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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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JOINT MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

SUBCOMMITTEE ON SAFETY RESEARCH PROGRAMS

AND

SUBCOMMITTEE ON FUTURE PLANT DESIGNS

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WEDNESDAY,

NOVEMBER 6, 2002

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ROCKVILLE, MARYLAND

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The Subcommittees met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., Drs. F. Peter Ford and Thomas S. Kress, Chairmen of the above Subcommittees, respectively, presiding.

SUBCOMMITTEE MEMBERS:

F. PETER FORD, Co-Chairman

THOMAS S. KRESS, Co-Chairman

MARIO V. BONACA, Member

GRAHAM M. LEITCH, Member

SUBCOMMITTEE MEMBERS: (CONT.)

VICTOR N. RANSOM, member

STEPHEN L. ROSEN, Member

WILLIAM J. SHACK, Member

JOHN D. SIEBER, Member

GRAHAM B. WALLIS, Member

ACRS STAFF PRESENT:

RICHARD P. SAVIO

NRC STAFF PRESENT:

RALPH CARUSO

STEVEN M. BAJOREK

FAROUK ELTAWILA

JOHN H. FLACK

WALTON JENSEN

RICHARD LEE

SHANLAI LU

JAMES E. LYONS

JOE MUSCARA

JACK ROSENTHAL

STUART RUBIN

ALSO PRESENT:

MICHAEL CORLETTI, Westinghouse

ADRIAN HEYMER, NEI

LUCA ORLANI, Westinghouse

VICTOR SNELL, AECL

ROB M. VERSLUIS, DOE

GARY VINE, EPRI

C-O-N-T-E-N-T-S

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

8:35 a.m.

CO-CHAIRMAN FORD: Good morning. The meeting will now come to order.

This is a meeting of the ACR Subcommittees on Research and on Future Reactors. My name is Peter Ford. I'm the Chairman of the Research Subcommittee, and my Co-Chair is Tom Kress, Chairman of the Future Reactors Subcommittee.

The ACRS staff member is Richard Savio. Other ACRS members in attendance are Graham Wallis, Victor Ransom, Mario Bonaca, Steve Rosen, Graham Leitch, Jack Sieber, and Bill Shack.

The purpose of this meeting is to gather information for the ACRS Research Report which is due out early next year. This report will comment on the completeness of the NRC Research's assessment of the regulatory and technical challenges for future reactors.

We have their report, "Advance Reactor Infrastructure Assessment," plus further pre-decisional appendices covering more details on ALWR designs, plus an itemization of activities for fiscal year '03. These are the prime bases for our comments in the report.

Thus, we shall hear from NRR and RES on their final reports. We shall also hear from DOE, NEI, and EPRI on their views on research needs for proposed advanced reactors. A segment of time has been set aside for comments from the general audience.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in The Federal Register. 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 and speak with sufficient clarity and volume so that they can be readily heard.

The first item of business is NRR. Jim, would you like to lead off?

MR. LYONS: Yes, I will lead off. I'm Jim Lyons. I am the Director of the New Reactor Licensing Project Office in NRR. We are responsible with the project management of any licensing reviews that will be held as we move forward in licensing new plants.

I want to start off with actually a slide that I showed to you about a month ago. Nothing really has changed on this, but I would like to walk through it just a little bit to put things in context of where we are and where we are going and what we are going to work on.

I guess in good, I don't know, presentation fashion, I will do a little highlights of things to come. Early site permits, we have three of those coming in in 2003. We are going to be here tomorrow to talk to the full Committee on the early site permit review standard and how we're planning on doing those reviews. So I'm not going to get into that too much today.

I just wanted to let you know that those are coming. There's a lot of staff effort that is going into that and to developing how we are going to review these sites to issue these early site permits. That is one part of the Part 52 licensing process, which includes early site permits, design certifications, and then, finally, combined licenses.

CO-CHAIRMAN KRESS: When you talk about early site permits from the viewpoint of research, do you see any research needs for that or is that just a process --

MR. LYONS: At this point we haven't developed any. One of the big areas that has really changed the way we did siting reviews in the past is in the seismic area.

CO-CHAIRMAN KRESS: Yes.

MR. LYONS: And there are some discussions, I think, going on in the seismic area of reviews, on how we would do those reviews and actually using the Part 100 appendices for the first time.

CO-CHAIRMAN KRESS: I guess we are supposed to have a discussion on early site permits later. So I will save my questions for then.

MR. LYONS: Right. Okay, good.

CO-CHAIRMAN FORD: But just as a kind of overview for this meeting's sake, is it planned that there will be a section in the infrastructure assessment relating to ESPs?

MR. LYONS: I don't think there is at this point.

CO-CHAIRMAN FORD: No, there isn't. My question is, I recognize the living document --

MR. LYONS: I think at this point we don't see the need for that.

CO-CHAIRMAN FORD: Okay. So there are no research dollars put aside, regardless of the source of those research dollars, for doing work on ESPs?

MR. LYONS: Right. But if we see a need, it is part of our reviews to ask Research to do certain things for us; we may do that. Right now we are in -- and we will talk about this tomorrow -- but we are in pre-application discussions with the three applicants and with NEI on exactly what the scope and the depth we are going to go to. So we are trying to identify those types of issues and to see where we are going to need help and where we might not.

MEMBER LEITCH: I have a lot of questions about ESP. I think probably tomorrow's discussion is a more appropriate time to ask those, but I mean just the seismic question, for example, how can one approve a site when you don't know the reactor design that is involved? I mean, some of these designs are very tall and others are underground. It seems to me that, in and of itself, would --

MR. LYONS: We'll discuss all that tomorrow.

MEMBER LEITCH: Okay.

MR. LYONS: Yes, a lot of that has to do with the way the early site permit, what do you really approve as part of the early site program, and we will get into that tomorrow.

MEMBER LEITCH: Okay, good, Jim.

MR. LYONS: The other thing upcoming is AP1000, the design certification. We are in the midst of that review. We have already issued our request for additional information. We are slated to issue a draft safety evaluation report on AP1000 in June of 2003, and we'll be coming back to the Committee for those reviews.

Again, I think tomorrow afternoon we have about a two-hour presentation on the AP1000, so we can discuss any of those issues.

CO-CHAIRMAN KRESS: Can I read this chart as being in priority order as you go down?

MR. LYONS: It's more in chronological order of when we see things starting, but in the same place that does kind of define our priorities. Kind of first-in/first-out is the way we have been working.

In fact, we had a meeting with the industry yesterday, with NEI. One of the things we raised was, is there a priority amongst the different projects that they see ongoing? Can industry give us a priority of what do we need to be really working on?

Certainly things that lead directly to a combined license are things that we would focus our efforts on. Early site permits go that way. Plants or designs that are in for design certification are in that way. The pre-application discussions we are having with the other vendors are important to move us forward, but they would necessarily take a back seat to some of the other efforts.

CO-CHAIRMAN KRESS: Is it too early to ask where ACRS would fit into that chart? Is it the red diamonds?

MR. LYONS: The red diamonds are where we see the ACRS having some input at that point or that we would be coming to the ACRS. Those are our dates. Obviously, we would come before that to you, probably a month or so before that, to discuss those issues. That is why I tried to raise those in red, to highlight where we see that.

The ESBWR pre-application, we've got that underway. We've decided what we're working on and where we are going to move forward to. You will hear a little bit in just a little while from Shanlai Lu on where we're looking for help and support on ESBWR and on AP1000.

The reason I've got milestone schedules for AP1000 and ESBWR up here, because those are the ones we've actually developed milestone schedules. The others we are still in the process of developing both through the early site permits and for the other pre-application reviews. So I would see this chart expanding and schedule expanding as we have those milestones established, and then would show how we would fit into that.

But let me walk through some of these others.

MEMBER WALLIS: Could I just ask now, this design certification, AP1000, there's about a four-year process?

MR. LYONS: Right.

MEMBER WALLIS: And then ESBWR, yours ends with a design certification application. Is there another four years of that before -- you are going about six years before you get an ESBWR approved?

MR. LYONS: How do I want to say this? The way that works is, if you look --

MEMBER WALLIS: Maybe it is five years?

MR. LYONS: In this September-October of 2004, that is when we actually would be issuing our final safety evaluation report and our final design approval. That would actually complete the staff's technical review of the design.

Between October of 2004 and December of 2005, that's the time we would see that it would take to actually develop the rulemaking and notice the rulemaking that puts the design certification -- that actually certifies the design as part of the rule.

MEMBER WALLIS: So that's got to be added on at the end of the ESBWR?

MR. LYONS: That's right. So in this case we are looking at about 30 months, I think was our review schedule for AP1000 -- I'm looking back at Larry to give me a yes -- from when we got started.

You have to remember, too, with the AP1000 we were able to realize a lot of efficiencies because we had already reviewed the AP600, and we are really just reviewing the changes in that design. For the other designs, we're starting a lot from ground zero. So our review time to reach a final safety evaluation will probably be longer than --

MEMBER WALLIS: It might be shorter if you did some stuff in the pre-application.

MR. LYONS: That's true.

MEMBER WALLIS: If you did enough work then, you might not have to spend so much time on that --

MR. LYONS: The pre-application reviews --

MEMBER WALLIS: -- design certification.

MR. LYONS: Right. The pre-application reviews help us, help both the vendor and the NRC, decide what are the key issues, try to resolve any of those, so that the vendor feels confident in moving forward with the design certification, so that they don't see any major obstacles.

In the ESBWR, what we are looking at is their codes, their thermal-hydraulic codes and their containment codes, and coupling them together and moving forward. They see that as one of the major hurdles. They feel if they can overcome that, then the rest that they could come in.

On these other reviews, ACR700 is the Advanced CANDU Reactor. That's a new design to the U.S., but it is certainly not a new design. It is an evolutionary design of the CANDU reactors that have been operating throughout the world.

As the NCR staff has to bring itself up-to-speed on some of the issues, one of the things we have done is we have started discussing with the Canadian Nuclear Safety Commission how we might cooperate in reviewing the ACR700, because AECL technologies, which are bringing the technology here to the United States, are also -- AECL is also seeking pre-licensing in Canada and in the United Kingdom.

So a couple of weeks ago we had a meeting amongst the three regulators to see how we might work together, and to what extent we could do that, and to what extent we all have our own regulatory processes. We have to meet and we all have to make our own safety findings, but the sharing of information and the sharing of knowledge we see as something that can be very beneficial.

MEMBER ROSEN: Did your discussions go to the sharing of any future research as well?

MR. LYONS: Yes, we did. We talked to some extent -- the Canadian Nuclear Safety Commission doesn't normally do any independent research like we do. So one of the things we were looking at exploring is whether they would want to cooperate with us.

They typically go to AECL and ask for AECL to do the research. But we are looking at the research that has been done on CANDU reactors and how we might fit into that, and what kind of information we need.

So part of it is learning what are some of the key issues in the CANDU reactors. They have a long history. They can help us a lot in that area. So we are looking to make that a program that helps us become more efficient and effective as we move on.

CO-CHAIRMAN FORD: Jim, I wonder if you could comment: These data you have on the board, there are obviously facts. That's what you have been presented with right now. As you look forward to seeing what the technology needs are, make those in fact successful, you may have a time crunch in meeting those schedules, especially for the gas-cooled reactors.

Do you have any comment about how you are going to avoid that time crunch?

MR. LYONS: Well, I think one of the things, I think this technology assessment, infrastructure assessment, that Research is putting forward is a good way of looking forward and trying to understand, if we are going to do these reviews, if they actually come into fruition, what are the information needs we need and what is it going to take to get ready for those information needs? We see that as one of the key aspects of their plan.

CO-CHAIRMAN FORD: So as we look forward in the next segment, I mean in the infrastructure assessment report, document that we have, it gives you fairly detailed PIRT activities and also implementation questions. Have they been taken into account as you look forward to the funding? When we look at the next section, maybe you could give us a pre-warning. The work that has been planned for fiscal year '03, did it go through a formal PIRT activity as described in the infrastructure assessment?

MR. LYONS: I would have to turn to Research.

CO-CHAIRMAN FORD: Okay.

MR. LYONS: Because what we have focused on from our end standpoint is the work that we've got on our plate. Obviously, with the Pebble Bed Modular Reactor we had started moving forward very quickly on that. When Exelon pulled out in April of this year and that project slowed down in the U.S., because it certainly is continuing forward in South Africa with a decision of whether or not they are going to be building a demonstration unit down there probably sometime early next year, we've kind of backed away from looking at the gas reactor technologies.

The work we are doing on the GT-MHR is at a fairly low level. We're still working with General Atomics to slowly define what we want to get out of the pre-application --

CO-CHAIRMAN FORD: And yet the technical challenges to both the GT-MHR and the PBMR, which you will see is back on your list again, are huge and will need a lot of time to resolve.

MR. LYONS: Yes.

CO-CHAIRMAN FORD: Does that come into the overall NRC thinking as to how they are going to proactively manage this?

MR. LYONS: Well, I think that's where this infrastructure assessment is the first step in doing that, is trying to define those issues and those areas that the staff would need information, and that we would use that to define how we are going to go forward.

CO-CHAIRMAN FORD: Okay.

MR. LYONS: Yes, and let me talk about the PBMR, although it is at the very bottom there, a little bit. We have had some further discussions with PBMR-PTY, the South African company, about their desire to reestablish a pre-application review probably in the beginning of fiscal year 2004. So we are keeping that on the horizon.

I think that is part of why we try to keep communications open with the various vendors, is so that we know what could be coming in, so that we can do as much planning as we can. But from a budget standpoint, it makes it very hard when it becomes uncertain out in the future what actually is coming in and what's going to move forward.

CO-CHAIRMAN FORD: I have one last burning question which is going around in this group. In your thinking about your resources to make this happen, is the longer-range vision this 50,000 megawatts we keep hearing about online in 2020?

MR. LYONS: I mean, we have discussions with the Department of Energy on their 2010 Initiative, and we try to understand. We don't think so much in terms of all those different reactors. We are looking more at making sure that our process is as efficient and effective as we can be, to move us towards that --

CO-CHAIRMAN FORD: But being driven reactively to what is currently coming onto your plate in the next year or two years?

MR. LYONS: Right, yes.

MEMBER ROSEN: Jim, you made mention of the budget and resources. Could you help me understand how much of this is actually funded by the vendors and how much is by the agency?

MR. LYONS: Well, for the pre-application reviews, design certification reviews, those are all fee-billable projects. So once we start into a pre-application review, we are billing the vendor for the work we are doing on that. The same with the early site permits; we are billing the utilities on the work that we're doing on them.

But even though they are fee-billable, we still, as the NRC, have to have that within our budget. We have certain ceilings that we are able to spend. So just because we can bill them for it doesn't mean we can do the work. We have to have the authorization to do that. We are only authorized a certain budget, and we have to work within that.

Obviously, these programs compete with other programs that are on the operating plants, such as license renewal and plant uprates, power uprates, work that is going on now, like on the Davis-Besse lessons learned. So we compete with all those resources.

MEMBER ROSEN: Seen from one perspective, that makes good sense. Obviously, no matter how much money you have, if you don't have the people, trained people, you can't do it anyway.

MR. LYONS: Right.

MEMBER ROSEN: So you are resource-constrained by the availability of trained and experienced people. So seen from that perspective, I really have no problem with it. But seen from the other perspective, that, gee whiz, they're paying for it, it is a little hard to understand why, other than the resource constraint, why one would say it has to be within a budget, a dollar budget, when the dollars really aren't, except I guess a small percentage, coming from the agency.

But that's a good enough answer for me.

MR. LYONS: Yes, and what you will see is, when you start talking about research efforts, if the research efforts directly are applicable to the licensing action that we are taking at the time, then we can bill the applicant. But if it goes beyond what is needed to make our regulatory decisions, then it gets into the big, overall pot that the current licensees pay through their annual fees. That covers all the overhead and a lot of the research work.

MEMBER LEITCH: Jim, I have a process question. Could you contrast between the pre-application review and the design certification review? Is the pre-application review always a prerequisite to design certification?

MR. LYONS: No. The pre-application review is voluntary. It is part of the Commission's Advanced Reactor Policy Statement that encourages early interaction with vendors, especially on innovative, new designs, so that we could try to address some of those issues upfront.

For example, as I was just thinking, it is a good segue. On the SWR-1000, they are doing some testing over the next year or two that we would be interested in observing or being involved, or observing and seeing, even though they are not really looking at starting their pre-application review until calendar year 2004. But they have some things going on that they can help us look at.

But what the pre-application review really does is it allows us to try to define some of the key technical areas that would have to be addressed as part of the design certification and try to resolve them, if necessary, or at least identify the information that would be needed to address those.

MEMBER LEITCH: So the three bottom lines on the chart, the GT-MHGR, the IRIS, and the PBMR don't seem to have a pre-application review or they are going to go directly to design certification?

MR. LYONS: No. The blue lines here indicate when the pre-application review, we see the pre-application review running. In there they talk when we would anticipate receiving a design certification. I would have to get my glasses out to see that.

MEMBER LEITCH: So that would imply, then, that the pre-application review for GT-MHGR, for example, has already taken place?

MR. LYONS: Right. We have started some discussions with them on where we want to go with the pre-application review and have had some meetings with them, and we have some meetings scheduled with them to take us forward to actually define what we are going to address as part of the pre-application.

Usually in these pre-application reviews -- actually, Westinghouse is the one who started it with the AP1000 -- is you do this what we've started to call Phase 1, where you have some discussions on what should we address as part of pre-application and then agree on that. That kind of completes Phase 1. The second phase is to look at what we have decided to look at and then to move forward.

MEMBER WALLIS: Why do you need all this? If you've got a water reactor and you've got all the codes in place, all they have to do is be sure they meet the regulations. Why do you have to have all this pre-application review?

MR. LYONS: Well, in a lot of cases there are issues that the vendor wants to make sure can be acceptably resolved before they commit to actually coming in with their design certification. In a lot of cases, in some of these cases the designs are still evolving as we are in discussions, and they are solidifying their designs.

MEMBER WALLIS: So that's it; they don't really have a design yet? They have a conceptual design?

MR. LYONS: A lot of them are very, yes, conceptual, and then they are in varying degrees of completeness.

I have probably taken up more time than I should because Shanlai has got some more discussion on the user needs that we actually have, currently we are working on, for the AP1000 and the ESBWR. So why don't I turn it over to him?

If there are other questions, I would be happy to answer them as we go through this. I will be here for most of the day to answer any questions that you have.

Thank you.

DR. LU: All right. My name is Shanlai Lu from Reactor Systems, and I'm a reactor systems engineer. I am here to give you a brief presentation about the four user needs.

We have already sent three of them, and one is under discussion with Research. I want to provide a little bit of details, particularly the background and the basis, why do we want to have that and what we want from Research regarding this user need, and what's the application, and also I will give you the status.

Actually, Dr. Jensen and Andrze Drozd from PRA, all are from NRR. They originated the two user needs for the AP1000. So we are going to cover that, too.

So at this point we have already sent the three, No. 1, for years PWR and a few for AP1000, to Research to ask for assistance from Research regarding different technical issues. This one, No. 2, we have been having discussion with Research regarding the TRAC-M development, improvement for the ESBWR application.

So I am going to go through each one of them and tell you the technical basis and why we want to do that, what's the application and the current status and progress.

In turn, for ESBWR application, we got a non-proprietary package from GE. They are talking about an ESBWR. We found that they are going to model, they are going to put GE-12 fuel into the ESBWR core for their pre-application design.

We look at their GE-12 fuel. One feature here is the large water rods, which each water rod operates three fuel tanks' location. Then the part-length rods are here; we have the red one. The water rods, the inlet and outlet are within the active fuel region. So the water goes to here and getting out from there. Then we also have part-length rods two-thirds through the core. It is dependent on the design. It might be, you know, it might be ones that are half. It depends on the cycle.

To model this for LOCA, for transients, and stability, we found our code at this point, RELAP-5 or TRAC-M or TRAC-B, or whatever, we don't have the necessary accuracy or capability to exactly match the capability that GE can handle. For example, the water, we cannot really model the water flow within the rod. We have to lump it into a bypass region.

That's when we started to think about, oh, how we are going to model for ESBWR application, and then we think, okay, maybe let's look at other fuel vendors. Are there any other fuel types we need to cover, the availability. They decided, the utility decided to use a Framatome fuel or Westinghouse fuel.

MEMBER WALLIS: Now this GE-12 fuel, is that just for the ESBWR or is that for other BWRs?

DR. LU: Yes. Actually, we found later

that, after we examined the capability, we said, "All right," and, actually, all of the fuel has already been loaded into the existing operating --

MEMBER WALLIS: Yes, it's already there.

DR. LU: Yes.

MEMBER WALLIS: So why are you now worried about modeling it? It is already there and being used.

DR. LU: Because GE was claiming this one, and they used TRAC-G to model this in the ESBWR, and we want to match that capability as well as we cannot really, you know, tell what's wrong or anything, review their application. We don't have the same level of accuracy in terms of modeling.

MEMBER WALLIS: Do they have full-scale experiments with this fuel?

DR. LU: I think so. They ran that for CPR correlation. That's what I recall.

MEMBER RANSOM: When you talk about models, are you talking about neutronics or thermal-hydraulics?

