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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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SAFETY RESEARCH PROGRAM SUBCOMMITTEE

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MEETING

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TUESDAY,

DECEMBER 18, 2007

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ROCKVILLE, MARYLAND

The subcommittee met at the Nuclear Regulatory Commission, Two White Flint North, Room T-2B1, 11545 Rockville Pike, at 10:00 a.m., DANA A. POWERS, Chairman, presiding.

MEMBERS PRESENT:

DANA A. POWERS, Chair

SAID ABDEL-KHALIK, Member

J. SAM ARMIJO, Member

MARIO V. BONACA, Member

MICHAEL CORRADINI, Member

WILLIAM J. SHACK, Member

JOHN D. SIEBER, Member

ACRS CONSULTANT:

ASHOK THADANI

ACRS/ACNW STAFF:

HOSSEIN NOURBAKHSH

Designated Federal Official

PANELISTS:

JOHN AHEARNE

GARY HOLAHAN, NRO

TOM MILLER, DOE

ROBERT HILL, ANL

ALEX MARION, NEI

BRIAN SHERON, RES

NRC STAFF:

DON CARLSON, RES/DSA

SAMANTHA CRANE, RES/DE

DON DUBE, NRO/DSRA

DON HELTON, RES/DSA

JOCELYN MITCHELL, RES/DSA

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

(10:13 a.m.)

OPENING REMARKS AND OBJECTIVES

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

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

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

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

Register notice. It is requested that speakers first identify themselves, use one of the microphones, and speak with sufficient clarity and volume so they can be readily heard.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting.

What we are doing today is responding to a request made by several members of the Commission to develop comments on the long-term scope and nature of research at the NRC.

In thinking about long-term research, I harken back to the words of Brian Sheron. And I'm very sympathetic to these words. Brian pointed out to us that if this were 1987, instead of 2007, he could come in here with discussions on how to dismantle the nuclear industry.

DR. SHERON: Actually, it was 2002.

CHAIRMAN POWERS: You don't even need to go back that far. And so the ability to forecast exactly what the research program will be working on is limited. My own interest is in how staff does its work for the NRC, rather than the specific things.

But in that regard, Ashok Thadani has put 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

know our functions. And you know its challenges and so on. So I think your views will be of great interest.

In particular, because of this forward look into 20 years, your involvement with NERAC will really, really bring some better understanding on our part.

Tom Miller. Tom Miller, of course, was well-known for a long time. Tom is Department of Energy, responsible for the lightwater reactor program there.

Gary Holahan. Gary I suspect all of you know is the Deputy Director of the Office of New Reactors. And I suspect he has a whole bunch of challenges ahead that he has to deal with. I think selective research can be of value to that organization, I expect.

Alex Marion. Marion from Nuclear Energy Institute will give us some strategic thinking in terms of what the industry thinks the future is going to hold. So the research will be of some real value for the country as we go forward.

Robert Hill is from Argonne National Laboratory. He is going to talk to us about GNEP and some aspects of Generation-IV designs. And, again, I

think that would be of some value.

I asked Robert if he can also touch upon GIF, the Generation-IV International Forum initiative, as to what is happening in the context of international initiatives.

With that, what I will do is to briefly go through some background. Background very simply is what is the objective of this effort and then what are some of the assumptions. That may or may not be appropriate but should be interesting in your views on that.

The first one is given the Commission request, 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?

There are two parts here that are important on that part of the sentence: infrastructure. By "infrastructure," what we mean is people's expertise, people who are knowledgeable and really understand those aspects of technologies and that they have ability to do analysis. That means they have analytical tools available to them.

And the third part of the infrastructure would be access to some place where they may need to

do some experiments to verify certain models. I say access because it could be national. It may be international. Some of the facilities may not be available in this country. And so that the infrastructure is basically the real talent in a technical area that might be of use to the agency.

The second part that is important there is that might be needed in a 10-to-20-year time frame. There might be different views as to why 10 to 20 years. Why not five to ten years? So any thoughts on that would be useful.

And then the second aspect of this objective is focused more on efficiency and effectiveness; that is, the computing technology. The power of computers is just going up and up and up.

Can one take many of these analysis tools, convert them to much more user-friendly fashion, give them to staff, for example, in the New Reactor Organization? For example, you can simplify PRA models. You can give that to 10 or 20 staff members who have some knowledge of PRA. They may be able to use these tools to do sensitivity studies to understand things perhaps a little bit better.

To what extent can one take advantage of this capability and simplify and provide information

to the reviewers now, technical reviewers in the line organization so they can get their work done perhaps in a more efficient and effective way?

The important considerations if one were to move forward in this direction certainly would be that whatever infrastructure is there, whatever tools are developed, the objective is that they will support timely decisions by the agency, critical timely decisions by the agency. And that would define the time line if one goes down this path. So when should one get started to be there to have the tools in time for appropriate decisions to be made?

I mean, it goes without saying that the whole idea of infrastructure is that it provides sound science and technology to the decision-making process.

Another element -- now, this is important. And over the last 30 years, the agency and the industry have moved more and more to try and understand what the margins might be and try to work towards cutting some margins as long as the end result is still adequate level of safety is maintained.

So the focus should probably be to make sure whatever infrastructure you have, that you understand what reality is, try to understand realism. My own experience tells me when you try to understand

what reality is, you end up needing more information and not less information.

But if you keep that in mind that realistic assessment is the goal, whatever margins are added, that's fine. At least try and understand the realistic outcome. Then that might be of some real benefit as we go down the road.

So what should be the scope of this long-term research the agency should, then, consider? First, we all know that the lightwater reactors are going to be around. They're going to be the dominant process.

But it may be that there may be some applications of non-lightwater reactors. The thought here is that if one has to address the issue of non-lightwater reactors, developing an appropriate infrastructure may be a long-term process.

People have talked about it might take a decade or so to develop an infrastructure to deal with non-lightwater reactors. It may or may not take a decade. It may take less. It may take longer. It would depend on various parameters.

Should one seriously consider some sort of non-lightwater reactor research? Should that be initiated, undertaken over the next 2 or 3 years

because we see that there is a potential need in the next 10 to 20 years?

The third element there applies to both the lightwater reactors and the non-lightwater reactors. The technology is moving on. I mean, there have been tremendous advances. I've given some examples here of some new materials, in fact, sensors, nondestructive examination techniques, and so on, which would very likely lead to enhancement in safety.

My own view is that they can also lead to improvement in economics if they use the new technology. The question is -- and wee can go through and if we have time this afternoon -- I have a list myself, but we can go through it -- are there some areas where it would be beneficial to be engaged?

The NRC research focus always got to be on safety. Vendors, designers have interests in economics. NRC's focus presumably would be to see if, in fact, these new technologies lead to simplification in design and/or these new technologies had new failure modes that one needs to understand. So there's an aspect that if the NRC were to move down this path the Commission would find some interest in.

So these are three we think fairly important issues. And it would be very useful if we

can get some thoughts from you. Some of the assumptions that largely are discussed among a few of us here, that nuclear power in the U.S. will grow over the next 20 years, lightwater reactor will be dominant.

There may be a small part in the staff workload in the non-lightwater reactor technology, but the more challenging issue if one were to go down this pathway would be -- it won't require long-term research to develop safety requirements and support future licensing decisions for non-lightwater reactors.

Second, I briefly touched upon this, that licensees are going to get more and more sophisticated. They're going to try and get more and understand what the expected outcome is going to be from accidents and try to tear away at some of the margins even further.

And these applications will probably be more demanding than some of the earlier ones, which were fairly straightforward, even if they have significant margins. One would expect if it continues, that the challenges to the staff might significant in terms of being able to approve such changes.

The third one is fairly straightforward. Nuclear power will become ever more international. NRC actually I think has done a great job. NRC has a whole bunch of bilateral, multinational, or international, the various programs ongoing for large international, multinational design evaluation program that Gary is involved in, Chairman Klein has been very engaged in, various components of manufacturing different parts, just the world we live in today. So it's pretty clear one has to start thinking globally when one talks about nuclear power in the next many years.

Now, here is the down side. The view is that when the nuclear power grows, it is not clear the NRC will grow at the same rate. NRC has been growing and will grow, but the rate of growth will be the same. This is especially if you look at history, there has always been a lag when the agency grows and the demand comes in. And only then the agency realizes it has to grow, but there is always a bit of a lag.

The next assumption is that a lot of talent has left the agency and a lot of talent is going to leave the agency. If you look at the demographics, it does appear that in the next five to

ten years, there will be significant loss of additional capabilities in the NRC.

And also if nuclear power is really going to grow in the way some people think, you will reach competition for limited resources. And this might lead the agency to be in the more challenging position of having to deal with some of those large numbers of applicants.

So these are some thoughts and assumptions and some broad-level considerations. We thought what would be best would be to try to get a picture not only of what I put up if that makes sense. Maybe you have some news that that's not that far from considering. So we're very open. We really and truly want your real views, both on these objectives and the assumptions.

Now, the plan was that every panelist may take like 10-15 minutes or whatever time, in that range, to give some thoughts and then in the afternoon to have some discussion period.

I have some backup charts. I put together seven what I would call very specific questions. And then if we have an opportunity, we can depending on how this morning goes then come back and try and take each issue by itself and have some discussion and see

where we end up before the end of the day.

With that, Brian?

DR. SHERON: Thanks. I apologize. I've got an office Christmas party. I probably can come back after 2:00 o'clock if you want.

DR. THADANI: Please. I think it would be very good.

DR. SHERON: I would like to make a presence at my office Christmas party with the staff.

I am going to tell you right now you have taken on a very complex subject. There are so many factors that are going to play into this. This is a piechart which kind of shows where our budget goes now. If you combined the '08 and '90 budget numbers, which is about $135 million total, this is basically how we divide it out. I've got some copies here I guess. I don't know if I have enough.

Basically what you see there, user needs drive about 67 percent of our research. And by "user needs," I mean this is work we are doing to supply offices, NRR, NRO, NMSS, FSME, NSIR, with products that they have requested from us.

And this will include things like international cooperative research because if they have asked for, for example, a validated computer

code, if we need experimental information to validate that, then that is considered part of the user need.

Agency-mandated programs. These are programs like we prepare the abnormal occurrence report that goes to Congress every year. We run the generic issues program. We develop the SPAR models. So it's those kind of programs that have been mandated by the agency, as I call it, and assigned to the Office of Research.

Long-term research, which is what you are focused on, if you just want a little history, when Chairman Klein first started here in July of 2006 -- and I had been the office director I think a whole two months prior to that.

And so I think I had my first meeting with him. And it was back. Actually, he had come and visited me, I guess, in August, the office. But I had my first real sit-down with him. It was probably in October or so.

The first question he asked me is, one of the things he says, "Well, what do you do about long-range research?"

And I said, "Well, you know, we plan out three years. That's our budgeting process. And, you know, we're working on the budget for three years."

And he says, "No, no, no, no." He says, "I'm talking 5, 10, 15 years from now." He says, "What are you doing to get the agency prepared?"

And I kind of was like a deer in headlights. And I said, "You know, well, we really don't plan out that far and everything."

He said, "You know, well, we really need to start thinking about, you know where the agency needs to be 10 or 15 years from now, what capabilities, what tools we'll need" and so forth. And so I took that sort of as a request to take a hard look at where we needed to be.

And I'm sure you've all seen we developed a first cut at a long-range research plan. We requested input, both from within the NRC as well as from the ACRS and from external stakeholders. And you're familiar with what we put together.

We had originally requested something, if I remember, on the order of about $6 million and about 8 FTE to conduct that. And then we got into the budget process. And before that made it up to the Commission, it was completely zeroed out of the agency's budget.

The Commission restored some of that. I think it was around -- I've got the numbers here.

I'll find it here, but it was around 2.6 million I think and about 2.4 FTE.

We have identified certain things in '09 that we would plan to fund with that money. I think there were 800k and .4 FTE for characterizing and evaluating promising sensor candidates for extended into inspection monitoring, 700k and 1 FTE for the development of an R&D facility for digital instrumentation in human control and human-machine interfaces. That was also a Commission SRM for us to look into that.

There was 500k and .8 FTE for research activities to review advanced fabrication techniques for materials and reinforced concrete, 400k and .3 FTE for development of MELCOR to be used for both level 2/3 as a PRA tool.

I did want to point out that with regard to looking down the road, we have also -- I've got some input from EPRI. This is a presentation they made recently at a workshop at CSNI in December, which was the role of research in a regulatory context.

There were three panels that were convened. One was on research needed for the current fleet of reactors. The second was for research needed for what we call new reactors. And then a third was

research for the advanced reactors, the non-lightwater reactors.

The areas that were identified by EPRI that are on their kind of high-priority list were material degradation, fuel performance, digital I&C technology, and cable diagnostics and alternative replacements.

And if you think about one of the big things -- and, as a matter of fact, we had an all-hands meeting yesterday and the Chairman came and spoke. One of the first things he mentioned that was high on his priority list was what I have termed "life beyond 60" as a long-term research area. And that is plants, as you know, have gotten license renewals for an additional 20 years.

I think the first plant is probably going to hit the end of their 40-year license in about 2 years, maybe Oyster Creek, I think. And then successional plants will start hitting the end of their 40-year term.

Some utility execs have come in and talked to I know Luis Reyes and the like and said, you know, "We have invested a lot of money in these plants so that they can run beyond 40 years in terms of replacement valves, motors, pumps, you name it."

They feel that, you know, with those investments, they don't really see these plants being able to have to shut down in 20 years but running beyond 60. And so the real question is what is needed, what are the technical issues that would have to be addressed to allow these plants to run beyond 60 years.

And so we have started taking a hard look at that. We have been working with the Department of Energy. As a matter of fact, there's a workshop, a three-day workshop, in February that's been scheduled out at the Hyatt Regency in Bethesda to discuss this very subject.

But if you really look at some of the areas that EPRI identified, they are all related: material degradation. You know, basically it's cracking. This is what is plaguing the industry, cracks and welds and so forth.

Being able to understand when and where material is going to fail, it's going to crack and degrade, and either go into a proactive replacement or a repair process is something the industry is very interested in.

You don't want to be on the right-hand side of the bathtub curve, where you're shutting down

every day because you're finding more and more things failing and breaking. So they're very interested in understanding material behavior and what they need to do to control it and predict it.

Fuel performance. They want to run these plants to higher and higher burnups. They're running right now -- one of the viewgraphs here says they're actually running beyond the validated range of a lot of computer codes. So there's going to be a real need to get fuel performance data and to understand its behavior, high burnups in order to allow the agency to authorize them to run beyond the current limits.

Digital I&C. I'm a little questionable about that one. I know there are going to be a lot of replacements as the operating fleet as the analog systems wear out. Given some of the experience Oconee has had trying to install a digital I&C platform to get it through the licensing process and particularly with the QA and answering a lot of questions about redundancy in diversity, our feeling is -- and my branch chief in the I&C area is from industry. And he's worked. And we have discussed this.

The feeling is that while they will develop new platforms and everything so they can replace outdated analog systems and the like, once

they have replaced them with digital, we're not sure there are going to be any great sweeping changes in this area.

The industry basically works on a three-year cycle, which is if I don't see a return on my investment in three years, I don't make it unless it's something extraordinary.

And the feeling is that unless they see a benefit, either in reduced down time or increased megawatts, there's really no incentive for them to go and develop more sophisticated digital systems if they're not going to provide any kind of return on investment.

As a matter of fact, Jim Dyer told us the other day that in 2009, he expects to see a lot of the PWRs coming in now for power uprates. And we're kind of scratching our heads, at least I am, trying to figure out how they're going to do that, especially if they're not going to have a 50.46(a) ECCS rule in place at that time.

But that is going to be a challenge because these plants, as Ashok said, most of these plants, are going to start pushing closer to the limits.

Cable diagnostics. I think there are two

limiting factors that prevent a plant from going out to a full 80 years, let's say, or something. One is concrete, especially the concrete that may be used to support the vessel, how does it behave the long term, the properties of it under irradiation and high temperature because that can't be replaced, really.

I think a vessel might even be able to be replaced these days. You know, when you see pictures of these where they cut a hole in containment and pull a steam generator out, you know, other than it's probably a lot more radioactive, I don't see why they couldn't at some point replace a vessel.

But cables. I don't think anybody wants to go through the headache of recabling an entire plant. So we're kind of thinking that -- and if the insulation starts to break down and not perform under the environmental qualification, what do they do?

And so we're thinking remote sensors, wireless. And so that's an area we are starting to look into right now, is to understand what are the safety implications of wireless transmission through the plant? You know, why replace a cable if I could just send a signal and pick it up somewhere?

So we see that. And I think EPRI has 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

sure with PBMR they are not talking about a containment. They are talking about a confinement that's a policy decision that's going to have to be made.

There's a lot of questions about in-service inspection for LMRs and stuff and how do you inspect the welds in the vessel and so forth, do you have to train the vessel.

So there's just a whole host of questions that really need to be looked at. And right now our funding levels, we have done very little on that.

For the advanced reactors, in '08, for gas-cooled, we had about $3 million and 5 and a half FTE and 100k and .3 FTE for the LMRs. In '09, I've got about 6.3 million and 7.7 FTE for gas-cooled and nothing for liquid metal in my budget now. And that is about it. There is nothing for the gas-cooled in the design certification review area either.

And then in '09, there is 500k and one FTE for GNEP. So, you know, I think the point is that from the standpoint of looking out 15 or 20 years, I am more worried about just how are we going to deal with these advanced designs that are going to be coming in in a couple of years and not being able to produce the tools.

And so one of the things we're trying to look at now is what kind of leverage we can get with either what is being done overseas. We're participating in a program called RAFAEL, which is a European consortium looking at gas-cooled, trying to see what we can get from that.

I know we want to interact with DOE because we're convinced they've got all the money, but there may be actually some work that they could do that would support our independent capability and the like.

So, you know, from a long-term -- the other thing I did want to point out before I am taking too much of my time here, when we define long-term research, it's not from a standpoint of looking at it as a huge budget. What we have defined it as is this is the exploratory stage. What are the issues that the agency needs to deal with.

And so when we talk about a long-term research program, what we are looking at is let me call it looking under the rocks. What are the digital issues? And once we have identified them, for example, if we have decided that wireless technology is something that we really need to focus on and understand better, I'm not going to keep it in a bin

called long-term research. I'm going to probably go over to my user offices, you know, like NRO and NRR, and make sure they're in agreement that this is an important area that we need to focus on and start to get information on. In other words, I will cultivate a user.

And then I am going to move that program into my baseline research program. It's not going to be called this long-term or this -- it's I'm going to budget it, and I am going to work on it.

So the long-term research program is really in my mind what we use to identify what the issues are, to focus, to say, "What do I need to work on? What can I ignore?"

And once I have identified what I really need to work on and I get buy-in from my user offices that says, "Yes, we are going to need this information down the road." I am going to start budgeting it into my regular research program because, quite honestly, when you put stuff through the NRC prioritization process, you know, anything that has the term "long-term" on it is going to fall off the edge. Okay? So I've got to get it into -- let me call it the baseline research program, where I have an identified user, an identified product, and the like.

The other piece of the long-term research is to identify the issues for the industry. Okay? We're not going to solve all of the issues needed for a plant to run beyond 60 years. That's not our job. We do confirmatory research and the like.

But we need to identify the problems and then tell the industry, "Here are the issues you are going to have to deal with. Here is the information you are going to have to submit and provide to us in order to demonstrate safe operations, say, beyond 60 years.

So if it means better NDE techniques to find cracking earlier, if it means getting more data on high burnup to be able to be able to run with higher burnup fuel, we will tell them that so that they have plenty of time to prepare and to get that information.

If they need to put more coupons in a reactor so they can get irradiation data to make sure that they're not going to bump up against some sort of a PTS limit, then they need to do that now.

So that's really where we are with long-term research. We're trying to focus on identifying what the issues are. The long-term research program, we intended to update it on an

annual basis.

We would go out to our external stakeholders I think every other year and look for updates, you know, what is new, what is different, what should we focus on, is there anything that has changed. And we will be coming back to the Committee, obviously, with that on a probably yearly basis.

With that, I will yield the microphone.

DR. THADANI: Thank you, Brian.

Brian has to leave soon. So there are a few minutes. If there are any questions for Brian, this might be a good time.

MEMBER SIEBER: Yes. I have one. This is probably a simpleminded question, but the way this industry started out is that the very first reactors, the very benign reactors, had lots of margin. And the regulations were deterministic. And they had lots of margin.

If you introduce new types of reactors, one way to do it is to analyze all the PRAs and everything, analyze all the accidents and where you would place the margin.

The other way to do it was the way this industry started out, which is the early reactors have the margin built in, everything that was done by

bounding analysis, and you rely on redundancy and defense-in-depth.

