role of NEA or

15 do they have a role, does IAEA have a role?

16 And many of you know the tensions that

17 exist between two organizations. But NEA, a great

18 deal of capability in scientific research. IAEA less,

19 is there a sense here that the future -- again, we're

20 talking about non-lightwater reactors, if you will.

21 It's in the context of question number 6,

22 addition number 6. Is there a role for IAEA and NEA?

23 And if there is, what is that role? Historically

24 research has been more from here, more involved with

25 the NEA and less so with IAEA until now in

1 non-lightwater reactors, it seems to me maybe IAEA is
2 doing a lot more than the NEA.
3 MR. HILL: I think there is still some
4 truth to thee statements you have, but the IAEA work
5 tends to be a little bit more shallow and not as
6 in-depth. But I think a lot of why it's got something
7 going in the LMR technology is because there are some
8 countries involved that are not part of the IAEA. And
9 they're driving something else.
10 DR. THADANI: I've seen some of the best
11 scientists in 18 years from various countries tend to
12 gravitate towards I think CNSI, in particular. And,
13 of course, they have the Nuclear Development Committee
14 as well.
15 MEMBER BONACA: Well, from what I hear,
16 IAEA is -- in the sense that you have hundreds of
17 countries there. And just everybody wants to have a
18 say. And even if they don't have any problem
19 eventually --
20 DR. THADANI: This is probably in the
21 context of the Nuclear Development Committee in IAEA,
22 I assume. Right? Well, with this, go back to Dana
23 and --
24 CHAIRMAN POWERS: Okay. Well, thank you,
25 Ashok. Thank you all. Do the members have any

1 comments they would like to make?

2 MEMBER BONACA: No. Just thank you to our

3 panelists and your assistants.

4 DR. THADANI: Answers were to come from

5 that side.

6 (Laughter.)

7 MEMBER SHACK: The questions are

8 important.

9 MEMBER SIEBER: So are the answers.

10 (Laughter.)

11 CHAIRMAN POWERS: I note that we have

12 disposed, I think, of the issue of the center for

13 manpower and whatnot to develop a response to the

14 Commission for the digital electronics and man-machine

15 interface. The research has developed a response to

16 that, to the Commission on that idea. And so it would

17 be useful if you could telegraph to us what your

18 response is.

19 DR. SHERON: Well, the paper is not

20 actually -- I think we got an extension. I think it's

21 not actually due to the Commission until February.

22 CHAIRMAN POWERS: February?

23 DR. SHERON: The staff did brief

24 Commissioner Lyons this afternoon at 2:30. I don't

25 know if they're still alive. He was an advocate of

1 this. I will find out more when I go back up to my
2 office.
3 MEMBER SHACK: That's why you're here.
4 It's better than being there.
5 (Laughter.)
6 DR. SHERON: But that paper won't go up
7 probably until February. And, as I said, there's a
8 paper that should go up in January outlining the plans
9 and so forth for advanced non-lightwater reactors.
10 That would form the basis for a Commission meeting,
11 which I think now is scheduled for February 20th.
12 CHAIRMAN POWERS: The reason I ask for
13 some telegraphing on that is that I felt an obligation
14 to respond to the Commission concerning that idea. I
15 was not a proponent of the idea. And so I developed
16 a noncommittal response. And I would like to make
17 sure that it is not orthogonal to yours.
18 DR. SHERON: I don't think so because I
19 think we were -- well, I was a bit skeptical that we
20 could support. And one of the reasons, obviously, is
21 that if you look at our digital I&C research plan,
22 most of the work that's identified in there finishes
23 up by the end of '09.
24 If we were to even start to think about
25 such a facility, unless there was some miracle, it

1 would have to be, as a minimum, with '10 funding. And
2 then that would just start us in terms of we would
3 have to go out for proposals and all of this other
4 stuff.
5 So if you did want to have some kind of a
6 center, it probably wouldn't be up and running until
7 2011 and 2012 or something like that. As I said,
8 beyond 2009 we haven't really identified other than
9 maybe looking at some of this wireless stuff any real
10 digital I&C issues specifically. Okay?
11 There may be some that come up, but if
12 somebody said, what is this facility going to work on
13 and do, I would have to say, "I'm not sure yet."
14 Okay? And that's kind of tough when you're asking for
15 several million dollars probably.
16 CHAIRMAN POWERS: Well, I had similar and
17 other reasons to be less than enthusiastic about it.
18 DR. SHERON: We do have a proposal. And
19 I don't know if it's possible. I mean, you know, if
20 you want to get a brief or the Subcommittee wants to
21 get a brief from the staff on where we are and what we
22 heard from the two workshops because, really, that is
23 what is forming a lot of our basis, we would be glad
24 to do that.
25 CHAIRMAN POWERS: Maybe just tell me who