DR. LU: Both. I will get into, after I show these three slides, I will give you both hydraulics and the neutronics company in terms of some hydraulics I am going to get into there.

CO-CHAIRMAN KRESS: What's the purpose of the water rods?

DR. LU: Okay, the water rod itself -- actually, I should get to the next page. Okay, here the higher fuel economy, and what they want to do is provide additional moderation within the fuel bundle, so that they can have the --

CO-CHAIRMAN KRESS: That's for moderation then?

DR. LU: Right.

CO-CHAIRMAN KRESS: Okay. That's because you have a relatively high void fraction up high and --

DR. LU: That's right.

CO-CHAIRMAN KRESS: -- you want to keep water --

DR. LU: Yes, especially in the upper part of the region.

CO-CHAIRMAN KRESS: The upper part? Okay.

DR. LU: Otherwise, your fuel bundle may be undermoderated. Also, for the LOCA it can provide a heat sink because not all the water can flow out very quickly out of the water during large-break LOCA, then the fan blowing -- you have the flash in the fuel, but still you retain certain water mass there or steam. Then that becomes the heat sink if you uncover the core.

MEMBER WALLIS: Let's go back.

DR. LU: Yes.

MEMBER WALLIS: GE already has a model for this in their codes? GE already has a model for the GE-12 fuel in their proprietary codes?

DR. LU: Exactly.

MEMBER WALLIS: And these codes are available to the NRC?

DR. LU: Exactly, but we cannot just use their proprietary code.

MEMBER WALLIS: At least you know it is in there. You can examine the details of it and see how credible it is.

DR. LU: That is what we are going to do actually for ESBWR review and also for the -- because at this stage they have not submitted that for LOCA review, and also we have not received a submitted package for ESBWR. That is something we are going to look into that, what's the model.

However, as a confirmatory analysis or basis, we want to have a similar level of accuracy within our own codes, so that we can evaluate their calculation results.

MEMBER WALLIS: Now we haven't seen many results from TRAC-M anyway yet.

DR. LU: That is the reason we want to start to use it.

MEMBER WALLIS: So, first of all, it has got to be able to do the things that it has claimed to be able to do, and then it has got to do this as well?

DR. LU: Yes. That's right. Otherwise, because we look at our codes, the RELAP-5, TRAC-M, TRAC-B, TRAC-P. None of them, if right now we have some kind of scenario or transient using one of our operating BWRs, and if we want to model the fuel behavior or the hydraulic behavior within the channel, which has been loaded with GE-12 fuel, we cannot handle it.

MEMBER WALLIS: Maybe I would say we need to move along this TRAC-M because it hasn't really emerged to solve the old problems, and now you are asking it to solve a new problem. So we need to move it along, so that it's a useful tool and actually has been used for existing problems.

DR. LU: Okay. Yes, I think that might be the -- I am not in the position to answer that question. It is probably for Steve.

MEMBER WALLIS: Well, he's listening. I

hope he's listening, yes.

(Laughter.)

MEMBER RANSOM: Could I interrupt?

DR. LU: Yes.

MEMBER RANSOM: One thing you mentioned several times is accuracy.

DR. LU: Correct.

MEMBER RANSOM: It would seem that the uncertainty associated with these codes is a key component --

DR. LU: Right.

MEMBER RANSOM: -- of assessing the accuracy.

DR. LU: Right.

MEMBER RANSOM: Yet, in the research programs I have seen there is no effort that I see addressing this particular issue. Of course, it would be an issue with the NRC codes that you use as an audit-type capability.

DR. LU: Correct.

MEMBER RANSOM: It also is an issue with the General Electric code, too, but that is their purview, I guess, to argue how they are going to deal with that problem.

DR. LU: Right.

MEMBER RANSOM: But as we move towards a risk-informed basis for licensing, it seems this uncertainty is a key component.

DR. LU: Correct.

MEMBER RANSOM: And I am not sure there's any effort underway right now to build into, say, TRAC-M the ability to assess its uncertainty associated with the various correlations, and whatnot, in the code, as well as some overriding consideration to allow for inaccuracies or whatever.

DR. LU: Okay.

MEMBER RANSOM: And why isn't that being requested?

DR. LU: All right, okay. It's not really my position to justify what's going on with TRAC-M development, but my understanding, actually, Research has already initiated the effort, and I think that Joe Kelly and Steve Bajorek have a significant assessment effort to assess the uncertainties of the fuels and the hydraulics and the correlations and physics models.

So that I think it should be better up to them to give to you the presentation about how to address the uncertainties here.

MEMBER RANSOM: Well, it is their job, but

I would think that you, as the license reviewer, would be one to set the need.

DR. LU: Yes, but definitely we will pick up whatever the best can be used for us as an audit. So that can give us additional comfort.

MEMBER WALLIS: Do you have any idea of what is an acceptable level for uncertainties for your purposes?

DR. LU: At this point and until this user need is completed, we can't go over and around the codes and see how well. At that point we probably will get the GE code, TRAC-G code, so we can see how much difference is there. Is there any way we can dig into some results from that TRAC-G results and the TRAC-M results at that time.

Right now this code is not -- right now even we don't have any functionality. We cannot be building a --

CO-CHAIRMAN KRESS: Asking a question a different way, if you had the uncertainties in these thermal-hydraulic models, how would you use them in your decision process?

DR. LU: That's a good question. Actually, right at this point we are developing a confirmatory analysis plan and trying to identify what would be the acceptance criteria for our own analysis. Because if we impose --

CO-CHAIRMAN KRESS: You think the uncertainties somehow ought to show up in the acceptance criteria maybe?

DR. LU: Exactly. Exactly. That would be done, and within that writeup, I guess, we are working on that right now.

But there is one thing I think we should be aware: that we do not have that much of a code development as much as the industry because that QA process costs a lot of money. Right now if we imposed exactly the same standard, we will not get it over there, especially when we don't have a code that can be used for transient LOCA, gas-cooled reactor, and the ESBWR, or AP1000.

So my opinion is we can use it as an auditing tool. It can give us additional comfort. That would be good.

MEMBER LEITCH: I'm looking at the lower tie plate debris filter.

DR. LU: Right.

MEMBER LEITCH: That's a new feature, is it not?

DR. LU: Oh, I think it has been there.

It has been there. No, it has been there. Even for GE-10 or GE-8 we have it already there.

MEMBER LEITCH: Yes, but I am a little concerned that that can be a two-edged sword. Certainly, it is designed to prevent mechanical damage to the fuel.

DR. LU: Right.

MEMBER LEITCH: But are you also concerned that under certain circumstances it could restrict the flow?

DR. LU: No, I don't recall --

MR. CARUSO: Dr. Leitch, this is Ralph Caruso from NRR.

The answer is, yes, we have discussed this with the vendors on quite a number of occasions, and they assure us that licensees, when they design, when they buy fuel, they make sure that the suction strainers, for example, in the ECCS recirculation system are sized so that debris is caught on the suction strainers and not on the fuel.

I believe there is a NUREG Guide that is going to be coming out that talks about this, and we specifically asked that that be included in the Reg. Guide about two or three months ago. Because this came to our attention, this exact issue came to our attention during the discussions that we hold with the vendors periodically. They showed us one of these things, and we looked at it and said, "Wow, that looks like an opening that's a lot smaller than the suction strainers."

We actually had something reported to us. One of the licensees was going to buy a particular vendor's fuel and a particular vendor's debris screen, and they discovered that screen size was smaller than their suction strainers. So they had to delay the feature purchase, I believe, until they did something about the suction strainers.

MEMBER LEITCH: Are you concerned about the pulverized resin on filter demineralizers working its way into that part of the system? I don't know what happens to that resin at, say, 540 degrees. It may completely disintegrate.

MR. CARUSO: I mean, the openings aren't really that small. I have an idea what resin sizes are, and they're very, very small.

MEMBER LEITCH: Yes.

MR. CARUSO: And these are not, these debris screens are not designed to trap resin beads. They are designed to trap things like metal shavings and springs and sort of long things.

MEMBER LEITCH: Yes.

MR. CARUSO: Maybe very, very thin, but long, not resin beads. It is not clear to me that a resin bead could even survive the transport, the temperatures.

MEMBER LEITCH: I think it would probably dissolve at that time, but I'm not really positive of that. Okay.

MEMBER ROSEN: What suction drainers are you talking about, Ralph?

MR. CARUSO: In the ECCS recirculation system, during a LOCA, eventually the plant has to go to recirculation from either the reactor-building sump or the suppression pool or the torus, or wherever. Because they are located in the building sumps, they've got to have screens on them. So there are requirements about sizing those screens that are related to head losses and debris and MPSH, lots of different requirements.

There's a new guidance document, I believe, that's coming out. We included this particular issue in that -- I'm not sure if it is a Reg. Guide or an SRP revision, but we have included it recently.

MEMBER LEITCH: But you are talking about

BWR? I mean this is a BWR issue?

MR. CARUSO: Both. Both. This is an issue for both types.

MEMBER ROSEN: For the BWRs you're talking about torus suction strainers?

MR. CARUSO: Right.

MEMBER ROSEN: And the PWR, containment suction strainers?

MR. CARUSO: Yes.

MEMBER SIEBER: But these debris filters are intended for normal operation mostly. For example, if you had machined inside the reactor vessel during an outage, left some chips or grindings in there, you don't want them to go and fret at the grid straps.

On the other hand, during ECCS the flow regimes are altogether different, where it would seem to me that the fuel debris filters are not in the flow streams in the same kind of way that they would be during normal operation.

DR. LU: We are asking a very ambitious question. If we really want to model the solid particles that are transporting through the entire system, then we would need to develop another code to handle that.

All right, I'll move along.

MEMBER WALLIS: There you're going to have to decide not just how to model it, but how to model any debris that might be on it.

DR. LU: That's right. That is where it becomes a water chemistry issue or the entire plant purification system and the reactor water treatment system.

All right, I will just move along. For ATRIUM-10 we have looked at GE-12 and we found worry. How about other vendors? We have ATRIUM-10. There is square-shaped water rods and part-length rods here. For Westinghouse fuel it is even more complicated, and it has water crossings, what they call water crossings here. There is water here. There is water here. Then there is not only a different fuel type here, they have a larger diameter of fuel pins here.

So our code right now, as it is right now, it can handle 8x8 bundle straight tube, the thick fuel pins, and the non-part-lengths run a four-length rod all the way through.

So we really want to model this and handle it to match the accuracy of the vendor's code. So that we can use an audit calculation, we need this.

MEMBER BONACA: Just a question --

DR. LU: Sure.

MEMBER BONACA: The ABB fuel I think has already been used, that fuel?

DR. LU: All of these fuels.

MEMBER BONACA: Okay.

DR. LU: All of the fuels have been loaded in the existing operating reactor, but the reason we get into this with the triggering point was we were reviewing what we needed to do to handle the ESBWR. It came out with --

MEMBER WALLIS: That's what puzzles me. I've asked the question before. These fuels are being used now.

DR. LU: Yes, it is.

MEMBER WALLIS: And, yet, you say you need to know how they work in order to analyze something which doesn't yet exist. I think you need to know them now to analyze what happens in --

MR. CARUSO: Dr. Wallis, I make the observation that there was a confluence of events that occurred this past summer that really pushed us to make this request from Research. It was the ESBWR plus some other topical reports that we are reviewing from operating reactors where fuel configuration is very important to be able to model it. So all these things came together this summer.

Although we need this in order to be able to evaluate the ESBWR, we also need it right now to do some evaluations for operating reactors. That is because the operating reactors have pushed the fuel and now they are pushing the analyses envelopes with that fuel. Their techniques are becoming more sophisticated. So we are trying to get our techniques as sophisticated as theirs.

MEMBER WALLIS: Well, this is an issue we came up against with uprates, that the uprates look okay as long as you really check on the fuel limits.

MR. CARUSO: That's correct.

MEMBER WALLIS: And so you have to have tools to do that.

MR. CARUSO: That's correct, and as I said, what has happened is this past summer we received some topical reports that involved being able to model this fuel better than we have in the past, and it is both us and the vendors. So it all came together this summer, and we decided to push for this.

MEMBER LEITCH: Isn't the ESBWR, as I recall, the fuel is only 10-feet long versus 12 feet?

DR. LU: Yes.

MEMBER LEITCH: Isn't that another

variable that you would have to consider in your model?

DR. LU: Right now, the user needs, what we worked with Research, should cover that, too. That is one of the software requirements that the Research technical people and NRR people will work together on the software requirement we send to Los Alamos when they code it this way.

So it can handle actually even 8-foot fuel. We can handle that, too.

MEMBER LEITCH: Okay.

DR. LU: Right.

MEMBER LEITCH: Thanks.

DR. LU: All right. Ralph has already addressed the questions about the existing upper reading.

All the new fuel will have higher fuel economy and lower linear heat generation rates, which actually provided a basis for a lot of power breed, and they provided more margins for the BWRs, and especially for the EPU plants.

So we asked Research -- actually, we should say it this way: The technical people from NRR and the Research worked together. We figured out what we exactly needed to do to use TRAC-M to model the fuel bundle, the part-lengths rods, water rods.

Since Framatome mentioned that they planned to use 12x12 fuel for their SWR1000, we put the limit, the code limit, to model 12x12 fuel pins. Right now, for GE-12 it is 10x10. Most of them are 10x10.

Yes?

MEMBER RANSOM: One question: You say more margins for PCT and minimum critical power ratio.

DR. LU: Right.

MEMBER RANSOM: My question would be, who has proven that? I mean, is that something that is claimed or is it something known?

DR. LU: It's something known. Actually, the LOCA generates a smaller diameter of pins, and the water also provides additional heat sink and the part-length rods.

MEMBER RANSOM: So that is sort of a subjective evaluation? Is it confirmed based on actual analysis?

DR. LU: Let me think. I personally have not done any confirmatory analysis on that.

MEMBER RANSOM: But the vendor, maybe that is based on his work?

MR. CARUSO: Dr. Ransom, the analyses for the PCT would be done using the normal codes. The critical power ratio determinations are done by actual tests of bundles in test facilities. The Columbia facility, they do this. The vendors do this regularly.

DR. LU: Okay. All right, so the status right now, I will give you the status. You showed this one. I think it was in July.

Right now the first chunk of code came out from Los Alamos and ISL on October 30, and everything was going very well with the management support from Research and technical people from Research, and we would be able to get the first chunk of the coding on schedule.

MEMBER WALLIS: This is the TRAC-M coding?

DR. LU: TRAC-M coding.

MEMBER WALLIS: And it works?

DR. LU: The source code just delivered has been delivered from Los Alamos and ISL, and I think that it is being tested by Research right now.

MEMBER LEITCH: Your viewgraph says, "Advanced Flowing Water Reactor Fuel Model." Is that in a generic sense? In other words, does this also apply to ESBWR?

DR. LU: Yes, yes, it applies for ESBWR.

You can take the 12x12. Right now we haven't seen that. Although we have heard from Framatome they may use the 12x12 fuel for the SWR1000, we haven't seen that yet. But that is what we call the Advanced BWR.

MEMBER LEITCH: So it is advanced not necessarily in the sense of ABWR but advanced in the sense of any --

DR. LU: Fuel. Right.

All right, I move to the second user need. It is a draft user need being discussed between Research and NRR at this point. What we want to deal with is specific for ESBWR's pre-application review. I think GE has come to give a brief presentation about their features.

Two features of our particular concern is the closely coupled containment vessel interaction during LOCA, because basically they have to depressurize it to the level of pressure, so that the containment of the gravity system can work. That actually requires the code can capture very dedicated pressure balance between the primary system and the containment system. This balance needs to be calculated reasonably well so that we can calculate the ECCS injection correctly.

So basically in July we looked at the

codes with Research technical staff. We had two meetings, technical meetings, that we exchanged the views as to how we are going to address all those features, and we came out with a list of items we needed to improve with the ESBWR, to improve TRAC-M code to address these unique features of the ESBWR. Right now it is being further discussed and considered as the action item, but we don't know where eventually what we are going to have.

MEMBER WALLIS: There's nothing new about gravity.

DR. LU: Yes.

MEMBER WALLIS: So what must be new is the result is more subject to change as a result of uncertainties or something? You're balancing off various little efforts here and there?

DR. LU: Yes, correct. Exactly.

MEMBER WALLIS: So whether it goes this way or that way depends on your accuracy with which you can predict things?

DR. LU: Exactly, exactly, and I will give you two examples here. We discussed some technical items. The reason I did not list that is because we not really come to any agreement as to where exactly it needs to be in the code.

But one of the issues we considered is PCCS non-condensable condensation. You know, you have steam and the non-condensable through the PCCS. That drives your pressure response of your containment significantly differently. If you have different correlation put over there, or how accurate is that, it will be quite different. That is one thing.

The second issue is traditionally for the BWR LOCA, for the containment analysis, basically, you assume basically you have a HPCI, or whatever, the RCIC running. So basically your initial blowdown state you do not have any coupling, and you don't have any backflow from the containment. But this one relies on this backflow, this pressure interaction so closely; then we needed to have very good model or code to calculate the interactions between the containment and the vessel.

So that is the reason we initiated the talk with Research technical staff and we worked together again and developed a list of things that needs to be done. Then we hope this user need can go forward.

MEMBER LEITCH: Now we have a draft, an advance copy of a paper, "ESBWR Advanced Reactor Research," that has a number of other apparent needs here other than the two that you have listed. These are just the two most important in your mind or --

DR. LU: At this point these are the most important because we went through that list and then we are still discussing that right now for the pre-application. If we have this handy, this too handy, we can do some runs already, but without the second one we will not be in very good shape if we want to calculate very accurately containment and the vessel interaction.

MEMBER LEITCH: I am not concerned about those two. I am concerned about the ones that are listed in this paper that you have not mentioned. You are just giving us a summary or --

DR. LU: Summary. A summary, correct.

MEMBER LEITCH: So there are other research --

DR. LU: That is the reason I am saying that other issues under consideration is covering that, whatever you probably have. We are discussing with them at this point.

MEMBER LEITCH: One thing I didn't see there is a whole lot of emphasis on BWR stability issues.

DR. LU: Yes.

MEMBER LEITCH: With this natural circulation chain, no recirc. pumps, it sounds like you are sort of always operating in the region where there is instability in a sense. I guess that is not really the case, but it seems to me we need to be taking a hard look at stability issues, and I don't see that as highlighted here as one of the issues.

DR. LU: Okay. If you look at one of the reasons why we want to have the advanced fuel model, it is to address the stability. If we cannot model that heat source and part-length rods, then the stability characteristics will be different. However, the stability issue is not unique for ESBWR. It is supplied right now. We are reviewing MELLA Plus for the generic application of the BWR, especially for EPU.

MEMBER LEITCH: It's not unique, but it seems to me that when you omit the recirc. pumps, it changes the whole thing significantly.

DR. LU: That's right. In that regard, actually, ESBWR has better stability features because they never use the jet pumps.

MEMBER LEITCH: We will have to hear more about that. That just seems counterintuitive to me.

DR. LU: Well, then that is a question we probably need to ask GE: why they think that natural circulation would work for ESBWR, right?

CO-CHAIRMAN FORD: I have a wider question along the same lines. You have cited four advanced reactors --

DR. LU: That's right.

CO-CHAIRMAN FORD: -- related advanced reactors. Yet, when I look at this Attachment 4 of all the advance reactor activities in 2003, it is much, much bigger than the four that you have given. Why is that? Is there a different model to use, a different funding source, or what is it?

DR. LU: Okay, it's not a question for me. I am technical staff, and I only give the presentation on a technical basis for using these. I think there will be a high-level discussion between Research and NRR. They need to resolve what exactly should be done, and I am giving you the basis of what we have already sent out.

CO-CHAIRMAN FORD: Okay, John, will you comment?

DR. LU: Okay, maybe somebody else can address that question.

CO-CHAIRMAN FORD: It will be covered today because it relates to resources. Okay.

DR. LU: Right. Okay. All right, I will move to the next one for AP1000. This user need was originated by Dr. Jensen from the Reactor Systems Branch.

Following a very successful user need that ADS did last year for Phase 2 review, this particular user need was issued to Research asking for Research's expertise regarding the COBRA/TRAC liquid entrainment.

The issue here is -- I'll go to the next page a little bit. I think it probably has been covered and presented to you. You understand, you know what is the issue there.

Basically, through the ADS and then the entrainment of the liquid from the vessel through the hot leg all the way to the ADS valve, where it impacted the vessel coolant inventory and the depressurization rate, and those issues Westinghouse claims they can handle that.

So Walt Jensen and Steve Bajorek from Research worked on this. I think they are on schedule to resolve all the issues at this point.

So basically that is the support for the Phase 3, AP1000 event --

MEMBER WALLIS: This affected the ADS 4 there. Is that relying on the work which is being done out in Washington?

DR. LU: I do not know the answer.

MEMBER WALLIS: Or Oregon.

DR. LU: Oregon.

DR. JENSEN: This is Walt Jensen, our Reactor Systems Branch.

We are looking at the results from the ATWS tests that are ongoing at Oregon State. There seems to be somewhat more entrainment shown in those tests than is predicted by Westinghouse for AP1000.

We have outstanding questions on that issue. We have a number of outstanding questions on the entrainment issue, which Westinghouse has told us they are going to answer by December of this year.