I sort of think that you are going to have to use a combination of those. And the question is, do we know what sophisticated things that we need to do to handle the general class of advanced reactors compared to things that we can solve and regulate by just adding margin to it?

DR. SHERON: Well, that's one of the things hopefully the research program is trying to identify.

MEMBER SIEBER: Yes. I don't see it in the documents that I have. Maybe it will.

DR. SHERON: Well, I think a lot of it is we just haven't progressed that far because we haven't had the resources to really look into these. One of the things that would concern me, though, is that -- and Tom might be able to address this better -- DOE is looking for commercial partners. In other words, this is not a demonstration.

MEMBER SIEBER: Right.

DR. SHERON: And I would worry that the industry would not participate if the costs, you know, for example, to develop a new technology, a new reactor type with this margin and because they

couldn't, you know, let me call it run it, you know, push it as hard as they could, that it wasn't profitable for them. And that would be a concern. That's all because there's a balance there, you know, unless DOE were to say, "Yes, we'll pick up the extra bucks here."

MEMBER SIEBER: Well, is there a possibility of some incentive like that? Because that's the way the early industry started out.

DR. SHERON: That may evolve just from the review process depending upon what the licensees can provide to support their technical bases, the amount of information and so forth.

You know, like with the gas-cooled reactor, if you license another Part 52, you're required to have a PRA. What kind of a database is there to support a PRA? What kind of failure data do you have on and, you know, what kind of margins, then, do you put on the PRA to account for the fact that you don't have a complete database like you have with lightwater reactors?

MEMBER SIEBER: Of all of the elements of uncertainty in a PRA, when you talk about gas-cooled reactors or other types, molten salt or whatever, those uncertainties are so big that they're basically

going to be covered by bounding analysis.

You know, you don't know much about the parameters because your equipment, the summary equipment, has not been built and operated. And you don't know everything there is to know about the modeling. The only thing I know for sure is the PRA techniques done properly are probably better than deterministic techniques for layer after layer of protection.

Well, anyway, those are the kinds of questions that go through my mind because I don't think government by itself is going to be able to sponsor new reactor types. Given the current political situation, I don't think industry is going to dive in there with something they're not sure that they can license or that will be economic. So, you know, it's sort of damned if you do and damned if you don't.

MEMBER BONACA: Just a question. Isn't there a risk that depending on user needs, you know, certainly thinking long-term initially when you go to users for their endorsement, isn't there a concern that that problem may be very myopic and in short eyesight?

Users typically are not concerned about

ten years. I mean, they have needs tomorrow. Isn't there a risk that your long-term planning becomes really a short-term problem?

DR. SHERON: Well, I mean, the long-term planning if you want to call it that, I mean, I don't see it as this is 20 years out. For example, with -- I was going through the numbers, for example. If you assume that the first plant is going to hit its 40-year life in 2 years and they get a 20-year extension, that means they can run up to 2029. Okay?

Most utilities have to plan probably about 15 years in advance for replacement generation, where, you know, "Do I need another power plant?" and the like.

So back off 15 years from that, and you're at 2014, which is not that far away. So from the standpoint of what's needed, they need to start thinking about this now.

So, in other words, when I talk about long-term research, I'm really probably thinking within about the next five or six years. And I think the regulatory offices, you know, Gary could probably talk about this from NRO's standpoint. They're looking in that time frame.

So I don't think it's that myopic. And

the issues that I have talked about are actually issues that are facing the industry to some extent today. They're just going to become more acute as the plants age.

Material degradation and cracking is an issue right now. You know, the concern is that it's going to get worse, you know, as these plants age. And what do we need to do more of? But we're still worried about it now.

The digital I&C is an issue right now for a lot of plants at Oconee with trying to replace their protection system and the like. And that has been going on since I was -- that was going on before, back when I was in the NRR, and they're still reviewing it. So there's a lot of technical issues and the like.

The life beyond 60, we're trying to get ahead of that one. And we're working with DOE. As I said, we've got a three-day workshop. And I would hope that some of the committee members would want to attend that.

I think there's a lot of interesting -- there are actually some issues that the industry has raised that didn't even cross our minds. I think one is potable water and stuff, which, you know, they're worried about having adequate supplies of fresh water

to cool these plants and stuff.

So there are other issues that the industry hopefully is thinking about that we haven't even thought of. And, you know, that will help us.

MEMBER ABDEL-KHALIK: Well, that sort of brings my question. I am sort of concerned about the direction of information flow. You indicate that research identifies the problems, then goes essentially and convinces the customer, whether it's NRR or NRO, that this is something that you guys will need a few years down the road. And once you get concurrence, you move that to your regular research program to start working on it.

Would it be more logical if the information flow was in the opposite direction?

DR. SHERON: Well, actually, it should be a two-way flow.

MEMBER ABDEL-KHALIK: Well, yes, but there has to be some information coming from the customer telling you that, hey, we've thought about this. We're the ones who are doing this. We know what we expect a few years down the road. And we really need information in this area, which we don't see as having in the agency. Would you mind working on this?

Is this loop closed? Is there sort of

bidirectional information flow on this issue, problem definition?

DR. SHERON: There will be. In other words, we're just at the starting edge, you might say, of this whole process with the life beyond 60.

MEMBER ABDEL-KHALIK: Well, not just that.

DR. SHERON: I understand. But yes, I mean, the industry has to identify obviously what they believe are the issues that they need to address.

They're going to identify the issues from an economic standpoint because they need to look. And they're going to say, can this plant run reliably and profitably for the next 20 years? And if it can't, they're probably not going to invest in it and the like.

And they're going to look at issues that maybe overlap with safety issues, but it's really going to be, does the safety -- if it's a safety issue as well as an economic issue, is it going to inhibit the ability of that plant to earn money for the utility?

The NRC is going to look at issues that the industry may not think about or may not believe that they have a problem. That's the two-way type of flow. The industry will tell us the issues that they

are going to have to deal with to make sure that that plant is going to be able to run safely and efficiently for the next 20 or whatever years.

We take an independent look at those issues. And we may come up with some of our own. And typically what we do is we go back to the industry. And we say, "Hey, you know, in addition to your issues, we've got a couple here that we're worried about."

The industry is either going to say, "No. You're wrong. And here is why you're wrong" and you don't have to worry about it or "Yeah, you've got a point. We're going to have to go look at this. And we'll get back to you."

MEMBER ABDEL-KHALIK: But who is doing that?

CHAIRMAN POWERS: We'll have lots of time. Said, we'll have lots of time for discussion in the afternoon.

MEMBER ABDEL-KHALIK: All right.

CHAIRMAN POWERS: We need to move along.

DR. THADANI: Brian, just a quick, quick question. Status. You mentioned a number of novel designs, some lightwater reactor designs. The agency's knowledge base is pretty thin. And a lot of

people in the industry seem to be walking away. So we're losing a lot of knowledge as we speak.

Is there any effort underway to sort of document what I would call state of knowledge? I think that might be a useful starting point so you know what the gaps are and where the challenges are.

DR. SHERON: Well, the biggest example, I guess, is Sid Ball down at Oak Ridge, who is working on gas-cooled reactors. I worked on Fort St. Vrain in 1979 for a short period. And I was working with Sid at that time. He's still working on gas-cooled reactors.

And we're actually trying to get him to document. We have a contract with him to actually try and document this information that he has and the like.

The other thing we do obviously is we have the rehired annuitant program, which I'm sure you're familiar with that. So we don't lose a lot of corporate knowledge.

When senior staff that have worked in these areas announce they're going to retire and the like, we can actually hire them back now. And the main purpose is for them to transfer that knowledge, either to write it down through some kind of a

document or to just pass it on through other means and the like.

A really classic example was back when I was in NRR. Paul Shewmanski before he retired wrote a document on equipment qualification. I picked it up, and it was basically a mind dump. It was just everything that he knew about equipment qualification and what you need to look for when you are doing a review. And it was great.

You know, if you were a new employee and you were coming in and you were assigned to be an equipment qualification reviewer and you read this thing, you would walk away from it when you were done and say, "I know exactly where to focus on, what to do."

So that is one of the things that we are trying to do. We have some what we call the community of practice. We have Web sites where people can actually ask questions and chat back and forth with some of the experts so new employees if they have a question can get information.

We are trying to really do a mentoring program where we link new employees up with senior staff. And, actually, in their job description now is the requirement that they are a mentor. And they try

and pass on knowledge to the new employees. And it seems to be working.

We have the resource seminars, where we bring in experts and we give them an opportunity to pass on that knowledge to the staff, not just research but to the agency staff. So we have just a number of forums that we're using to try and pass on to capture all of that knowledge.

The other thing we are doing is, you know, we have a lot of reports that were generated over the past 30 years or so, you know, technical reports, NUREGs, and so forth.

A lot of them prior to ADAMS, you might say, and the internet and all of that are in documents that are just kind of laying around in people's offices. A lot of people every time we move or have to do something, you know, they're pitching.

We're trying to capture these and scan them in so that that information that was generated back, you know, '70s, whatever, in the '80s isn't lost.

One of my old professors in graduate school, Charlie Graves, used to always tell me. He said, "Engineers tend to redesign things every 20 years." And he said, "The reason is because they

forget that it was designed 20 years ago because nobody passed on that knowledge that said, 'Hey, we already did this.'"

So we're trying to do that. So we're trying to capture all of these documents, these technical documents, you know, in electronic form so they don't get pitched out the next time somebody has to move or they decide to retire.

So I don't know. I hope that answers a little bit of your question about what we're trying to do. But it's a very serious issue with the agency. Okay? And both the Commission and the EDO are very supportive of knowledge management activities. It's actually in our SES contracts if that helps.

DR. THADANI: Very good. Thank you very much.

DR. AHEARNE: Okay. First let me say I am here under false pretenses. It says NERAC. NERAC doesn't exist anymore.

(Laughter.)

DR. AHEARNE: It disappeared. Now, over the last eight months, there has been an effort to re-form something called the Nuclear Advisory Committee for NE, DOE. And I'm not sure whether it's the problems of the General Counsel or the problems of

getting prospective members to agree to be special government employees, but it has been taking months and months and months.

So, Mike, the answer to the question you were asked, I don't know what is happening.

MEMBER CORRADINI: Thanks for guessing.

DR. AHEARNE: In theory, I am still vice chair of something.

(Laughter.)

MEMBER CORRADINI: Short memory of it.

DR. AHEARNE: And then the second, when Ashok called me, I said, "Look, I don't live in this world." And so I'm not like Brian obviously in detail. Tom lives with it. All of these guys spend their days thinking and worrying about this stuff. Even Mike, who teaches all of this stuff. I don't. So I'm going to give you a perhaps broader perspective because it's about all I can do.

And I'll tell my colleagues here I'm not going to talk as long as Brian did. So you will have a chance.

(Laughter.)

MR. MARION: The best news I've heard all morning.

(Laughter.)

DR. AHEARNE: Okay. The perspective I will take is that I view the NRC and then the Research as the leader of it to do something that goes with it to provide the protection of public health and safety, but it's to make the public understand and be convinced that the NRC is protecting the public health and safety.

And that turns out to mean that the information that gets developed and the areas in which people work have to take into account who is the user of that information. And it's not just NRR, NRO, or the industry. It's a lot of the people who are skeptical or perhaps agnostic about nuclear power. And I think that's something that has to be kept in mind.

So, for example, I'll just go through the things that we're thinking about. I was glad to hear Brian saying most of these are on the agenda.

What has to be done to prepare for going beyond 60 years? I hear a lot from the people who have this general community of skeptics, can you really trust the NRC to actually look carefully at what is a degradation that is occurring and can you trust the NRC in being able to say that a plant can go 80 years? Those are some of the things that research

should be looking at and what are the issues there.

The much higher burnup fuels. I know NE has been pushing that for a long time. And that is something obviously that fuel begins to fail that causes a problem, again, out in the public.

There's a lot of interest through GNEP and through the world on fast reactors. And one of the issues that obviously comes up when you talk about fast reactors is they're too expensive. Well, if you can recall back when the lightwater reactor was viewed as too expensive, some of the people -- and I think it was started by John Taylor at EPRI -- looked at the idea of going towards passive safety and eliminating a lot of the active safety systems.

Well, there are some people beginning to talk about going back to the EBR2 experiment that was done and say, "Well, can't you, then, on a fast reactor eliminate a lot of the active safety systems?" And if you did, then the cost of that reactor would come down a lot. So that is something the challenge for the regulator to be able to say what has to be shown that this would be safe.

The issues that constantly come up about -- and, now, this is something that -- I realize part of the problem is the research here office doesn't

handle everything. Low levels of radioactivity are still a constant issue. The threshold question of linear is obviously always raised.

And recently some more studies are beginning to come out about increased leukemia and cancer around nuclear power plants. These issues don't go away. And it is blind if the NRC doesn't realize that that is a major objection that keeps on popping up. And it would be better if they knew more about this area and worked on it.

The high-temperature materials. Hydrogen production is talked about. You're going to need to essentially get 50 percent higher temperature, which has been a real challenge for the materials. And that's an area of research where people should be spending a lot of time on.

Well, I don't care whether you call it reprocessing, regeneration, or reuse, whatever terminology, but there are a lot of new approaches being studied. DOE has been talking about UREX I, UREX Plus 2, UREX Plus 3, UREX Plus 4. These are waste streams that are going to come out of this.

And I realize part of the problem, research has almost been kept away from the waste management area. Remember, we worked on that.

DR. THADANI: Yes.

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

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

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

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

built in the United States, but issues are going to be as to the safety and the regulatory framework for a fusion reactor.

There's the issue of working with NE, with DOE. We all know that there is a problem about conflict of interest and maintaining this barrier. There have to be continued, though, better working relationships because they're both trying to accomplish the same thing.

I realize that NE's role is trying to encourage the growth of nuclear power. NRC is not trying to encourage the growth of nuclear power. It's trying to make sure that the growth of nuclear power is done safely and environmentally soundly. But those two are not contradictory roles.

And then there is the question of non-proliferation. Research really has to think about when you're getting a whole bunch of new designs, new reactors, and the world is growing rapidly in the use of reactors, the non-proliferation issue is going to still be there. It's bubbling underneath the surface in many places.

Finally, the use of contractors. The issue was brought up. People here in the NRC are aging, like all of us. And the question about, are

you going to have the expertise there, that would be a problem, even if there weren't a lot of new designs coming in, a lot of new applications.

But with a flood of applications, the NRC has the potential of being seen as the roadblock, the obstacle for the growth of nuclear power. And I think research has to think about one of the ways to access the contract community is Argonne and other national labs, a lot of very bright and knowledgeable people, in some cases prevented from working on NRC issues because they're working on DOE issues.

Well, man-power is a finite resource. Knowledgeable man-power is an even more finite resource. And that has to be used as best as possible.

So that's my short summary that I was thinking about. We can discuss some later.

DR. THADANI: Thank you, John.

CHAIRMAN POWERS: Let me ask you a quick question on the non-proliferation. Are you aware of anyone that has used fuel from a nuclear plant to go to hard generation as a root to weapons-grade material?

DR. AHEARNE: Of course, because if you reprocess that fuel and you get the plutonium out of

it --

CHAIRMAN POWERS: Even with weapons material, any material.

DR. AHEARNE: This is not a design of a weapon that you could put on, make it a very --

CHAIRMAN POWERS: Sophisticated.

DR. AHEARNE: -- long-range nuclear missile, weight-limited. However, you could still get a pretty good explosion from that plutonium.

Of course, the other issue which is constantly in the news, if you're going to make the fuel itself, as we all know, you enrich it. Well, you don't have to stop there.

DR. THADANI: I'm just thinking I know we might start to lose people. Maybe we should take a ten-minute break and come back.

MEMBER CORRADINI: Five, anything.

DR. THADANI: Well, let's say ten because I don't think people will be back. After a ten-minute break, we'll start with Tom.

(Whereupon, the foregoing matter went off the record at 11:26 a.m. and went back on the record at 11:34 a.m.)

CHAIRMAN POWERS: Let's come back into session.

DR. THADANI: I understand Alex has a commitment at 12:00 o'clock. So why don't we go to Alex first? Then we'll go to Tom Miller.

MR. MARION: Okay. Thank you.

I am Alex Marion. I am the Executive Director of Nuclear Operations and Engineering at the Nuclear Energy Institute. And I am pleased to have the opportunity to offer industry perspectives on NRC's long-term research objectives and goals.

As background, I also participated on the expert panel that Dr. Thadani referred to that was chaired by former Commissioner Rogers in looking at the role of NRC research.

One of the key recommendations that was identified from that activity is still applicable today. And that's for the NRC to strive to seek additional opportunities for collaborative research, collaborative from the standpoint of more industry participation as well as collaboration with other federal agencies, such as the Department of Energy.

I recognize pursuing such collaboration is not going to proceed successfully without its challenges, but I think in the environment that we have today, where we are all struggling for resources, it only makes sense to look for these opportunities so

that we can be more efficient, more effective, and more focused as we go forward because fundamentally assuring appropriate technical research to sustain the current operating plants as well as develop new technology I think is in everyone's best interest as long as we maintain a focus on safety and do it in an open manner such that the public is aware of the actions and activities that are being pursued.

Brian Sheron mentioned a number of areas where research will be needed to support basically current plant activities as well as future plant activities. He mentioned materials degradation. We, of course, agree that that is fundamentally important.

The industry has put forth a significant effort in understanding and identifying and understanding known degradation mechanisms based upon operating experience.

And we are working towards prioritizing those gaps that we have identified in our knowledge base relative to effective management of those degradation mechanisms. And we have had some preliminary discussions with the Office of Research on potential opportunities for collaborative research.

I'm hoping that that progresses in a successful manner because we're both interested in

making sure our programs in diagnostics are effective in managing degradation today as well as into the future. And along with that, in-service inspection, diagnostic techniques, et cetera, are critically important, especially from the standpoint of nondestructive examination.

On digital technology, I must take issue. And I am sorry Brian is not here, but I made a note to follow up with him directly. I have to respectfully disagree with Dr. Sheron's assessment on how the industry deals with the application of new technologies, especially with regard to the planning horizon and incentives that he mentioned earlier in his comments.

Fundamentally, if his premise was valid, we would not have any utilities that had pursued license renewal, nor will we have utilities that submit applications to the NRC for new plants. And so I submit that his premise is incorrect. And, as I said, I will take that up with him individually.

Risk assessment --

MEMBER ARMIJO: Were you talking about the three-year payback kind of concept?

MR. MARION: Yes, yes. That is just incorrect.

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

MR. MARION: It's possible I could have misinterpreted --

MEMBER ARMIJO: Yes.

MR. MARION: -- the point, but I don't think so. Application of risk analysis is extremely important. We have had a tremendous amount of positive constructive collaboration with the NRC in the area of fire risk and research in that area. And I think that needs to grow. We need to develop that and use that as a benchmark for further activities.

Dr. Thadani mentioned the importance of leveraging computer technology and that capability. I think we need to take a look at what kind of computer modeling analytical techniques are we going to need in the future.

But fundamentally today we have a situation where the fuel vendors have a computer model, the industry has computer models, the NRC has computer models that do similar analysis.

We can't afford to operate that way going forward into the future. And we have got computer technology that we are all using today, all of us, the vendors, the industry, and the NRC. And we have had sufficient operating experience with those computer

methods. We ought to seek an opportunity to get together and collaborate so we have one computer software program that we're all confident and as we go forward.

I understand the principle of independence on the part of the NRC, but there are some areas where we can gain significant efficiencies and improvement. And I submit that that is one because what happens over time, the owner of the software in terms of the original developer will fight that product and try to continue use of that product to the grave. And that doesn't serve any of us well. So that's something that we're going to be discussing with the NRC in the future.

Fuel performance, of course, is another important area. Brian touched on that, and we agree.

He mentioned license renewal and the fact that there is this workshop in February. We support that completely. There are utilities that are starting to consider license renewal beyond 60 years. And I hope we don't necessarily, if you will, reinvent the wheel.

We have a stable license renewal process in terms of seeking NRC approval. We have up to this point established reasonably effective aging

management programs to support license renewal in that additional 20-year term. We use that as a foundation going forward beyond the 60 years, instead of creating a new one.

We have a good, excellent foundation to build on. And I suggest we do so as we go forward. And that will be raised at the workshop in February.

That essentially completes the comments that I wanted to make. And I do apologize, but I do have a 12:00 o'clock appointment. I will be returning after lunch to participate in the discussion. And I thank you for the opportunity.

DR. THADANI: Thank you, Alex.

Any questions for Alex?

CHAIRMAN POWERS: I think we'll chat with Alex later, when he comes back later.

DR. THADANI: Tom?

MR. MILLER: Thank you.

My name is Tom Miller, Office of Nuclear Energy within DOE. My focus has been on lightwater reactors. And that's really what I wanted to talk from, that focus, today.