1 to chat with about that so I can make sure our words
2 don't walk on your words.
3 DR. SHERON: Okay. Rick Croteau. Do you
4 know Rick? He's Jennifer Uhle's deputy.
5 CHAIRMAN POWERS: No.
6 DR. SHERON: And then Russ Sydnor, who is
7 the Chief of the Electrical Engineering Branch.
8 CHAIRMAN POWERS: Oh, okay. Yes.
9 DR. SHERON: They would be the two people
10 I would recommend.
11 CHAIRMAN POWERS: Okay. I don't want a
12 conflict, and I didn't have it.
13 The other issue that comes clear in the
14 presentation is that there is a tension that develops
15 between a call for increased collaboration and still
16 maintaining an aura of independence. And I haven't
17 come to a clear understanding in my own mind when
18 we're independent and when we're not.
19 I have always been a strong supporter of
20 the memorandum of understanding, which I think, Ashok,
21 you actually signed, between you and EPRI that said
22 that collaboration on experiments was a useful thing
23 to do. But the interpretation and analysis of the
24 data would be done independently.
25 Now when you talk about collaborating on

1 those things via the models and whatnot, I don't see
2 how that contributes to the image of an independent
3 analysis. And I struggled more with that because I
4 think you do have an obligation to persuade the public
5 that you are providing for adequate protection in an
6 independent fashion. So that remains a struggle for
7 me in here.
8 DR. THADANI: Just to clarify, when I
9 talked about verification and validation, I was only
10 talking about the regulators, international
11 regulators. That's all, not for this.
12 DR. SHERON: If I could just interject on
13 collaboration? I agree with exactly what Ashok's
14 philosophy is we're following. And that is that you
15 draw the line on the experimental data.
16 It's fine to get collaboratively
17 experimental data. You should go off and analysis it
18 and evaluate it and draw your conclusion from it
19 separately.
20 We don't collaborate our developing models
21 or anything like that, but what we do is obviously if
22 we run our model and the industry runs theirs and we
23 get totally different results, we want to understand
24 why. And so we will work with the industry to
25 understand those differences.

1 And if we do one of these and be "Oh,
2 geez, we didn't think of that" or they go "Oh, geez,
3 we didn't think of that," where many times, it's like
4 "Okay. We agree to disagree, and we'll go our
5 separate ways." I think we had that on seismic
6 response directors some time ago with that where we
7 just couldn't reach agreement. And there were some
8 months of your accidents, as I'm sure you remember.
9 So, I mean, we don't collaborate on
10 developing models, but we certainly want to understand
11 if there are major differences in our predictive
12 capabilities to understand why there are differences
13 and at least to be able to explain.
14 CHAIRMAN POWERS: Okay. Well, thank you.
15 Thank all of the panelists. And I'll adjourn this
16 Subcommittee meeting.
17 (Whereupon, the foregoing matter was
18 concluded at 4:47 p.m.)
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25

CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: n/a

Location: Rockville, MD

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

Eric Mollen

Eric Mollen
Official Reporter
Neal R. Gross & Co., Inc.

1218 NRC 1916

Advisory Committee on Reactor Safeguards
Safety Research Program Subcommittee Meeting
Rockville, MD
December 18, 2007

due COB
TH 12·27

- Proposed Agenda –

Cognizant Staff Engineer: Hossein Nourbakhsh (301-415-5622, hpn@nrc.gov)

	Topic	Presenter(s)	Time
	Opening Remarks and Objectives	Dana Powers, ACRS	!0:00-10:10 am
I	Remarks by Members of the Panel	John Ahearne, NERAC Jim Dyer, NRR Gary Holahan, NRO Tom Miller, DOE Robert Hill, ANL Alex Marion, NEI Brian Sheron, RES Ashok Thadani, ACRS Consultant	10:10 am-12:30 pm
	Lunch		12:30-1:30 pm
II	Discussion	ALL	1:30- 3:30 pm
	Break		3:30-3:45 pm
III	Discussion	ALL	3:45-5:00pm
	Adjourn		5:00 pm

Notes:

- Presentation time should not exceed 50% of the total time allocated for a specific item.
Number of copies of presentation materials to be provided to the ACRS - 25.