MEMBER SIEBER: So you could actually say that the problem isn't solved, that you can't predict with accuracy what's going on in the entrainment area right now?

DR. JENSEN: Well, we're still looking at it. It's under review. Westinghouse is giving us a topical report showing sensitivity studies that show that it really doesn't make a great deal of difference for cooling what the entrainment prediction is, that the amount of inventory in the reactor core is relatively insensitive to the amount of entrainment.

We are looking at that.

But there are additional tests being done at Oregon State. We would like to factor those into our review as much as possible.

MEMBER SIEBER: An additional question regarding that: Between the AP1000 and the AP600 there's a different number of valves, different valve sizes, and different header configurations. On the other hand, why doesn't the entrainment issue emerge in the AP600 to the extent that it did in the AP1000?

DR. JENSEN: There were a number of integral system scale tests done that were scaled for the AP600. Some of those were done at Oregon State at the APEX facility. Some were done at SPES.

We felt that the data for AP600 was more applicable than these same tests for AP1000. For AP1000, the hot leg, it is the same size for AP600, but the ADS 4 it's much larger, and I think it is supposed to be like seventy-something percent more flow going through ADS 4 for AP1000.

MEMBER SIEBER: But the Oregon tests are still small-scale tests that are scaled up for either plant?

DR. JENSEN: That is true.

MEMBER SIEBER: So it is not clear to me

that scaling isn't part of the problem.

DR. JENSEN: There have been scaling studies done for AP600 and AP1000. We are still discussing with Westinghouse whether the original Oregon State test at the APEX facility that were done for AP600 would be applicable to AP1000.

There will be additional tests done at Oregon State. They are being funded by the Department of Energy. For those tests, the facility has been rescaled and reconstructed to look more like AP1000.

MEMBER SIEBER: And that is along the lines of the presentations on scaling that we heard four or five months ago?

DR. JENSEN: Yes. Yes, that's true.

MEMBER SIEBER: Okay, thank you.

MEMBER ROSEN: Since we are on this point, can I ask a question about the qualification of these valves for different liquid entrainment levels?

DR. JENSEN: We're relying on this test data. There has been no full-scale test of these large ADS 4 valves for either plant.

MEMBER ROSEN: It seemed to me that they have to be qualified over whatever liquid entrainment range you expect, including uncertainties.

MR. CORLETTI: This is Mike Corletti from

Westinghouse.

Maybe we could talk about this tomorrow, but I guess in regards to the qualification of the valves, I think the entrainment is not a major design feature. Maybe I need a little bit more help with the question in regards to the qualification.

MEMBER ROSEN: Well, valves that are qualified for steam are one thing. Valves that are qualified for steam and a certain quality of water is another thing.

MR. CORLETTI: Okay, yes. These are what we call our squib valves. They are a full-pressure, high-pressure, high-temperature valve. How we model them in our codes is really the valve loss characteristics. So in regard to their operation with steam or water, we are really interested in the pressure drop characteristics of the valve.

MEMBER ROSEN: Well, from a modeling standpoint, for sure, but I am interested in their survivability during the transient or accident.

MR. CORLETTI: Oh, they will be qualified for the duty that they will see, which would include single-phase and two-phase conditions.

MEMBER WALLIS: But the modeling I think is important. We saw that there are transients in this hot leg and you get surges of water that go up the pipe, and there is different amounts of storage of liquid in the vertical leg. Then slugs of liquid go to the valves.

So you have to get the transient pressure fluctuations of the valve throughout the system in order to do an analysis of whether or not they grow or decay, and so on. So the auxiliary transients can be important here. So you've got to get a reasonable model of the valve receiving quite a range of qualities.

MR. CORLETTI: Yes, and maybe to clarify, the valves do not close. These are a one-time-opening valve. So they are not closing against two-phase or steam conditions.

MEMBER WALLIS: No, there is just a resistance once they are opened.

MR. CORLETTI: That's right.

MEMBER WALLIS: Right.

DR. LU: Okay, I'll move forward to the next one, the last item I will cover.

MEMBER WALLIS: I'm sorry, when you say status on schedule, I think you need to have a more critical evaluation of whether or not it is giving you the results that you need. We have been through this, and maybe we need to revisit this with RES. This Committee or the Subcommittee has been looking at these results and had some questions about whether or not the needed results would be achieved.

DR. LU: All right, do you have any comments?

DR. JENSEN: Our schedule that we see at NRR is the questions we have sent to Westinghouse and the answering of the questions, and so far that work is on schedule. We don't plan to hold up the licensing of AP1000 because of any delay in these tests.

MEMBER WALLIS: That's very interesting. So you are going to make the decision whether or not you have the information?

DR. JENSEN: We hope to. Westinghouse has told us that the results are insensitive to the entrainment. We have outstanding questions on that issue. If they can prevail and show us that the sensitivity, it's within the range of our knowledge, then that should be acceptable.

DR. LU: All right, I will go over the last one, and Andrze Drozd from NRR/PRA Branch, he originated this need, asked the Research team to work on the severe accident stuff.

Overall, he has emphasized we are trying to get at whether to evaluate the applicability of the conclusions from AP600 in-vessel retention and the fuel coolant interaction review and to see whether it can be applied, directly applied, to AP1000, and to perform the MELCOR analysis and for risk-dominant accidents.

Right now we have three milestones. The September milestone provided recommended RAIs and prepared the MELCOR input deck for AP1000 and finished on October 2nd, and the review of AP600 in-vessel fuel coolant interaction.

CO-CHAIRMAN KRESS: Does that include the in-vessel retention review also?

DR. LU: Yes, that's my understanding.

CO-CHAIRMAN KRESS: Both of them?

DR. LU: Yes, that's my understanding. That's part of the support; he needs to review that portion.

CO-CHAIRMAN KRESS: Yes. So we haven't seen that document yet. It's just recently been completed?

DR. LU: I don't know too much about that and I didn't do that.

So that's our schedule right now. There

are other tests -- okay, hold on. Richard?

MR. LEE: Richard Lee from Research.

Tom, this is the review of the AP600 previous document written for AP600, the applicability of the methodology, and so forth, to AP1000. But we will be doing analysis of that later.

DR. LU: Thanks. All right, that's basically what I need present. Overall here, the status is the ongoing three user needs requests have been going on very well. The technical staffs from both offices are working together to get all the issues resolved, the technical issues resolved, code developed. Right now everything is on schedule. We hope it stays on schedule so that we can get the code.

MEMBER WALLIS: I think I would be happier if, rather than talking about schedule, you talked about technical achievements that need to be achieved in order to get from A to B, and you could reassure me that these technical milestones have been passed, rather than that some time milestone had been passed.

DR. LU: Okay, okay. Actually, when I prepared this one, I thought it would be, I was thinking, probably 15 minutes or 20 minutes. I did not prepare that. Actually, it was in my original handouts.

I was thinking maybe should I get into the details of what exactly has been achieved and whether that would take maybe another half-an-hour to talk about that. So I did not, but if you need that, we could give you a copy of the user needs.

MEMBER WALLIS: Of what you would have said if you had longer?

DR. LU: I have already exceeded my time.

MEMBER WALLIS: Yes, yes.

DR. LU: But if you need that, we can give you the user needs, what exactly we passed to Research, and then a copy of that, and you are going to see that. Okay?

MEMBER LEITCH: I am just a little confused about the priorities here. We have the draft papers about ESBWR and ACR700. I am a little confused. I would have thought your presentation would be on ESBWR and the ACR700.

DR. LU: Both, the ESBWR and -- no, no.

MEMBER LEITCH: Are we going to hear later about ACR700?

DR. LU: No, that was not from me. That would not be from me, no.

Regarding whatever the draft, the ESBWR paper, I think --

MEMBER BONACA: But the improvements you are making on TRAC-M seem to be supporting also the other two designs, insofar as the needs that you have.

DR. LU: That's right. That's right. For example, the containment coupling with TRAC-M can be used to apply any coupled containment interaction if you do need to model the containment backflow, if we cannot couple the containment analysis from the primary system.

CO-CHAIRMAN FORD: I think if we've got a thing that is on the board of things that still need to be discussed, it is very much your question, Graham, about how the prioritization of these four NRR user needs projects relate to what we have seen in the infrastructure assessment, and hopefully we'll hear that in the next talk.

In the meantime, let's adjourn until 10 o'clock.

CO-CHAIRMAN KRESS: Not adjourn.

CO-CHAIRMAN FORD: Not adjourn? What is the word?

CO-CHAIRMAN KRESS: Recess.

CO-CHAIRMAN FORD: Recess.

CO-CHAIRMAN KRESS: Take a break.

CO-CHAIRMAN FORD: Take a break until 10

o'clock.

(Whereupon, the foregoing matter went off the record at 9:50 a.m. and went back on the record at 10:05 a.m.)

CO-CHAIRMAN FORD: I'd like us to come back into session.

The next presentation is by John Flack on the research presentations and primarily an update on what's happened since our July 18th memo on the REV-1.

MR. FLACK: Right. That is correct.

Good morning. My name is John Flack, the Branch Chief of the Regulatory Effectiveness and Human Factors Branch, which is the home of the Advanced Reactor Group in the Office of Research.

To my left is Steve Bajorek, who will be addressing the ESBWR and the ACR-700 additions to the infrastructure plan.

Basically what I'll do is I'll briefly go through some background on the plan, which we now consider to be really an infrastructure assessment. So as we move forward, I'll be referring to it as that.

We'll discuss the responses to the ACRS comments that we provided back to you. I'll provide an overview of the SECY that's on its way up to the

Commission, which is really a summary of the plan itself, and then we'll talk about the additions, which is, again, the ESBWR and the ACR-700, and then Steve will do that part of the presentation. Then I'll come back and talk to you a little bit about activities that we plan to do this coming fiscal year and then summarize.

CO-CHAIRMAN FORD: John, on the very question of changing the title of that document from plan to infrastructure assessment, is that just tipping your hat to the fact that in that original document there was no milestones, no budgets, no management implementation activities itemized?

MR. FLACK: Yes.

CO-CHAIRMAN FORD: And so this just simply here are the gaps in the technology for putting in advanced reactors.

MR. FLACK: Right, right. The plan would be a bigger thing, which would include actually execution of the infrastructure itself. Having gone through this, recognizing that really the purpose is to identify the gaps that you describe, it's pretty much that.

It's an assessment of needs. Now, when we go to exercise those needs, how much we actually do will depend a lot on how much we see from the applicant and how much has been accomplished in other places as well.

So its real purpose is to do just that. It's to look at the infrastructure, identify gaps, try to link to ongoing research throughout the world, and bring it into a common document, and that's the document.

CO-CHAIRMAN FORD: Now, in the covering letter, I believe, to the infrastructure assessment, mention was made to fiscal year '02 to '06, I think it was, which is a planning time frame.

MR. FLACK: Yes.

CO-CHAIRMAN FORD: So really when you're talking about the technical gaps, it is not time dependent; is that correct?

MR. FLACK: That is correct. Originally we were planning on establishing what work we would need to do over that period of time, but it evolved to more of just a gap analysis, which is pretty much where we are right now.

CO-CHAIRMAN FORD: Okay, and when will we see the plan?

MR. FLACK: Well, the planning process is a process in itself. The idea is to bring forth those things that we will need to do and then prioritize those with respect to other activities going on in the office.

So the actual prioritization is bigger than just the advanced reactors. At one point, the advanced reactor was fenced off. We had monies allocated just for that activity, but as we speak today, it's really across the office. So it actually competes with other ongoing projects within the office for resources.

So we have, and I'll touch upon it a little bit about how we go about doing that planning process.

Okay. With that I'll start. This viewgraph is just to reflect on the meetings that took place that set the stage for the advanced reactor work. Last year there were three key workshops that took place, the first being the ACRS. That was early on, and it brought together vendors, DOE, and the staff to talk about technology challenges associated with these advanced designs.

That was followed with a workshop by NRR, which talked about early site permits and COLs, and then finally there was a workshop by Research that pulled experts around the world to try to understand what the status was on this research going on in the high temperature, gas cooled field.

This year we had a number of interactions, as you remember, with the ACRS. We gave a briefing at the full committee in April, which was very brief actually in contrast to the following meeting which occurred later that year in July, where we did spend a day going through pretty much all of the areas that are in the plan and the technical issues and challenges they presented.

That generated -- well, we went to the full committee following that subcommittee. That generated a letter from the ACRS with a number of comments, and that was in July of this past year.

We responded in August to those comments, and I'll go through those in a moment.

We also appeared before the ACNW for information only. We briefed them on that part of the plan that was relevant to our nuclear waste and materials, and then today, of course, is a joint subcommittee.

So that pretty much gives -- that's not all of the meetings obviously that took place, but those were some of the key meetings that certainly took place.

With respect to the comments in the letter, there were ten comments that were made by the ACRS in their letter, and we responded by first indicating that things had changed from earlier in the year where Exelon and pebble bed, of course, had a high priority and then as Exelon did pull out of the pre-application review, we did shift our focus somewhat, recognizing that there is the need also to continue this work at some level, but not as compressed, as you might say, as it was envisioned when Exelon had it at pre-application.

We do have the application, of course, with GT-MHR, which is ongoing right now, but again, at a somewhat lower level.

CO-CHAIRMAN FORD: Could I ask a question on that one?

MR. FLACK: Sure.

CO-CHAIRMAN FORD: Because the two gas cooled reactors, they are both now on the books. The PBMR will be on the books again. It's not dead entirely.

MR. FLACK: Yeah.

CO-CHAIRMAN FORD: The technology challenges are considerable and will require a lot of research over a long time period. Just because your priorities have changed because of the stress of other advanced light water reactors, is that a good enough reason? Is a risk not still there, the risk defined by the risk of not doing the work times the likelihood of it being actually a successful applicant?

What's the rationale behind dropping the priority on the gas cooled reactors?

MR. FLACK: Well, it lowered it. It didn't eliminate it certainly. I think we're working within a fixed budget, and needs as come up on the horizon as to really what industry is looking for.

We do not, again, want to be a pinch point in the process. We want to be best prepared to deal with designs as they come in as we can. So certainly the ones that appear to be immediate future would take the higher priority since we want to get those through the system as effectively and efficiently as possible.

So as we change our priorities as these new pre-applicants come in, there still remains many challenges ahead in the HTGR world, and so what we have done now is kind of look more towards what else is going on in the world and trying to capitalize in the meantime on what else is out there instead of trying to just forge ahead on our own.

So I think in some sense it's giving us

time to do that, to find areas in which the work is going on and where we can draw cooperative agreements.

At the same time though, it is important that we do maintain a certain level of research going on in our own office in that field. So I don't know if that addresses your concern completely, but again, because of the way the budget is fixed in some regards --

CO-CHAIRMAN FORD: Now, what was the risk associated with that? If you're putting many of your regs. into the collaborative lessons learned from other people, Europeans, Japanese, et cetera, has anyone assessed the risk of your not getting the relevant information from these organized issues?

MR. FLACK: Well, the risk is, again, time dependent, you know. It's the sort of thing as when do I need the information to make what kind of decision.

And there's always a risk that something could happen a lot faster than you thought, and so one has to continuously adjust to accommodate that risk, and that's why this document is really a living document.

Each year we're planning to come back and reflect on where we are at that time and then use it, recognizing the needs that are there. Again, it's a place where we can see the terrain and come back to that and decide at that point how we need to adjust again.

But I don't think there's one answer. I think it's something that's very time dependent and you have to feel your way through.

Okay. As mentioned, the scope has expanded now to these additional advanced light water reactors, and what I'll do now is go briefly through our responses to the ten comments that were raised by the ACRS in their letter back in July.

The first comment was to focus -- and it's more or less our response -- yeah, we'll be focusing HTGR research primarily on the generic level and not have it so much design dependent. There's many challenging generic issues like the fuel and materials that are quite generic and we remain focused on that.

Of course, there's a GT-MHR, and that is ongoing at the pre-application review.

Fission product release for TRISO fuel is a key research area. We see that as a key research area.

By the way, we agreed pretty much with all of the ACRS comments, which is good to know.

The number two will obviously be supporting or play a role in supporting or providing technical basis to some of the policy issues I'm sure that you see coming forward right now.

So, yes, we see that as an important area to continue research on.

Framework for licensing, we consider that at this time of year to be a high priority up to this point, and I do have a viewgraph on that. We have not done a whole lot, but this coming year we plan to do much more.

And number four was we wanted to consider fission product releases for high burn-up fuel, and we've added a piece into the plan on that to continue to consider that and the source term that evolves from the higher burn-ups of the fuel.

CO-CHAIRMAN KRESS: Are you having any success in getting the VERCORS data?

MR. FLACK: Let me see. Where is Richard Lee?

MR. LEE: The answer to your question, Tom, that we are getting the VERCORS data, and we already have the two reports on the high burn-up fuel, the MOX fuel from VERCORS, and they are preparing an assessment report of all the data, and this report is in preparation right now by IRSN, and we are going to get this report once they are completed.

CO-CHAIRMAN KRESS: Wonderful. Thank you.

MR. FLACK: Okay. The fifth comment had to do with selecting design basis events, and we already had started pursuing that as part of the PTMR, using risk insights and discussing not so much design basis, but licensing basis events which cover a spectrum of events, including beyond what we would consider the design basis today.

And this is also part of a policy issue that is now moving up to the Commission on how we select accidents.

Number six had to do with the question of how do we establish priorities, and that, as mentioned earlier, we use PIRT to rank, and we use the planning, budgeting and performance management process to prioritize, and that process is used across the office, as well as, which I hadn't mentioned on there, but stakeholder input, of course, which is through workshops, meetings with the ACRS and others.

CO-CHAIRMAN FORD: Will you discuss this particular item because it relates to Graham's questions and my questions about the ranking of the user need ones we heard just before the break versus the listing that you have supplied for 2003? So we'll hear about this?

MR. FLACK: Well, I could talk about it a little bit now. There's really two types of work that goes on. One is fee billable in support of pre-application, design certification, and so on, and then there's from the general fund a more global kinds of research, which involves infrastructure development.

So both of them, again, come out of the same budget. We have only allowed so much funds, but part of it is, again, supporting through user needs the reviews of licensing submittals, RAIs, evaluation of those RAIs, providing input to safety analysis reports.

And then there's the other part of research that deals with understanding beyond, for example, design basis accidents, margins, providing confidence in decisions, providing technical basis for decisions and the confidence that goes with that.

So that type of research is broader in extent and does go beyond just the immediate need for user needs.

CO-CHAIRMAN KRESS: You don't have to pry into user needs.

MR. FLACK: That's right.

CO-CHAIRMAN KRESS: That's for NRR to do. I mean, that's an automatic priority.

MR. FLACK: We have to do that work right.

CO-CHAIRMAN FORD: Okay. So in answer to Graham's question and mine, I guess, just because we only saw four programs in the previous presentation doesn't mean to say that there's only going to be four programs on advanced reactors --

MR. FLACK: That's right.

CO-CHAIRMAN FORD: -- in 2003.

MR. ELTAWILA: I think in general that's true.

This is Farouk Eltawila again, and Gary is behind me. He can correct me if he wants.

I think the immediate need --

(Laughter.)

MR. ELTAWILA: -- the immediate need right now that you saw it is to try to complete the pre-application review, and so that they identify models that need to be put into the quote to be able to do counterpart analysis to see if there are issues that need further investigation or not.

What you see in the plan that we provide to you, that we have additional information that we need because in order for us to provide NRR with a qualified tool, we have to look at the range and the applicability of all the high ranking phenomenon models in the code.

So we need to arrange the parameter, and we need to look at the experimental data, and we need to run some experimental. We have the facility at the PUMA facility, for example, and we assess the code against it.

And at that time, we will say that the code is ready for the certification. So the immediate need that we have right now is just to make the tool available right now to be able to do analysis, but the final product with a certified quote from the Office of Research, and this code has met all of our assessment process and things like that; that's the additional work that you see in the plan.

The other part of it, again, because we expect it to do the same thing, for example, several accident, we know that there are issues in severe accidents like in AP1000, although you don't see the need right now from NRR because it's not part of the pre-application review, but we are identified it in the plan, and we are going to continue negotiation with NRR and see if these are the issues that need to be discussed and followed on or not.

And that's how we merge together and eventually every fiscal year you will find a new activity to be carried on, you know, that we will perform based on a discussion between us and the user office.

MEMBER LEITCH: I'm still confused on this Attachment 4 that we received, just the one page list of activities scheduled for fiscal year 2003. I don't see any AP1000 activities on that list at all.

MR. FLACK: Yeah, that is more for infrastructure. I'll come back to that list in the end.

MEMBER LEITCH: Okay.

MR. ELTAWILA: Let me answer that question. I'm sorry, John.

MR. FLACK: Yeah, sure.

MR. ELTAWILA: We believe that the only things that we have right now for AP1000 is as indicated by Shanlai Lu, is the issue of entrainment and de-entrainment right now, and we have a program right now at Oregon State University to supplement the work that DOE is working.

That work, although it's not specific for AP1000, it's for code assessments so we consider that part of the developing the infrastructure for our tools and things like that.

MEMBER LEITCH: I see.

MR. ELTAWILA: But we have not identified any major issue that in the AP1000 that would need additional research at that time. Based on the pre-application review, we have not identified any issue.