I was glad Ashok put up several of the preliminary assumptions and assumptions on the board earlier because I felt like it was important to lay

some groundwork with you on where we see things coming from.

We expect that the industry and policy-makers are going to continue to push nuclear energy as an energy security climate change solution. And, therefore, there is going to be a continued call for expanded use of nuclear energy. I expect, even with an administration change, it will still be a push.

It is our belief lightwater reactor technology, existing lightwater reactors and new ALWRs will be the dominant reactor technology for the commercial nuclear power deployment. And you can pick a date. Some people say as late as 2050. But it's going to be for the foreseeable future and within the guidelines of your long-term deployment or research program.

Brian mentioned the gas reactor and the congressional mandate to have one in place by 2021. Expectations I think by the industry would be that's great. That's a demonstration unit. It's commercially. But one is really to become commercially feasible for them. We would expect that there would be at least some five years of operation before the industry is going to really want to deploy

them on a commercial basis.

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

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

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

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

New plant deployment. We think for the foreseeable future, the existing identified designs will be what the utilities pursue: GE's ABWR on the ESBWR, AP-1000, AREVA's EPR, and MHI's APWR.

Several of those are in the design certification process. Another one is expected. But these technologies are pretty well-known. Our expectations are that they be minimum or a little confirmatory R&D required.

However, there are some beliefs that as small reactors are pursued as part of GNEP, that there will be small LWR reactor certifications coming forward, concepts like IRIS. There is another new concept that we heard about just last week called NuScale. And then because of their integral reactor designs, we would expect that there would be a significant amount of confirmatory research involved in those.

I don't know what the time frames are, but we understand that -- well, IRIS has been in preapplication design certification discussions for a while. And I understand this newer concept, which is based on an INL reactor design that came out under the NERI program, that they will be coming in in the near future, over the next couple of years.

Some comments about implementation of R&D. It has been mentioned, but I think we will have to do a better job of coordinating and collaborating on R&D to leverage our meager resources, limited resources; minimize any duplicative activities, tests, or experiments; and maximize the use of test facilities.

The workshop has been mentioned. We are working with staff on RES, both from the Office of Nuclear Energy and the Office of Science, to put that workshop together. We see this as a very valuable input to our R&D program. We are planning. We also see it as a very valuable input to RES as to what they need to be looking at.

At least at a working level, we agreed that there is a potential for collaborative research with RES and the Office of Nuclear Energy and the Office of Science. It is now getting down to what is it we have to do and how to collaborate. And that is yet to be determined.

Although we have some near-term examples of how we have done that in the recent past, many may not know this, but the Department's Nuclear Energy Plan Optimization program, NEPO program, back in 2000 to 2005 had several activities in which we collaborated, one in particular being the annealing

demonstration project up at Marble Hill, where we collaborated and were able to obtain test data on the facility as it was heated up at that temperature. It was a good show of how we collaborated to get the test data for our own purposes.

Another opportunity happened under the Nuclear Power 2010 program, where we were doing some testing out at the Oregon State University Apex facility for the AP-1000 certification. And we did a test program coordinating some air entrainment experiments between RES and ourselves and Westinghouse. So the examples are there. We just need to do a better job at working together to find out where it is and what it is we collaborate on.

We are working, NE is working, with the industry and the laboratory community and RES on what is going to be required in research terms for lightwater reactors in the future.

Idaho National Laboratory and their utility advisory board and EPRI have worked and pulled together a strategic plan for lightwater research for the department we just received at the end of November. We will be making this available to those that are interested.

This plan at least identifies in a

preliminary sense areas that we feel that it was necessary. And it looks at extending plant life beyond 60 years and looking at improving performance of the plants. That is existing plants.

Sustained expansion of or deployment of lightwater reactors. The plan also includes some areas of infrastructure enhancement or development that support both of those two other objectives.

Areas of interest I think that we have in research. Component life extension improved lifetime prediction. We think there are issues involving degradation and corrosion of structural and vessel materials, structural steels and structural concrete. Brian mentioned, you know, reactor vessel supports. These areas need to be looked at for life beyond 60.

Things such as why do inconel and other high-temperature alloys continue to crack. We believe that there is an opportunity for the Office of Science and some of their fundamental research to be tapped to help us address these issues.

Integrated material performance and under various chemistry regimes. We think that is an area that needs to be looked at a lot closer as we age the plants.

Identify a potential environmental

precursor for degradation to improve predictions of component life. Improvements to in-service inspection diagnostics, maintenance and repair techniques. This has been mentioned by both Brian and Alex.

I will bring this up, but it has been in our plan for transition to state-of-the-art digital technology. One of the main reasons this has come up in our discussions with industry representatives, utility management, has come from the perspective of not reducing margins or improving performance as much as it is from obsolescence. You can't get the parts and pieces for the components.

And if you start looking at movement to a digital technology, computerized technology, the rate of improvement in those technologies is a lot shorter than it was for analog technology. And, therefore, the obsolescence of those might be happening in a shorter period of duration.

So we need to establish a mechanism to be able to upgrade to some of the latest technologies. It's obvious in the digital I&C area in a easier manner than it happens today. And we have that as part of a collaborative program that we're planning.

Advances in fuel. I would start from the perspective of advancing fuel reliability of existing

fuels, particularly trying to resolve some of the clad degradation issues, and then a move toward a higher burnup fuel. I think that way we can support industry's goal to observe defects by 2010 in fuel and then take the fuel to higher performance levels.

Again, higher performance levels, we need to look at new fuel designs, new clad materials. There are some issues that need to be developed there and the corresponding research that RES would do to look at those.

Another area of our R&D plan we believe is important, and it has some -- as has been mentioned, an expanded use of probabilistic risk methods and tools, improved safety and understanding of safety margins. We believe advanced simulation in modeling techniques, improvements in there is important.

One of the areas that, in particular, were brought up were having the ability to do fuel pin-to-pin safety margin analysis. And, in particular, one area that came up was just because of bypass flow and things like that that it became an issue. And it didn't have the capability to do that.

Seismic design safety margins. I think recent earthquake in Japan has kind of raised that issue up again. Plus, some of the new work on new

plants has raised seismic as a potential area that needs to be looked at.

It was mentioned earlier advanced fabrication, construction, inspection methods for new ALWRs. There is a portion in the industry to do modular construction, shorten the construction period, minimize the construction period. Can we do that effectively, efficiently and still maintain the inspection to assure safety of the plant as built is an area that has been brought up by the industry for us to consider.

Other improvements in advanced lightwater reactors has been raised as an item in hopes that we would continue to improve lightwater reactor technology. In addition, some other I'll say not necessarily nuclear but other areas, alternative cooling technologies, industry has raised a specter of what if they start to reduce the cooling water flows so that we can utilize for these plants as we go to relicense.

The drought in Georgia and some of the low lake water levels sort of raise the specter up. In particular, one utility executive said that's probably his topic issue right now as far as how to place and where to place plants, new plants.

And, correspondingly, what are the implications to safety of those alternate cooling technologies? Process heat applications and other performance improvements is another subject we're looking at.

There is an infrastructure focus in our plan and related to workforce and identifying critical skills needed for nuclear, not only for new plants but existing plants and what, if anything, the Department should be doing.

That is an open item. It's something we feel like is important to look at. I think from everyone's perspective, we don't have as many people coming in to the industry as we did before.

We have more people leaving than have the experience and knowledge base and somehow several other methods we talked about, but this is a subject we're looking at.

I think there is another area that deals with the limited infrastructure in the United States and how we look at and how we evaluate additional foreign content that's in the plants to date or will be in the plants coming up in the future. I think there are additional challenges that might be there.

Laboratory facilities for experiments,

tests we think needs to be evaluated again. In some of our I'll say more recent fuel-related projects, we have run into some issues on post-irradiation examination of components that cause us to step back and look at it. And I believe that probably some of the other facilities as we move into looking at new types of plants, it's going to be an issue. And we're willing to continue talking with the RES about that.

One area that I mentioned at the break, I was asked if we were losing manpower. And I said, "Absolutely." We're having people retire. I had a good young materials engineer leave me just recently and go to the industry. I think for her overall career, it was good, but for me, it was terrible. And I said I blame myself for that because I suggested she do an internship at the utility.

(Laughter.)

MR. MILLER: But I found when she came back, she had a very good appreciation and understanding of what utility life was like, what activities they go through. And it was something that she as growing in DOE had not experienced.

I think that is a good way for some of the knowledge and some of the experience to be transferred 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

to shut down nuclear and decontaminate nuclear facilities. And you want to expand nuclear energy of particular research.

MEMBER ARMIJO: I know it's not a glamorous area, but it's an important area.

MR. MILLER: One thing that's going on right now is NE is exploring and I guess trying to progress ATR to a users' facility; therefore, you know, open it up to these kinds of experimentations and testing. In doing so, I mean, they're going to need to also have the hot cells.

One of the things that we ran into is a problem with the post-radiation examination and on the hot cell, we didn't have the equipment in there that we needed right away.

So it will be a focus for us in this fuel area. That's about all I can answer right now.

DR. THADANI: Tom, do you know, for the lightwater reactors, we have learned enormous things, like from the operating experience of the reactor operation.

What strikes me is after the Three Mile Island accident, we needed to understand small breaks better than we did. And we were trying to figure out, what do we do, where do we go. We realized we really

didn't have an experimental capability to run some tests to see if we're really interested in small breaks.

With these new passive reactors, we don't have operational experience. Presumably in this country, they will go in operation in five to ten years' time frame. And you know we are going to learn lessons from operation.

I didn't hear you say anything about what infrastructure you think should be in place or should be considered to make sure that the country is prepared if there are events that take place in the process, prepared to say, "We understand that and can deal with that." Are we really prepared? I didn't hear you say anything in that regard.

MR. MILLER: I don't think I have an answer for you to be honest with you.

DR. THADANI: It's about to be considered. I think these plants will operate from five to ten years from now. We have an opportunity to think about what might be appropriate.

MR. MILLER: What might be appropriate and what test facilities have been created to try and maintain them viable, Oregon State University has what they call an apex test facility, which is, what is it,

a quarter-scale, full-pressure, full-temperature circulation of the AP-1000. And we have used it.

Well, it was designed and put in place for the AP-600 certification. And we updated it when Westinghouse came in for the certification of the AP-1000. They used it, and we have used it since then.

Oregon also has a scale model of this new concept, this new scale concept that they want to use. And I'm not sure of the status of some of the facilities at Purdue, but these are some of the test facilities at universities. Okay. But it is some of the test facilities that if there were questions that we would want to go back to and use as a minimum. That's a good point.

DR. THADANI: Gary?

MR. HOLAHAN: Well, thank you for inviting me to participate. I am going to speak about new reactors. And I think the first thing I will do is to talk about the fact that there are new reactors and there are new reactors.

Last week we got our fourth application for a combined license. And we anticipate a lot more. So we're looking at in the next few years probably 22 applications for 31 or 32 units.

Those are all lightwater reactors that have a lot of interesting features, but they are not what you would call advanced reactors. Every one is a lightwater reactor. And most of them have pretty conventional features.

I think probably the important thing to say is when we are talking about new reactors, doing research during the licensing process is a bad idea. We were currently looking at about 24 months for early site permits, 30 months for technical review of a combined license, and 42 months for design certification.

I think if there are technical issues requiring research, they really ought to be done during, actually before design certifications because even a 42-month design certification doesn't lend itself to a developing, putting in place a research program, getting the results, understanding them, having some peer review and some consensus on what they mean. The entire design certification would have gone by while that process was developing.

So I guess my first thought is when we talk about new reactors, this next generation of new reactors is really based on the research activities that were put together in the 1990s. And most of the

facilities that were just mentioned are 1990s activities that took place, particularly for the passive designs. And I think that's the right model.

If you have fundamental research issues that are opened, you're not ready to go into the licensing process. That's begging for a process that's sort of uncertain with respect to both time and outcome. And I think neither the NRC nor the industry is interested in sort of experimenting its way through the next generation of reactors.

If I apply this logic to the advanced non-lightwater reactors, it means you have to do the research, you have to understand the issues in some sort of long-term research concept.

And I won't adopt Brian's definition and his distinction here because I think to me long-term research is anything that's not near-term or short-term research. And whether it has a user need or not I think is a peculiarity of the NRC's budget process. You can call a rooster a hen, but you still can't get eggs. Okay? So in my mind, not all of this is helpful terminology. So I think that there needs to be a research program to support long-term reactor concepts.

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

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

There is a current peculiarity also in the NRC program in which the Office of New Reactors is responsible for lightwater reactors. And the Office of Research is responsible for prelicensing activities on non-lightwater reactors. So to a certain extent, the Office of Research is its own customer on non-lightwater reactors.

Now, that is an issue that we are rethinking. It has been discussed somewhat. It's the subject of a February Commission meeting. And there are some papers under development. And I think the Office of New Reactors and the Office of Research are rethinking our roles in this area.

Probably the Office of New Reactors is going to turn out to be the customer and Research is going to take a more traditional research program role with respect to the non-lightwater reactors. And that may help in having the customer and the supplier relationship sort of a little clarified.

I would like to make --

CHAIRMAN POWERS: The applicant needs to brought into this process, too.

MR. HOLAHAN: Yes, right.

CHAIRMAN POWERS: I mean, you have to

communicate to him --

MR. HOLAHAN: Yes.

CHAIRMAN POWERS: -- what he is expected to bring to the table.

MR. HOLAHAN: Absolutely.

CHAIRMAN POWERS: Is there a formal process for -- I guess there isn't because you are still deciding who is responsible for --

MR. HOLAHAN: Yes. There's an informal process. I mean, both the Office of New Reactors and the Office of Research do get contacted by people who are interested in advanced technologies.

But in the non-lightwater area, I mean, we have a more formal program. We send a letter out every year, saying, "What are your goals? When do you intend to send in an application? What kind of application?"

So we have a more structured program for finding out what is going on and getting prepared for it. It can be a little difficult. You know, people have their proprietary considerations, but we can usually work with those concepts.

My last point I'm going to get to who does the research question, but I want to hold off on that just a moment. In this area; that is, long-term

research planning, we often run into the plans versus planning program. And I was once told that it was General Eisenhower who said that planning was essential but plans were useless.

I think his point was you have to do the planning process. You have got to know where you're going. And it's essential. But when you get into a battle, it is not going to go according to plan. You've got to be prepared to throw that plan away and move forward as best you can.

Well, I think in the long-term research question, we get into the planned versus planning problem. That is, any plan we produce today is probably going to be wrong. It's not going to be exactly the way the world turns out. I think you have got to sort of get over that problem and say that's not a good reason for not planning.

We have to have planning for a long-term research program, even though things are not going to go that way, some of the things we plan for won't turn out, some of the money that is spent will never be done in a useful way. But if you're going to have a long-term program, it's got to be that sort of exploratory in a sense that there's no guaranteed return on those investments.

Brian is right. The research program will see some skepticism on the part of the Commission and the OMB and the Congress because it can't guarantee its usefulness in that way. But I think you have to face up to that issue. You have got to lay out the issues and make the decision-makers make their decisions in a well-informed way, make them part of the process, not outside the process. So I think we are in favor of planning for long-term research, even though it can't be done in any really perfect, 100 percent guaranteed fashion.

In that sense, I think ultimately -- and this is something that our interest in the long-term research program has -- we would like to see not just a list of tasks. We would like to see a vision, a strategy, and a program for long-term research activities on advanced reactors. And I think it's got to get to the point where the Commission buys in on those thoughts.

I used to be an advisor to a chairman during the period when some research was being cut. And I can tell you that research was cut, in part, because it wasn't at all clear what it would lead to.

I think to get Commission, certainly OMB agreement, there needs to be a much clearer idea about

where the research program is going and what it might achieve and the down side of not doing it.

Ashok asked me to talk about a yellow piece of paper, which is not yellow because it is old, although it is fairly old. I kept it in my desk for a while. And then Ashok borrowed it.

But the fact is I'm not sure how many of these thoughts are mine and how many are his because we have discussed it over a number of years. And that is a piece of paper that says, "Why do research?" And I think if you don't understand why you're doing research, you can't possibly have a long-term research plan that makes any sense.

So this is part of the vision thought. Why would you want to do research? The first one says, "Acquire tools for independent analysis." And the idea of independence and Dr. Ahearne's comments about the public and others need confidence in what the NRC does and says. And I think that is an important element of it.

The second one is to identify area as high safety significance and large uncertainty and those that are amenable to change. And so you've got to have all of those characteristics. You can't afford to spend money on topics that are not important or

topics that are really important but are well-understood.

But also you have to understand that when you spend a dollar, you have to change the uncertainty. So there may be topics for which the topic is important and the uncertainties are large and spending a lot of money on it doesn't accomplish anything, which makes me a little suspicious about the LNT issue. I wonder about whether a linear non-threshold issue will ever be solved with a lot of dollars.

So for me that's one of the elements about whether to go forward with that topic. It can be important. The uncertainties can be large. But you've got to think that I'm going to accomplish something with the dollars.

Third thought is research informs and educates the staff on safety issues. It simply makes better regulators out of the staff.

The fourth is to explore beyond design basis events. And I think that issue is less important now than it was in the past, but we went through the first generation of plants, where the utilities, the vendors, and all of their supporting research programs were design basis-oriented.

If we required a double-ended guillotine rupture, they would do research to show how it behaved. If we didn't require a core melt or an ex-vessel phenomenon, then it wasn't in the industry research program. So it was left to the NRC to explore those topics. And I think that is a very important reason for a research program.

As we moved into this upcoming generation of reactors, requiring more information on the probabilistic risk assessments, I think hiding behind the design basis issue is not so easy. But I think, even in the future, it will be for NRC to confirm that the design basis works as it should and to explore beyond design basis capabilities. So that's one thing that probably a research program with an NRC emphasis ought to do beyond an industry program.

The fifth is to confirm engineering judgments for areas of high safety significance. There will always be areas in which judgments are necessary because you just don't have the information, and I think that's all the more reason why we should be clear about saying how judgments are made in the regulatory process.

Engineering judgment is okay, especially if you have experienced people and they can quote what

experience they're basing it on. But you would like to be able to confirm that those judgments are the right things to do.

Now, if that's the list of why you do things, it didn't say anything about, really, who should do them. And I think when the first generation of reactors was done, the separation between the NRC and the Department of Energy didn't exist or at least we were kind of on the tail end of that activity.

And so the distinction between an NRC research program and an Energy research program, like LOFT. for example -- was LOFT an NRC program or a Department of Energy program? Well, at the time there was no distinction. And I think both the regulators and the DOE promoters of nuclear energy were very interested in the program. And it wasn't like you got paid 10 percent per year and 90 percent for there. It just wasn't like that.

So who does it? It's kind of an outcome of the independent regulator. And if you look at the current generation, the next generation that we're looking at, the passive designs, the AP-600, AP-1000, ESBWR, and even some of the earlier GE designs, the largely research for those was done by the vendor with DOE support in many cases, with the NRC kind of

tagging on maybe 10 percent on the end and doing a few extra experiments.

But even though the NRC had an independent program, it almost never had independent facilities to do those programs. And I think that is a fine model. I think independence in my mind is more intellectual than it is a nuts and bolts issue.

If you have people with a different point of view with a different reason for doing the analysis who have full access to the information, full access to how the experiment was set up and what the results are, I think you can be perfectly independent with one facility and even one experiment supporting both the developer and the independent regulator.

So I am less concerned about the independence of the facility than the intellectual independence of the people using the information, which says as you go into a long-term research program, to me -- and I think what we ought to be looking for is a single integrated program that says you're generating enough information for the developer, the supporters of the program, the independent regulator, and the other stakeholders, who need to be convinced that this is the sensible thing to do. And to me that says you ought to have one

long-term research program, which has many elements to it, but it needs to be one integrated thought about how long-term research is done.

I guess that's the end of my thoughts.

DR. THADANI: Thank you. Thanks, Gary.

Any questions?

CHAIRMAN POWERS: A quick one, Gary.

MR. HOLAHAN: Yes?

CHAIRMAN POWERS: You spoke to the independence of facilities. How about the independence of models?

MR. HOLAHAN: Well, I guess in the past, we have had independent models. I guess I am a little undecided on that subject. If I go back to current examples, probabilistic risk assessment, the NRC has models and the industry has models. We spent some part of the last ten years talking about how can we get to the point where there's just one model.

I think I don't have a problem when we are talking about a large model. Certainly if we're talking about doing things like CFD, you know, no one is going to insist on developing an entirely new CFD code. I think that, even if you don't do your own model, there is certainly enough room to critique or criticize how the model is used.