Global Nuclear Energy Partnership (GNEP)

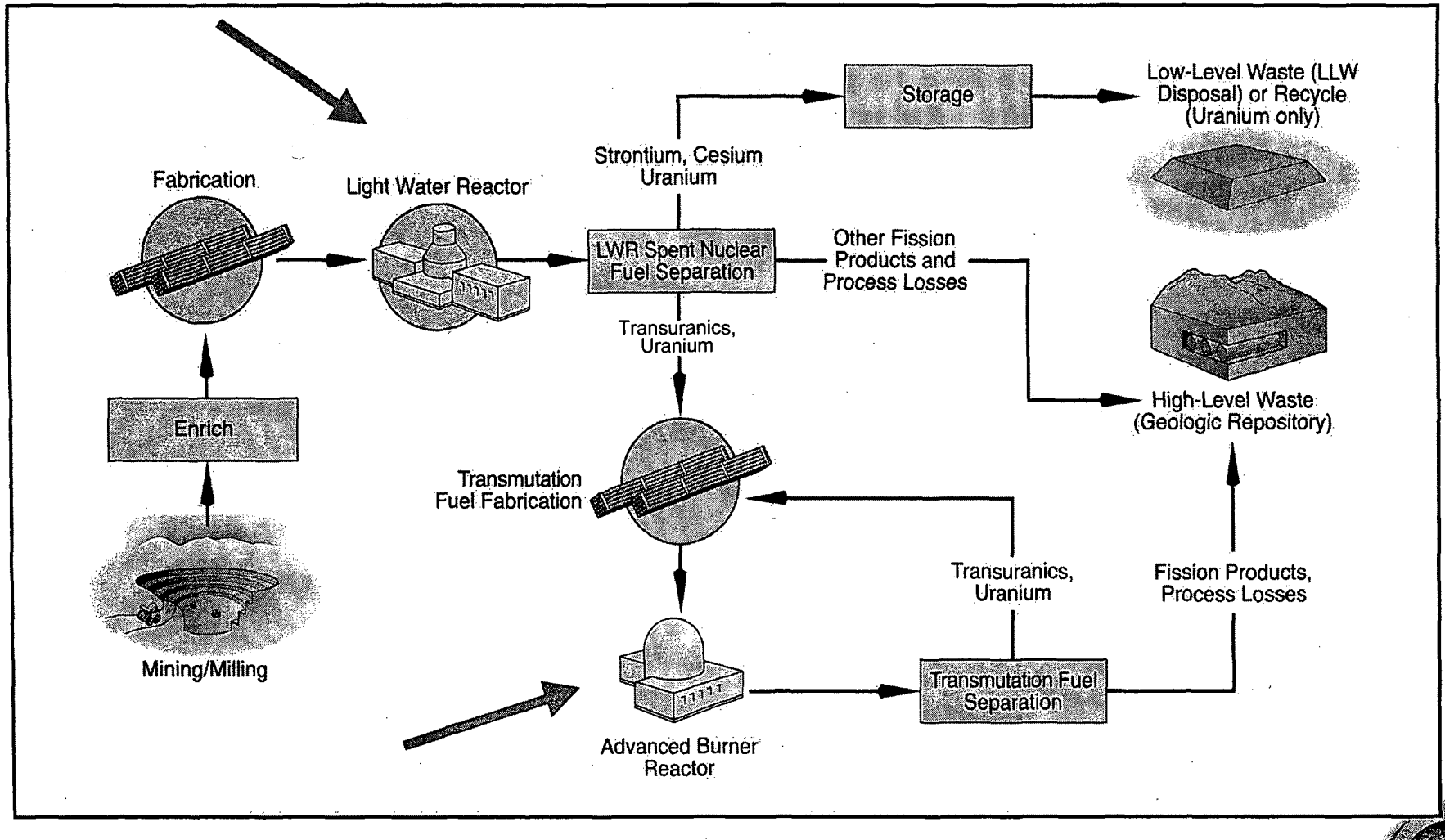
Non-LWR Research and Development Discussion

Robert N. Hill

GNEP Reactor Campaign Director

ACRS Safety Research Subcommittee Mtg
December 18, 2007
Rockville, MD

GNEP Closed Fuel Cycle Strategy



Three Main Technology Components

- **Advanced Separations**
  - Improved waste management
  - Proliferation resistant approach (e.g., no separated Pu, safeguards)
- **Advanced Fuels**
  - New fuel forms with recycle materials
- **Advanced reactors**
  - Fast spectrum for repeated recycle
  - Cost reduction through technology innovations and optimization
  - *Less reliance on active safety/control systems*
  - *Improved margin to severe accident progression*