The work that Richard will talk about about the applicability of the AP600 severe accident data in core melt retention and fuel coolant interaction and issues like that, we are reviewing them right now, and if the issue comes out, that review, we'll be discussing it and we'll identify this issue as happened.

But as far as I'm concerned, I don't try to take too much time here. The issue of in vessel melt retention, NRR did not give credit to Westinghouse for the AP600. It was there. It may work, but we really did not take full credit for it in the certification process.

Whether that's going to be the same way they are going to deal with it for AP1000 or not, that's a need to be determined.

MEMBER LEITCH: Okay. Let me just ask one other question. The list that we -- well, you're going to come back to Attachment 4. I'll defer the question until that time, John.

Thank you.

MEMBER RANSOM: John, I have a question relative to number six. The use of the PIRT process for establishing research needs, that assumes a panel of experts, I guess, would rate and rank them.

MR. FLACK: Yes.

MEMBER RANSOM: Do you have a panel?

MR. FLACK: Well, we choose from experts in the field. We just had a PIRT last week on fuel, TRISO fuel. What are the issues? What are the things that we need to focus on? And how does that rank as far as priority? Which scenarios play out to be the most important, and so on?

MEMBER RANSOM: Well, are you doing this sort of area by area or are you --

MR. FLACK: Yes.

MEMBER RANSOM: How do you do the generic prioritization?

MR. FLACK: Well, I would say the closest thing we got was this workshop that I described back last year where we brought experts in from around the world to try to get a status and to try to understand what other important issues for HTGRs anyway.

And so from there we went forward and from there to identify specific areas. Now, these areas are very complex, just like fuel is in and of itself. So it really needs to be looked at as a specific fuel.

MEMBER RANSOM: Have those results been documented so that they're available to review who was involved?

MR. FLACK: The workshop?

MEMBER RANSOM: The workshop or --

MR. FLACK: Yes, there was a report written on the workshop. We can get you a copy. The PIRT that just took place, there will be a report that comes out on that as well.

CO-CHAIRMAN KRESS: Farouk, could I ask you another question about the AP1000?

MR. ELTAWILA: Yeah.

CO-CHAIRMAN KRESS: In vessel retention.

MR. ELTAWILA: Yeah.

CO-CHAIRMAN KRESS: One of the concerns I had with that was with the higher power of the AP1000, that all of the -- and they will turn on and put the water in there, even though they're not taking any credit for it; that that will hold up the molten fuel for a while and allow it to perhaps stratify and segregate the metal from the oxide.

MR. ELTAWILA: That's correct.

CO-CHAIRMAN KRESS: And then the failure location is likely again to be where the metal is.

MR. ELTAWILA: That's correct.

CO-CHAIRMAN KRESS: And what you have then is an ideal situation for an injection of a hot, molten metal into a water pool that's connected to the containment, which is an ideal situation for fuel coolant interaction, which is like a high pressure metal injection, and actually the failed containment is the same time, have a lot of fine particles expelled to the air.

Is that on your radar as something to --

MR. ELTAWILA: I think you hit the point exactly because we really believe, based on the information that we have seen from Moscow and the Raspolov Programs in Russia, that because of the high power rating retention, the vessel might require some design changes.

But based on the old information that we have, you might need to design the insulation around the vessel and so on. So retention, in vessel retention is not highly assured for high power reactor. So the issue that becomes very important is exactly as you indicated, is ex vessel fuel-coolant interaction, and that's what we are going to focus most of our work on in the analysis and see if there are experimental data to support analysis of that issue or not.

CO-CHAIRMAN KRESS: Thank you very much.

MR. FLACK: Okay. Moving right along, number seven. We did add a piece in the plan to investigate the correlation or the link between activity in the primary and potential latent failures of fuel so that as an indicator for future performance of fuel at higher temperatures or under accident conditions.

That was brought to our attention. That was a new area that we've added, and --

CO-CHAIRMAN KRESS: How are you approaching that?

MR. FLACK: Carefully. I don't know. Stu Rubin is with us. He could probably respond to that.

MR. RUBIN: Repeat that question again.

MR. FLACK: The question on how --

CO-CHAIRMAN KRESS: I wanted to know how you're approaching that particular --

MR. FLACK: We are approaching the relationship of coolant activity with latent fuel failures.

MR. RUBIN: Oh, yeah. The issue --

MR. FLACK: Stu, the microphone.

MR. RUBIN: Yes, sorry about that. Stu Rubin, Office of Research.

The ACRS raised an issue which had been mulling in our own mind for some time, and that is the effectiveness of coolant activity monitoring systems that are going to be used in HTGRs to monitor fuel performance, and they basically do this by monitoring nobel gas activity in the helium.

And so this is the kind of a system that's been used going back to the earliest HTGRs, and the issue in our mind is not so much the detection of failed fuel in operation. That can be correlated fairly easily with test data, but rather, the ability of these monitoring systems to detect what we would call latent failures. These are conditions that may arise from manufacturing, such as so-called fuel, manufactured fuel outside the specification that somehow gets through the QA process, let's say, or weakening of fuel due to operating the fuel at conditions beyond the design, hot spots, let's say, where local temperatures are higher than expected.

These kinds of conditions can lead to a weakening in the fuel that may or may not be detectable by such an on line core monitoring system and only would be revealed by, let's say, an accident condition.

And so our thought was to include in the research plan some work which would involve both analytical work, as well as irradiation testing and accident testing.

And with regard to the evaluating of whether or not the core condition monitoring systems could detect a weakening fuel that would slowly be revealed as failures during operation or not, we would plan to include in the irradiation program testing at higher temperatures to see if those higher temperatures would result in failures during operation, and take that same fuel whether or not it did or didn't result in failures, and then put it through an accident heat-up test.

And so the idea there would be that if the fuel did not reveal higher failure rates due to the higher operating temperatures, but did see increased failures in the accident regime, that might be problematic for an on line monitoring system to detect latent failures due to operations conditions outside design.

And with regard to the fuel fabrication issue, the thought was that you can't very well take fuel that is manufactured at various degrees of variance from the manufacturing specification. That's not a practical approach, but the thought would be to do sensitivity studies with analytical code where you can actually simulate fuel performance during operation and during accidents and crank in different fabrication anomalies, so to speak, and see how that would play out during operations and during the accident sequence.

Again, if the operations phase of the simulation didn't result in increased failures, but we saw it in the accident, that also may prove to be somewhat problematic for an on line monitoring system.

So we are picking that up in the plan.

CO-CHAIRMAN KRESS: Sounds good. Thank you.

MR. FLACK: And more than you asked for, right?

But thanks, Stu.

Okay. Number eight, we're certainly tracking what's going on in Generation IV near term deployment by continuing representation on the NERAC, and aware of DOE activities in that area.

Number nine was research activities to assess the full range of ex vessel severe accident phenomena. I think we just discussed a little bit about that, and that's in the plan.

And ten, there was a comment on license by test concept and the need for large scale testing, and that was also addressed in response to that question and comment within the context of our regulatory process.

So that pretty much covered the comments and our responses to the comments.

I do have one viewgraph on framework, which pretty much you've seen somewhat before. The work, again, will be starting in FY '03. It's currently under development. It's going to capitalize on Part 50 work and risk informing Part 50, utilizing a top-down approach that begins with the goals supported by cornerstones and then strategies and tactics to insure that those cornerstones provide the protections needed to protect the public health and safety.

The undertaking will also capitalize on, you know, risk informing current LWRs, Reg Guide 1.174, and so on, and ground that has been broken in that regard.

It will certainly be key or have to dovetail certainly with the policy issue paper that's coming in front of the Commission in December, and as well as the technical issues that are coming about as we discuss them.

And also using the input from NEI, and I think you'll hear more about that this afternoon, and other stakeholders as we need.

So that's all I --

CO-CHAIRMAN FORD: Now, we heard from Mary Drouin some time ago. We had the impression that the framework in 2003 was low priority. That is no longer the case?

MR. FLACK: Well, I guess the question is how do you put it in perspective. I don't know what context she described it as low priority.

CO-CHAIRMAN FORD: Well, that was the impression that I personally came away from the meeting with, and I think many of the other members also had the same impression.

The reason why it's puzzling is that in the infrastructure assessment you see quite specifically that the framework work is a basis for many of the other priorities and prioritization of many other technical challenges and, therefore, it has got to be high priority.

MR. FLACK: It would be part of that

process, yeah.

CO-CHAIRMAN FORD: So I take it that the framework work is high priority?

MR. ELTAWILA: The answer is it is a funded activity in fiscal year '03, but we don't have funds anyway, so it's irrelevant. I'll answer anyway.

So we are on a continuance resolution, and every two weeks we'll get some money to spend. But for fiscal year '03, we have budget to start the framework. So it is ranked high among the budget activity, and it is going to be funded once we get our full allotment of funds.

CO-CHAIRMAN FORD: Now, what is the timing on that, bearing in mind it's the baseline for all of your subsequent prioritizations? Presumably you've got a very fast objective to be met, milestone.

MR. ELTAWILA: Okay. Let me try to answer that here. I just want to make it clear to you that for light water reactor, they can be licensed and certified under existing framework. So they don't have to wait for the new framework to get certification.

Now, we are talking now about gas core reactor and other non-light water reactor. So the time frame for that is definitely much more relaxed than when Exelon was in the figure and tried to certify the PBMR.

All indication then we're getting from G.E. and from the PBMR, Limited, indicate that their time horizon is on the order for early 2007 to 2010. So we're really going to provide, develop that framework not on accelerated time frame like we were thinking before, but it's going to be continuously developed, but will not get this accelerated --

CO-CHAIRMAN FORD: I'm concerned that some of the technical problems which were based on the framework -- this is for the gas cooled reactors -- will take some time, and even though they commercially may want to go on line in 2010, they've got to be doing the technical work now.

MR. ELTAWILA: We actually, as Stu indicated, we have identified some key issues that need a long lead time, and we're continuing working on this issue, for example, but we are limited not necessarily by resources, and I want to make that clear. We are limited by availability of fuel, for example, to run the test on.

So if I want to run tests on fuel, I have to have the table's fuel or GA fuel to be able to run the test. That's one limitation.

The second limitation is that NRC will not be able to fund this fuel testing alone. So we have to rely on DOE, and DOE has a plan right now. We are continuously interacting with them. So if DOE cannot run the test, they will not be deployed. So we are not really going to be behind the schedule in this case, you know.

So as far as the fuel is concerned, I think we are in good shape because, again, they are not going to deploy until DOE performs the test for this new type of fuel.

There are other issues like material issue and graphite issue, and I think Joe Muscara, if he wants to add something, we are working in this area.

So the critical issues we are working on, and in some cases we are relying in cooperative agreement and we're relying on memorandum of understanding with DOE. So we have not stopped completely, but we are not on the same pace like we were about a year ago.

MEMBER BONACA: Well, first of all, I'm kind of anxious to see what this framework will be, of course, and so that's why I'm interested in this question, but, you know, in the plan there is a clear reference to starting with some thoughts for Option 3, which makes sense.

And so there if you look at Option 3, it speaks of some apportionment quantitatively to prevention versus mitigation, and clearly there we understand how the structure is.

So I've been trying to understand who, for example, for HPGR you would go about answering those kinds of questions there, and if you need to do research on fuel and understanding fuel before you can set certain quantitative criteria there or vice versa.

I mean, that's really what I would like to understand. I mean, I don't have an expectation that you have the framework already ready, but at least a thought process to support it. It would help me if we at some point in the near future, we had just an understanding of how you're reflecting on it. At least it would give me comfort that you're thinking about it if you're not working on it.

MR. FLACK: Oh, no, we are thinking about it. I think the work that is going on on the policy issues paper is very important because I think that's going to set the stage, and a lot is going to depend on how the Commission views those issues and how they go about doing that.

Once it passes through that process, then the question is a technical one really. Can you provide a technical basis to make this come true?

There's one thing in saying it, and the other there is demonstrating it. So I think it involves both sides, the policy as well as the technical, and they really dovetail together as you move forward.

But having said that, I don't think we need to wait for a framework document in order to do what we're doing. I think going forward with the policy issues, and it will evolve, and I think the thing will certainly get back to the ACRS many times on this, I'm sure, but it will be something that is evolutionary. It's going to need to take into consideration stakeholders' comments, and it's not holding up anything at this point in time.

We can move forward and license the plants that are coming in on the pre-application review with the process that we have in place. So it's again moving forward, and I think those are the lines on which it's moving forward.

MEMBER BONACA: Yeah. The point I'm making is that if, however, you have a well delineated process by which you're going to get to that framework, the thought process you're going to develop, and the policies issue may be the first one, in fact.

MR. FLACK: Yeah, I think that --

MEMBER BONACA: Then that may help you in prioritizing what steps you have to accomplish for different designs to bring them to a technology neutral framework.

MR. FLACK: Yes, because it will flesh it out. It will get the things out on the table, the discussions, defense in depth, and what we mean by that, and so on.

MEMBER BONACA: So the policy document will be the first --

MR. FLACK: It's going to be a major step forward in that.

MEMBER BONACA: We will have it some time this month, I understand.

MR. FLACK: Well, it's due up to the Commission in December, and we held a workshop two weeks ago. I guess it was a public workshop on it. I don't know what exactly the schedule is to come back. The full committee probably before it technically gets sent up, yeah.

MR. FLACK: John?

MR. MUSCARA: If I might follow up on

Peter's question about how are we handling the issues that have a long lead time to get a resolution, in the materials area, clearly we did get a reduction in emphasis and budget, and what we have done in this area is to essentially stretch out the program.

Originally we had a five to six year program. Now we have planned a nine to ten year program. What we are doing is addressing the issues first that we need to have answers for, for example, in designing the plans, things, for example, that have to do with fatigue life, crack initiation, those things being addressed in the earlier years.

Items having to do with problems you might expect in service, such as crack growth rates, those now being addressed in the latter part of the ten year program.

So we've had a reduction in budget. We've shifted the program, stretched it out, and addressing questions that we need answer to at the design and licensing stage, and in those areas, we will be doing work on fatigue, stress corrosion cracking and creep.

In the graphite area, we're depending a great deal on work being conducted in Europe, but we will be doing some work in that area also starting in '08.

And I guess let me mention also that we do have work ongoing to review and evaluate design codes and standards and updating those codes and standards because those are some of the things we need to have done early on in the process. So that work is ongoing right now.

CO-CHAIRMAN FORD: You don't think it's going to be ten years before you get the final results of many of these materials questions. You don't think those are going to be limiting on the commercialization of a gas cooled reactor.

MR. MUSCARA: That's correct. That's correct. I mean, those will be questions that will come up during the operation of the plants, and if there is a problem, we'll have enough time to deal with those kinds of questions.

CO-CHAIRMAN FORD: Okay. So we'll be regulating as we go, so to speak.

MR. MUSCARA: For the kinds of problems you expect in service. For the design stage, where you want to design a plant so that it does last its design period, that work gets completed by FY '06.

That is, we will have enough work done to be able to ask questions about is there an effect on the environment and fatigue. We'll have enough work done to identify the problem if it's there, and possibly not enough work to update the codes, but at least we'll have enough work done so that we can request additional information.

CO-CHAIRMAN FORD: This is not a question for you, Joe, but for other of your colleagues. It seems that many of these prioritizations and reactions to what may come down the line is forcing you to go towards a "regulate as you go" stance. Is it healthy?

MR. MUSCARA: I see this as regular as needed. I'm not sure as you go. I think we still have enough lead time to address the issue and determine whether there's a potential problem.

A lot of the questions that we have in the materials area are based on lessons learned from light water reactor, and clearly we think those may happen also in the advanced gas cooled reactors.

But there's no data to say one way or the other. So I think we're doing enough work to be able to identify the problem, determine if updates are needed, and I believe on a timely basis so that they can be addressed either in design or later on during operation.

CO-CHAIRMAN FORD: Okay. Thank you, Joe.

MR. FLACK: Also, if I can just add to the comment, I guess the feedback that we get from operating plants is very important in making decisions, and so as we regulate, we try to raise the questions up front obviously to try to get as many answers and get things nailed down as much as you can, but then feedback as the plant operates is important to validate and confirm what our expectations are.

So I wouldn't necessarily call it regulate as we go, but certainly take regulatory action as we need, if it's not consistent with, you know, what's up front. But it's very important not to underestimate the need to get these questions and answers as best we can up front, I mean, certainly.

CO-CHAIRMAN FORD: Well, do any of my colleagues? I mean, Jack, you are intimately involved in some of the start-ups of the current light water reactor fleet. Does it not worry you? It doesn't?

MEMBER SIEBER: No. I think that's been the past practice for some time now or at least some version of it, and I think that we've managed to address problems.

MEMBER ROSEN: Peter, it does worry me. I guess the history of light water reactor development is the key to understanding why I'm worried. We spent literally the 40 year period from, say, 1960 to the year 2000 working on materials problems that showed up during operation.

Now, if you don't learn from the past, I guess you're doomed to repeat it. So I didn't make that saying up, by the way.

So here we are about to design, license, and build and operate a whole new family of reactors and find out what's wrong with them. You know, we'll do enough work to license them and then deal with the licensing issues.

But we never seem to find the resolve to do enough work to find out, get a handle on what the operating issues might be at a time before we actually operate them, and that's troubling.

And I guess there's a Catch-22 involved in the thought process. You can't know what you don't know about operating until you operate, but I wish there was a way that somebody could come along and cut that knot and help us with it because otherwise you just -- the operator of the plants have potentially the same sort of fate in front of them as the ones that ran the light water reactors for the last 30 or 40 years.

MR. FLACK: Well, there's no question about that concern, but I think the whole concept of trying to look at the infrastructure, what we're doing now, and trying to find out where the gaps are and what questions to ask is really trying to get at that. Be prepared; ask the right questions. What are the areas that are dominating as being the things of the highest uncertainty? What are the risk implications?

All of these questions are the things we're struggling with as we go right now with this infrastructure, and that's why I think it's very important to lay that out now in some systematic way, identifying where we need to focus our resources so that we don't end up with surprises later on.

And it's not an easy thing to do, believe me. It's a challenging top, you know, as you could see in the size of the document. There are just a lot of things, a lot of areas to consider.

MEMBER BONACA: You need to limit yourself to safety issues. That's a possibility.

MR. FLACK: Well, certainly.

MEMBER BONACA: Well, I mean, some of the experience we've had, it's a learning experience, and you know, some of the issues were not of a safety nature. They were really more of an operability nature of the components and the cost to the licensee.

So the burden is heavy on designers for

these.

MR. FLACK: That's right.

MEMBER ROSEN: Yeah, I think you're right, Mario, that what we saw during the light water framework that we just lived through was a whole slew of things evince themselves as operability or reliability issues rather than safety, direct safety issues.

The trouble with that thinking though is that as plants struggle to deal with the operability and reliability issues, they get diverted, and there's a lot of attention paid to those kinds of operability and reliability issues to the detriment of a broader view.

And so I think it's important to create a framework for the new operators of these plants that doesn't have so much distraction in it. I don't know how to do it, but, Peter, you invited questions about who was troubled by it, and I certainly am.

MEMBER LEITCH: And I'd like to add my voice to those that are troubled. You know, when you see the struggle that it has been to remediate some of the existing fleet by changing out materials and applying different chemistry methods, not to mention the cost and radiation exposure to make some of those modifications, it certainly argues against waiting for operation to reveal problems if, in fact, those problems could have been foreseen and revealed in the design phase.

MEMBER SIEBER: I think one of the things that in the past -- and I guess I'm old enough to have lived through that -- the practice years and years ago was to build prototype reactors. The Navy did it. The first commercial reactor was a prototype, had oodles of margin.

And so the safety challenges really weren't there, and the plants were docile. And what people were trying to find out was were pumps adequate; were the flow adequate, you know; can you control the plant; how stable is it?

And you know, obviously the anticipated transience and severe accidents have enough margin to take care of it.

Where the industry began to get in trouble with this, when they would take -- the vendors would say, "Well, I can sell more megawatts in the same package," and so the temperatures went up. The pressures went up. The linear heat flux went up. The fuel design became more sophisticated, and the operators now spent a lot of time worrying about margin, scratching their head in the materials, whether it's a new plant or an old plant, a prototype plant or not. The materials are always out there, and the very minute you fabricate them, they begin to corrode, right?

You know, it's like the day you're born is the day you start to die, and so those problems are always with us.

On the other hand, I think it's a mistake if anybody thinks that they're going to take a new concept of a plant and build a plant with very high productivity and capacity and very little margin and get it right the first time.

And I think you have to take that into account when you do your research, and you need a little extra margin for those things where the uncertainty is a little higher than you would like for it to be.

And so having lived through that process, and I, frankly, enjoyed the process because I learned an awful lot about plants without having so many of the production headaches that plague current day operators. It was sort of fun.

I think that's a way for an industry to grow. I'm not sure that the industry can afford to grow that way now, and the engineering and research tools are much better now.

And so maybe we can skip part of that step and not be so timid. On the other hand, I think that we need like the pebble bed concept some kind of a prototype out there where we can do a little learning. And so that's the basis for my conclusion.