I guess I probably want to approach the issue on a case-by-case basis. There are probably some topics for which a completely separate approach to the problem might be worthwhile. But in most cases, you know, I think if the model can be exercised or be discussed in a way that addresses features of that model that can look at different things, whether it's through a sensitivity analysis or different modules in an overall model, I think those are all possible.

So I wouldn't want to go at this dogmatically to say the NRC always and forever needs independent and different models. The thing I wouldn't want to lose is the fact that it's possible that sometimes the way an issue is approached, the way the model was developed will begin to convince people that the answers are right.

And every time I have seen a research program that compared calculations from one model versus another, the differences between models are always bigger than the uncertainties ascribed to the models, which says the model uncertainty is really larger than people recognize.

So I think you have to be open to that somehow. But there may be cases in which the industry

has more than one model. And so for the staff to have a third model it seems to me it does not necessarily have this independent role.

So I think I would go back to just it's independence in thinking that I am most interested in. And whether it is a model or an experiment, I think you have got to approach it on a case-by-case basis to see whether you are comfortable with a diversity of views that can be recognized.

DR. THADANI: Thank you.

Robert?

MR. HILL: Yes. I did have handouts here. Let me go through very quickly.

I was asked to comment on the non-LWR research issues. And, in particular, I am going to go very quickly through research and a high-level overview of what we are going to be doing in the GNEP program. And I'm going to talk about some recommendations for NRC long-term research based on that.

For the GNEP, I think the second figure in the package I handed out shows the closed fuel cycle. And I am going to be recapping a lot of what you have heard from the other presenters in the previous presentations in my talk. I think there is the

recognition that LWRs are going to be the dominant power producers and they will be the dominant part of the fuel cycle, which is the main power-producing reactors.

However, if we go to a closed fuel cycle, we will have several new technologies beyond that. And that is in the center of this diagram, which is a separations technology, a fuels technology for the recycle fuels, and a new type of reactor that is using the recycle fuels. And those are really the three main areas of research that are going on within the GNEP program, are those three technologies.

And as far as what the focus is within GNEP for those three technologies, it's obviously not just the safety issues but other issues. On the advanced separations, the issue there is the improved waste management.

So they are worried about things like low separation losses and technologies that can be very efficient to be done, also inexpensively to do the separations.

There are proliferation issues, as raised by the previous speakers. And some of the items there are looking at technologies that don't have separated plutonium and also looking at advanced safeguards

technologies.

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

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

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

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

will happen, both for different types of designs and for different off-normal conditions.

So these new modeling and simulation tools are both useful for design optimization, which is a lot of what they are being developed for. But they are also useful for assessing what the uncertainties are and what the behavior will be in off-normal conditions, which is important, obviously, for the safety analysis.

I am going to skip the next one. It is just talking about how for the reactor area, there are a lot of different fields that we are trying to capture in this modeling and simulation. It is a very broad area. We are trying to do better reactor simulation.

Now, there is within the GNEP program a cross-cut that's looking at regulatory issues. And the reason this is a cross-cut is there are regulatory issues for a separations plant if you would build it. There are regulatory issues related to fuel fabrication and performance and regulatory issues related to the reactor.

These are just some of the activities that are starting within the program. It is trying to look at what the guidelines might be for some of these

advanced technologies and also what is the status of the current technology for that. So I think the outcomes and the output from this work will be very useful as the NRC considers what is needed for their internal program.

And the next slide there, I really just wanted to go to the second bullet of this, which is a very important point, which is the regulatory framework for fast reactors and reprocessing facilities has not been exercised in a long time. And in some cases, it never has been exercised.

So this is something where there is a lot of work, there is a lot of speculation on what the criteria will be, and it is going to be very important that there is a lot of interaction between the NRC and the people who are trying to develop these concepts on what the appropriate criteria area.

That was sort of a quick, trying not to make everybody late for lunch, overview of what the research is that is going on within GNEP. What I am going to talk about now are some of the recommendations on the topic that was asked, which was what would you see, then, as useful for an NRC program on long-term research.

All of these are issues that have been

mentioned in previous talks, and this is sort of a recapping of these issues and maybe a little bit different spin based on the non-LWR technologies.

The first item is the knowledge base. There needs to be an in-house capability within the regulatory agency. And this capability needs to be very broad. The first part of the bullets here is I am trying to give an idea of how broad the interest is and what the possible applications are of advanced technology.

We're talking about different kinds of chemical separations. There are both advanced aqueous processes and dry chemical processes that are being looked at for future application.

There is a variety of fuel forms. Besides the oxide -- and fast reactor oxide behaves very differently than LWR oxide fuel -- there is metal fuel that we are also looking for our fast reactors. And in the gas reactor technology with the Generation-IV program, there is TRISO fuel, which is coated particle fuel. And even there, they've got different kernels that are within the coated particles that they're looking at depending on the particular application.

There is a variety of different coolants that are being looked at. The main ones that are

being looked at for the advanced technologies are sodium, helium, and heavy metals. And these coolants tend to operate in different regimes. For the sodium, your single phase, liquid phase, and you tend to operate at low pressures; whereas, for the gas, your single gas phase, but you're operating at very high pressure compared to LWR systems. So there are different coolants operating in different operating regimes.

And, really, to do the regulatory issue here, you need to be looking not just obviously at the normal operating conditions of these systems but how they will respond to off-normal conditions, which takes a deeper level of understanding of what is going on than just the standard operating conditions.

So there needs to be this broad knowledge base, and there needs to be this in-house capability to do this. And we face the same challenge within the DOE programs that were talked about here, which is limited human resources and expertise within these. And this is a real issue of human resources and how we have the people who have this capability and knowledge to be able to address this wide range of systems.

The last item I have here is there is this real issue of as we go to a more risk-informed basis

on the safety, how do we handle systems where there is less experience with the systems.

You can do a PSA, and you can make some engineering judgment on what the failure mechanisms are and the probabilities of them are, but how does this need to be done in a safety and a regulatory environment as we're looking at systems where I don't have the experience base, I can't point to pumps that I have run for 20-40 years of this precise design and how they will fail?

The second area, then, is safety assessment tools. And this is the discussion that was just had with Gary's talk, which was, you know, do I need an independent analyst or do I need an independent tool or do I need totally independent capability with the testing also?

And, as I state here, the traditional approach was to have independent tools. I am not sure that this is advisable as we go forward. We're going to be doing a lot of work within the research program on the development of advanced methods. And I think at least some of those should be applicable for the safety analysis also and very useful.

And this goes back very closely, then, to the first one, which is the knowledge base because I

agree totally that you need the independent intellectual approach to it from the regulatory body to where you can assess whether these tools are useful or not. And in general they will probably have to be adapted for the specific issues that you are going to have looking at the safety cases.

From the NRC perspective, this is both to develop what the standards are going to be and then to look at the specific applications that will be brought in by the applicant.

A key issue on this is validation and how do we validate these tools because the tools are modeling very different physics than were modeled for the LWR safety issues. I've got a little bit on that on the next slide there.

With modern computing, we are going to be doing a lot more reliance on the simulation and the results of the simulation with probably more limited testing, both because of better computing power and lack of facilities to do the testing. And, therefore, it's going to be very important to validate how well these tools are modeling the basic physics of what is going on.

I think you are going to get somewhat into some new regimes. Instead of testing very specific

design configurations, you will be testing the physics and the modeling of the physics of what is going on. We are doing that. And we are starting to develop testing plans within the program for the advanced safety methods.

One issue that is very important is that we have a lot of data historically. And that data is not all well-documented. And one issue we are going through now is preserving the existing knowledge and the testing knowledge for these advanced technologies. And any early identification of gaps in the validation basis will be very important.

One other issue as we go into these advanced simulation methods is we are working very hard to make sure that the uncertainty assessment and the uncertainty propagation are included in these methods from day one and that we don't just develop a best estimate method and then later have to guess what the uncertainties are in that method.

Now, this is well done already and well understood for certain fields. Like for reactor physics, we have fairly good estimates of what the errors are in the nuclear data. We have very formalized techniques of how to propagate that into the predictions. It's less well-specified for other

areas, like CFD, how you account for the uncertainties.

There is work going on in this field. And we are trying to make sure that it is applied in the new methods that are being developed. I think we will have something in the next five years that is much better both for the fidelity of the thermal calculations but also for how we do the uncertainty evaluation for those.

The third area for the NRC, the first two, again, were the knowledge base and the assessment tool. The third area is the regulation development. There is a lot of speculation among the people who are looking at these advanced designs on what the criteria are going to be. In order to do a lot of the work that is being done out there, you have to make some assumptions on what the design criteria are going to be. And this is one of the key roles obviously in the NRC to establish what the design criteria are for advanced non-LWR systems.

Some of the areas that need to be done on our what are the proper shutdown limits are going to be the heat removal requirements and the containment approach and technical limits.

And these really are key issues for some

of the advanced designs because, for instance, the liquid metal designs rely a lot on inherent feedbacks and reactivity feedbacks, which are very related to what the shutdown issues are and those where, for instance, the gas reactor concepts have a very large heat removal and a very large heat retention capability within the system with their low-powered incidence. So the heat removal requirements become very important for those designs.

And some way to translate what is in the existing body of regulations and capture the essence of the safety criteria for the LWR and how it will then be applied to the advanced systems I think is going to be needed by everybody in the long run.

This work obviously -- I put these in the order for this. This follows very carefully, then, from the knowledge base and the safety assessment tools. Both of those things are needed, I think, to be able to set what the design criteria are going to be and what makes sense for these advanced systems.

So, to summarize, then, within the GNEP program, we are looking at three different areas of technology. We are looking at advanced chemical separations; advanced fuels; and advanced reactor concepts, particularly fast reactors in GNEP and the

gas reactor in the GEN-IV program.

Some of the key issues that were identified in our presentation were this in-house knowledge base, safety assessment tools, and regulatory practices and procedures.

I think as those three areas are concentrated on in the long-term research program, the specific issues, what technologies do we need to test, what more detailed testing analysis needs to be done, will fall out from those three areas as the concepts that are being pursued become more clear five, ten years from now and as where the gaps are become more clear, the specific issues will fall out. There is no one issue I can point out today and say, "This is the key safety issue." I think they will come out as the focus in the long-term research is on these three areas.

Another important role that I was asked to talk about is international collaboration. There are really two different contexts in which international collaboration is being pursued. There are several international agreements within the GNEP program. And those are on developments both of the separations technology and the advanced reactor technology.

We have agreements, and we are doing

active work with the Japanese, in particular, on fast reactor technology. We are having discussions also with the Russians and the French. And that will be both the technology for the reactors and the advanced simulation methods for the reactors.

The other context in which there is international collaboration is the Generation-IV international forum. There's been a lot of work over many years to set up the international agreements there such that you have an international agreement to do and to share research and development results within that context.

There is a lot of ongoing work there on gas reactor materials because one of the main issues there is the high-temperature materials within the system and also on the fuels within the system for the TRISO fuels.

Within the Generation-IV international forum context, there is also work on fast reactors. It has a lot of the same character as the work that's within GNEP but a little bit broader context of the parties that are involved within the Generation-IV program. And I can answer more specific questions after lunch this afternoon on the details for the international collaboration.

DR. THADANI: Thank you very much, Robert.

Any clarification questions?

(No response.)

DR. THADANI: So we will take a break until 1:45.

CHAIRMAN POWERS: Well, you're more generous than I was going to be. I was going to say 1:30.

PARTICIPANT: He is in charge.

(Laughter.)

DR. THADANI: I would recommend 1:45.

CHAIRMAN POWERS: All right. 1:45.

(Whereupon, a luncheon recess was taken at 12:47 p.m.)

CHAIRMAN POWERS: Okay. Let's come back into the session, and I'll promptly turn it back to Ashok.

DR. THADANI: Robert sort of, I thought, felt compelled to rush through his presentation.

CHAIRMAN POWERS: Oh, I don't know why you'd think that.

DR. THADANI: I think it's only fair that we see if Robert has any areas he wants to emphasize, go back to. And also I suspect there's a lot of interest and there's questions probably in this area.

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

MR. HILL: Yes. First of all, I just wanted to highlight sort of the different time frames. Because I know there was discussion over what things were of interest and what time frame.

The current GNEP plans talk a lot about facilities in the 2020 time frame which would need licensing then and soon. 2010 time frame.

The technologies for that would be the separations technology. And there would be issues with licensing issues for that. And then for the reactor technology and that time frame, it would definitely be sodium cooled reactor. We're looking at both metal and oxide fuel options for the sodium cooled fast reactor. And that would be in that type of time frame, the technology that you're talking about, for the reactor specifically to use the recycled fuels.

And the initial reactor probably would be testing those fuels. It would probably start up on a more conventional fuel because we just don't have the experience yet with the recycled fuels.

The other reactor technology non-LWR that's out and being looked at as what's also talked about as in the NGNP. That's the gas reactor. A similar means, the ultimate approach with that is to

go to very high temperature for hydrogen production and then they back off for the initial application to more of a -- but still, much higher temperature than the other technologies we're interested in. And they have a variety of fuels, the TRISO fuel options that they're looking at for that reactor.

And as far as I know, and Tim you can correct me if I'm wrong, they're looking at both pebble bed and the prismatic options within the GNEP program so there isn't any firm decision on that yet at this point.

DR. AHEARNE: You also have fuel fabrication facilities.

MR. HILL: Fuel fabrication facilities? Yes. But again for the 2020 time frame for the initial start of facilities, you'll probably be starting up on a more conventional fuel and then you'll be doing testing early on of these recycled
fuels so that the fuel fabrication, the new part where you're doing other recycled materials a little bit farther on. So trying to get a handle on here as a little bit what the time frames are for the different applications.

MEMBER ARMIJO: On the LMR, we decided whether it's pool type, loop type do you have a

reactor design decision?

MR. HILL: Yes. There is no decision. There are four industry teams that we're working with at the moment in GNEP. And both are being considered among those four teams.

MEMBER ARMIJO: Okay.

MR. HILL: In general what you'll see is each country has a preference replica of what it's got the more experience with. Now in the U.S. we've got experience both with pool designs and loop designs.

MEMBER ARMIJO: We haven't decided yet?

MR. HILL: It has not been decided.

CHAIRMAN POWERS: Anybody have any good experience with loop designs?

MR. HILL: FFTF was a loop design.

MEMBER ARMIJO: And steam generators are probably a weakness in both systems. Any work on that?

MR. HILL: Steam generators have been where there's been a lot of leaks in the past. Now there really has been a lot of progress made in the demonstration reactors that have run. And I think today that you would have better experience than you have in those previous reactors.

DR. AHEARNE: You're not talking about

Monju and Phoenix, are you?

MR. HILL: Monju the leak wasn't in the steam generator.

DR. AHEARNE: But you're saying good experience.

MR. HILL: Well, the BN-600 has had much better experience then.

DR. AHEARNE: Okay.

MR. HILL: Super-Phoenix -- Phoenix had good experience with steam generators. And EBR-2 had good experience with steam generators. FFTF didn't have a steam generators.

MEMBER ARMIJO: FBRs had great steam generators.

MR. HILL: Yes. Exactly. But to be able to make that design economic -- so that's what they're looking at now. But they had great experience.

I think you could do better today than what was done in the past. We are looking at options, though. There's a lot of work going on both in generation for and in GNEP on a super critical carbon dioxide Brayton cycle as an alternative to the conventional steam cycle for use with sodium systems. And that's a promising feature for the future. Now 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.

CHAIRMAN POWERS: The NRC has sponsored two phenomena identification and granting exercises in connection with the gas pooled reactor, one focused strictly on the TRISO fuel, the other one focused more broadly on the accident analysis. Do you have any thoughts on those? Were they adequate identification of safety issues to consider overly conservative? I mean, what are your thoughts?

MR. HILL: Yes. I'm not personally aware of either of those. I can contact the right people and let them know that you've requested some feedback on them.

CHAIRMAN POWERS: Okay. Yes. It would be useful to find out because right now there's an example of a fairly proactive step that the Agency had taken.

MR. HILL: Right.

CHAIRMAN POWERS: And I know for certain that the analysis of the issues that are associated with fission product released from the fuel is unequivocally excellent. That would be of interest.

MR. HILL: Okay. I will pass that request on to the GEN-IV leaders, and that particularly from the ACRS Subcommittee they requested some feedback on that.

CHAIRMAN POWERS: Please.

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

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

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

and working effectively together on trying to apply these tools nd getting the most out of the modern techniques. And I think \you really will see some higher fidelity, better user interface, much better methods available. And I think you'll start to see that on the reactor side in the next five years assuming any reasonable funding level for this work. And I think those will be out in the five year time frame and available.

CHAIRMAN POWERS: I mean, you hit right to the heart of our interest here.

DR. THADANI: My understanding is that for years Pratt & Whitney for their jet engines have advanced CFD codes, tied into CAD/CAM. So both from a design perspective as well as a perspective of somebody who wants to say what if I change to this, what might it do, so on and so forth.

It appears to me that the nuclear side may be a little bit behind times.

MR. HILL: Yes. I think that's accurate. And I think this is going to be something that the NRC has to struggle with. Because the safety issues are different for nuclear systems then for these other types of systems, but there are these advances tools. And how do I correctly account for the advances that

I have there and the better fidelity and the more predictability I can get there than I used to be able to get in the past with what's going on while still maintaining the correct level of safety for these systems.

MEMBER ABDEL-KHALIK: The better predictability, does that come from enhanced validation based on experimentation or what?

MR. HILL: It's a combination of better modeling the physics and enhanced experimentation. Let me give an example from an LMR, one on liquid metal reactor, one I'm very familiar with.

Back when they developed the tools about 20 years ago we really could only do two dimensional modeling. So some of the issues about swirl and what happened with wire rod were just taken into account with what they called eddy diffusivity factors. Now we're coming up with methods that remove that. You don't have this knob that gets you within channel, subchannel mixing, but you directly model or you have a very fine model that generates those factors for you. Instead of having to do the experiment to generate those factors for you.

So the better predictability is partly just from a better modeling of the physics of what's

going on, that that's for that area. Now in other areas where we have a fairly robust experimental base, for instance on the physics prediction, let's say what the power events to use within the reactor, there we have a fairly robust experimental base. There we go to better validation techniques to wrap in the modeling uncertainties with what we know from integral experiments to get better levels of uncertainty.

So it's really a combination of better methods and better validation.

MEMBER ABDEL-KHALIK: Well, what I'm struggling with, you know, throughout the day here is the boundary between the responsibility of the developer/promoter/vendor and the regulator. In order for you to come up with a credible design based on economic constraints, you really have to have the research base to support your design. And the question is is that the starting point for the regulator?

MR. HILL: I think it will become that as you develop a new generation of tools in the next five years, which is what the designers are going to be basing some of their technology changes on. Yes, I think that's the best place to start. And then they will be used and adjusted slightly differently by the regulator for the issues that need to be looked at for

safety.

MEMBER ABDEL-KHALIK: I mean, if that is the case, then the incremental additional research that the regulator would have to do would be relatively minimal.

MEMBER ARMIJO: Unless the designers have made a big mistake.

MEMBER ABDEL-KHALIK: Right.

MEMBER ARMIJO: Well, that's happened.

MR. HILL: Well, it my be incremental in the sense that the extra additional onto those tools that needs to be done. But it's not incremental in that you can't just start up and start and starting using the tool and the next day you're able to get good and useful results out of it. It takes time.

I mean, I'm having to train people on fast reactor analyses methods, which is not taught very well in schools today, and it takes years from when they start to when they're able to know and have a good enough feel on the results to where they can get good calculations and good analysis.

So the timing issue, it's a little bit more incremental but as far as what capability needs to be added, you may be correct.

MEMBER ABDEL-KHALIK: But the idea of

intellectual independence that Gary Holahan was talking about implies that, okay, you have the basic data that support the methods that you have developed and validated and the regulator can start from the same basic data and can either take your tools and recheck the validation or go through the whole process of developing new tools, albeit using the same supporting data. And that's what I mean about, you know, the same starting point without jeopardizes the so called this intellectual independence.

MR. HILL: I agree.

MEMBER SHACK: The question that you need to do that in order to maintain intellectual independence is that it certainly would do it. But, you know, is that the only way to do it? You know, is it necessary? That's not so clear.

DR. THADANI: No. There are several documents written about what are good attributes for a strong regulator of nuclear power. IAEA has actually standards, if you will, for what a good regulator is.

Public confidence that John talked about is a very strong element into those attributes that you look for in a strong regulator.

Most people agree, most organizations

would agree that you should have some capability for independent judgment of what is put in the front. To have confidence in that independent judgment, you certainly need very competent people. To have competent people they can't just be ones who review other people's work. That's not enough. That's an attribute, but it's not sufficient.

So there's this issue of truly understanding safety by having done something, by having been involved in something rather than spending lifetime reviewing others.

So these documents, IAEA and other documents recommend strongly certain things: That you should have capability for independent assessment; you should have adequate resources. It's a larger list. There are other issues.