- **Modeling and Simulation Crosscut**
- **Regulatory Crosscut**

Advanced Modeling and Simulation

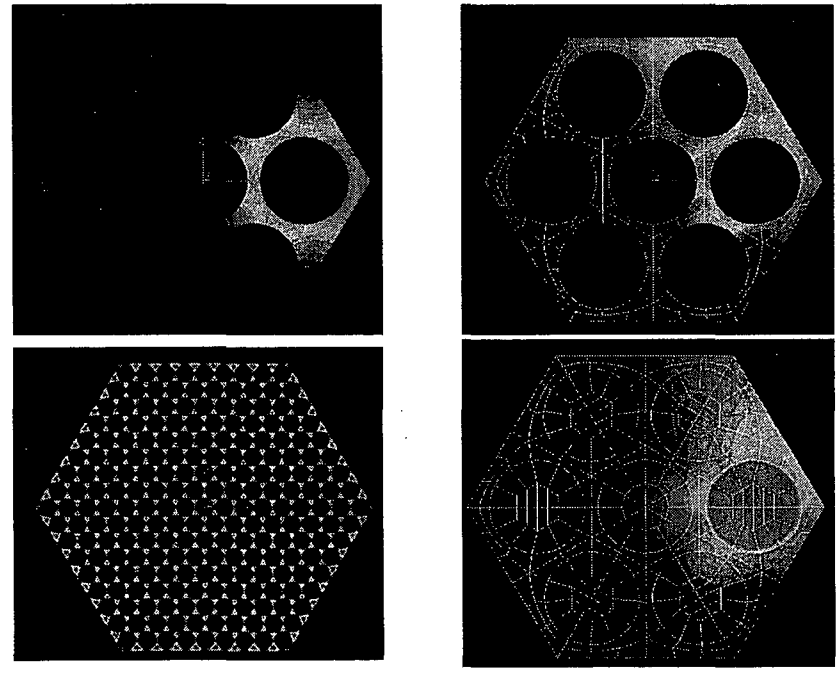
Simulation research has different character for each area

- **Separations**
  - Plant modeling tool for optimizing layout
  - Relies heavily on chemistry experimental approach
- **Fuels**
  - Goal is significant improvement in modeling and predictive ability
  - Can help to focus and supplement testing experiments
- **Reactor**
  - Predictive models are backbone of reactor design/analysis
  - Improved fidelity and reduced calibration with advanced methods
  - Useful for both design optimization and reduction of uncertainty for reactor performance and safety behavior

Fast Reactor Simulation Example

Comprehensive simulation covers wide range of scientific disciplines:

- **Reactor Physics**
- **Thermal Fluid Dynamics**
- **Structural and Mechanical Design**
- **Diverse Materials Failure Modes**
- **Transient and Accident Analysis**
- ***Fuel Behavior***
- **Coupled Reactivity Feedbacks**



Several concurrent approaches:

- **Improved modeling**
- **Validation**
- **Integration into a design tool**

Scope of GNEP Regulatory Crosscut

- **Regulatory Framework**
  - Assess and Maintain Requirements & Criteria
  - Evaluate Guidelines
  - Develop Regulatory Approach
- **Regulatory Technology Assessment**
  - Assess state of safety technology and determine gaps
    - *Data Mining: Experiments & Testing*
    - *Modeling and Simulation Tools*
    - *Design Integration & Analysis Methodologies*
    - *Advanced safeguards and security instrumentation and technology*
    - *Training*
- **Confirm Safety, Security, and Safeguards of GNEP Facility Designs for DOE**
- **Make Capabilities available to NRC & Industry**
  - Qualified Staff, Training, Data, Computational Codes

A Few Observations on Regulatory Status

- The facility licensee would conduct safety and security assessments as part of their design effort in order to obtain construction authorization
- Regulatory frameworks for fast reactors and reprocessing facilities have not been exercised in a long time
- The state of the data and methods for regulatory assessments is not well characterized at this point in time
- Obtaining construction authorization for commercial facilities could require significant effort

Recommendation #1: Knowledge Base

- **NRC needs to develop in-house capability for technical assessment of new (non-LWR) technologies**
  - Chemical separations (advanced aqueous and dry)
  - New fuel forms (FR oxide, metal, TRISO)
  - Coolant (sodium, helium, heavy metal alloys)
  - Component performance and failures (advanced energy conversion)
  - Integrate reactor systems response to off-normal conditions
- **For many, the operating regime is quite different from conventional LWR technology**
  - Coolant pressure and phase regime
  - Operating temperatures and power density
- **A general approach for application of risk-informed assessment to less mature technology (how apply PSA with less data?)**