CO-CHAIRMAN FORD: John, if you take those comments, and Mario's comment about, well, let's try and keep the proactive work to safety related items, about a year ago Dana Powers reported on the pebble bed and, by extension, the gas cooled turbine reactor with some fairly severe safety related comments, which are physics based insuperable in terms of the instability of the core, in terms of defense in depth because of the asymmetry of some of the pebbles.

Have those been addressed?

MR. FLACK: Well, they're in the plan. The plan, you know, reflects those areas that he was concerned about. It's work that needs to be done. So --

CO-CHAIRMAN FORD: These are fundamental safety related, you know, physics insuperable problems. Should they not be, therefore, if you take Mario's argument, that they should be done now? They should be examined right now?

MR. FLACK: Well,l yeah. The PIRT process is really the process by which to determine, you know, the significance of these issues, and we're going through that exercise right now. We had the fuels, for example, PIRT just recently that took place.

CO-CHAIRMAN FORD: And was that discussed, those items?

MR. FLACK: Well, I --

MR. RUBIN: Let me just give you an example. My recollection is one of the issues that Dana had was the effective air ingress into the core and whether or not that would lead to fuel failures to a level that would be well beyond what we would find acceptable.

And the PIRT process that we went through last week got into the phenomena that affects fuel oxidation, including the oxidation rates on the graphite, the matrix material on the various layers, whether they're phenomena of temperature, fluance, burn-up, et cetera, to try to really understand the phenomena at its most basic level and then to build up what the data needs are and what the modeling needs are to truly analyze what would be expected to happen under, let's say, a worse case air intrusion and beyond that worst case.

So that in our plan, and we started with the first step last week of developing those detailed phenomena that play into that concern.

CO-CHAIRMAN KRESS: The strategy we heard before on air ingression accidents was twofold: one, to determine the actual frequency to be very low so that on a risk basis it's a low frequency event and high consequence, but the product may be acceptable.

The other was that the amount of air available for this interaction could be limited so that it could be oxygen limited in terms of the total amount of oxidation you would go through, and that would limit the amount of material interacting and the amount of release.

Are those still on the table as strategies to go with air ingression accidents?

MR. RUBIN: Yes. In fact, at the PIRT, we got a presentation by INEEL of some preliminary studies that they've done for various volumes of air that would be available in an accident and see what level of oxidation and fuel failures that you would see for those, and clearly if there was an unlimited amount of air to temperatures that we might predict for a large break, things do get serious, and that has to be, I guess, weighed against the probability that we would result in that amount of air because you start out with a volume that is the confinement space, and that's not infinite. That's far short of infinite, but you need to think about how you can get some air replenishment through holes, so to speak, in the confinement space and whether or not those holes can be plugged by human actions, et cetera.

CO-CHAIRMAN KRESS: I guess, and this is an ancillary question, is NRC going to put that on the agenda as a design basis accident or would it be beyond the design basis? And do you have some criteria for evaluating --

MR. FLACK: Well, I think, you know, the whole concept of design basis itself is now, you know, considered to be licensing basis and what do we mean by that and so on, is under discussion.

CO-CHAIRMAN KRESS: It's all under discussion.

MR. FLACK: Yeah.

MR. RUBIN: The PBMR and GTMHR have presented a licensing approach, not to start from a new framework for regulation, but a licensing approach which one would eventually plot for various scenarios consequences versus probability, and you've seen those plots, and there are limits for various probabilities in terms of dose limits, let's say.

And one of those data points is air intrusion, and what amount of air for that air intrusion. And one has to reflect upon where that probability is for that level of air for an air intrusion event, and make some decisions on whether or not that needs to be considered in the licensing basis.

But we don't have enough information on the consequence models and the PRA models to think much more at this point.

CO-CHAIRMAN KRESS: Yeah. What concerns me there is that the natural tendency is to use the prompt fatality safety goal as a top level criteria for deciding, and I think that would be a mistake.

And the reason I think that is in our ingression accident, it leads to consequences that are far beyond prompt fatalities in terms of land contamination and how far it goes and latent cancers.

MR. FLACK: Right, right, sure.

CO-CHAIRMAN KRESS: So I hope we don't get stuck on the LERF prompt fatality safety goal as the driving force for this.

MR. FLACK: Well, that's one of the things we'll be looking at as part of the framework development, sure.

MEMBER ROSEN: This discussion also raises in my mind one other nuance, and that is that we always think or I always thought of confinement and containment as functions of a device to keep things from getting out.

Now we're talking about a containment or confinement which has two functions. It's multi-functioned. It's intended to keep radioactive releases from getting out, but it's also intended from keeping air from getting in.

MR. RUBIN: That's true.

MEMBER ROSEN: And those two functions may be contradictory in some designs that I could envision and might create quite a challenge to designers.

CO-CHAIRMAN FORD: John, I'm looking at the time here.

MR. FLACK: Yeah, I know. I am, too.

CO-CHAIRMAN FORD: How are you going to fare under the time needed?

MR. FLACK: Yeah. What I suggest is we'll skip the next three viewgraphs, if I can. They really talk about the SECY paper, which is really the subject that we've been talking about here. I don't see anything new on these viewgraphs that would --

MEMBER LEITCH: John, I just have one question before you leave the framework. If today I'm trying to license an advanced light water reactor, the present licensing is still applicable and would be adequate for licensing an advanced light water reactor. But if I was coming forward with a plan, I might be confused by or I might tend to defer that action pending a new framework being developed, a new risk informed framework being developed.

So I guess I could see a real decision point here, whether to license a new advanced light water reactor with the existing framework or wait for this new framework document, which seems to be quite some time off.

And I guess basically my question is: have we thought about need this document be technology neutral or could it be for light water reactors and another one later for gas reactors?

MR. FLACK: Well, I think that's what this one is really seeking. The work is really focused on the non-light water reactors, the reactors that are not in the immediate future, but ones that relate to the policy issues that are currently now or that will be before the Commission at the end of the year, which are the non-light water reactor policy issues, the containment, the confinement, and that sort of thing.

But there is always spinoff. I mean, it comes down to efficiency and effectiveness of the regulatory process, and that's really what you want, an effective and efficient process.

So what can be capitalized on, the development of this framework even though it may be years from now before it's complete, I would expect there will be spinoff that could be used currently, but I wouldn't necessarily wait for that because I think the process is in place now that can be used to license and certify the design.

So if there is something that comes along that connects the process, certainly we'll take advantage of that.

MEMBER LEITCH: Thank you.

MR. FLACK: Okay.

MEMBER RANSOM: John, I have just one quick question.

MR. FLACK: Sure.

MEMBER RANSOM: On your next slide there, commission paper?

MR. FLACK: Yes.

MEMBER RANSOM: What is that?

MR. FLACK: Oh, the transmittal of this document that you've reviewed is to the Commission. The paper that I talk about on those viewgraphs is just a summary of what's in there, and --

CO-CHAIRMAN KRESS: That's why we call it the Tom King paper?

MR. FLACK: No, no, this is not Tom King's. This is the infrastructure assessment paper. It's two papers.

CO-CHAIRMAN FORD: It's a formal transmission of what we --

MR. FLACK: That's right. The formal transmission of the larger document. There's four attachments to the SECY. The one is the thick document which you've been reviewing. Two of the attachments, one is on ESBWR and ACR-700 that Steve is about to go through with you, and then there's a fourth attachment which lists the activities for FY '03.

MEMBER SIEBER: Would you tell us what the SECY number is?

MR. FLACK: Oh, it's to be --

MEMBER SIEBER: You don't have it yet?

MR. FLACK: Not yet. Right, it's on its way up.

CO-CHAIRMAN FORD: Is this essentially the draft letter?

MR. FLACK: Pre-decisional, yes. That's right.

CO-CHAIRMAN FORD: But essentially that?

MR. FLACK: That's it, yes. It hasn't changed very much at all from what you're seeing.

Okay. AT this point in time, Steve, I'll turn it over to you.

MR. BAJOREK: Thank you, John.

MR. FLACK: Do you want to use this or that?

MR. BAJOREK: No, I'm going to try to use high tech.

MEMBER WALLIS: Why did you pick Steve to make this technical presentation?

(Laughter.)

MEMBER WALLIS: No, I mean, seriously. Why are the only technical presentations which we're getting today having to do with thermal hydraulics? I wold think the hydraulics is in good shape because we got all of this work over the decades, and the things which we need to worry about are the things which are not in good shape, and we just hear generalities about them.

But I just have this strange question. Why is it, you know? Why did you pick to only present thermal hydraulics today in terms of any detail?

MR. FLACK: Well, it was the additions to the plan that we wanted to come to the committee with since you had seen much of it before.

MEMBER WALLIS: Maybe they're the only ones where there's anything concrete going on.

CO-CHAIRMAN FORD: They'll be covered in Appendix 4.

MEMBER WALLIS: Okay. Well, I'm grasping for the right question, but you know, that's what puzzles me.

MR. FLACK: I'm grasping for the right answer, but we were here to brief you on what has been an edit to the plan in our thinking, and things have changed since we started with what was very heavily focused on HTGR and now is shifting to light water reactors because of the immediate need.

And Steve was going to go over those additions to the plan.

MEMBER WALLIS: Just the immediate need, which is why we're here.

MR. FLACK: Which is the pre-applications.

MR. BAJOREK: And kind of in reference to that, too, I'm not going to try to talk just only about thermal hydraulics, but also about some of the fuel issues and also to cover some of the severe accident issues as well.

All right. Well, good morning. One of the things that I would like to at least let you know at this point, I'm going to try to focus most of what I'm going to talk about on ESBWR and the SWR-1000. I can talk about AP1000, those issues if you'd like. I've got some presentation material on that, but I really want to try to focus on some of the new designs, those two in particular.

It really wasn't until, I guess, the advance reactor's research plan was completed in about April. The ink was almost dry when we got four new applications very quickly over the course of the summer. ESBWR, we began talking with General Electric in the beginning. I guess it was around June. They have put in an application now for precertification. They submitted a lot of their documentation, but not all of it at the end of August, the beginning of September. We've begun to take a look at that.

SWR-1000, another passive BWR was submitted also for precertification review. We don't have the documentation on that, but we've had a couple of presentations from Framatome. We've looked at that design. We see a lot of issues and things that we would want to take a look at that are very much related to ESBWR.

More recently we've begun to take a look at I'll call it the advanced CANDU, but the ACR-700 light water cooled, but heavy water moderated CANDU type of reactor, and most recently Westinghouse came in, gave us a presentation I guess it was in the beginning of October talking about the IRIS design.

So over the course of the last two or three months, we've begun to try to reassess our infrastructure. What experimental data might we need to obtain? What code development might we need to entertain here over the next, two, three, four years looking further downstream so that when we have to support NRR and when we have to make decisions for severe accidents and perhaps even fuel related issues, we can start to develop those tools now and have them ready when these four units get into the design certification phase.

AP1000, we think we know what the issues are. They've been on the table now for several months at least, and we have programs ongoing to try to resolve those issues, but it's these newer applications where we have the most concern.

What I would like to do this morning is talk about ESBWR, highlight what are the design changes, the design differences between SBWR and other boiling water reactors that we need to concern ourselves with. Likewise, the same for ACR-700, and try to highlight what are those areas where we think we're going to need code development and potentially more data.

We've tried to address this I would say in sort of a PIRT type thought process. In looking at these designs, and we have to admit that we don't have all of the documentation, and in some cases the design isn't complete, but what are those physical processes which are going to be the most dominant ones that we're going to have to address ourselves with when it comes to the kinetics, the fuel design, thermal hydraulics, and the severe accident issues?

Now, in getting into discussions with NRR and other researchers in thermal hydraulics, severe issues, fuel, it kind of comes up, well, why should you have any research related issues for these newer reactors.

We've been dealing with BWRs, PWRs for 30, 40 years. We've got codes that have been approved for looking at numerous issues here. I'd like to throw out four reasons why we think there is going to be additional work necessary.

First of all, most of these units are essentially driven by passive safety systems. These rely on natural circulation, low driving heads, relatively low flow rates from some reservoir of liquid into a vessel that's partially voided. Regardless of what code you use, one of these codes don't like to do nothing.

They operate better with large driving heads, more of a large break type of scenario when we're trying to analyze problems where the delta Ps around the loop are very small. We find ourselves in the situation that these codes can be very divergent and give us a very wide range of answers if we're off in one of those components, be it the friction, the interfacial drag, the gravitational head that we might expect.

So trying to analyze these very low flow rates and natural circulation leads to relatively high uncertainties.

MEMBER ROSEN: Let me ask you a question about that particular point. Is that uncertainty a function of the codes or of the phenomenon?

MR. BAJOREK: To cover it, I think I'd probably like to say both because I think there are some of those processes which have relatively large uncertainties. So even if I have a code that is perfect and I know how to analyze and model a particular system, those uncertainties can lead to large differences in answers because these transients proceed over hundreds of thousands of seconds.

A small uncertainty in a thermal hydraulic model can propagate in time, okay, and lead to, you know, a large uncertainty in whether it's core uncovery (phonetic), pressure in the containment, you know, a large uncertainty in one of those critical parameters that you're trying to assess.

The other thing that you see time and time again is if you take someone and you have them do a calculation with RELAP. You have someone else do a calculation with COBRA/TRAC. We'll take someone else and have them do a TRAC evaluation. The same problem, the same boundary conditions.

The one thing you can assure yourself, you're going to have three different answers. So I think, yes, the processes themselves, the uncertainty in the models lead to confusion and issues here, but also the fact that we're looking at using computer codes by differing organizations for new systems. That also can lead to uncertainties in what your answer is going to be.

MEMBER ROSEN: But you understand my question is that no matter how good the code is, if the friction factor you're using for a piping system turns out actually to be different than what you thought it was or maybe it varies, maybe it's time variant during a long transient because of some surface phenomena that occur, that without the driving heads of these big displacements, you know, pumping systems, these kinds of small changes which would normally be swapped by the kind of safety systems we've operated in the past, become important in the actual phenomena.

MEMBER SIEBER: In other words, what you're saying is could Plant A, which is supposed to be identical to Plant B, act differently because it has more corrosion build-up or some subtle feature is slightly different?

MEMBER ROSEN: Yes, that's what I'm saying.

MEMBER SIEBER: Yeah, I think that's a real possibility.

MEMBER ROSEN: I'm also saying that Plant

A, if it had the accident five years after operation, would be different than Plant A if it had the accident in the first year.

MEMBER SIEBER: Yeah, and I'm not sure how you deal with that analytically, but I would like to hear.

MEMBER WALLIS: Well, on this passive safety feature, the world has been told for several years now that passive is better. This is a real advance in nuclear safety because we've gone away from these accumulators and pumps and things that drive flows and now we have nature doing it, and that's better.

So now you're changing the tune and saying it may be worse.

MR. BAJOREK: No, not necessarily saying it's worse.

MEMBER WALLIS: Well, there are more uncertainties associated with it.

MR. BAJOREK: The difficulty in analyzing the transient --

MEMBER WALLIS: Well, that's a bad feature. That's a bad feature of a design if you can't analyze it accurately.

MR. BAJOREK: It's more difficult to

analyze.

MEMBER WALLIS: Not sure which way the flows are going and things. That doesn't sound like a good design.

MR. BAJOREK: But I think the focus is changing, however, rather than -- and that's why I wanted to throw the other bullet up here -- is because these traditional accident scenarios that we have been looking at for traditional reactor systems are also changing.

Yes, they're a stronger function of these smaller driving heads and smaller uncertainty in the friction factors and things like that.

MEMBER WALLIS: No, no. I don't think. Is it really so? I mean, if you've got a big tank up here of water and you've got a reactor down here, gravity is going to pull the water from here into here. Now, it's not going to go the other way. So there are some simple reasons why this passive design is good.

MR. BAJOREK: Yes. I think in all of these designs the question has gone away from how high the temperatures will get in your hot assembly to whether you would have core uncovery and what might be the depth of that core uncovery.

So I think that, yes, they're clearly safer and they have more margin than the earlier designs, but assuring our answers have become more difficult because we're looking at different scenarios, and we're looking at processes that we haven't focused on over the last 20 years in our research programs.

MEMBER RANSOM: Just one clarification. It's my opinion though the uncertainty is not in the behavior of the plant, but in the ability to model that behavior.

MR. BAJOREK: Okay.

MR. FLACK: One might almost go as far as to say that the human error has now shifted from the operational side of the plant to the design part of the plant and the ability to analyze the plant.

MR. BAJOREK: This is not so much the case for ESBWR. Maybe it somewhat applies to ACR-700, but in the case of the SWR-1000 and IRIS, we see new plant components, aspects of the plant, features of the plant that we haven't encountered before. So we know those are areas that we're going to have to sharpen our pencils on, perhaps develop some new components.

And finally, I would say it's the state of the art in boiling condensation in two stage flow. We find ourselves looking at processes that inherently have relatively high uncertainty. I think that's where we see problems in the AP1000.

We're looking at entrainment now driving the question on whether we're going to have core uncovery, how deep it is. Entrainment is inherently very difficult to try to model and analyze, and as a result, there's a high uncertainty in those correlations that are really available to us right now to put in those codes. So that's harder for us to get a handle on.

If we take a look at ESBWR, and I think the same can be said for SWR-1000, we're going to be dealing quite frequently with condensation in the presence of a noncondensable gas, another process that we didn't really have to depend on getting a good answer for for large break calculation, but now to try to come up with a quantifiable answer for many of these small break type scenarios in ESBWR and similar types of systems, we have to be able to assess how well we can get condensation heat transfer coefficients in the presence of a noncondensable gas.

And, again, another process that has a relatively large uncertainty that we have to model in a transient that has a very significant length.

MEMBER RANSOM: Steve, one comment that I'd like to have. I didn't see on your list the anomalous behavior of codes, and every code that I've seen so far, and if it's been eliminated in TRAC-MN, why, just tell me, but it's variously called water packing or, you know, phase transitions and things like this, which cause pressure perturbations that do overwhelm the driving heads of these natural circulation reactors.

And so I think that's a key issue. I don't see anything being said about that, but like I say, if it has gone away, why, just tell me

MR. BAJOREK: We won't claim that it has gone away at this point, but I guess in that case we would look at that as being almost a generic problem as part of the codes, whereas for this infrastructure assessment, we want to try to look at those things which are very peculiar or incident to the advanced reactors, but you know, that's a good point.

MEMBER RANSOM: Well, it is something that's important now, whereas in large break LOCA and some of the others, it was overwhelmed --

MR. BAJOREK: Yes.

MEMBER RANSOM: -- even though we're dealing with higher pressures, higher driving heads, and it wasn't so much of an issue.

But I k now from experience in modeling the SBWR that it hasn't gone away in RELAP-5, and I doubt if it's gone away in TRAC-M.

MR. BAJOREK: I would doubt that, too, but I think that also factors into the earlier comment on some of the user uncertainties and the assumptions on input parameters, almost the boundary conditions.

It's very small differences, okay, that either the user throws in or the code decides to toss into the mix that can cover up some of the real effects of those processes that you're trying to analyze.

What I'd like to do is kind of step through the two designs, ESBWR and then the ACR-700; just kind of point out in sort of a broad brush fashion what are some of the major differences that we see that would affect the codes and potential use of data.

Start off with the ESBWR. A couple of points that I think ought to be made is this is a relatively high power BWR system, 4,000 megawatt thermal, and you can see the comparisons to SBWR, ABWR, and the BWR-6. So we're looking at a relatively high powered core, relatively high power density. Of major significance is there's no recirculation pumps. I guess that's a good way to get rid of the jet pump types of problems, but eliminate those altogether and now it's natural circulation that derives your flow, will not only during the accident scenarios, but during normal operation as well.

Now, they compensated for this by making the vessel taller so that you have more of a driving head in the downcomer, a taller chimney. There's significantly more water in the vessel at the start of any type of a transient, more subcooled water to the vessel itself, and that extra inventory helps to make transience a bit more forgiving than what they may have been in the SWR or some of the other types of design.

The higher power is accomplished by having, you know, a lot of more fuel bundles within the core and sort of a wider, shorter core, as compared to the other systems, and of course, it's the passive safety systems.

MEMBER WALLIS: Now, the main thing that's different is the chimney. Everything else we've seen before.

MR. BAJOREK: Yes.

MEMBER WALLIS: And there are many real

questions about how a chimney will behave, particularly if there aren't many baffles in there. There will be large scale circulation patterns. Maybe the steamer will go to one side and swirl around and what comes into the separators will not be a uniform mixture and all.

That's the new thing that you ought to focus on, it seems to me. Everything else you've seen before. All of these other components have been in BWRs for a long time.

MR. BAJOREK: We've seen a lot of work in the compression pools.

MEMBER WALLIS: Yeah.

MR. BAJOREK: One of the newer features that I think Shanlai had pointed out is there is a relatively tight coupling between what goes on in the containment and the safety systems and how it affects delivery from the GDCS back to the vessel. We see that as being different.

I'm not sure we phrased it real well within the advanced reactor's research plan for ESBWR, but we are concerned with this idea of several flow loops that we have to be able to analyze accurately using, you know, code like TRAC-M.

Now, we focused at this point more on

those loops and those low driving head flow patterns that get GDCS into the vessel and drive a mixture of air and steam up through the PCC heat exchangers. We see those as perhaps being a more difficult research issue and potentially more important from the safety issue because that's how you're going to get the decay heat out of this system over the long term.

So that has kind of been maybe the highest of the highs.