If you come to an agreement that I'm willing to use a tool that you have developed, chances of success are better if the regulator has had a say in terms of understanding your experimental support, the types of experiments that were done and probably QA issues and other things that would come up in hearings down the road.

So from that perspective, I said this earlier, long term research collaboration has to be

really, really early between the industry and the NRC to have confidence to be able to go to hearings and so on and say "No, by gosh, I just didn't accept what the utility or the license gave it to me. I was involved. I watched, I saw these experiments. I saw what was going on." Otherwise you expose yourself, I think, during the hearing process to some potentially significant challenges.

So it's a workable system if you get involved early. I forget who used the words about "early integrated long-term research." I forget who said that. But day one you need to sit down and make sure you're tracking plenty.

Good. I am glad Brian is back.

DR. SHERON: And I only had iced tea.

DR. THADANI: This is your Christmas party, come on.

DR. AHEARNE: Could I ask a question.

DR. THADANI: Please, John.

DR. AHEARNE: Do you have any comments on the recent National Academy study on GNEP?

MR. HILL: No.

DR. AHEARNE: I'll talk to you in the hall, outside this room.

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.

MR. HILL: That's all part of that. It's all wrapped together. Yes.

DR. THADANI: Just on that, I put up my question number one which really we have been talking about for the past 20 minutes or so, basically.

DR. AHEARNE: Needed infrastructure for what?

DR. THADANI: Is there infrastructure needed if the Commission has to deal with some non-light water reactors of science coming in for approval. And that infrastructure is when those expert staffs, that's fundamental to all of this. But expertise comes at a cost.

DR. AHEARNE: But if you don't develop it, there's even a larger cost.

DR. THADANI: That you don't like.

DR. AHEARNE: If you don't develop it, it's an even larger cost?

DR. THADANI: Yes. Yes.

CHAIRMAN POWERS: It seems to me that if it's needed, is it needed such that we need to start on developing it now.

DR. THADANI: Yes.

CHAIRMAN POWERS: If not now, is it five years from now?

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

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

DR. AHEARNE: Right. Right.

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

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

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

MEMBER ARMIJO: Right. Right.

CHAIRMAN POWERS: You know, I find no overlap.

MEMBER ARMIJO: I don't think it's a cliff. I mean, there's people as these technologies are becoming more likely to be deployed, it's easy to take an experienced people, let's say, just evolve into your advanced reactor fuels.

I don't know about systems. Systems are probably more complicated. But for some of the technologies it's an easy.

DR. THADANI: This is sort of -- I would say this is more in a context of systems. Well, two parts -- it seems to me two parts are important. One is in selected areas and the NRC has at least started with this. Say we want to confirm certain selected areas of what the industry claims, and we'll go off and do our thing to confirm if those claims are okay.

The second part, in my words, is the regulatory agency would probably want to poke and probe in some areas where the industry's not likely to look.

CHAIRMAN POWERS: Right.

DR. THADANI: Which generally means the industry probably does not want to look to the point

of failure.

CHAIRMAN POWERS: You're right.

DR. THADANI: It's a success oriented approach to thing, which means I think someone said here, beyond design-based accidents, severe accident considerations. It's very difficult for NRC to push the industry to do certain things which are not explicitly called for by the requirements. On the other hand --

MEMBER SHACK: When we're dealing with new reactors, we can have new requirements.

DR. THADANI: Are they going to be to obtain it?

MEMBER SHACK: And do we have to license every reactor that somebody brings to us?

DR. THADANI: That's right.

MEMBER SHACK: You know, if the guy walks in with his wood -- reactor, do we tell him to go home?

DR. THADANI: If there's a utility involved, NRC has to review it, right?

MEMBER CORRADINI: If there's a potential customer involved, yes.

DR. THADANI: Well, it's more than potential now because priorities being with the upper

resources, they want a letter from a utility, right?

MEMBER CORRADINI: But I guess I wanted to ask Brian a question, because --

CHAIRMAN POWERS: What's the answer?

MEMBER CORRADINI: Oh, I'm sorry.

DR. SHERON: Well, I was just going to object and say that, you know -- and I've had this discussion with the Commissioners periodically. I guess since I took this job, which is now over a year and a half ago I guess, you probably almost from the get-go I started lobbying for the fact that we would not be ready for these advanced reactors. So when you're saying when should we have started this research for the non-light water reactors, my contention would probably have been about three years ago.

There are some parts of it that I don't think are going to be a big problem. Both the gas-cooled and the liquid metal reactor are single phase coolants, okay. So you're not dealing with any of these two phase problems that you have with the codes, for example like with RELAP and TRACE and all that.

And I don't know if you know, but when I started my career in '73 up at the Atomic Energy Commission, I worked for three years on the Clinch

River Breeder. On the thermal hydraulics, I was the project manager for development of the DEMO code, which was the Westinghouse code for the reactor. So I'm fairly familiar with LMR behavior and stuff.

And there are some areas that are a lot simpler, okay. As I said, the single phase fluid, the heat transfer and all that; it's a fairly straightforward calculation. You know, again, you're not dealing with a very compressible fluid. So to some extent you don't even have to solve the momentum equation.

When you get into the things that make it different, for example when you have a steam generator that has sodium on one side and water on another, you open up a whole new pile of accidents.

That's probably one of the door alarms.

You know, because obviously when sodium to air it burns, when it's exposed to water it explodes. So there's a whole new area there with pressure pulses and everything that I think really I'm not sure how much we know about it.

I know when you get, as you said, beyond design-basis to the HCDA type accident and transient overpower where you have a whole different accident, I'm not sure how much we really know about that.

Gas-cooled reactors are different, you know the pebble bed. You know, they're coming in saying you can't melt the fuel. We can't come up with an accident that melts the fuel.

DR. THADANI: As long as there's no air, no moisture.

DR. SHERON: Yes.

DR. AHEARNE: And no cracks.

DR. SHERON: And no cracks, right. Or no airplanes. And I won't go any further.

But it does rise a whole set of policy questions, okay. And if a license is going to come in under Part 52, then they have to do a PRA which doesn't stop at the design-base. So there is an nexus to -- or at least some link to say you need to have some understanding of how this plant behaves beyond the design-base in order to do the risk assessment.

The Commission has taken a position, at least previously when I spoke with them, that given all the light water reactors that were saying they were going to come in with an application and had licensees right in tow with customers, the guidance I was getting was that unless the non-light water vendors have a customer in tow, we're really not going

to put them at the top of the list. In other words, they can come in and they can submit all the design certification reviews they want, but the priorities are going to be we're going to work with the people that have customers.

And originally, you know, when I would talk to Westinghouse, the PBMR part of Westinghouse that would come, you know they would always say that they had interested utilities. They never had a customer in tow. But now Toshiba, for example, supposedly has the city of Galena, Alaska, although I'm not really sure they understand what they're getting into or the costs of doing a review. But that's pat of the whole issue is that, you know, maybe we don't need to be ready right now if the agency is just not going to entertain these applications because of resources. In other words, even if they came in we may say, you know, you're not going to -- and, you know, I've had Westinghouse had the PBMR people sort of say, "Well, you know, if you guys don't review it, you're going to close down this technology to the U.S. You know, we're just not going to pursue it here;" that kind of stuff. And I basically tell them is, I said you know, let me show you what the 17th floor and the 18th floor is over in that building is. You know,

you need to go over and talk to them, and the like.

But that's really where the Commission is right now I think. And that is that they're looking at -- you know, even with the light water reactors, they're basically telling people is that unless you come in with a commitment. And to some extent they're really saying is, you know, to prioritize you, we're going to prioritize you based on whose put the money up front to order long lead equipment, you know the big fortunes and everything. Because that's demonstrating more of a commitment than just somebody that comes in and says I want to get the license in hand, I want to get the certification in hand and then I'll decide later if I want to go, and like.

So anyway, I just wanted to pass that on that that's sort of in the priority. But I think for non-light water reactors there's a whole bunch of areas I think that we've learned about since we first worked on these things back in the '80s. There's material questions that I think are going to come up. And I think that's a lot of NDE questions that you have to figure out, especially for the LMRs and stuff. And then also the, as I said earlier, the PRAs, you know, what database do you have.

I remember Clinch River actually did a PRA

back in the early '70s and they were coming up with ten to the minus 14 as a core melt. And they were coming into the NRC. And I remember at the time the NRC was, you know, after they picked themselves up off the floor laughing --

DR. THADANI: I can tell you this came to me.

DR. SHERON: Yes.

DR. THADANI: And what do you think is the likelihood of failure to SCRAM? And we had this long discussion about that. And I think it was then recognized that those earlier studies considered only random failures. The common cause failures were excluded.

DR. AHEARNE: It seems to me --

DR. THADANI: Yes?

DR. AHEARNE: Okay. Go ahead.

DR. SHERON: I'm done. I'm done.

DR. THADANI: Go ahead.

DR. AHEARNE: I want to pick up a question that Mike had asked. I don't see how you can expect to get a utility to be putting up saying we're interested in any of these advance designs.

Now I just coming off the utility board, and we look at what I would say the pragmatic reality.

And an advanced design reactor with all the wondrous description of this, is not something that you're immediately going to go for. But on the other hand, I think the NRC has had an experience. I can think back when there was a suggestion well maybe Candu could be licensed. And it turned out at the time, the NRC had no codes to apply to it, they had no experience in doing that. And that concluding would take about four years just to begin to go through that.

So I think that if we really -- or you, really see the likelihood of some of these more advanced designs coming down, you've got to get prepared for it. And that means you've got to educate people. you've got to work on look at what kind of codes are going to be needed. And then look around the world to see what kind of experimental facilities are available that you might have to use.

MEMBER ABDEL-KHALIK: If I may just follow on that, something you said. You indicated that you expect to have some sort of advanced within five years. It's a very short period of time. Is the NRC cognizant of what you're going to have five years from now? Have they been involved at all in the definition of what needs to be there five years from now? Have they identified any holes in whatever you will have

five years from now that they need to work on today so that five years from now they will have not only your tools, but the tools to fill the holes that you might have?

MR. HILL: They have not been really involved in the development tool --

MEMBER ABDEL-KHALIK: Why not?

DR. SHERON: Because we have no resources.

MR. MARION: Well that gets to the question, that's a point that I was going to raise, that in some of these areas specifically with analytical tools that are being developed under GNEP, the NRC has to make a conscious decision at some point to get involved to understand those tools because ultimately they're going to be applicable.

MEMBER ABDEL-KHALIK: Right.

MR. MARION: And the challenges make that decision in some point in time, then get the staff involved to understand that technology so that when it is submitted for regulatory approval, you have the expertise here to do a credible review. That seems to me the question.

From a utility point of view, you're absolutely correct. They're not going to look at anything new. They're going to look at existing plants

or existing designs that are out there that are proven that they can license. You know, that's the reality of the way industry looks at these things.

It's not going to say that they're not going to support some new reactor in the future. But right now they're going to look at what's already out there on an international scale.

MEMBER ABDEL-KHALIK: The answer to that question I posed, you said they haven't done that because we don't have the resources. So maybe the very first question we need to address is where do we start? What are the resources needed and how do you secure those resources?

DR. THADANI: Number one, where do we think the gaps are? What information may be needed at what time? Second, what resources do you have, what you can practically do? Don't constrain yourself up front by saying, you know, I'm not going to have resources, I'm not going to bother thinking.

The idea, it seems to me at least, would be to do as good a job as you can of what you see future challenges might be, what would it take to be ready to license these designs. Go to the Commission. Say "Commission, these are the resources that we think would be needed on this time scale." And the

Commission may come back "We support you, we'll go to Congress." And assuming Congress says okay, then you're all right.

But it's quite likely the Commission would say "Well, no. You still have to go prioritize some of this stuff. You have to come in with X amount."

I think where we are now, we're just trying to say what those challenges are and what would it take before you jump. I wouldn't jump into resources issue until later. Do the best job you can technically saying what you think would be needed so the agency is really prepared.

MEMBER ABDEL-KHALIK: To define those challenges, to identify the holes, we have to know the landscape.

DR. THADANI: Yes.

MEMBER ABDEL-KHALIK: And that was the basic question I was asking. Why hasn't the NRC been involved in sort of finding out what the landscape is all about?

DR. THADANI: I think, Brian, doesn't the resources --

DR. SHERON: Well, you said we don't know what the landscape is. I'm not sure exactly what you're --

MEMBER ABDEL-KHALIK: Well, he's saying, you know he's given super duper tools five years from now. Do you know what those tools are?

DR. SHERON: No, we don't. Because, first off, we don't have an applicant.

Second is that I don't have a mechanism to go and basically get that information from him. All right?

We are putting together a Commission paper, which will go up I think in January as a combination with NRO and Research. And it addresses that very issue that you're going in. And that is that we're trying to give the Commission a picture of the advanced reactor landscape as we know it today.

As a matter of fact, you probably ought to listen to that meeting. Because in the morning it's going to be a two part meeting. In the morning they're going to bring in all of the vendors that are talking about design certifications. They're going to bring in representatives from PBMR, representatives from Toshiba. I even think for maybe the IRIS reactor. And I think DOE, which we kind of look at as the ringleader, if you want to call it that, in terms of developing these advances reactors and the like. And the reason is is we want these vendors to tell the

Commission and we want the Commission to have the opportunity to quiz them exactly how serious are they.

You know, that's another part of the equation is how serious are you? I mean, it's nice to come in and say we want this, we want that and everything. And I'm not going to go off and devote a whole pile of staff and money, okay, for something that's never going to materialize.

So we do have to get some feel. For example, with GNEP, okay, I mean even the Commission is very skeptical. We just see it -- you know, one day it's on the top of the pile, the next day it's at the bottom. You know, we're not ready to go off and chase that until we get a better read from DOE on what the long-term commitment is on that.

In the afternoon both NRO and Research are going to report to the Commission. And I'm not going to go in there and tell them, you know, I need this or I need that and pull my pockets inside out. But basically we will tell them to what level we will be ready to support the Regulatory Office with what tools we have.

And as was said earlier, okay, it may be -- I mean we've licensed plants before, it's a little tougher if you don't have all the tools. You make

more conservative decisions a lot of times. But it'll basically kind of define what we can provide the regulator on what time scale and then, you know, what the licensee is going to have to provide in order to provide the assurance that the plant can be designed and operated safely. And we'll go from there and see what the Commission does.

But you got to remember when you're talking about, gee, how can we have resources, okay, NRC's budgets are not set on any logic. Well, I apologize, but I mean it's true. The Chairman just told us yesterday. You know, he says in years that are divisible by two, it's not too logic; in years that are divisible by four, it's even less logical.

The '09 budget, for example, we got cut by OMB $211 million on the passback and 641 FTE was the passbacks, was the cuts we got. That put the FTE ceiling below where we are now. Okay. We actually had to lose people to reach the '09 levels, okay.

The Commission went back and got a $813 million and the 641 FTE. We just found out the other day we got the 641 FTE, but we only $100 million. So now the agency is struggling to figure out how do I take a $83 million cut in my '09 budget, $61 million of it is fee recoverable and the rest of is out of the

treasury, okay?

So we may not even be doing work on some light water reactors. And I don't know how they're going to allocate those cuts.

But resources are a very important thing in this whole process.

And the other thing is it's not just money. You have to have people that can manage the money. It's not just a matter of saying, you know, give me dollars and I'll shovel it out and stuff. I really need to have competent project managers that know how to write and know what the work that is needed and know how to interpret it and know how it meshes and fits in. And that's a very important part of the process.

So just throwing money at it really doesn't solve or get you what you want, okay?

And I've estimated, for example, right now the Office of Research has 243 FTE, that's my allocation for 2008. And I think that's my number also for 2009. I'm presuming somewhere down the road that the agency is supposed to go from 3400 where it is now, up to over 4000 that the demands on the Office of Research would go up proportionately. So I'm presuming at some point all the FTE, you know my

staffing would rise to maybe 280/275 people. Now, is 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 meet the August '08 date. And basically it says that, you know --

MEMBER ARMIJO: You licensed a gas reactor.

DR. SHERON: Yes, we did. We will proceed with Part 52. And I think what the plan is to risk-inform some parts of the Part 50 regulations as pat of it. Okay. But the real key is going to be whether, you know Part 52 requires the submittal of a fairly complete design. And the question is is DOE going to have a fairly complete design on the time scale that they need to submit in order to meet the startup date, you might say, at '20/21. And I think that's going to be the critical part of it.

We've estimated like a four year review time once the application is on. But, you know, the Commission has gone out and told the industry in no uncertain terms that if you want to get these licenses on a predictable time scale, you have to have a quality complete submittal. And that's the real question is is DOE going to have any kind of a complete design for a gas-cooled reactor that will pass the Part 52 test.

DR. THADANI: Shall we, moving along.

This one has to do -- we've discussed this also for the classes in technologies. This relates to both things like advanced monitoring system, predicting potential failures that might come about, keeping track of buried piping and things of that sort. To just have a much better idea of what's going on, and including cables. Cables. Actually, there is an interagency group, or has been for a while, and a great deal of research has been done. I don't mean nuclear. There's a great deal of research trying to understand cable fires, cable failures and such. There's a lot of technology available that can tell you likely places for failures, types of leakages you might get and so on.

DR. AHEARNE: That's an example that has been around for almost 40 years.

DR. THADANI: Yes. Yes. And so that's one side is the prior technology. But the other side is, of course, technological advances as then might relate to software, models including -- has grown a great deal.

With that sort of background, are there things that you think research should be looking at over the next several years?

My personal view is if you pay attention to this, I think you probably do two things. You enhance safety and I think things also become more economically from an industry perspective. You have a better idea of what's going on, you can take better preventive actions and so on.

MR. MARION: If I understand -- this is Alex Marion.

If I understand the scope here, this is probably an area that is ripe for collaboration with industry and other industries that applied more advance forms of science and technology. And I think everyone is watching what's going on with digital INC. You know, it's an embarrassment because I know of one utility that has a number of non-nuclear plants and nuclear plants in Calvert County, Maryland. Twelve years ago they upgraded their non-nuclear facility control rooms to digital. Twelve years ago. And they're not even thinking about it on the large scale for the nuclear facilities. And the question is, you know at some point we have to look at what were the barriers created that prevented us from staying abreast of that technology. Because the U.S. lags the world. Okay. And what are we going to learn from this experience so we don't fall into that trap again

with newer technology as it develops?

I mean, those are the kinds of things that really need to be addressed at a policy level. Because everyone in this country is watching what's going on with our efforts with the staff on digital upgrades. And we're committed to make it successful, but it's going to take a while. And, hopefully, we'll get there and we can use that as a stepping stone to do a better job with other technologies.

And in the digital world, you know what is licensed today is probably going to be a different product that has to be relicensed three to five years from now because the technology is improving so fast.

CHAIRMAN POWERS: Well certainly non-nuclear digital systems were they commercial off-the-shelf systems?

MR. MARION: Yes. They were demonstrated systems that were used in other industries. Yes. But they met some of the electrical standards, but not necessarily the electrical standards that are adopted by the Nuclear Regulatory Commission.

DR. THADANI: See, Alex, it seems to me I only put safety here. Because -- economics are involved. From regulators perspective for new technology, you want to be sure you understand what

the failure modes might be and whatever it takes to gain some level of confidence in that. And if I look back to research that NRC did to understand aging of components and so on, I think that really is and you can see a lot of confidence to uphold this license renewal. And in the same way if the agency selectively focuses on some key advanced technologies that the industry is likely to utilize, it might solve the problem. Because ultimately you want which carry here now, they need to have confidence so they can move quickly to approve the use of such technologies.

What are some of the important areas that the industry might be looking at that perhaps Research at NRC should get started on?

MR. MARION: I think -- well, I don't know if we're collaborating or not, but the industry is putting a tremendous amount of resources in nonhistorical examination. And that's another area of the collaboration.

And also nominal inspection techniques for unavailable like systems. And when you get into to start thinking about license renewal for an additional 20 years, the obvious question comes up

of what confidence do you have that the rebar in our concrete structure is still adequate and sufficient.

So some diagnostic technique has to be available for that. And I think there are a number of things that can be done in a collaborative manner. Because the thing about it is when the way I look at research there are some fundamental principles that need to be confirmed. But then the marketplace has to step in play.

And when you think about the industry and where we are on this threshold of expansion, there is going to be a marketplace out there to develop new techniques as long as the principles have been established. Because those vendors are going to recognize the importance of new probes for NDE, et cetera, as we go forward. That's the kind of thing that really needs to get laid out. And I think that's extremely important.

Cable diagnostics, I'm not really sure that we can do much more because in the real industry in terms of the electrical distribution industry, they've done a tremendous amount of testing and investigation of diagnostic techniques on cables used in underground systems. And there isn't a solution to the problem today. Okay. And they've invested millions and millions of dollars in research and can't come up with an effective repeatable diagnostic

technique.