Recommendation #2: Safety Assessment Tools

- **Some form of independent assessment capability required to perform the regulatory role**
  - Traditional approach was to develop independent tools
  - Utilization of advanced simulation techniques may be advisable
    - *Adaptation of modules for safety assessment*
    - *Knowledge base for utilization of new tools*
  - Independent analysis team must be equipped and trained
- **The specification of standard, design codes, and regulatory criteria will rely on this capability**
- **A key issue will be validation of these assessment tools**
  - Assessment of safety margins
  - Useful experience for the training function noted above

Validation of Safety Assessment Tools

- **With modern computing capabilities, reliance on modeling and simulation for design and regulation will increase**
- **A key for successful application of modern simulation tools is a strong validation effort to confirm advanced methods**
  - Preservation and organization of existing experimental data
  - Early identification of any validation gaps
  - New validation experiments may be required
- **Direct inclusion of uncertainty evaluation and error propagation in analysis tools is recommended**
  - Existing formalization in some fields (e.g., reactor physics)
  - Limited database for others (e.g., fuel behavior, thermal modeling)
  - Introduce more predictive models to overcome limitations
  - Utilize advanced techniques for consistent uncertainty quantification

Summary

- **GNEP closed fuel cycle research will develop several non-LWR technologies for eventual licensing consideration**
  - Chemical separations
  - Advanced recycle fuels
  - Advanced reactors (currently SFR in GNEP and VHTR in Gen-4)
- **Key issues identified for NRC long-term research**
  - In-house knowledge base
  - Safety assessment tools
  - Regulatory practices and procedures
- **Specific issues for long-term research focus will as the product of development and application of these primary capabilities**
  - As observed, in practice, for LWR technology
- **International collaboration will also play an important role in the development and validation of advanced simulation tools**

Recommendation #3: Regulation Development

- **Another important NRC role is to establish the General Design Criteria (GDCs) for advanced non-LWR systems**
  - Shutdown limits
  - Heat removal requirements
  - Containment approach and technical limits
- **LWR criteria embodied in 10CFR50 Appendix A are not applicable in many situations**
  - More generalized top-level criteria would allow a translation to specific criteria for alternative reactor types
- **This work relies heavily on both the knowledge base and safety assessment capabilities**

U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

ACRS Subcommittee on Safety Research Program

Rockville, MD
December 18, 2007

Ashok Thadani
ACRS Consultant

OBJECTIVES

- Should a portion of NRC research activities be devoted to the development of the technical infrastructure that may be needed in the 10 to 20 year time frame and to the development of user friendly tools (taking advantage of the computing power) to support more effective and efficient line organizations' regulatory work?
  - Timely
  - based on sound technology and science
  - make maximum use of realistic assessments consistent with the state-of-the-art and the available data

OBJECTIVES (Continued)

- What should be the scope of long-term research that the agency should consider ?
  - What Should the research focus be on LWRs?
  - How long might it take to develop a technical infrastructure to support sound safety decisions on non-LWRs (e.g., Gas-Cooled Reactors, GNEP, GEN-IV) ? What non-LWR research should be undertaken?
  - Advances in technology (e.g., new materials, sensors, computing power) make it possible to further enhance safety (and improve economics). What areas may deserve long term research?

ASSUMPTIONS-1

- Use of nuclear power in the USA will grow over the next 20 years
  - light water technology will be dominant
  - reactors using non-LWR technology may be a small part of the NRC staff workload but may well require long term research to develop safety requirements and support future licensing decisions

ASSUMPTIONS-2

- Licensees will continue to seek to utilize the current margin that exists between operations and regulatory limits
  - Submittals will become more technically sophisticated and complicated. NRC tools would need to assure appropriate limits and margins are maintained

ASSUMPTIONS-3

- Nuclear power will become an ever more international field leading to greater collaboration in research

- Staffing at NRC will likely not grow at a rate commensurate with the growth of nuclear power

ASSUMPTIONS-4

- The average experience of NRC staff will decrease over the next decade and then stabilize at perhaps a level lower than it is today
  - matter of demographics
  - exacerbated perhaps by the competition for manpower within the nuclear community

DISCUSSION

- Do you agree with the objectives?
  - Should there be other objectives?
- Do you agree with the assumptions?
  - Should other or different assumptions be made?