MEMBER WALLIS: But you don't know yet. I mean, if you run -- when you've got your TRAC working and you run it, it may be that you show that this is a very robust system. You can put in all kinds of assumptions about entrainments and whatever, interface friction and so on, and it doesn't matter. Gravity brings everything into the right place.

It may be that it isn't a problem. We don't know yet. I think the first thing to do is get this TRAC so that it can run some simulations and do some sensitivity studies.

MR. BAJOREK: I'm going to come to that, and I want to maybe contradict a little bit what we heard earlier from NRR in terms of where we're at with TRAC-M because, in fact, we do have a fairly long list of assessments that we have been working on over the last several months. Okay? We're not as far along as we would really like, but when it comes to taking a look at processes for the ESBWR, we have been doing things like the Oak Ridge level swell experiments, modeling those. We did the G-2 level swell. We're doing Achilles right now.

We're looking at things that help us with the interfacial drag within the vessel. Now, we're still working on those. In comparison to how TRAC and RELAP would behave, TRAC-M seems to be right in there. Some tests are better; some are worse, but we're at the point where I think we'll be able to characterize how well the code is doing, and that's going to be important for looking at this inter-vessel level swell for ESBWR and ESWR-1000, but I'll talk about that a little bit later.

In terms of what we need to do in the advanced research plan, try to break this up into three larger areas. What we might need to do in terms of fuel behavior, be able to model and kinetics, thermal hydraulics, and then I'll talk about severe accident. I'll take what hopefully is the easier one first.

The ESBWR fuel, I think as we saw earlier, is going to be a GE-12 type fuel bundle design. This is the same picture that Shanlai had up there earlier. It has water rods, part length fuel rods, a number of differences in that fuel bundle that makes it a little bit different than some of the earlier designs that have been used.

Reporting in models into TRAC-M to try to account for these geometric differences, but in terms of a research issue, do we need data? Do we need significant code development?

Our answer to that is no, certainly not for ESBWR because our expectation is we don't get much core uncovery. So some of these individual features of the fuel assembly, we wouldn't expect those to matter a whole lot, and I think that is sort of backed up by G.E.'s PIRT that ranks a number of these fuel heat transfer, fuel related issues as relatively low in comparison to other issues.

I think it was pointed out earlier that, hey, wait a second. We've also gotten rid of the jet pumps, and we know that in BWRs there is a question on power stability. In our initial look at ESBWR, we flagged that as well because now we look at a shorter core, which should help, but a wider core which should make stability a little bit worse, and we're going to have to start up this plant without the benefit of the recirculation pumps to drive the flow.

You're at a little bit of the mercy of the flow starting, perhaps condensing up in the chimney region, and having a flow reversal. So we look at stability as something that we need to address.

Our initial reaction is that between what can be done with TRAC-M, TRAC-M coupled with PARCS, experimental data that we've obtained from the PUMA facility where we're running tests right now to look at stability type issues, give us a database to try to assess that.

Our preliminary assessment is that our computational tools and data are probably okay for ESBWR. We think we're at least as good for doing this plant as we are for other BWRs, not to say that there isn't any work to be done, but we think that we're on relatively good footing there.

More work to be done in the thermal hydraulic area. I point out in particular this flow loop that originates in the drywell where in the case of either a main steam line break or a LOCA we would be pushing some fraction of the noncondensable gases to hide out somewhere lower in the drywell, up through the PCC heat exchanger, developing a head of liquid that will eventually go back to the vessel, and perging the noncondensables down into the wet well.

As we've observed and we've talked with General Electric, we think it's going to be very important for us to get this correct. Okay? And we would see the need at least to do a fair amount of assessment, potentially some model development in order to be able to model condensation, the presence of noncondensable gases within this PCC heat exchanger.

There is a relatively large amount of data that's available through the PANTHERS test that G.E. has run. So we think that there's relatively good data there. We have some from other Purdue tests. There's other data out in the literature.

But we see this as being important for long-term decay heat removal because this is what's ultimately going to help recover the vessel, keep liquid inventory in the vessel, and will eventually drive what your containment pressure is during the long-term cooling.

MEMBER RANSOM: And one thing you might point out, Steve, that vent line goes down into the --

MR. BAJOREK: Yeah.

MEMBER RANSOM: It's not shown on the viewgraph very clearly.

MR. BAJOREK: Yeah. The soda straw kind of just dips down into that.

MEMBER RANSOM: That's where the noncondensables go.

MR. BAJOREK: Right, right. And also in those PANTHERS tests, this wasn't a nice, steady flow behavior. It chugged. I guess you would build up ahead before you pushed some liquid in, and the gas would purge itself periodically into the wet well.

So I think in terms of, well, gee, if we've got to get this thing right and this is something that we're going to have to start taking seriously right now in order to get the right models and the right assessments in place and identify if we need any additional data for this type of a flow loop and this type of a condensing system in order to model this appropriate for the ESBWR.

MEMBER ROSEN: You know, we have quite a bit of experience with chugging and large forces in drywell Tauruses, Tauruses and BW MARK Is, for example, and the remedies for that, including those ram's heads and diffusers and the like and the very large forces that can be imparted at least through BWR MARK I.

So are you thinking about those kinds of things here, too, or are we talking about now in process or are the forces that could be expected during these kinds of events similar to what we have calculated would be expected in MARK I events?

MR. ELTAWILA: Can I help on that? I think what you're talking about, Steve, was from the primary system. The driving force was very hot. This is a very low pressure system here. So the charging loads are not going to be as high as the one that we've seen in MARK I and MARK II design. That's why we add the -- I'm surprised that you called it ram's head. You know, that's the old -- they have quencher now, dequencher, and things like that, yeah.

So that's not the same issue. I would like to add, too, that even though that what Steve identified as an important modeling phenomena, what we've seen in the PANDA facility that, again, this is a self-correcting problem. You know, you build up enough pressure and you are going to push the noncondensable out.

So it's a modeling issue, not a phenomena that is going to affect the safety of the plant or anything. It's just how we can make our code predict that phenomena.

And again, so there are a wealth of data from the PANDA facility and to a certain extent from the PUMA facility on that.

MEMBER RANSOM: Along that line, you may be the inappropriate person to ask this question to, but sine I agree that you want to model the phenomena and understand it and that drives the research that you're doing, but the other question is: what is going to be the licensing basis for these points? You know, what are you going to look for?

The core doesn't uncover, and as long as it remains covered, you're not going to have peak clad temperature as, say, an indicator, and I'm wondering has that question been answered as to what are we looking for.

MR. BAJOREK: I think NRR would need to answer that one, but right now in the calculations that we've seen from G.E., peak cladding temperature isn't a real concern. The core stays covered. I think there is even for the GDCS line break there's still a meter of water above the top of the core.

Where I would expect them to put more attention is going to be in containment pressure. After 72 hours, the containment pressure is still within the design limit, but is relatively high, okay, and I think in earlier meetings that's been raised as something that they would want to take a look at because it doesn't meet one of the general design criteria that says that after so many hours' period of time, your pressure should be decreasing, and it doesn't seem to do that.

So I would think that it's going to be the events in containment which are going to be more of the regulatory criteria issues that will drive what's going to go on in the ESBWR.

MEMBER BONACA: The only other one I can think of is reactivity accidents, which would have to do with instability, and I don't know if that's really a concern or not.

MR. BAJOREK: That's not an area where I believe research has gotten into discussions considerably. I think that in terms of analyzing, if we're requested to look at that, I think that the TRAC-M PARKS and the data that we have from PUMA, yeah, we have a pretty good start on doing that.

But I believe that traditionally some of the frequency domain codes, the core and some of the other industry codes to try to look at stability first.

With regards to the ESBWR thermal hydraulic, the issues that we're going to pay particular attention to at this point is going to be the distribution, the effects of the noncondensable gases throughout the containment.

How they're transported through the containment, be it the PCC heat exchangers or the suppression pool, in the plan we've mentioned, well, we also have to take a look at what happens when the vacuum break. We get condensation in some parts of the accident, and the vacuum breakers let gas back into the drywell from the wet wells.

Well, looking at those, invariably it's looking at where the noncondensable gases are, what their effect are on condensation, what their effect would be as they go through suppression pool. Those are the ones that we think at this point are the most important.

We would anticipate having to improve the models in TRAC-M. That's been identified previously as an area that we think is fairly weak. We think that we're going to have to do the assessments for that.

And also we need to really get moving on the assessment of what I would call the integral tests for natural circulation. We have started some of those, looking at things like ROSA 3, FIST, GIST.

We're in the beginnings of those.

We will likely also need to continue assessment of TRAC-M for other types of tests at low pressure that involve lots of natural circulation. Maybe the OSU tests and the APEX facility, not strictly for BWR, but things that we need to do and to assess the code to insure ourselves that it's doing a good job when it's dealing with natural circulation.

And I think as Farouka pointed out, this is an assessment that needs to be done, potentially some model improvement. There's a relatively good database for condensation with a noncondensable gas. We'll look at those. We're probably in good grounds, but we don't want to rule out having to do anything else at --

MEMBER WALLIS: So there are no new phenomena. All of these phenomena have been met before. All of them are modeled in the codes one way or another.

MR. BAJOREK: Yes.

MEMBER WALLIS: What you're concerned about is how well the code represent them. So we're getting back to questions of uncertainties in the codes.

MR. BAJOREK: Yes, yes.

MR. ROSENTHAL: If I might interject, you know, before we just get into the severe accident side, typical Level 1 PRA, you drew an event tree, and you said, "Do I have my normal complement of ECCS?" And you used Chapter 15 very conservative analysis, and if you said yes, you drew a line and you said okay.

And your whole focus was on the unreliability of active components, and the uncertainty in how well you predicated your Level 1 PRA results was tied up in how well you thought that you modeled your active safety systems and the data that supported how good were these active components.

Okay. Now, with respect to Level 1, as I said, just before we get on the severe accident side, you're going to want to draw your PRA and your event trees again, and you're going to be putting in passive systems, and you may find out as you go through that that, in fact, the uncertainties in your predictions are dominated not by active component reliability, but rather by your ability to do analysis and how well do you think that you faithfully replicate what's going on in the plant?

If we are used to thinking in terms of ten to the minus three, ten to the minus four systems for active components with multiple trains, then for the same level of knowledge, we would want to know these phenomena to some degree of accuracy.

And what I'm saying is a concept that's driving us to recognize that we want to be able to do better in our analysis, in our predictions.

MEMBER WALLIS: It's not just that, but the PRA must reflect these model uncertainties because that's where the uncertainties are, and so --

MR. ROSENTHAL: And that would be a new challenge in a new area.

MEMBER WALLIS: This is a new challenge. I mean, some hydraulic models have been around for a long time, but putting some hydraulic model uncertainties into the PRA is a new task, and it seems to be what you must do because that's where all of the uncertainty is. Almost all of it is.

MR. ROSENTHAL: Well, let me just say that I think that we recognize this as an issue.

MR. BAJOREK: Okay. Let me kind of get through ESBWR severe accident issues. We've looked at that. Again, we're looking at this as having many similarities to existing BWRs.

When it comes to doing things with the MELCOR code, we don't see any tremendous needs here.

Most of these are issues that we can deal with in terms of licensing.

Now, ACR-700, okay, we think is probably going to require us to do a bit more fundamental work. This shows just some of the differences between ACR-700 and other types of CANDUs.

The interesting feature is that it's a light water cooled reactor with a heavy water moderator within the outer calandria region. It is not an entirely passive system, but requires accumulators for high pressure injection and uses pumps to supply water at low pressure to the headers, okay, to insure that you have covery of the pressure tubes during a LOCA or other accident.

This shows the pressure tube. Just to point out, there's something like 43 elements in here. The central elements are natural uranium with like a four percent dysprosium poison in them. These are two percent enriched that's surrounded by a pressure tube that has an annulus separating it from the calandria tube and the heavy water moderator in the outer region of the pressure tubes.

When we look at fuel and neutronics types of questions, we see some fairly complex modeling types of questions. We have both light water and heavy water multiple enrichments with dysprosium, which is different than what we have normally used in a code. It's a one type of moderator, a standard, uniform type enrichment. So we know that we have to do -- I'm sorry?

MEMBER SIEBER: Finish your thought and then I'll ask my question.

MR. BAJOREK: We know we have to do additional work in order to model this better and, you know, perhaps a different way than we had in the past. We're going to have to update libraries.

We have some questions on burst and) blockage of the fuel. Okay? But with regards to the kinetics issues, we see those as being tractable with effort to resolve these modeling type differences, potential for experimental data when it comes to some of the fuel performance.

MEMBER SIEBER: Yeah, I withdraw my question. You've answered it.

MR. BAJOREK: Oh. Okay. Thermal hydraulic issues, some of us have kind of talked that maybe the way of getting out of the modeling issues is to convince AECL to take this thing and stolt (phonetic) it to 90 degrees because we've kind of grown up and our codes of matured with this idea that refloods go from bottom up or town down in some cases, but they're along the lines of gravity. It's not perpendicular to it.

So modeling events that will occur laterally along this pressure tube be it the flow patterns in an aided bundle and how those patterns transitioned, what the rewet and the clinch processes will look like. Okay? If you get a dry patch, how stable will it be? What will happen when you try to flood a heated pressure tube from both ends? Will you get any water into this hot patch?

And we get on to the next one. Well, what happens when that tube starts to sag? And if you remember from that fuel bundle and that pressure tube starts to make contact with the calandria tube. We think there's a whole wealth of thermal hydraulic issues that we're going to have to deal with in order to try to model this, in addition to what's the flow distribution as we go from this bank of tubes from the header, as we're potentially draining the system and some tubes at the top are uncovered and they aren't on the bottom.

There's a lot of thermal hydraulic issues that we are identifying and we think are going to have real modeling needs and real needs for experimental data.

I think I covered this one already talking about the heat transfer between this pressure tube and the calandria tube as the bundle heats up an this tube sags and begins to make contact with this or potentially fails the calandria tube, and I'll let the kinetics people worry about what happens when you mix the light water and the heavy water and you have to worry about reactivity insertions.

MEMBER SIEBER: Maybe I'll go back to my older question.

MR. BAJOREK: Ut-oh. I haven't answered it, I guess.

MEMBER SIEBER: When you manufacture something like this combination of pressure tube and calandria tube, I would guess that unless you only made one of them that they wouldn't be concentric necessarily, and because that gas annulus is so narrow, I would think that that variability would have a big effect on what the heat transfer characteristics are, and in addition, in an accident condition, it's changing over time.

MR. BAJOREK: Yeah.

MEMBER SIEBER: How do you deal with something like that?

MR. BAJOREK: You don't know right now. That's one of the things that we're going to have to deal with, and it's clear from some of the things that we've seen from AECL that that has been a problem in their --

MEMBER SIEBER: It's an issue.

MR. BAJOREK: It's an issue because where do they put the spacers, and there's been a lot of work on that.

MEMBER SIEBER: I would think that depending on what that geometry really is would determine what the heat output and the temperature of the fuel assembly would be, and that would have a fairly good uncertainty unless you have a lot of margin.

And it's not clear to me how you would model that.

MR. BAJOREK: We agree. I think there's a lot of questions, and with the ACR-700, we don't have any documentation on that yet. It hasn't been submitted as part of the design certification. This is based on workshop and handouts. We're trying to formulate where we're at and where we're going to go.

MEMBER WALLIS: It seems to me --

MEMBER SIEBER: Did they not have a

damaged fuel assembly in one of those reactors at one time where they might have observed what the behavior was?

MR. BAJOREK: I thought they had, but I'm -- I'm reaching because I remember cracking has been a problem on these.

MEMBER SIEBER: Well, that was a different problem. This was earlier than that. Well, my memory isn't that great.

MEMBER WALLIS: Well, there are so many questions with this ACR-700 which you're not prepared that it seems to me that you may simply have to say we can't make decisions about it, and therefore, we won't accept applications because we're burdened with all of this other work on these other reactors. It would take too long, too much effort to come up to speed on all of these questions that you've raised here. So we won't ever consider it.

MR. BAJOREK: Right now we have with we have, and I think as far as decisions on how to proceed at this point, it's going to have to be up to the management.

MR. FLACK: Yeah, I think it's important to realize that we are in the space of just trying to be proactive and trying to understand what's coming.

It hasn't come yet and so we're really -- we don't know how significant these things will play out until we learn more about the plant, but again, we haven't really entered into pre-application review. Hopefully we'll get a lot of these answers as we move along.

MR. BAJOREK: I guess our point is compared to ESBWR or AP1000 things, we think there are a lot of significant questions and a lot of work that's still going to have to be entertained.

MEMBER WALLIS: But the assumption seems to be made at the beginning that you're going to do enough research to be able to answer all of the questions about all of these reactors coming along, and it probably will turn out that you can't do that.

MR. FLACK: Well, not us as an agency, but I think us as relying on the bigger picture of all the work that's going on, and we're still trying to figure out where all of that lies.

So there will be a trip to Chalk River coming up in December. We'll be looking at what has been done, and certainly we want to get the answers to the questions, but the burden is always on the licensee, the applicant, to come forth, and then it's up to us look at that and see what other questions we have.

But we're still at a very preliminary stage, and we're again trying to be proactive, think ahead, put in where we are today, and as Steve mentioned, we haven't really looked at the plant itself yet.

So at this point there is uncertainty.

MR. BAJOREK: We see some of that with the thermal hydraulics. I mean, a number of issues and problems.

When it comes to severe accidents, the situation or the issues may actually even become more difficult because our initial read of the database, the modeling that has been gone on previously is that there hasn't been a tremendous amount of that due to the way that this reactor has been regulated in Canada.

And we would, again, anticipate a relatively robust need to address severe accident issues, such as the pressure tube/calandria tube failure, how you get fuel failure and melt progression in a horizontal core as opposed to a vertically oriented core, how you fail this calandria in the outer shield tank.

We don't see a whole lot of information. We see very little in the way of test data available even to the designers at this point. We think at this point it's prudent for us to say that if we're going to be the ones to be relied upon to come up with credible auditing tools, we have a difficult task ahead of us.

I think I basically said that.

MEMBER RANSOM: Steve do you k now if AECL has any severe accident codes for modeling CANDU?

MR. BAJOREK: I've talked to a few people on that, and I think their general consensus is no.

MR. SNELL: Yeah, I'd like to correct that. We have adapted the map code for severe accidents.

Oh, sorry. Identify yourself. Victor Snell for ACL.

We have adapted the map code for CANDU. It's been copied with the Canadian utilities, and that's our severe accident tool with them.

MR. BAJOREK: I just want to summarize some of the work that has been ongoing to try to look at these two reactors in addition to some of the others. As John has noted, there's been work to try to develop advanced research plans for ESBWR and for the ACR-700.

We haven't started work on the SWR-1000 or

IRIS at this point, but would anticipate that would be done some time in the future.

The work that's ongoing that gives us a little bit of a head start on some of these, as Shanlai pointed out, and I think I hope I emphasized earlier, we see a very tight coupling between what goes on in the ESBWR containment and what goes on within the primary vessel.

We've recently coupled TRAC-M and the contain code to give us a tool that will be able to exercise and try to look at uncertainties, how uncertainties in containment affect the vessel and vice versa.

In our developmental assessment, we've given all of the BWR related assessments a higher priority now. We've sort of shifted what we're doing, and it started things like the ROSA III, the GIST, the FIST, a number of component assessments in order to try to get TRAC-M qualified for BWR applications, maybe a little bit ahead of where we would want to be for PWRs.

With respect to the ACR-700, we're in the process of resurrecting and identifying work that has been done previously by the staff, more so in the case of the CANDU. There was some work done by INEEL that identified what models they would recommend changing in TRAC-M, what was the database that was acceptable back then for some of these processes, some of which are the same.

They've identified code changes. We also have a partnership with some of the Korean organizations who have also looked at or have been analyzing the CANDU reactors. So we've had some preliminary discussions with them on looking at some of their work that might be useful to assessing the ACR-700.

To summarize, I think it's pretty safe to say that there's been a lot of renewed activity now in these advanced light water reactors. As John pointed out, we don't have all of the documentation yet. We're still waiting for a great bulk of that, but our goal is to try to look at the physical processes, where we're at in our ability to model and assess those things which are going to have the highest uncertainties, and start to formulate plans that will lead eventually to code modifications or possibly to experimental programs.

Thanks.

MR. FLACK: Okay. We're just about on schedule.

There's two more viewgraphs actually to go through. This one is to just go quickly over what we're planning to do in '03, and that was an attachment. It's actually an attachment to the paper, and basically there's three things we're trying to achieve.

One is to expand our current capability. That's pretty much in the codes, the TRAC that you've heard about and MELCOR and also establish cooperative agreements in various areas, primarily in the fuels analysis area, where it's very costly to do this work ourselves, and as well in the materials area, analysis area, where we're looking at the codes and standards that are out there and reviewing them and revising them and also seeking cooperative agreements.

Framework we talked about and PRA, as far as PRA and its application to advanced designs, looking for data and experience is out there that we can use to better be able to quantify risk for those types of plants.

And in the structural analysis area, we're also looking at codes. The seismic -- updating seismic curves and looking at what we can gain from cooperative agreements with Japan is one area that has done some work on modular concepts and designs.

So were there any other questions on that? Yes.