So anyway, I only made that comment because I'm an electrical engineer.

CHAIRMAN POWERS: Yes. But it's really important that you identify whether it is --

DR. SHERON: If I can interject on the digital part --

COURT REPORTER: Excuse me. Is somebody using a BlackBerry or something? Because that interferes on the microphones and I can't really hear very well. If you could turn it off or just avoid the microphones.

DR. SHERON: You know, you all know Mike Mayfield and I can tell you what he said at one point, and that was he said that if the industry -- in other words, one of the things we're looking for in digital is the diversity and separation, okay, and the like. He said, you know, if somebody for example developed a digital protection system that had two channels that were designed and constructed by different companies and whatever, you know, and the logic -- he said we'd be happy. He says but the trouble is the industry starts putting common connections between -- basically in the platforms and everything. And the more they do that, the more questions get raised about the common

mode failure, you know.

So to some extent this is kind of a self-inflicted wound from the standpoint of the industry. And when we asked the questions about well how do you assure you're not going to have a common mode failure or whatever, in other words what programming error, all right, and you could shutdown wipe both trains, and that's what worries everyone. And that's why we --

MEMBER BONACA: Foreign designs have the advantage of having more redundant systems --

DR. SHERON: And some of them are actually putting in, for example I think in Finland when we asked, they said you know, well we have the digital. Well, they've got analog backup.

MEMBER BONACA: That's right. More redundant failure. It's like four times then German design where then you can focus better on the issue of common cause and they're designed for that.

DR. SHERON: But when we asked the questions, I mean I sit on the CSNI. And when I go over there and I even asked folks over there, I said what have you done on digital. And it's basically nothing because from a PRA standpoint they don't know how to model a digital system in a PRA because it's

not a random failure, okay? If there's a programming error, it's there, it's going to happen every time. And so they struggled with well how do I represent that in a PRA. And as a matter of fact, we've got a whole group over there that's trying to figure this one out.

So when you say, you know, well you know our primary purpose is safety, and it is, okay, and when the industry comes in with these new digital systems that have all these common connections and everything we asked the question how safe is it. Well, they can't give us a risk answer because they don't have a risk assessment, okay? You know, and you say well how do you know you're not going to have a common mode and, you know, their arms go above the head and everything.

We are finding that there are, even though they say they're isolated from the rest of the world, they are still connections. We say can a hacker get in there? Because somebody could do something, you know. And while these systems may have been used successfully in non-nuclear plants, you got to remember if one of these systems fails in a non-nuclear plant, like a boiler or something, well maybe it'd melt a tube or something but it's not going to

make the ***Washington Post***. It's a lot different than if it screws up in a nuclear plant, and that's part of the logic.

DR. THADANI: Well, ABWR had an analog backup, too.

MEMBER BONACA: Yes. And in addition to that, I mean if you look at the typical design it was based on the four redundant trains and it was designed for common cause. So therefore you could back in to a digital system more easily because you had provisions of separation, the redundance took care of that and it's for designs if you already have two trains. Maybe South Texas can do better.

DR. SHERON: Well, we have a whole digital research plan, digital INC research plan. And I think -- I don't know if it's been briefed to the Committee. But you know what the scope is of what we're looking at and everything.

CHAIRMAN POWERS: They held that briefing. WE never got the Mayfield quote you go, which was -- I mean, it seems to me that's the biggest problem with these digital systems is that you let digital engineers work on them and they are insistent on putting in more features. They make them progressively more and more complicated. And especially for safety

systems, it seems like that's not necessary.

MEMBER SHACK: Should be doing it the other way.

CHAIRMAN POWERS: Should be going the other way, exactly. That when you add in features you get into this complication of what are the requirements and things like that. And if what would in fact satisfy Mike, and I have tremendous faith in Mike's safety judgment, is two independent systems not connected together, I think you've solved the problem right there. I think that solves the problem.

And then the only other hurdle to go over is that you would like to use commercial off-the-shelf equipment. And that has a --

DR. SHERON: Yes. But that's where I go back and I say part of this is a self-inflicted wound.

CHAIRMAN POWERS: Yes.

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

MEMBER SHACK: I think it's a safety policy, it's a philosophy, it's a defense-in-depth to structural kind of thing --

DR. SHERON: Yes.

MEMBER SHACK: -- that the interim staff guidance does address, basically.

DR. SHERON: Or they could put in an

analog backup.

MEMBER SHACK: Well, that's another way to get --

DR. SHERON: We're not telling them how to do, okay? We're just telling them what the performance measures are.

MEMBER SIEBER: Well, if you just back up the protection system, you know that's 90 percent of it.

MEMBER SHACK: But I mean there are still issues that are addressable by research. I mean, that's not one, I don't think.

DR. THADANI: There's a whole bunch of other issues.

MEMBER SHACK: Right. There's a bunch of other issues.

MEMBER SIEBER: If you look at the cost of the protection system versus the cost of everything else, the protection system you can afford to put that in as analog or hard wired without driving the cost of your control room out of sight.

DR. THADANI: Okay, Alex. Moving on. We were talking about the non-light water reactors it's the sense that we've learned everything that we can learn about light water reactors. Why is there a need

for any further research in light water reactor technology?

Now we have certified passive designs. We don't have any operating experience, as I said earlier and I believe if history is any teacher, we learned a great deal about light water reactors from operating experience. Things happened, things we didn't expect.

I would think when passive design plants come into operation six, seven, eight, ten years from now in this country, I suspect there may well be events. And earlier I used the example of small break LOCAs which became an issue and we had to scrounge around and find a way to be able to do some experiments in small break LOCAs as well.

Does the agency need to do something such that in five to ten years from now and if plants start operation and if events were to occur, would the agency be prepared to say we understand what these events are all about, I can go do A,B,C to deal with what I saw here and there? Is there a need for such consideration for long-term research on passive designs? And if there is, what should be the makeup of that? That's the issue.

DR. AHEARNE: Well I think that, as I mentioned earlier, I think it's not just like water

passive systems we have to do it, yes.

MEMBER BONACA: But I think you need -- that's not long term, in my judgment. You need it now.

DR. AHEARNE: Yes.

MEMBER BONACA: I mean, we are reviewing ESBWRs. We have approved the AP-1000.

MEMBER SHACK: Yes.

DR. THADANI: The designs have been certified. The Agency ignores all it used to know about safety, and that's why the word "confirm" is there. Because often times to me that's confirmatory research. I used my base judgment or I got a decision. But, in case, I think I want to go to Research and say do some work, confirm that what I did was in fact --

MEMBER SIEBER: Well, I think in a passive plant that's a pretty good idea. Because the portions that drive the safety systems are small compared to a 1000 horse power someplace pumping it here. You know, you know that it's going to go only for the horse power behind it. But when you're relying on gravity and bouncy and all kinds of things, you're relying totally on the calculations.

DR. THADANI: And particularly because you have power flow paths and are there aging effects, corrosion products building up? In these passive

designs you really need to know where the water is going.

MEMBER SIEBER: Yes.

DR. THADANI: And how much.

MEMBER SIEBER: Yes.

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

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

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

MEMBER BONACA: I understand.

MEMBER SHACK: Although rather than those passive systems, I mean I got a 100 reactors out

there. I would guess that the biggest challenge I'm going to have as they continue to operate, is they're going to want to cut margin because that's the cheapest way to get kilowatts.

DR. THADANI: Yes. There is an issue I want to go into as well.

MEMBER SHACK: And I think I would -- if I was seeing a need for long-term research in LWRs, I think they're going to become much more sophisticated in their analysis techniques getting everything they can get and you're going to be less and less capable of deciding whether -- you've seen them do that.

DR. THADANI: I am in total agreement. So that's going to happen.

MEMBER BONACA: We've seen it with several of the power uprates recently. I mean, they are getting more complicated different kind of fuels, all the issues we have raised in the recent application reviews in Susquehanna.

CHAIRMAN POWERS: Let me ask this question combining what Bill said and what the slide says is -- we have a member who is not with us that insists very much that with passive plants that you have to have all hide test facilities.And that suppose we go ahead and we do certify yet another passive plant whose

plants do get constructed and we know that at least one of the applications coming in here is an advanced plant, does the NRC need full height test facilities to look at requests to yet further erode the margin based on very sophisticated CFD kinds of analysis, which the same member claims have an inherent deficiency and need experimental confirmation?

MEMBER ARMIJO: I mean we're in the midst of reviewing the ESBWR, for example. Does the Agency know that there are no stability problems associated with the ESBWR?

DR. SHERON: Mr. Holly is not here. I mean, I'm not actively involved in the review of ESBWR or --

CHAIRMAN POWERS: Stability in what sense? Nuclear stability?

MEMBER ARMIJO: Right. Coupled neutronic thermal hydraulic stability. You're operating under the natural circulation line.

DR. SHERON: Well, I mean the licensee has computer codes. We have computer codes.

MEMBER SIEBER: You're talking about a lot of the reactors are critical that are running?

MEMBER ARMIJO: Right.

CHAIRMAN POWERS: I would think with --

MEMBER SIEBER: It depends on what regime you're in.

CHAIRMAN POWERS: Well, I'm sure that.

MEMBER SIEBER: They appeared in an accident situation, you can forget about it.

DR. SHERON: But, again, I would argue that in the past we have -- if the Agency believes that there are unanswered questions that require experimental data from integral facilities, typically the licensee is held accountable to produce that data.

MEMBER SIEBER: Yes.

DR. SHERON: What NRC has historically done is their own confirmatory testing. And typically what we do is we will address issues such as facility scale if there are questions.

Most of the time no one's going to build the full scale facility, obviously it's way too expensive. So you have compromises.

If you remember on AP-600, Westinghouse first came in and they said well we're going to run a facility over in Italy. And that was a full height facility, all right. But it was also horribly one dimensional and had horrible heat losses because of the surface areas. And there were a lot of questions that came up about that -- I'm sorry. I take that

back. They started out with the Apex facility. I'm sorry. They started out with the Apex facility in University of Oregon, which was I call the short fact facility. It didn't times fails, or whatever, and it was low pressure. And we went through the assessment. I was in Research at the time. And I remember talking to Tom Murley. And I said there are a lot of phenomena that occurred in AP-600 while the reactor is at a much higher pressure than the Apex facility. And I said that I didn't really think that Apex was going to cover the full spectrum of events.

NRR in turn went back to Westinghouse and said you guys got a problem. So Westinghouse went off and said all right. So they went off and they got a contract to run the SPES facility, which was the full height facility, full pressure but, as I said, very one dimensional. So it introduced a whole new set of scale and distortions, okay, that were totally different from Apex.

So I had short/fat and tall/skinny.

We looked around, and as a matter of fact it was Larry Hochreiter from Westinghouse who even suggested, he says have you guys looked at the ROSA facility in Japan? And we went over and we looked. And Japan was more willing to want to use the facility

because they were trying to find a use for it. And so we modified it so we could run our own set of experiments, okay. And it was sort of a cross between the new facilities, if you want.

So now I had three facilities in three different scales. And the logic was is that, you know under the assumption that I could understand scaling distortions, go through my code validation, it provided me with enough assurance that I can rely on my codes to tell me how well the AP-600 was going to perform.

When we got to AP-1000, okay, the agency went through another assessment and decided what aspects were different. And we concluded that we didn't need to go through that whole thing again. Okay. In other words, the codes were still validated but there were some parts that needed, you know, further refinement or investigation.

When they went through it for the ESBWR, the conclusion was is that we didn't really need to build an independent facility to do that testing. There was enough confidence in the computer codes.

And I apologize, I wasn't part of that assessment and there are people that are, but that was the logic that was used.

MEMBER SIEBER: They questioned if they did the full height.

DR. SHERON: Yes. Yes. But we didn't see a need for the NRC to have to go off and --

MEMBER SIEBER: And you should have.

DR. SHERON: Right.

CHAIRMAN POWERS: A question. I don't think the AP would want the 600 licensing, and I guess I'm reading through the ESBWR. The question I think I'm asking now is you're going to get some AP-1000s built, and they're going to run -- you're going to give them a license for 50 years. Over the course of that 40 years it's not unreasonable to assume that they'll come in and say, gee, we would like to change our licensing basis because we've got a little more out. And we've run this computer code. And it says it's safe to do so.

The question I'm asking is does there need to be the capability to independently check that at the NRC with a full height test facility, which one of the members of the ACRS really thinks that that --

DR. SHERON: Likes the idea.

CHAIRMAN POWERS: Yes. Well, I like to blame to him. And he's very blamable, by the way. Or is a more ad hoc approach because it's very difficult

to anticipate what issue is going to come up and what kind of an experiment you would actually need, the best or more cost effective approach to take? I don't know the answer. I mean, I don't have a prejudice either way.

DR. SHERON: Well, I have a very strong opinion because we just went through this exercise over in the CSNI because there's a lot of European facilities that are struggling with the same question. Okay. And the conclusion that was reached out of the CSNI was that, yes, we would like to maintain infrastructure facilities, but only if there is a meaningful course of work for them to do. In other words, you don't want to have this facility sitting here and you're doing nothing but dreaming up things for it to do to keep it busy while you're waiting for that event to happen that you want to really use it for. Because you got to remember, you know I mean even though somebody may be running tests, then someone's got to analyze them, which means you got all this -- and so all of a sudden you're talking millions of dollars every year to support a facility. And somebody is going to say why are you doing this? Okay. You're waiting around for this thing to happen that may never happen and you're just spending.

And so the whole logic was that we really don't -- we can't afford that luxury, okay.

DR. AHEARNE: Well, it's more than just a luxury, though. Because you say you're waiting around, it may never happen. But you are then still building some expert knowledge. You're learning how to examine new designs, new approaches. That point may not come up, but you pointed out you're going to be losing people, you're going to be losing expertise. So --

DR. SHERON: Semi-scale across the agency in about 1977/78 dollars, about $7 million a year. Okay. LOFT I think back in those days was running at about 40 or 50 million a year. So translate that into 2007 dollars, and -- I don't want to go to the Commission and say I need $20 million to run an integral loop.

DR. AHEARNE: Yes.

DR. SHERON: And I can't tell them what I'm doing it for.

DR. AHEARNE: Let me make a few comments. The world has changed since I chaired the Commission, I realize that. But nevertheless I found that when we really had a very strong argument, even though we had been told you couldn't get the money, by me going

personally to the Deputy Director of OMB and spending an hour arguing with him and finally getting him to agree, and personally going to the Appropriations Committees and arguing to get them to agree we were able to get money that we were told we could never get.

So it depends on how important you can make the case.

DR. THADANI: This Chairman has -- this is now being recorded, so -- anyway. This Chairman has also -- he's willing to go and fight for resources if a proper case is made. And I think he is -- I believe, current Commission, he is interested in this whole general subject matter. And they seem to be anxious to get some reasonable set of recommendations that they can have confidence in. And they seem to indicate they're willing to go to make the case for resources if this country is really ready to build -- what was it? A 100 more reactors or maybe even 200 in the next 20/30 years. There has to be an investment to make it really happen.

DR. SHERON: But should it be industry make that investment rather than the NRC?

DR. THADANI: Oh, I agree.

DR. SHERON: We worked on AP-600. But,

you know, you're going to have an EPR, you're going to have an ESBWR. Should I have facilities for all of those? In which case now I'm probably -- you know, and then I've got Tosbiha, you know, Advanced PWR.

DR. THADANI: For Research has to make some --

DR. SHERON: Maybe DOE should really take on that issue. They got a lot bigger budget than we do. All right.

MEMBER CORRADINI: And they're not here either.

DR. SHERON: Right. That's part of my logic. But I'm just suggesting that -- if somebody gave me a lot of money right now and said go build a facility, I'd probably say should I build a facility where I can test gas-cooled reactor technology or LMR, for example? Do I need a close loop test facility to understand LMRs or gas-cooled reactors.

You know, I've even tried to -- Farouk Altaweil, and I said, you know, we want so many experiments and so many facilities. We have data we haven't even analyzed yet.

CHAIRMAN POWERS: You're losing that data faster than --

DR. SHERON: You know, when you look at

all the facilities that were run both pre and post TMI And the kind of transients, I mean we've reached a point where we couldn't think of any -- for example with LOFT, okay, I can remember we reached a point where we said we're done with it. Then we went over to CSNI and we got a three year reprieve through a cooperative program. And after three years the international community couldn't think of anything else to run in LOFT and the like.

Semi-scale was the same way. We just ran out of stuff to run. We'd run every kind of transient we could think of for code validation.

The MIST facility which simulated the BMW design, you know, after BMW built it and we took it over and ran it and everything, we ran out of stuff.

So, you know, a lot of it is we kind of reached a saturation point. And ROSA is still around and we're still running some stuff over ROSA right now. As a matter of fact, when I came to Research I was shocked that it was still around, but it is.

CHAIRMAN POWERS: I mean, you bring up one of the issues that I have with -- that I don't quite understand about thermal hydraulic facilities is that when I build a facility and maintain it, ten years later I have computer codes that are asking different

kinds of questions and I don't have the capability or the instrumentation or something in that existing facility to answer those questions.

DR. SHERON: That was the answer I got from Farouk when I asked him, I said why are we still running the ROSA facility. He said well for code. I said well we ran tests on that a long time ago. And he says, oh, yes, but we didn't have the right instrumentation. So now we're instrumenting it right so we can get the data. And I said okay,

So I mean we're trying to do that, okay. But to some extent here I'm a little skeptical. You know, I mean we were working on thermal hydraulic code since -- going on 40 years now. You know, I keep asking Farouk, I said I really want to see a comparison of Zion with a LOCA calculation today versus the best estimate LOCA we did in 1979. And I'd like to see how different they really are in terms of what are predicted capability. Because I really think, quite honestly, I mean at some point, yes, you got to keep the capability and everything. But to some extent I wonder whether the codes are really turning into the lumpy mattress where you push it here and it pops up there, push it there and it pops up here.

And we reach a level of sophistication and accuracy that's totally adequate for regulatory purposes. Okay. And do I need to focus my resources on other safety issues, which I think are really going to be the ones are material issues. You know, worrying about what's going to crack next and do I have an inspection program that's going to find it before it comes up and bites me.

MEMBER ARMIJO: Brian, you mentioned and that brings something up that I've been thinking about.

In some areas in materials in the BWR in particular they've instituted a new water chemistry, the hydrogen water chemistry.

DR. SHERON: Right.

MEMBER ARMIJO: And, you know, the question I ask is this a permanent fix to the IGSCC and IASCC or is this just it'll last for a certain time and then things will start cracking again. And what should the Commission do to confirm -- or the industry, somebody, to confirm that yes, this is it. This is the magic bullet that will stop cracking on things that haven't already started to crack and maybe even stop cracking on things that have already started to crack.

It seems to me that we left that unfinished, and that applies to other mitigation techniques, weld overlay, induction heating stress improvement, all of these things are they really permanent fixes or are they just a patch for the --

DR. SHERON: I don't know. When the industry came back and they said, you know, we're going to fix the vessel heads by replacing them with Inconel 690.

MEMBER ARMIJO: Yes.

DR. SHERON: And they came in and they said oh you guys don't need these inspection requirements anymore because we're putting in the -- and we went uh-uh, you know. You know, you told us 30 years ago Inconel 600 wasn't going to crack and it was the toughest stuff going and 30 years later we're suffering. Okay.

We said we agree 690 is tougher, okay? But you're not going to get out of doing inspections altogether. You still have to do inspections. Maybe not as frequently, but you need to monitor.

And I think that's the same thing is that we don't know whether that's the magic bullet. It's probably going to help. And all we have to do is really say can we back off on our inspection frequency

and if so, how much and still be safe.

MEMBER ARMIJO: If you did enough research or the industry? Too bad that Alex left because I think this is really an industry responsibility.

DR. SHERON: Yes.

MEMBER ARMIJO: If they really would do the necessary research to demonstrate that this really works even under the worst conditions of poor fabrication or marginal material, then they could come back and request with confidence some relief on certain inspections.

MEMBER BONACA: Yes. And there has been issues of physical inspections.

MEMBER ARMIJO: Yes.

MEMBER BONACA: For example, in license renewal we found more and more exceptions taken by licensees because they can now get rid of inspection physically that the BWR review people would recommend. So there are those issues there that we're wrestling with.

MEMBER SIEBER: But they've been doing that through the first license, too. You know, there's a fair amount, 20/30 percent. The fact is that you can't get the whole --

DR. THADANI: Well, before we take our

break in a few minutes, this next issue is Dana Powers. So, Dana, why don't you --

CHAIRMAN POWERS: The question, this really has to do with how line organizations do their work as opposed to what they're working on. And the question that I -- what I see is a vastly growing computational resources capability. Have lots of people coming in, new hires coming in that expect to have at their desk certain kinds of software. Now, they couldn't solve the momentum equation if you begged them to, but they certainly know that they're computer kids, they're capable of doing -- and already, the infinite element analysis like Abacus codes and things like that that they just kind of expect to have available to them to do their work.