CO-CHAIRMAN FORD: In your Attachment 4, you give lots of subsets for these framework analysis, et cetera. Were those subsets derived by the formal PIRT activity that you outline in the infrastructure assessment plan?

MR. FLACK: I would say most of the subset, the actual subsets come from further development of our infrastructure and asking questions and trying to understand what's out there and capitalizing, leveraging on what else is going on in the world today.

It's not so much comparing one against the other, but recognizing the domain, the spectrum of areas that need to be worked, and from that, again, trying to not actually jump inside doing work in one area, but trying to capitalize on what work has already been done in these areas. So --

CO-CHAIRMAN FORD: But you're capitalizing on the low cost tasks.

MR. FLACK: That's basically it, trying to take advantage, trying to understand what the status and advances that have been made and where do we need to go from there.

So I would say this fiscal year, again, is still trying to establish a vision and building on what already has been done.

CO-CHAIRMAN FORD: But you're no longer confined to the statement about fiscal year '03 to '06. It's no longer a five year plan.

MR. FLACK: No. It's pretty much this document will be revisited again in the next year and revised based on what we know and what we need to know, and so it's a living document, and it projects as far out as we can in that regards.

CO-CHAIRMAN FORD: So it's a rolling plan with input of the technical challenges as given in the infrastructure assessment, and it's a rolling plan as to how you implement that.

MR. FLACK: Yeah, the plan is the broader picture, and that involves resources and where you're going to put them and prioritize them. The infrastructure assessment is really an assessment of our needs, where the issues are, technical challenges, what's out there and where we need to go.

So there's these two parts of it, and the one, the piece about what we actually will be doing is the prioritization process, and that plays out against other things that are going on in the office.

So it's not in the sense of, you know, here's what we need over the next five years and we'll do this in fiscal year '02, '03, '04, '05, and '06. It's to continuously revisit this based on new information as information becomes available, and prioritizing the work as we see it against other work that's going on.

CO-CHAIRMAN FORD: So it's very unlike a structured program that you'd have in many other organizations.

MR. FLACK: I think because it's so far reaching it's difficult to just establish and know all that needs to be known to write something down that's very structured. It's more flexibility there in making decisions as we go and as needs arise and as we can capitalize on things.

And, again, in the sense of infrastructure is one thing, and then how we apply that to a particular plant will depend on how much is available from the applicant. So the more that we can understand and gain from the applicant, the less we'll need to do, but the more that we see that we have outstanding questions that that time will require us to do more.

So it's not clear exactly where that line is drawn at this point. There's always a gray area when it comes down to --

CO-CHAIRMAN FORD: I'm trying to struggle to get away from the uncomfortable feeling that this whole PIRT program is driven entirely by resources, dollars and manpower, as opposed to safety.

Now, is that an unfair statement?

MR. FLACK: Well, I think as far as the PIRT is concerned, the issue is safety, and it's how you prioritize your work. The phenomena that's important will depend on its implication with respect to safety. So within the PIRT process, I think it's intrinsic to the process that safety is foremost.

MR. ELTAWILA: Can I? I really think there is a confusion here about the PIRT. The PIRT process applies only to certain phenomena. A thermal hydraulic code, try to identify the phenomena, and among these phenomena say which is the most important one that drive the risk or influence the behavior of the plant, and from that you try to develop your data and analysis tool.

So that's related to the structure of our database and our codes and things like that, and that's the only use of the PIRT.

The way we project is we use the -- I

forgot the acronym PPM, PM something, you know, but you look at they are measured against the performance goal of the agency, and the performance goal of the agency, the first one of them is maintaining safety.

So you try to look for each of these activities. The work that we are doing for ESPWR or ACR-700, how is it used to address these four performance goals: maintaining security (phonetic), reducing unnecessary burden, and all this stuff?

And that's how we come up with the prioritization to allocate the money.

In addition to that, there is another layer built on that, is the long lead time, you know. For example, you know that your fuel testing is going to take ten years before you get results. So after even you go through all of these processes, you will go further and say do I need this work in a year or two years or five years, and this or that I will look at the resources.

CO-CHAIRMAN FORD: So that comes into the thought process.

MR. ELTAWILA: That's correct.

CO-CHAIRMAN FORD: So if I look at this list here that Graham and myself were looking at and trying to work out where it fitted into what we've heard today, it will all be done in fiscal year '03.

MR. FLACK: Well, no, I don't think it's to say that it'll all be done. At least it will be initiated.

CO-CHAIRMAN FORD: Oh, okay. All right. It will all be initiated in '03.

MR. FLACK: Yes, right. That is correct.

MEMBER WALLIS: Now, I asked a question earlier about why was Steve presenting to us.

MR. ELTAWILA: We know that you think the thermal hydraulic is the center of the universe.

MEMBER WALLIS: No, no, no.

MR. ELTAWILA: So we try to please you.

(Laughter.)

MEMBER WALLIS: No, no. That's not the case. I mean, I'm trying the various hypotheses I have. One is that --

MR. FLACK: It's the area that needs the most work.

MEMBER WALLIS: Yes. Steve is the only person who has really thought about what needs to be done, and in these other areas it hasn't been done, or the other one is that these other areas are in such tremendously great shape, and Steve is the one who needs some help from us. So you put him in front of them.

(Laughter.)

MEMBER WALLIS: Is it true that if we had heard something from the fuels analysis people, like what Steve presented, it would have been something very close to the kind of presentation he gave?

MR. ELTAWILA: Well, there are no new fuel issues for ESPWR and ACR-700.

MEMBER WALLIS: Yeah, but there are for the --

MR. ELTAWILA: Because we can identify --

MEMBER WALLIS: But it is all fuel.

MR. FLACK: Right. We came down I guess it was in July and we spent a day with the subcommittee to talk about the different areas. Of course, fuel was one of them that we discussed, but you know, within that time frame. We spent a number of hours I think while Stu was given that presentation, and then also as one on materials.

Materials is also equally important, and there is a piece on ACR-700 that's in the plan on materials. So there are areas in there which we just don't have the time to cover today, which could easily be covered -- well, it wouldn't easily be covered, but could be covered in subcommittees at the very --

MEMBER WALLIS: Do you think Steve was being typical of the status in these other areas? I mean, of course, the problems are different, and they're for different reactors, but should you take him as being typical of what's going on?

I found that personally what he presented helped me a great deal as opposed to what I read. I mean, it helped me a great deal as a supplement to what I had read.

MEMBER BONACA: It was very good.

MEMBER WALLIS: And probably if I had heard more about materials today, that would have helped me a great deal as a supplement to what I have read.

MR. FLACK: Yes. When you see the attachments, of course, what Steve had covered was most of what's in the Attachments 2 and 3. The other parts are somewhat generic.

There is, again -- I apologize. If we had some time; in fact, if we would like to hear about the materials for ACR-700, there's a discussion of that, but primarily the information that's in the Attachments 2 and 3 right now from how far we can go with them at this stage is primarily the issues that Steve had covered, which is the thermal hydraulics and the severe accidents in the nuclear part of it.

So he covered 90 percent. For SBWR it was pretty much what's in there now.

MEMBER BONACA: It seems to me for all of these plants, the I&C, I mean, digital I&C is also.

MR. FLACK: Yeah. I mean, it's more generic. It's ongoing. I think the systems analysis piece though is very important in not only developing codes for application, but as you develop these codes, you understand the plant better. You understand what the success criteria means.

So you grow with that, and you become aware of the plant, which we sometimes forget that this is how we understand the plant. So that's why it's a critical piece in all of this.

CO-CHAIRMAN FORD: Just one final thing. I asked the question whether all of these activities will be started in fiscal year '03, and you said yes.

MR. FLACK: Yes.

CO-CHAIRMAN FORD: You mentioned two others, the ones we heard about AP1000. Is the reason why they're not on this list -- this is the NRR usually -- the reason they're not on this, is it --

MR. FLACK: Yeah, I guess they were already ongoing, and these were more for things that we were initiating. So, yeah, I think it would be safe to say that the AP1000 could have been added to this list if we were trying to be complete on this.

CO-CHAIRMAN FORD: So these are starts.

MR. FLACK: These are more, yeah, in the context of initiating work.

MR. ELTAWILA: The other reason, John, that some of the AP1000 especially in the severe accident issue is done by the staff here internally. So that just may be reflecting that these are the contract work that is going out, you know. So maybe that's why it was not mentioned.

CO-CHAIRMAN FORD: Well, thank you very much.

MEMBER RANSOM: Peter, I'd like to make one final comment.

CO-CHAIRMAN FORD: Yes, of course.

MEMBER RANSOM: Which has to do with uncertainty again, and you've presented research tasks that are primarily driven by lack of knowledge, you know, that we understand.

But there is another approach, and I'm hoping that the NRC eventually will adopt something along these lines that the Europeans are using now in which they call self-assessment built into a code.

It's not actually self-assessment, but it's like self-sensitivity to the uncertainties that are known and the various models in the code.

And so when they go through the 59 runs that Professor Wallis has identified as necessary to get the 9595 assurance, they can actually tell how much sensitivity to this model, that model, the other models.

It would be nice to see a research driven by the sensitivity, you know, of these calculations to those various models. Are they the most sensitive?

MR. BAJOREK: We're heading in that direction. I think our first goal is to try to get TRAC-M consolidated and assessed at this point because the uncertainties won't mean anything unless we have some basic confidence.

But we have been working with Ally Mosely and Mohammed Mudaris at University of Maryland to start to put together an uncertainty methodology where we would apply it to the code results.

We started earlier in the summer. We're thinking about using AP1000 as a preliminary tool, but the idea here if you could come up with an uncertainty methodology that we could use at least with TRAC-M and start to use that to address some of your questions.

MEMBER RANSOM: Well, the reason I bring it up is some of these methods have to be built into the code, and since you're developing TRAC-M now, now would be the time to actually build this kind of capability in.

MR. FLACK: Yeah, certainly sensitivities runs -- to understand the significance of the uncertainties is certainly an important part of the code development, I would think. So we'll take your comment certainly into serious consideration during the development of the codes.

CO-CHAIRMAN FORD: I'll be asking the members for their comments on specifically the NRC, the NRR and the contributions of this morning. I'll be asking for that later on today.

So thank you very much, indeed, John.

MR. FLACK: Okay

CO-CHAIRMAN FORD: I hope you will be here for this afternoon.

MR. FLACK: Just the one more conclusion slide to mention that, just the two bottom bullets. I think the rest we have already discussed.

CO-CHAIRMAN FORD: All right.

MR. FLACK: The two papers that are going forward.

CO-CHAIRMAN FORD: All right.

MR. FLACK: The one pretty much that you had seen, and then Tom's, well, the policy issue paper. That's also going up.

CO-CHAIRMAN FORD: All right. Thank you very much. I hope you will be here for some of the presentations this afternoon.

MR. FLACK: Yes, I will.

CO-CHAIRMAN FORD: Well, we are going to recess until one o'clock, ten past one.

(Whereupon, at 12:13 p.m., the meeting was recessed for lunch, to reconvene at 1:10 p.m., the same day.)

CO-CHAIRMAN FORD: Okay. I'd like us to get back into session, please. This morning we heard the NRR and RES presentations relating to the infrastructure assessment report, which we will be reporting on in our yearly RES report to the Commissioners.

This afternoon we've got three talks slated, which will give us some background to the industry's needs. First one is being given by Dr. Rob Versluis, from the Office of Nuclear Energy, Department of Energy. He's going to talk about the Gen IV Program, and his slides will be passed out in a minute. Rob.

DR. VERSLUIS: Thank you very much for giving DOE the opportunity to provide its perspectives on future plant deployment. And actually, as you pointed out, I am the Project Manager for Generation IV initiative, but I'm going to be talking about the near term deployment of nuclear reactors in the U.S., as well. There is a program, NP2010, Nuclear Power 2010 which Tom Miller is the Program Manager, and he can unfortunately not be with us this afternoon.

I'm going to talk a little about the gas reactor fuel development qualification program that currently is under the management of Madeleine Feltis, and then I'll talk about Gen IV, as well.

MEMBER WALLIS: Excuse me. Do we have a copy of your slides?

CO-CHAIRMAN FORD: Yes, it's coming.

DR. VERSLUIS: Starting with the near-term deployment, let me go quickly through it. You probably know most of it. It's a new initiative that was unveiled early this year. It was based on a near-term deployment road map that was completed in 2001. And it addresses public/private partnerships to explore sites that could host new nuclear power plants, demonstrate new regulatory processes, and assist in development of advanced reactor technologies, all in the context of near-term deployment, with the final goal that it's just kind of below the level here, to achieve an industry decision by 2005 to deploy at least one new advanced power plant by the year 2010.

The regulatory demonstration project situation is the following. The early site permit has three awarded projects ongoing, and we expect that they will lead to applications to the NRC in the fiscal year 2003. The combined construction and operating license, the COL part of the project, will -- is very much dependent really on the degree of enthusiasm from the owner operators, from the private sector. It's not really completely -- it's not under our control, so we feel that the earliest initiation could be in fiscal year 2004, but probably it will be later. And an application to the NRC would then result a year or so later.

MEMBER SIEBER: I have a quick question. In the last slide you used the word "deploy", and I was curious as to what that means. Does that mean order one? Does that mean build one? Does it mean to license one, or does it mean to operate one?

DR. VERSLUIS: Well, in the context of

near-term deployment, our goal is really to do all of these things, lead to an operating new power plant.

MEMBER SIEBER: By 2010?

DR. VERSLUIS: You can have it as a goal.

MEMBER SIEBER: Okay. Thank you.

DR. VERSLUIS: It's recognized that that is a very aggressive goal.

MEMBER SIEBER: Okay.

DR. VERSLUIS: But when the program was formulated, those were the time frames that were put on it, and we'll see where it ends up. Okay. I'm finished with this.

In the area of reactor technology development projects, there is an advanced reactor design certification project. The solicitation to go forward with this is planned this month, and we foresee up to two awards, one or two, or zero. The first --

MEMBER WALLIS: What do you mean by an "award"? This is a -- what sort of award is this?

DR. VERSLUIS: Well, we'll go out with a solicitation, and we expect the private sector to come in with bids, in other words, the reactor vendors to come in with bids for DOE support for design certifications.

MEMBER WALLIS: So you're going to pay them to write these design certifications.

DR. VERSLUIS: At least we -- it's going to be a public/private partnership, so obviously, we are looking also for them to do cost-shares.

CO-CHAIRMAN FORD: So this does not include the reactors we were talking about this morning. For instance, ACR-700 or ESBWR, or AP-1000. They're already going, so --

DR. VERSLUIS: No. AP-1000 is not design certified. ACRS-700 is not design certified.

CO-CHAIRMAN FORD: So they can -- I mean, GE could come to you --

DR. VERSLUIS: Yeah.

CO-CHAIRMAN FORD: -- and ask for an award or whatever that --

DR. VERSLUIS: Now ABWR is design certified, as is the AP-600, but the ESBWR is not, and neither is the AP-1000. So there are some certified designs which are actually the System AD Plus from Westinghouse, now Westinghouse. I used to work for Combustion Engineering, and I still think of it as Combustion Engineering. The AP-600 and the ABWR, they are design certified. They are certified designs, but there are now evolutions from these designs, such as the AP-1000 --

CO-CHAIRMAN FORD: Yes.

DR. VERSLUIS: -- that is not yet certified.

CO-CHAIRMAN FORD: So what are the criteria, say for people came along to you, it could be quite likely. What are the criteria as to which two you're going to award, give awards to?

DR. VERSLUIS: Well, you're asking me something that I don't really know the answer to. This is Tom Miller's program, and I don't really know how to answer what the criteria are, but I can speculate that they have to do with how much cost-sharing from the vendors is anticipated, what the cost will be, what the economics? I mean, to me, those kind of criteria will apply, I imagine, in the award.

CO-CHAIRMAN FORD: And the driver for DOE to be giving this government money to the private sector is environmental control?

DR. VERSLUIS: No, this is design certification so this is, in our view, related to regulatory processes. And one of our objectives with the Nuclear Power 2010 Program is to assist the private sector with design, or with regulatory processes and support them in regulatory processes, so design certification.

CO-CHAIRMAN FORD: But the driver for you doing this, as opposed to a hydroelectric plant, or something else, is to meet the government requirement that they want to have 30 percent --

DR. VERSLUIS: Now you're asking a really big question, what is the energy policy of this government. The -- it would probably take -- I would not do very good justice to it, but definitely nuclear power is an important element of the future energy mixture that this administration sees. The National Energy Plan states that very clearly, and it has some recommendations in that area.

The Department of Energy, in the person of Secretary Abraham has gone around and made similar statements, and is actually quite positive about nuclear energy as an option for the future. It's an option at this point, because we have no new orders yet. The first thing that has to happen is that the private sector, you know, sees fit to order another nuclear power plant. But the Office of Nuclear Energy, along with the support of the Department of Energy, the higher-ups, is planning for a future where nuclear energy will play a significant role. And that's the context in which you have to see these programs. I mean, if we don't plan on a significant role, there isn't too much to do.

CO-CHAIRMAN FORD: Okay.

DR. VERSLUIS: So we make -- we plan for the case that this work is really needed.

All right. So that is the advanced reactor design certification part of the program. There is also a first of a kind engineering for a standardized plan component. That is, at this point, just a component. It will be very much driven by the COL activities. Obviously, until you have someone who wants to build a plant and operate it, there is not much point in spending money on first of a kind engineering activities by the government anyway. And we have also currently, an assessment of construction technologies and schedules underway. The idea here is to kind of get a second opinion of all the claims that are being made by various vendors as to how fast they can build nuclear power plants, and what techniques they are using. DOE would like to have a vetting of these claims, so that's what this assessment is doing.

And then eventually there will be a need to test systems, materials and components, again in the case that design certification goes forward, the plant gets ordered, first of a kind engineering takes place. And I just wrote down some examples, and you shouldn't make any conclusions out of those examples. It's at least not my intention, but things like large CANNED-ROTOR pumps have never really been operated at the size foreseen in an AP-1000. A direct-cycle helium turbine for a gas reactor, same thing. We really haven't got one of those running. Helical steam generators for IRIS reactors is new. I'm giving some examples as to what might come up.

CO-CHAIRMAN FORD: And these are component developments that the government is funding somewhere.

DR. VERSLUIS: Part of it, yes.

MEMBER SHACK: A partnership by and large on the --

CO-CHAIRMAN FORD: I know, but it's free money.

DR. VERSLUIS: The government finds it very important that the nuclear option remains a viable option for the future.

CO-CHAIRMAN FORD: And that's the drive, that's the main driver.

DR. VERSLUIS: And that's the driver.

MEMBER SHACK: Now you did something similar or AP-600 and the ABWRs.

DR. VERSLUIS: Oh, yes. Yeah.

MEMBER SHACK: This is not new.

DR. VERSLUIS: Oh, this is definitely not new. That doesn't mean you can't question it, of course. But yes, the administration's position is when we look at our energy needs and the world's energy needs in the 21st Century, and societal needs, and environmental needs, we feel -- we, the government, feel that the nuclear option should be an option that is available to us. And if we do not get new plant builds in this country, the infrastructure for nuclear energy will slowly dissipate, and therefore, let's provide support, and at least keep that option open.

CO-CHAIRMAN FORD: Right.

MEMBER WALLIS: How about system tests, the loft-type that we heard this morning, these passive designs and all the questions have to do with how the various system components interact following an accident. That's a long way from these individual component tests.

DR. VERSLUIS: Yeah. I imagine if that comes up as an issue, that will then also have to be considered as a potential area for joint public/private partnerships. I would say that is probably part of the advanced reactor design certification.

Well, I kind of stuck my neck out here, and this is not a prediction. This is just speculation about what might expect in terms of most likely deployed designs. The ABWR, of course, is already design certified. The AP-1000 is running hard. It is not finished yet. The ACR-700 has jumped on the scene, I think, with great energy.

MEMBER WALLIS: Do you think that's more likely than the SBWR?

DR. VERSLUIS: Oh, I don't want to speculate any more than this.

MEMBER WALLIS: But you just speculated. You put --

DR. VERSLUIS: Maybe I didn't understand the question. Is it more likely than --

MEMBER WALLIS: I was questioning whether ACR-700 really was more likely than ASBWR.

DR. VERSLUIS: Well, that gets me speculating. Yes.

CO-CHAIRMAN FORD: Now why do you put not likely for IRIS?

DR. VERSLUIS: Well, Westinghouse is probably going to reserve their money for one design, and again, you're really asking the wrong guy, but let's go on. Let's get off this thing.

CO-CHAIRMAN FORD: It's not based on physical --

DR. VERSLUIS: This is not based on any special knowledge that we have.

CO-CHAIRMAN FORD: Is it timing within the 2010 --

DR. VERSLUIS: Yeah, and also funding. IRIS probably requires more funding, more demonstration. And Westinghouse is going to have to choose how they're going to expend their resources on new reactor design.

MEMBER WALLIS: What is this logo? This is an eagle hiding behind a shield?

DR. VERSLUIS: This one here?

MEMBER WALLIS: Right. Is it an eagle? What is the thing in there? Hiding behind a big shield, a very modest eagle.