And so the question was if in fact we forecast a growth with the nuclear industry but not a concomitant growth in the NRC staff and if you can see that the number of licensing actions per plant is about the same as now, you conclude that the people in NRR or NRO, wherever they are, are going to have to be more productive. And the only way I can see they become productive is in fact through technology. What kinds of technology should RES be developing for this future era? And so I said should we expect that in 20

years someone like NRR would have at their desk the TRACE code and they could run a thermal hydraulic analysis for a plant without calling up RES to get help to do it? Should they be able to run a PRA for a plant without calling RES up to do it?

In other words, should RES make these tools user friendly with the intention of having them on the line organization's desk to do their work very quickly and without the intercession of expertise from RES? And that's essentially the question I'm asking is what kinds of things does the line organization need to have available to them to do the work in the future, recognizing that the guy that authorized that line organization is probably five years out of school and has never been in a nuclear power plant before in his life?

MEMBER SIEBER: You're talking about resident inspectors.

CHAIRMAN POWERS: No. I'm really talking about NRR.

MEMBER SIEBER: Okay.

DR. THADANI: And NRO.

CHAIRMAN POWERS: And NRO.

DR. THADANI: Yes.

CHAIRMAN POWERS: I think there's another

set of questions at the licensing organization, but I wanted to start with NRR.

DR. AHEARNE: How would you do the QA?

CHAIRMAN POWERS: The QA --

DR. AHEARNE: In other words, you've given this neophyte this large amount of capability for independent assessment. All right. He or she does that assessment.

CHAIRMAN POWERS: Yes.

DR. AHEARNE: Who checks?

CHAIRMAN POWERS: What does he do? He comes up and he says yes. What the license has told me is correct and his calculations have been elaborately QA checked.

DR. AHEARNE: And rarely they said they're wrong. And so I now go to the back and tell them they're wrong --

CHAIRMAN POWERS: I mean the ordinary course of events would be, gee, we get a different result here, please explain this. And they would issue an RAI asking for additional information.

DR. AHEARNE: They work independently. It's a little troubling.

CHAIRMAN POWERS: For instance, I mean what I'm most acutely familiar with is source term

analyses which have for historical reasons always been done completely independently by the staff. And if they come up and they gee, we calculate your 24.4 rem at the site boundary --

DR. AHEARNE: Yes. But you used the word "we." At the beginning of that discussion you had an individual in an office.

CHAIRMAN POWERS: Yes. Right. It's done by an individual. I mean Jay Lee over in NRR actually does it. And he uses his own code called TRENDS or something like that. And I guess Rad Tread, not TRENDS. Rad Tread. And when he comes up with an answer that's different, they go back to the licensees and find out. If they can't resolve it, then his number -- but typically they say, oh, the size distribution or something is different.

DR. AHEARNE: But he's more experienced.

CHAIRMAN POWERS: He's very experienced. Very experienced. The guy that replaces him, which is coming pretty quick, is not going to be so experienced.

MEMBER BONACA: Let me give you an example, has been SPAR. Now SPAR clearly has not -- as it hasn't been developed to the extent of some of the other tools, but there is an advantage there in

the fact that you have a consistent application of the same inputs or assumptions in it from model-to-model. And while the utility PRAs have made different assumptions, they got their certain inputs, sequences have not been modeled and so on and so forth.

So here you have an example of a code that may not be as sophisticated as the one of the utility's, but it is consistently applied.

MEMBER SIEBER: But it could be consistently wrong, couldn't it?

MEMBER BONACA: Well, no. Because they've been benchmarking them to the utility codes. On the other hand, the level of scope and the -- it's identically understood from SPAR to SPAR wherever they apply it. And once you have that you can improve it, refine it as is being done now. And, you know, it could be a very powerful tool for verification.

MEMBER CORRADINI: I guess, could I go back to not SPAR, but the other one you're talking about which is thermal hydraulic hydroxide fuel. I think Dana's point, at least my impression of it is in some sense it's an ability to train the new individual as well as not just do independent assessment. Because some of these folks aren't going to know, have been in the plant or have been in a situation. And

this is their way in some sense to get to learn more about the phenomena by actually going through the calculations themselves. At least that's my interpretation of part of what you're after, particularly when you get a newer individual that's not knowing the details of --

CHAIRMAN POWERS: Well, yes, that's one of the ancillary benefits, I'm sure. The question in my mind is how much of this do we think they're going to have to have in 20 years? And I'm presuming that we have light water reactors, some of them are passive but half of them at least, maybe two-thirds of them, are just like the existing reactors. Do we continue to operate in the same fashion?

Like right now if you want a thermal hydraulics fuel calculation for Susquehanna, you probably call up the RES and say put together a deck and run some calculations for me. Certainly other kinds of analyses that sort of thing is done. And how much of it do you want to just be able to have the line organization able to do fairly routinely, which means it has to have a lot of the user friendly interfaces and things like that, good support documentation, probably an expert system associated

with it for -- you know, a help file sort of a capability.

MEMBER BONACA: I had used the SPAR as an example only because I do think that in ten years there will be almost no decision being made without an evaluation with PRA, too.

MEMBER SHACK: Well, I think if you looked at analyses capability, the two tools that most people will be using will probably be a PRA tool and a thermal hydraulics tool.

MEMBER BONACA: Sure.

MEMBER SHACK: You know, those are the two leading candidates for giving people that capability.

CHAIRMAN POWERS: What? PRAISE will be--

MEMBER SHACK: That's probably still a special one.

MEMBER CORRADINI: What?

MEMBER SHACK: PRAISE, probabilistic fracture mechanics.

MEMBER CORRADINI: Oh. Oh.

MEMBER SHACK: You're going to need some tools if you do that. I know what the answer is.

DR. SHERON: I would like to point out that, you know, NRR does have the capability to run the codes. And we've provided that to them. You

know, we will provide them with input decks in terms of preparation of the deck and everything, and we will work with them to assist them if they run into trouble. But they have -- we've provided them with the codes and they have the capability to perform those calculations.

CHAIRMAN POWERS: Right now the way they do it, the line is conceptually not any different than having RES run it in that we call a specialist guy to run it.

DR. SHERON: Yes. I mean, I would not expect and I would not want somebody, as you said, five years out of school or something that really doesn't understand

MEMBER SHACK: Twenty years.

DR. SHERON: Yes.

MEMBER SHACK: Twenty years, it's a long time.

DR. SHERON: I'm not looking out 20 years from now. Okay? You know, I'm thinking more in the terms of five years from now.

CHAIRMAN POWERS: It's still going to have TRACE, it's not going to have --

DR. SHERON: I mean, first off, they're going to be 20 years from now. I mean, if you look at

how the computing capabilities have changed in the past five years, okay, and stuff. I mean, I don't know if you know, Research is supposed to move up to a building in Rockville, 21 Church Street. And we've been estimating now just I've got to build one of these little nuclear batteries next to the building just to power the computing.

If you look at the amperage and stuff that we're requiring and the backup batteries, okay, we're looking at floor loadings. All right? They're talking about we got to put batteries somewhere, these lead acid batteries, the backup for these computing systems that we need to run these advanced codes. Because we do have -- yes, I mean we do have the computing capability up there. But, you know, where we're going to be 20 years from now, Lord only knows. I mean, this stuff will all be in our hand.

DR. THADANI: Well, Brian, while you were gone -- your comment that you made this morning --

DR. SHERON: On what? In terms of?

DR. THADANI: You know, your vision that you talked about this morning that you look ahead three years because of the level of confidence you have in terms of --

DR. SHERON: No. I just said that the

budgeting process looks ahead three years. I mean we -- all right.

DR. THADANI: It was a point that was made --

DR. SHERON: All right. We're going to start the 2010 budget process now and I said the industry has historically had a three year planning horizon, at least that's what it used to be from the standpoint of when they need to return in their investment. Okay. I said that it's kind of hard to look beyond that because, first of all, you know it's not only that I don't know what my budget is going to be and the like, but I also have to see where the industry is going.

DR. THADANI: Alex said he's going to give you a call.

DR. SHERON: Yes. And that's the biggest thing, is to find out where the industry is going. Okay. What are they focusing on? What are they worrying about? And to try and draw that out from them sometimes is not an easy thing. And then to determine --

DR. AHEARNE: His main concern was a few year time frame --

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

needed it, but --

DR. THADANI: I think Gary had the same point also.

CHAIRMAN POWERS: I'm just concerned about time frame. I think I'm worried about an exactly, what you say, Brian, is the industry going to a more technically sophisticated kind of application to further erode the margin between where they operate now and where the regulatory limits are. Because they've done all the easy stuff. And so to get further, you have to become more technically sophisticated, more realistic and things like that. And if so, do you want that analyses to continue to be a burden to RES, you want more of that to move out into the line organization. And if it moves out of the line organization, what kinds of tools and capabilities are they going to need to have?

DR. SHERON: Well, and you know we've developed a tool for that. You know, it's a margin assessment tool and Mirela Gavrilas has developed that, and the like. And we've been developing for about the past three or four years. You know, it's a very structured way of assessing margins.

And, you know I've gone to NRR because I said, you know, you know you guys want to use this,

okay, I mean we've developed the tool. And as a matter of fact, when I was in NRR Research came over and I said fine, let's apply it on a pilot application. And I could never get -- you know and then I went to Research and I checked and I said did we ever do that? And they said well NRR never came up with a pilot.

And I called up Jim Wiggins just several months ago. And I said "You guys want this thing or not?" And the message I'm sort of getting is that it's for a license amendment they don't really see a need for it because, first off, it's not an easy tool to use. You know, and when you're saying okay, for the average license amendment you got 40 staff hours, that's the benchmark, I guess, for an average one. You know, the staff is not going to go off and spend another 80 hours trying to do some margin assessment on a license amendment. Okay. Because first off, the licensee is going to scream bloody murder because they're getting charged for it. It's going to delay the thing, okay.

And the other thing is that they're saying it doesn't matter. Okay? As long as they meet the Commission's rules and regulations, that plan -- that license amendment is acceptable and the plant is safe. Okay.

In other words, you know, I always tell people, I said you know you've got adequate protection here, you got the licensing requirements here and you got safety where the plant operate is up here. We let them come down to that licensing line as close as they want. Okay. When they drop below it, okay, we make them come back into compliance. All right. And how long it takes to come back into compliance usually depends on how close they get to that adequate protection line. You know, if you're way down here, okay, it's okay. You shut the plant down or whatever, or you come back into compliance real quick. If you drop a little bit below it, you know, okay yes you find

you can put some compensatory measures in place and a couple of months from now you can come back in compliance.

But where I see the tool, this margin assessment tool being useful is in assessing regulation changes. And so, for example, I've already proposed to CSNI to do a study to apply it against the 5046A rule and say okay, we're proposing to change the margins in 5041 to allow -- you know, we're going to change the break size and all this other stuff. How am I effecting the margins, the safety margins.

And so to me the use of that margin assessment tool is probably if it has any application, it's going to be in assessing regulations and whether or not and how I change the regulation. Okay. And so we've got that study going on that we're trying to work internationally through CSNI through a working group. And Merila's-- well, she's working on the committee. I think the Swiss or the Sweds are heading up that group. But there is going to be a meeting here of that group in January. And you might want to have somebody sit in on that because they're going to be talking about applying it to the LOCA as a trial.

So anyway, you know, we do have tools that we're trying to develop to assess margins. But you got to remember that the regulators are -- when you're doing license amendments and you're cranking out 1500 a year, you're trying to do it in a -- it's a production mode, you know. And you don't want to get into deep heavy duty analyses.

As a matter of fact, most licensees just want to come in and say, you know, hey here's a license amendment. You already approved three of these or ten of these before, approve this one.

MEMBER SHACK: Well, I mean partly I would argue that the first question you asked is would this

tool be useful. Now if it takes them 40 hours to do it now, you know with a little bit of research maybe you can get it down so we can do it in an hour. You know, the real first question is is whether the tool will be useful. And one of your arguments, again, coming back to my -- you know, you say it's going to go all the way down to the licensing basis. Well, he's going to compute that he goes all the way down to the license basis.

DR. SHERON: Right.

MEMBER SHACK: The question is whether you believe it.

DR. SHERON: Right.

MEMBER SHACK: And do you trust his analysis or do you have a tool that's as capable as his of saying yes you did get to the licensing basis?

DR. SHERON: Yes.

MEMBER SHACK: I'm a little worried, you know when he's talking over here, you know he's talking about a tool that DOE's developing. And I can sort of see, yes, I can over and hand that to the NRC and we can argue whether the NRC then needs to develop an independent tool. A licensee or a vendor develops a capability, he isn't going to be so happy about handing it over to the NRC. So I think it's going to

be a different sort of thing and a different kind of decision that you're going to have to make.

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 not know whether they cross and that there is some probability that you're going to fail in a catastrophic way. And so you got to be careful how you use that margin tool.

CHAIRMAN POWERS: Well, I had promised to break at 3:30. And so I will -- five minutes late, and we'll resume at ten of.

(Whereupon, at 3:36 p.m. a recess until 3:56 p.m.)

CHAIRMAN POWERS: Let's go back into session.

MEMBER ABDEL-KHALIK: If we can go back to issue four on the previous slide? There is a comment that I wanted to make. If you were to provide a young engineer with five years of experience with tools of this type, that would fundamentally change the nature of their work because the way in the limited time I have been on ACRS, I view the work the government engineers do.

It's sort of like pattern recognition, just like students doing homework. They try to find a problem that is pretty close to it. They match it

and change a few numbers. And that is their job; whereas, if you give them tools of this type, the nature of their work, the way they approach their work, would be completely different.

And to me that would be a very valuable thing to come out of this process.

DR. SHERON: Well, you know we do that a little bit right now in the sense that a lot of the staff, the younger staff, that do the code analyses, you know, we're getting them from universities that have contracts with the NRC; for example, Penn State, M.I.T., whatever.

They're coming out with full knowledge on how to run these computer codes because they ran them when they were in grad school through their professors and the like. And we're trying to scop them up as fast as we can.

And we're getting topnotch people. You know, Joe Staudemeier came out of Penn State. He came in. He knew exactly what he was doing, you know, with the code. And Joe Kelly, who came from the labs, he knows.

So I have a lot of confidence that we have topnotch staff that are just not coming in and, you know, going through the motions. I mean, they fully

understand these thermal hydraulic codes. You know, they understand them. They know when they run them. They know when they're getting good results and bad results, you know.

So we're getting quality people out of the universities. And part of it is that synergy, as I said, you know, where we have contracts with the universities, you know. And they're training the grad students for us. You know, when they're ready to graduate, we try and go in there and woo them to come and work for us.

DR. THADANI: What we need here, what you really need is NRO and NRR because they are the ones who have to really say, "Yes, indeed, we think there is significant value in this. And we would support them."

DR. THADANI: The point -- and I go back. I left NRR, what, about 10-11 years ago to go to Research. At the time I was Associate Director of NRR.

And I was, I remain today a very strong believer that the reviewers in some branches should have access to some analysis tools because I think you get a better understanding of issues.

If you don't do any analysis yourself,

even some -- suppose there are questions and John has legitimate concerns about their knowledge of the tool itself. But let's say you are just doing some sensitivity studies. You get a much better understanding of areas of emphasis and so on.

I hate to think that if you just ask people to go review somebody's work, you're potentially destroying some curiosity as well. You want people to be curious. You want them to ask questions, not go back to look at the last set of questions asked on the last application. That's not what I mean. But you want them to really have their own activity, to show up in these activities.

And if you give them more tools -- and I agree they could be abused. I recognize that. On the other hand, you can also end up with, really, I think more effective, you know, results from the agency.

MEMBER SIEBER: Well, there are a couple of questions that come out of that. If you expand the scope of work for reviewers, you're going to need more reviewers and probably less of your expert types.

On the other hand, when you distribute this work to the reviewers, you're going to lose a nominal consistency across the board. So those are things that you would consider when you were making

the decision as to whether you wanted to do that or not.

DR. AHEARNE: In the back of the question, 20 years from now, there is an issue of what will the material being submitted by the applicants look like.

MEMBER SIEBER: It's going to be a lot different than that.

DR. AHEARNE: Right. I mean, I would assume --

MEMBER SIEBER: It's going to be more sophisticated.

DR. AHEARNE: I would assume it would be much more sophisticated. They will also have been either developing new tools, new codes, new methods of analysis. And I would expect that the applications would be all electronic.

MEMBER SIEBER: I imagine that is true, too. And just to codify your point, look at how it has changed over the last 30 years, the sophistication of applications. I noticed a big difference.

And you're going to get more and more sophisticated as people start to eat away at the margin because you're going to have to be more exacting, better calculations, and better tools, better arguments.

DR. AHEARNE: And if there really are as many new applicants as some are forecasting, you're going to get applications from people who have never applied before.

MEMBER SIEBER: Yes.

DR. AHEARNE: And so you also have some mixture of the quality because of that.

DR. SHERON: A lot of the margin, though, is going to come from areas that are not where you just do an analysis. I mean, a lot of the stuff comes in. I want to change my ISI inspection requirements. I want to inspect a different way or I want to change my frequency. There's no margin and the like. That's a tough one. I mean, that's not something you can --

MEMBER SIEBER: Well, you do that almost by feel or some statistical analysis of the probability of finding the failures.

DR. SHERON: But, I mean, for example, we changed the ECCS code back in, what was it, '90 or '89 or '88, what I call statistical loading.

You know, Westinghouse was the only one that took advantage of it. The other vendors, you know, didn't because they didn't need the margins.

MEMBER SIEBER: That's right. Westinghouse was always the one that was --

DR. SHERON: Yes. B&W was far away from 22. They just didn't help that many.

MEMBER SIEBER: You may find that in your revised incumbent space, too. Just one vendor is going to pay for it.

DR. THADANI: All right. Moving on. And I think we had some discussion of this, centers of excellence and somewhat negative experience that brought us back. But I would think the Committee would certainly want to at least give it some thought and see where --

MEMBER ARMIJO: Was that supposed to be discussed?

CHAIRMAN POWERS: The question that you posed at the beginning, where you said define areas where there are unique agents and needs for long involvement, that is the future of our report.

Right now we have it written down. It says, "Gee, the agency will for the foreseeable future, which we kind of define as 20 years. Need expertise in the area of fuels, neutronics, and PRA." Those are the ones we wrote down.

We went on and said they have ongoing challenges in the area of materials and thermal hydraulics. Okay? The other research activities that

we identify, we still get at particular issues that they are confronting now presumably get solved.

One of those was digital I&C. You know, presumably that gets solved and you don't have an ongoing need. That may be incorrect because the digital I&C world refuses to remain very constant.

And certainly we had had the issue of wireless transmissions through the plants come up. And I presume over the next 20 years, there will be others. So maybe we're wrong about digital I&C, but in the area of fuels, neutronics, and PRA, PRA because the agency is tied to this regulatory system to get the information, so they never get out of that business, fuels and neutronics because our reactors don't run without fuel and the agency is pretty much looked at as being in an area that will have an expertise in fuels and neutronics, no matter what. I mean, it's not just the public. It's the other government agencies that look to NRC to have an expertise in those areas.

So the question comes up that I pose, have we identified the right subset as enduring needs for the technical capabilities that the NRC needs to have in its research program, almost regardless of what applications come in?

DR. THADANI: On my list, I added seismic.

CHAIRMAN POWERS: Seismic because of the --

DR. THADANI: Things have happened that there are questions raised about whether we have by way of ground motion models hazards. Are there issues of instrumentation in the right places? There is some interest in things coming out of the Japanese experience.

Is there a core someplace that you can say really has a good capability to take information and assess it and come back and say, "Yes. We" --

CHAIRMAN POWERS: I mean, seismic is a very interesting issue because i's the vulnerability of all these advanced plans.

DR. THADANI: Yes, yes.

CHAIRMAN POWERS: The reason I have been reluctant to call that a core competency is because there's a belief on my part, no matter -- perhaps erroneous, but it's a belief on my part. The agency has a seismic issue come up.

There are about 11,000 body shops in California in Berkeley Laboratory that they could call up and say, "Send me your best guy and help me out here" and be confident that that person was not

conflicted with a licensee.

DR. THADANI: If you paid them, say, $50,000 a year, you'll have a place at the table and they will listen to you.

CHAIRMAN POWERS: Yes. Well --

DR. THADANI: Give you some --

MEMBER SHACK: I think Dana's bigger point is that seismic is a widely -- you know, neutronics only matters to us.

DR. THADANI: Yes.

MEMBER SHACK: Seismic matters --

DR. THADANI: Fuels is us.

MEMBER SHACK: Fuels is us. Seismic --

DR. THADANI: I agree. I agree.

MEMBER SHACK: -- the whole world worries about.

CHAIRMAN POWERS: And the breakthrough is in understanding and whatnot are likely to come someplace else. And the breakthroughs in understanding in neutronics are going to be within the nuclear industry and things like that. That's how I went about the plan.

I mean, I agree with you. To my mind, the agency is hooked into some serious seismic work with these advanced plans because when they come in and

say, "I have a 10^{-8} CDF," I break into laughter because I know they can't survive a 10^{-6} earthquake with 90 percent probability because that's an earthquake that's undesignable because of the uncertainty in seismic things.

DR. THADANI: Hearing that, there might be some interesting insights coming. Brian probably knows more than I do, but the Japanese are responsive to various --

CHAIRMAN POWERS: Yes. I will put in some advertising on this and substantiate my point here that there do seem to be some active investigations of that earthquake.

DR. THADANI: Yes.

CHAIRMAN POWERS: And the American Nuclear Society is sponsoring a panel discussion of the factual observations at its June meeting and a paper session on it at its winter meeting on it.

The panel will be made up of four contracting firms, seismic engineering firms, that have looked at it, presumably will prepare, will just observe what is expected. And my understanding is that that's surprisingly large discrepancies between what we expected based on the IEEE and what was actually observed.

DR. SHERON: I would just say that I think I wouldn't say seismic but I would say the ologies were fundamental --

CHAIRMAN POWERS: Theologies?

(Laughter.)

DR. SHERON: No, not theologies. What Jack Rosenthal told me a long time ago when I was in C3 reactor systems, he came in my office one day. He said, "This agency doesn't need any more engineers and scientists. We need more priests and rabbis."

(Laughter.)

DR. AHEARNE: You already had some?

DR. SHERON: Apparently. But I would agree that seismic issues as long as I have been in the agency continue to rear their head. As you said, there are a lot of people on the West Coast. Okay? And they're all studying earthquakes. And they're learning new things.

And so, for example, we can mark out GSI-199, which is to reevaluate the seismicity down by the New Madrid area and everything. What does that mean? Okay. Do we have to take any action with the operating plant? So these issues continually come up and the like.

The groundwater issue with the tritium, my

staff has been -- I have been getting e-mails from the regions. They're just in love with my staff because they're the only guys who understand groundwater and can talk about how tritium migrates and why it is or isn't a problem. You know, I'm kind of thankful that we had the expertise that could support the regions.

DR. THADANI: But it's leaving soon.

DR. SHERON: What?

DR. THADANI: It's leaving soon.

DR. SHERON: But I'm just saying that these kind of issues just continually -- you know, especially as plants get older, as these buried pipes leak, these are issues that we have to deal with.

MEMBER SHACK: I mean, you do have a seismic program that seems to be trying to stay aware effectively of developments. You know, it seems to me active and at all focused that way that if you're not actually doing the research itself, they're certainly staying abreast of whatever is going on out there.

DR. THADANI: You notice one of the charts we used earlier about current capability and where it's likely to be in a matter of a few years? That's the issue. A whole bunch of technology is going to leave the agency.

CHAIRMAN POWERS: If I could just

interject? If somebody could talk to me about that tritium experience you have? I think that's something we might want to highlight in our research report, your ability to respond to that.

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

CHAIRMAN POWERS: Bill?

DR. SHERON: Ott. I can have him call you or --

CHAIRMAN POWERS: If you would, I mean, just pointing out your capabilities?

DR. SHERON: Yes. Actually, that's an area of concern because most of that branch has been involved in decommissioning. And that was an area that got whacked in the budget.

It may be that that branch is going to get broken up because I just don't have work for it because FSME pulled back the decommissioning funds. They're not going to have user needs, and they're not going to have a need for the work. I don't have any work to give them.

DR. THADANI: You can talk to John. Next to you, he can talk to the Commission, saying, "You should move research to research organizations." You have that, John?

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

a call.

CHAIRMAN POWERS: Thank you.

DR. THADANI: All right. I'll put up the next one. It's again a personal thinking that Chairman Klein has given lots of speeches, saying that for future reactors, we have to think really globally. Manufacturers are all over the world.

And he has said -- I am just quoting him from his public statements -- that that the international community should come together and work towards common safety principles.

My sense is that for lightwater reactors and giving the timing and so on, it's probably not a practical consideration. On the other hand, if we're really talking 10 to 20 years from now, some non-lightwater reactor science, research has an initiative of technology-neutral framework, for example, that sort of approach, which is fairly high-level safety principles, can key countries come together, countries that design and sell reactors, if you will? Can they come together to develop from regulators' perspective now what are some high-level safety principles that these designs should satisfy?

There are three tiers to this. So this is high-level safety principles; light technology-neutral

framework; but then you get to technology-specific considerations, where you would need more standards and guidance and things of that sort. Can that be done internationally? It's not clear. IAEA would certainly say yes.

Then the third part is we sort of talked about a little bit this morning when we talked about industry's tools, regulator's tools, and somebody else's tools. Does it make sense for the international community to agree and say, "Well, let's take our different tools and see if we can't do some verification and validation of these tools?" to say, "Yes. We're sort of in the same ballpark. We're not too far off"?

So what I do in France, I do some work using code X, but you can have some certain level of confidence. And you may not want to repeat what I do.

So should research organizations be thinking about such things and saying, "You know, yes. Maybe at some pace we can begin some dialogue"? My motivation in this was I have been supporting NRC in multinational design evaluation program.

That program, three phases, first phase was the EPR at Finland. Three countries, Finland, France, and U.S., identified selected areas and said,

"We'll sort of review together and learn from one another, see what comes up."

Phase 2 took it one step further. The charter of phase 2 was to see beyond what was done on phase one what areas the multinational group -- in this case it's ten countries -- are there areas where they can least understand what their requirements are? Are there areas where cooperation could go forward and even to the extent of just using one's countries results or whatever work they had done? And it also had the longer-term perspective of if you go to Generation-IV, can we establish common safety requirements?

The thinking in the Commission, Gary just told me the Commission pretty much has agreed on the next set of areas of cooperation between a subset of the ten countries.

When the Commission has not yet come back to the staff with a clear guidance, it's just this area. So the thought process here is, can research be doing something such that after Commission approval they can perhaps say in five or ten years from now, "We think we would be able to go get this common understanding and maybe even convergence of safety requirements"?

Remember, this doesn't have anything to do with the issue of licensing process and individual country decisions. It stays purely on the technical side.

If I read the Chairman's speeches, I sense that he would like to see the agency get there. But it's a complicated, tough process. Fortunately, research has done a lot of work on the project. It can be a starting point. I know some countries wouldn't agree.

So the point here was to get there ten years from now, can we get started on some activities in the next few years, three years so that in ten years or so, we have a chance of success or failure, for that matter? It just didn't work. We tried it. It didn't work. That's the top here. And I wish the regulatory side of the house was here.

For your information, Gary and I have known each other a long, long time. We have discussed some of these issues. And his sense, as I read it, is that maybe for non-lightwater reactors, but he also has some concerns about considering this for lightwater reactors, for obvious reasons.

So, with that background, I am looking for some views the Committee might want to consider.

DR. AHEARNE: What would be the long-term advantage?

DR. THADANI: That's a constant. Long-term advantage would be, of course, U.S.-designed plants can be bought by country X without what seems to be happening now, which is, "Well, we have questions about your requirements. Why is it for" --

DR. AHEARNE: Okay. What you are saying is that you would like to set up an internationally agreed licensing set of standards. The only way you are going to do that is it's going to have to be sufficiently flexible so that the country that adopts a tougher standard can find it in there and a country that wants a weaker standard can also use it.

As you know, for many years, the standard was the NRC's regulations.

DR. THADANI: Yes. Was. Was.

DR. AHEARNE: And if a plant met the NRC's regulations, then most countries would accept it as being acceptable.

DR. THADANI: Right. Here is the situation. If you look on the multinational design evaluation program, one of the questions was what are your requirements, both deterministic and probabilistic? Now, I'll just use that as an example.

And we can go to QA and other things.

But what at least from the countries that participated in the exercise, by and large, I would say, the deterministic requirements were pretty similar, by and large. But there were differences in all of those considerations, particularly when the NRC in their design certification stated that the designs have to meet the core damage frequency of 10^{-4} for the reactor.

What you find in the expectations of the countries that participate in this exercise is that the core damage frequency should be 10^{-5} per reactor year or less.

See, the difference is this, my personal view again. Our requirement as laid out appears to --

DR. AHEARNE: I see that part.

DR. THADANI: But when you go to the designs themselves, there is another slot in the 10^{-5}. But estimated core damage frequency is less than 10^{-5}.

DR. AHEARNE: For example, one of the things that comes to mind, right now, as we all know, there is a big emphasis in the U.S. regulatory world for what do you do about terrorist attacks. I don't pick up that same attitude in some of the other countries.

MEMBER SIEBER: I mean, some European countries, it's even worse.

DR. THADANI: Yes. I was going to say I don't know how much we can say.

DR. AHEARNE: I didn't detect in the discussions with my Japanese colleagues the same level.

MEMBER CORRADINI: So are you saying, John, it might be easy to get a minimum set of standards?

DR. AHEARNE: Yes.

MEMBER CORRADINI: It may be necessary but not sufficient.

DR. AHEARNE: Right, yes. That's fine. I think that's what I'm trying to say.

DR. THADANI: But I don't know about that. I agree with --

MEMBER SIEBER: Europeans, for example.

DR. AHEARNE: And I also haven't seen that much in the Russian standards either.

MEMBER BONACA: What I thought is, you know, you want to match the differences to the past 20 years that have been caused by commercial things. I mean, you know very well that there have been ways of introducing technical requirements as a means of

excluding somebody from the table. Okay? It is a common thing.

I would like to ask, you know, what specifically you make of that. But do you believe that country X will ever buy any ESBWR? They will try to sell a design and --

MEMBER SIEBER: They will get pulled by the U.K.

MEMBER CORRADINI: No, they won't. No, not even then.

DR. THADANI: As long as you understand --

MEMBER BONACA: So there are issues like that, too, with that.

CHAIRMAN POWERS: Ashok, let me ask you this question. Finland, who just bought an EPR, is trying to construct and even contemplating buying a couple of more. And so, I mean, that's a market. It's a market which I don't believe any U.S. firm chose to bid on.

DR. THADANI: No, no.

MEMBER ARMIJO: The first one, yes, was open.

DR. THADANI: The first one was open.

MEMBER ARMIJO: The first one was open. There were ABWR --

CHAIRMAN POWERS: The AP-1000 did not.

DR. THADANI: I know.

CHAIRMAN POWERS: And so my question is, why did the AP-1000 not choose to bid? And was it because of the safety requirements? You know, were the safety requirements sufficiently different in Finland to preclude AP-1000 from bidding on it?

DR. THADANI: You know, I don't know for sure, but some probably, some factors. I don't know.

Finnish requirements are pretty stiff, pretty stiff requirements, more so than some of our requirements in this country. The other thing is the Finnish are at a very theoretical stage of just requirements, not the implementation of the requirements because people do different things.

The other issue certainly has been -- John has raised it -- security issue. The Finnish prepared a rule which on paper looks very challenging. The aircraft of certain size, certain velocity, the plant has to be able to withstand that.

CHAIRMAN POWERS: Right.

DR. THADANI: I personally don't know what factors draw Westinghouse to not fight for that, you know, potential sale to Finland. But the Finns have pretty -- I have seen. They have even probabilistic

standards tougher than 10^{-5} core damage frequency.

MEMBER SIEBER: Security issues.

DR. THADANI: That's the reason I can't say too much.

MEMBER SIEBER: We shouldn't get into detail, but I understand it.

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

MEMBER CORRADINI: There's a different coach.

DR. AHEARNE: Ashok, when you have validation-verification, are you talking about baselining codes one country to other?

DR. THADANI: Yes.

DR. AHEARNE: That takes care of the validation. Verification requires experimental data.

DR. THADANI: Yes, yes. If the countries agree to go down this path, they will have to set up standard exercises. They will have to have experimental facilities there. It's not a cheap process.

CHAIRMAN POWERS: It's a big deal.

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

MEMBER ARMIJO: And that's gets back to John's original question. What do you get for all of this effort? I don't see a prize at the end. I think

the commercial issues should be left to the commercial guys.

DR. THADANI: No. You see, I think it's a cost-sharing issue. I think in the end, you can have increased confidence in your own tools. And you may actually find that you were wrong. I'll give you an example. I'll give you an example.

About six years ago, there was an exercise, standard exercise. I was in France, presentation being given by nine countries. And it was amazing, actually amazing, that nine countries resolved on this particular front. They were not too bad. They were not too far off. I mean, there were differences, but generally I was sitting. I was very surprised.

The thing was the tenth country that actually did the experiment put up the data. Guess what? Nine were wrong. Okay? And so there may well be some benefit to having this international cooperative effort.

MEMBER ARMIJO: On specific issues, specific problems, I can see where it is very valuable, but just across the board --

DR. THADANI: They do it on pieces. You see, that's what CSNI does basically. There are a

whole bunch of standard problems. They're up to like 50-something, something like that, a whole bunch of standard problems. It depends on what countries want to participate in that for that piece.

And part of this exercise is to go back, step back, and look at some of that work and see, did we learn, really.

MEMBER BONACA: Well, I mean, one advantage, of course, would be the one of recouping some credibility maybe in part of the lot. I mean, I have heard things, people claiming that the U.S. plants are as bad as the Russian plants. This was like 10-15 years ago.

You know, those are flat statements that clearly have no basis in many ways. And it would help in trying to correct some because that translates itself into opinion and then the advantage of the market.

So there would be some advantage in that. I'm not sure there would be an advantage from a service standpoint. It would be more like reputation, credibility, and all that kind of thing, which are important, too, in the long run.

MR. HILL: One thing, I don't know if everybody is aware of it, but there is some of this

already going on for non-LWR systems. In the IAEA context, we're already participating in a benchmark which is a natural circulation test that was done in Monju before it shut down.

And there is another one with IAEA going on, which is on shutdown experiments in Phoenix that are going to take place next year. And both of these are validation and verification because they are both many different countries' calculations and a comparison of them, but they have an experiment that is being compared to where they have actual data.

DR. THADANI: This is working with IAEA?

MR. HILL: Correct.

DR. THADANI: In fact, that is an interesting point you make. And in the context of this issue, there has always been this question of when can we benefit from, what is the role of NEA or do they have a role, does IAEA have a role?

And many of you know the tensions that exist between two organizations. But NEA, a great deal of capability in scientific research. IAEA less, is there a sense here that the future -- again, we're talking about non-lightwater reactors, if you will.

It's in the context of question number 6, addition number 6. Is there a role for IAEA and NEA?

And if there is, what is that role? Historically research has been more from here, more involved with the NEA and less so with IAEA until now in non-lightwater reactors, it seems to me maybe IAEA is doing a lot more than the NEA.

MR. HILL: I think there is still some truth to thee statements you have, but the IAEA work tends to be a little bit more shallow and not as in-depth. But I think a lot of why it's got something going in the LMR technology is because there are some countries involved that are not part of the IAEA. And they're driving something else.

DR. THADANI: I've seen some of the best scientists in 18 years from various countries tend to gravitate towards I think CNSI, in particular. And, of course, they have the Nuclear Development Committee as well.

MEMBER BONACA: Well, from what I hear, IAEA is -- in the sense that you have hundreds of countries there. And just everybody wants to have a say. And even if they don't have any problem eventually --

DR. THADANI: This is probably in the context of the Nuclear Development Committee in IAEA, I assume. Right? Well, with this, go back to Dana

and --

CHAIRMAN POWERS: Okay. Well, thank you, Ashok. Thank you all. Do the members have any comments they would like to make?

MEMBER BONACA: No. Just thank you to our panelists and your assistants.

DR. THADANI: Answers were to come from that side.

(Laughter.)

MEMBER SHACK: The questions are important.

MEMBER SIEBER: So are the answers.

(Laughter.)

CHAIRMAN POWERS: I note that we have disposed, I think, of the issue of the center for manpower and whatnot to develop a response to the Commission for the digital electronics and man-machine interface. The research has developed a response to that, to the Commission on that idea. And so it would be useful if you could telegraph to us what your response is.

DR. SHERON: Well, the paper is not actually -- I think we got an extension. I think it's not actually due to the Commission until February.

CHAIRMAN POWERS: February?

DR. SHERON: The staff did brief Commissioner Lyons this afternoon at 2:30. I don't know if they're still alive. He was an advocate of this. I will find out more when I go back up to my office.

MEMBER SHACK: That's why you're here. It's better than being there.

(Laughter.)

DR. SHERON: But that paper won't go up probably until February. And, as I said, there's a paper that should go up in January outlining the plans and so forth for advanced non-lightwater reactors. That would form the basis for a Commission meeting, which I think now is scheduled for February 20th.

CHAIRMAN POWERS: The reason I ask for some telegraphing on that is that I felt an obligation to respond to the Commission concerning that idea. I was not a proponent of the idea. And so I developed a noncommittal response. And I would like to make sure that it is not orthogonal to yours.

DR. SHERON: I don't think so because I think we were -- well, I was a bit skeptical that we could support. And one of the reasons, obviously, is that if you look at our digital I&C research plan, most of the work that's identified in there finishes

up by the end of '09.

If we were to even start to think about such a facility, unless there was some miracle, it would have to be, as a minimum, with '10 funding. And then that would just start us in terms of we would have to go out for proposals and all of this other stuff.

So if you did want to have some kind of a center, it probably wouldn't be up and running until 2011 and 2012 or something like that. As I said, beyond 2009 we haven't really identified other than maybe looking at some of this wireless stuff any real digital I&C issues specifically. Okay?

There may be some that come up, but if somebody said, what is this facility going to work on and do, I would have to say, "I'm not sure yet." Okay? And that's kind of tough when you're asking for several million dollars probably.

CHAIRMAN POWERS: Well, I had similar and other reasons to be less than enthusiastic about it.

DR. SHERON: We do have a proposal. And I don't know if it's possible. I mean, you know, if you want to get a brief or the Subcommittee wants to get a brief from the staff on where we are and what we heard from the two workshops because, really, that is

what is forming a lot of our basis, we would be glad to do that.

CHAIRMAN POWERS: Maybe just tell me who to chat with about that so I can make sure our words don't walk on your words.

DR. SHERON: Okay. Rick Croteau. Do you know Rick? He's Jennifer Uhle's deputy.

CHAIRMAN POWERS: No.

DR. SHERON: And then Russ Sydnor, who is the Chief of the Electrical Engineering Branch.

CHAIRMAN POWERS: Oh, okay. Yes.

DR. SHERON: They would be the two people I would recommend.

CHAIRMAN POWERS: Okay. I don't want a conflict, and I didn't have it.

The other issue that comes clear in the presentation is that there is a tension that develops between a call for increased collaboration and still maintaining an aura of independence. And I haven't come to a clear understanding in my own mind when we're independent and when we're not.

I have always been a strong supporter of the memorandum of understanding, which I think, Ashok, you actually signed, between you and EPRI that said that collaboration on experiments was a useful thing

to do. But the interpretation and analysis of the data would be done independently.

Now when you talk about collaborating on those things via the models and whatnot, I don't see how that contributes to the image of an independent analysis. And I struggled more with that because I think you do have an obligation to persuade the public that you are providing for adequate protection in an independent fashion. So that remains a struggle for me in here.

DR. THADANI: Just to clarify, when I talked about verification and validation, I was only talking about the regulators, international regulators. That's all, not for this.

DR. SHERON: If I could just interject on collaboration? I agree with exactly what Ashok's philosophy is we're following. And that is that you draw the line on the experimental data.

It's fine to get collaboratively experimental data. You should go off and analysis it and evaluate it and draw your conclusion from it separately.

We don't collaborate our developing models or anything like that, but what we do is obviously if we run our model and the industry runs theirs and we

get totally different results, we want to understand why. And so we will work with the industry to understand those differences.

And if we do one of these and be "Oh, geez, we didn't think of that" or they go "Oh, geez, we didn't think of that," where many times, it's like "Okay. We agree to disagree, and we'll go our separate ways." I think we had that on seismic response directors some time ago with that where we just couldn't reach agreement. And there were some months of your accidents, as I'm sure you remember.

So, I mean, we don't collaborate on developing models, but we certainly want to understand if there are major differences in our predictive capabilities to understand why there are differences and at least to be able to explain.

CHAIRMAN POWERS: Okay. Well, thank you. Thank all of the panelists. And I'll adjourn this Subcommittee meeting.

(Whereupon, the foregoing matter was concluded at 4:47 p.m.)

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