DR. VERSLUIS: This is definitely not a complete list, but it gives an idea of where the NRC might get involved in these designs. And I listened to some of the presentations this morning. It sounds like you, the NRC, and probably the ACRS know really much better where they will get involved. Nevertheless, I identified areas for evaluation, assessment, confirmatory testing and analysis that would come into play. I&C, human-machine interface, digital instrumentation and controls. Actually, the human-machine interface itself, control rooms, and safety grade software.

In the area of the fuels, there may be a need for gas reactor fuel performance fabrication, and in the case of the ACR-700, at least an assessment of the fuel and its behavior.

Materials is -- there will be materials evaluations required and testing for gas reactors, and I imagine ACR-700, as well. In the thermal-hydraulics and neutronics analysis, the passive safety systems as you heard this morning, they really kind of operate -- the models operate at the edge of their capability, and the edge of the data pool that's used for validation, so there's definitely work needed over there. The issue of models for the ACR-700 was brought up this morning too, and the gas reactor thermal-hydraulics physics actually go in structural analysis, and so on. All that needs work.

To some extent, if there are innovative construction technologies and first of a kind components, and I imagine that test specifications the NRC will get involved in. And finally, the use of international codes and standards might become an issue.

CO-CHAIRMAN FORD: So your listing those specific areas is purely engineering judgment, is it? Because the list is far, far longer than that.

DR. VERSLUIS: It's far longer than that.

CO-CHAIRMAN FORD: That's just engineering judgment. It's not based on a safety analysis PRA.

DR. VERSLUIS: No.

CO-CHAIRMAN FORD: No.

DR. VERSLUIS: No, it is not.

Okay. I'd like to now go to the advanced gas reactor fuel development program, fuel development and qualification. And this picture kind of illustrates that this is a shared need for both the, let's say the more mature designs, the prismatic modular reactor and the pebble-bed reactor-types, but it will also serve Generation IV reactors, or designs, or concepts, such as the very high temperature reactor, is what the VHTR stands for, very high temperature reactor, and gas fast reactor. And those are two systems that were selected as having a promising --having promise in the Generation IV road map.

And in brief, this indicates where the R&D

for PMRPBR, it will focus on fuel particles, materials, helium systems, computer codes and fuel cycle. And for the VHTR, where we take these designs and extend them to higher temperatures, you get into the problems of high temperature fuel behavior and materials, and so those are very important components of that. But also, the reason we are going to these higher temperatures is to be able to operate wider application of energy products, such as hydrogen generation, and that's shown in here. There will be an intermediate heat exchanger for the heat process, for the heat to be transferred to a hydrogen production plant. If you're truly going to these kind of temperatures, Zirconium coated fuel will be needed, Silicon Carbide is no longer sufficient. And hydrogen product technology will have to be developed. We'll say a little bit more about that.

And then going even farther, going to a -- these are thermal spectrum designs. Going to fast spectrum, the materials problems become even more difficult, and also -- well, I'm running ahead. I'm going to be talking a little bit more about that later, so safety systems and fuel cycle processes come in.

Just in case somebody didn't know what a ceramic fuel particle looks like for advanced gas reactors, this is what it looks like. It has several layers. This is the size approximately compared to a pencil. This is the size of a compact, a compact that these particles -- a fuel compact from these particles, and this is a fuel element. And this is, of course, based on the general atomic design.

Now gas reactor fuels have actually quite a long history, and we aren't going into any great detail about it because much of it must be known to you already. It started with the German coating process, and German particle fuel that actually performed extremely well, and that they've never really successfully copied in the United States. We've had high temperature gas reactor programs for a long time. We've had demonstration reactors, like the Peach Bottom, and we did a lot of work on the new production reactor, but we never could get it quite right. Now this goes back what these will all be used for, once we can reach the high temperature. Let me not say much more about that.

CO-CHAIRMAN FORD: Could you give us an idea on this last one, the idea of hydrogen production? We keep hearing about nuclear reactors in combination with the whole idea of the hydrogen economy. In your view, how far away is that in time?

DR. VERSLUIS: Not so very far. The market for hydrogen today is already very large.

CO-CHAIRMAN FORD: Yes.

DR. VERSLUIS: And it is primarily in the petrochemical industry, so that -- and because the oils, the crude oils that are now the source for fuel for cars, and airplanes and so on, these crude oils are going down in quality more and more. And in order to bring up the hydrogen content, you need more and more hydrogen. That will only continue because the quality of the crude will get worse and worse as the good crudes are exhausted, so that's one market.

And for example, the last hydrogen production plant that was ordered was something like 3,000 megawatts. I mean, they're already ordering big plants. But in addition to that, again this administration is very much focused on trying to make hydrogen a fuel carrier, or energy carrier, I should say. Electricity and hydrogen potentially being clean fuels, not fuels, the carriers. But hydrogen, of course, has to be created somehow, and if this can be done with nuclear energy, then it will avoid any kind of carbon fuels. And so the reasoning is that while hydrogen can be made by any of the other fuels as the source material, and as a source of heat, if it is done with nuclear energy, you avoid any kind of carbon fuels and whatever climate impacts there are.

CO-CHAIRMAN FORD: But you say it's close, and it's not on here.

DR. VERSLUIS: There are -- again, this is all speculation as to what kind of scenarios you believe for the future. But some of the scenarios that were not made by us, but by the World Energy Council, and the International Institute for Systems Analysis, I think they're called, they're international bodies. We take middle of the road scenarios from them, then something like 2015, 2020 is the time when we should get into this market, because this market is growing fairly rapidly.

CO-CHAIRMAN FORD: So we could have commercial application by nuclear reactor tied into the hydrogen production plant, hydrogen pipelines for distribution.

DR. VERSLUIS: Yeah. That is a credible scenario. I'm not predicting that it will be true.

MEMBER ROSEN: It doesn't necessarily have to have five points. I mean, it could be built at a petrochemical complex where they use the hydrogen from the nuclear plant right over the fence, to take heavy sour crude and make it into light sweet crude.

CO-CHAIRMAN FORD: Okay. Thank you.

DR. VERSLUIS: Let me quickly go over the gas reactor fuel program. It builds on U.S. capability and technology to incorporate the best German fabrication experience to recreate a manufacturing capability in the U.S. That will be able to manufacture high quality coated fuel particles, so that we can irradiate and test them. And the reference design for that would be low-energy Uranium with an MHR configuration. Then doing actually the testing in ATR in Idaho, the Advance Test Reactor, and providing irradiation data, proposed irradiation examinations and demonstrate that we connect the fuel performance to the fabrication processes, and demonstrate that we know how to do it. And then I added that this supports also same time foundation for the needs of the Gen IV Program.

And this is somewhat repetitive, but the program goals are to manufacture high quality fuel kernels, particles and compacts, and to actually get the specifications for these -- for both the material and manufacturing specifications, but also the process specifications.

Then part of that should be also to model and do tests on these particles to improve our understanding of how the fuel characteristics in the fabrication process relate to the fuel performance. That is one of those lessons that we have learned, and if you don't do that, things can go wrong in the new production program.

Demonstrate the fuel performance during normal and accident conditions, and we are planning to do eight irradiation capsules for irradiation in the Advance Test Reactor, and investigate and examine them afterward.

CO-CHAIRMAN FORD: Now where physically would this work be done?

DR. VERSLUIS: The Advance Test Reactor is at INEEL; that is, the Idaho National Engineering and Environmental Laboratory.

Another need is to improve the gas reactor fuel behavior and fission product transfer modeling capability, and kind of reduce the market entry risks.

This program is actually in the process of being formulated. I mean, there is a clear wish to do this program. There is a draft program planned, but all the decisions and schedules have not been finalized, so let me give you an idea as to what this program will contain and what the schedule is.

It would extend through 2012, although the qualification part of the program would be completed by 2010. This year, the work would concentrate on the fuel kernel manufacture, the coating process development, and the quality control method development. We would actually be making the first fuel specimens, so that the capsule can be designed. We would actually design the irradiation capsule, and formulate the test specifications, and we would initiate the fuel performance efforts, and getting thermochemical and thermophysical properties.

CO-CHAIRMAN FORD: You were here this morning. You heard --

DR. VERSLUIS: Part of it, not the whole morning.

CO-CHAIRMAN FORD: All right. You would have heard, I'm sure, some of the budget constraints that the NRR, well NRR and RES have on them. I recognize it's a ticklish situation of hanging collaboration between DOE and NRC, but is that a possibility given the time constraints, and the budget constraint of collaborative programs?

DR. VERSLUIS: I'm not an authority in this area, so let me speculate a little bit. And then somebody can correct me if I'm not saying this right.

It seems to me that if the tests are structured correctly and the data is taken correctly, then both sides, the DOE and the NRC, can use the data to make their own conclusions and support their own models and evaluations.

MEMBER ROSEN: If the government can cooperate in this fashion with the industry, really the government can cooperate with itself in this fashion.

CO-CHAIRMAN FORD: Yeah. I'm just thinking of Yucca Mountain where the regulator versus --

DR. VERSLUIS: So I think the answer is yes. If it's carefully done and the tests are carefully planned --

CO-CHAIRMAN FORD: Are there plans to have such collaborative? I mean, this is very --

DR. VERSLUIS: I believe so.

CO-CHAIRMAN FORD: This is very relevant to some of the concerns.

DR. VERSLUIS: This is not an area where I have direct responsibility, but I believe so.

MR. CORLETTI: This is Mike Corletti from Westinghouse. I can just speak to one instance.

There is, for AP-1000 there is some DOE testing being sponsored at Oregon State University. We talked about that a little bit at the Apex facility. That testing is being -- is a DOE sponsored test that the data is going to be made available to both NRC, and to Westinghouse, as part of confirmatory testing for AP-1000. That's probably one example where DOE collaborative effort, if you will, is taking place. And I think they're looking for more ways.

DR. VERSLUIS: Yeah. I believe that there have been discussions between NRC and DOE about how to set up this program that it would satisfy both needs.

MEMBER SIEBER: If I would comment, I think that what you're hinting toward is, would DOE fund directly NRC activities? And I think the answer to that is no.

CO-CHAIRMAN FORD: No. I was talking about a true collaboration, not funding.

MEMBER SIEBER: Collaborative efforts I think they could do. They're already demonstrated --

DR. VERSLUIS: This would be an effort where the results are needed both by the designers/vendors and by the regulators, so it would make sense, and does make sense.

MEMBER SHACK: We have collaborative

efforts with our NRC sponsored work on steam generators, and the NEP program, not the GEN IV people, but the -- you know, so that we've collaborated on effort -- you know, materials that we've gotten from the McGuire reactor. DOE has supplied funds to help us build the glovebox we needed to work on to examine it, so there's certainly precedents.

MR. MUSCARA: This is Joe Muscara. Peter, yes, I know there are efforts going on with Stu Rubin is talking to his counterparts at DOE to set up testing on fuel that are common interest. I know they've been negotiating what these tests should be, so there are ongoing efforts for this cooperation.

DR. VERSLUIS: I think you're confirming my impression. Thank you. Let me finish up with what we anticipate we would be doing in `04 in terms of continuing this program, continuation of the fuel manufacture and the properties testing. The first capsule would inserted for irradiation in October of `04. We would obtain early feedback for the fabrication process, and the initial fission product and gas release transfer studies, the internals would be performed. This is a serious program, as I say. It's in the process of being formulated, but it is a serious program.

Now I'd like to go over to Generation IV, and I recognize that the Generation IV systems are a little far away for the NRC and the ACRS to be concerned about, but it might be useful to indicate at least what concepts have been selected as possible next generation designs, and say a few words about the road map activity that we have just completed.

Now I'm showing the gas, generation for gas reactors here because they -- of the six concepts that were selected by an international, let's say group of collaborators on the road map, of those six, the gas reactors are very -- are crucial to the Department of Energy's program, so let me say a few words about them. I already showed you that graph before.

The primary mission then of the very high temperature gas reactor is nuclear heat applications, and I'll say a little more about that. The secondary mission is still electricity production. High temperatures will lead to high efficiencies, and there is -- and they should be deployable by 2020. Now, you know, it's anybody's guess what will actually happen, but the road map experts looked at a best-case scenario for deployment, if a lot of resources were set in, were applied, and countries would pool together their resources, it could be done by 2020. That was their judgment. It's anybody's guess.

The gas fast reactor, it's primary mission would be, besides electricity production, actinide management, and I'll say a little bit more about actinide management in a moment, so let me leave it there. And the secondary mission, it would still operate at fairly high temperatures, would be nuclear heat applications deployable by 2025.

Now this shows actually what kind of process heat needs there are that's in this part of the graph. This shows the temperature in Celsius, and it shows where the reactors are operating, and the current LWRs are operating at about 320 Celsius. The sodium fast reactor and the lead fast reactor would be operating, sodium around 500, lead can go higher to about 700. And the advanced gas reactor and the very high temperature reactor, they would be pushing this up to 800 and 1200. That is the concept for these high temperature reactors. What could they then do? Well, I don't want to read off all these applications, but if you get in -- you know, by 700 you really can't do much in the way of hydrogen, direct hydrogen production using thermal chemical means. You can't do gasification of coal. You can't really use a gas turbine, so when you get into this temperature regime, these become possible. And that includes, and I don't know that it will ever be economically feasible, cement manufacture, glass manufacture, and other, you know, large-scale manufacturing processes.

But right now, we are primarily focusing on the hydrogen. We believe that market will develop rapidly. And there are various ways of actually making hydrogen. The one that's used right now is steam reforming, and all you need is high temperature heat and natural gas as the source. That can be done with nuclear heat or any other heat.

But there are also processes where you crack water directly, and this is schematic of such a process. Water goes in, heat goes in at 850 Celsius, and oxygen and hydrogen are coming out. And I won't go into this. This is nasty stuff.

CO-CHAIRMAN FORD: It is a horrendous brew.

DR. VERSLUIS: Sulfuric acid and stuff like that, and there are other processes under consideration. And these actually have to be proven. That's part of the GEN IV program, is to show the proof of principle. They have been shown in the lab, but not really to the point that we believe -- that we are certain it will work.

And finally, there is also, of course, electrolysis, and both cold electrolysis and hot electrolysis are other possibilities. They're not on here, but they're another way of making hydrogen.

CO-CHAIRMAN FORD: But you say that there's a commercial driver to have one of these very high temperature gas reactors doing these sort of things by 2015, 2010, 2020? This is what you said earlier when we were talking about hydrogen.

DR. VERSLUIS: Yes. Right.

CO-CHAIRMAN FORD: So that's -- a commercial reason for having them on-line doing this stuff, so that means that NRC might be faced commercially, based on commercial drivers in the next five years of having to look at one of these systems.

DR. VERSLUIS: They might be. The likelihood of it happening is subject to question, but yeah. It is a scenario that is credible.

CO-CHAIRMAN FORD: Exciting.

MEMBER SIEBER: The key word is "might".

DR. VERSLUIS: Yeah.

MEMBER RANSOM: One of the process is the IS process. Is that right?

DR. VERSLUIS: Yes, it is the IS process. Correct. The iodine sulfur process. It's one of the leading processes. There is also a calcium bromide process.

Now let me take a step at explaining actinide management. And this shows a time frame from 2000 to -- well, this actually says 2065, so the better part of this century. And the center trunk is the electricity generation mission, which is traditionally the mission that nuclear power plants have been used for. And in fact, it shows that a number of them are operating and will continue to operate near mid-century.

It also shows that new designs will come on line around here and around there. This is, again, this is conceptual. This is not a prediction, so it remains an important part of the nuclear portfolio. But it also shows that around 2015, the market for hydrogen production with nuclear heat will materialize. And when I say that, it means that we have to develop and build the reactor, license and build the reactor, and it has to be economic, otherwise this will not happen. But we believe that it is possible.

Around 2025, under this scenario and the scenarios that we studied for Generation IV, again they were taken from the World Energy Council, and we took a medium scenario where the nuclear portion of the generating capacity remained constant. It didn't increase, it remained constant. And if you do that, you go from something like 370 gigawatt electric worldwide today to about 2000 mid-century and 6000 end of the century. Now that is mind-boggling, but nevertheless, these are the scenarios that these world bodies come up with. And it does not increase the nuclear component, so this energy has to come from somewhere.

And the driving factors, of course, are that while here in the west we have a good living standard, in a lot of the world, the living standard has to come up. And the population growth, together with the increase of living standard, and absent any catastrophic occurrences would, in fact, show that kind of scenario.

So given such scenarios to plan for, by around 2025 there will be a lot of spent nuclear fuel if we have a once-through fuel cycle. In fact, by around 2010, 2015 the current Yucca Mountain geologic repository, which does not exist yet, but if it were to be built, would already be completely claimed by the spent nuclear fuel that's been generated up to that point by current reactors in the U.S., so we are starting to look at a second repository. And if these curves keep going up like that, we're looking by mid-century at building repositories at a fairly constant clip.

So what can you do about that? How can you make nuclear energy more environmentally friendly, more sustainable? Well, the way to do it is to condition the spent nuclear fuel, recycle the parts that can be turned into fuel, and more optimally manage the components of the waste, such that you can put a lot more of the highly radioactive waste into the repositories that are going to be built. That's what's meant with waste burn-down. It's basically closing the fuel cycle, and starting with the mountain of spent nuclear fuel from the light water reactors and recycling that fuel.

For that you're going to need fast spectrum reactors. And that's what this indicates. We are going to need fast spectrum reactors here to start with the waste burn-down in spent nuclear fuel. It is the back of the fuel cycle that will be staring us in the face before we get to the problem of is there going to enough Uranium.

That is, however, something that will eventually occur, and there are people that say that it will never occur, but it is likely to occur somewhere in the second part of this century. We recognize that we will probably find better extraction techniques and find new deposits, and there will be more there than we currently know, but sooner or later with this kind of a projected growth, it will be very nice to start tapping into the fact that the fast spectrum reactors, you can create as much fissile material as you burn-up. And so you can -- in fact, you can create enough to also start feeding the thermal spectrum reactors that are operating here. That's what's meant with actinide management.

Now I am prepared to go through each of the six concepts quickly, and I would have one slide that shows what it looks like, what the features are, and one slide what the R&D needs are. And if there is enough time for that, I'll be happy to do that.

Starting with the VHTR then, it's a thermal spectrum graphite-moderated helium-cooled reactor. It supplies high temperature process heat over 1000 Celsius for nuclear heat applications. It's fueled by ceramic-coat uranium-plutonium oxide particles in prismatic or pebble-bed configuration.

And it shows here the intermediate heat exchanger, which has not been developed yet, and a hydrogen production plant.

When we talk about R&D needs, there are issues of viability for some of these concepts. They are show-stoppers. If you can't get across -- if you can't come up with a solution for the materials or the fuels, you know, the concept goes away. And so this is a kind of a mixture of viability R&D, which is what we will be focusing on first, and performance which is a matter of optimizing the performance of such a concept.

For the VHTR, novel fuel materials will have to be developed that allow increasing the ultimate temperature from 850 Celsius to above 1000. The maximum fuel temperature during abnormal accident conditions has to be raised from 1600 where it is about now, to 1800. Burn-ups of 150 to 200 gigawatt days per metric ton will have to be realized, and more uniform core temperatures in the core layout. Energy coupling technologies for the use of the nuclear heat, and in the case of electricity production which will always be part of the mix, I'm sure, the development and demonstration of a direct cycle helium turbine. You'll see that come back for each of these tasks.

CO-CHAIRMAN FORD: Now when you've been looking at those needs, have you been driven at all by ideas that, for instance, Dana Powers has come up about core instabilities of this designer fuel because of, if you like, unpredictable random walk of the pellets around the core, or design-basis defense in depth problems for failure in the fuel?

DR. VERSLUIS: First of all, the reference design really is a configuration like the modular, the prismatic reactor where you know where the fuel is.

CO-CHAIRMAN FORD: Okay.

DR. VERSLUIS: But that's the reference design, which does not mean that we'll never be looking at pebble-bed reactors.

CO-CHAIRMAN FORD: Okay.

DR. VERSLUIS: But to, you know, to frame the answer a little differently, we don't think that that really is a show-stopper. That is more a matter of performance R&D to get that right.

CO-CHAIRMAN FORD: Okay.

DR. VERSLUIS: Show-stoppers are more can you develop the right fuel, the Zirconium carbide, can you come up with the right structural materials at these temperatures and pressures.

CO-CHAIRMAN FORD: Okay.

MEMBER SIEBER: I would think that, you know, if you look through the past hundred years of energy production, there's always been a temperature that's been a killer. Temperature is a killer because of materials issues, and if you're going to focus on something for Gen IV that would be -- to me that's where you would put your dollars.

DR. VERSLUIS: It's recognized that almost all of them push higher temperatures, and so materials work is very prominent in the early part of Gen IV. But there's also a lot more --better methodology for developing new materials than there was 40 years ago, so our materials people tell us that there's promise there.

The gas-cooled fast reactor has a fast spectrum. The reference reactor is a helium-cooled reactor, but there are also alternate designs that look at supercritical carbon dioxide as the coolant. Supercritical carbon dioxide has some really nice thermodynamic properties, and would operate at lower temperatures and pressures. But the reference is helium. It would require direct cycle helium turbine for electricity production, and that is actually shown here. And, of course, all these gas reactors are looking for one of those.

It would also allow for hydrogen production. It's fueled by closely packed ceramic coated uranium-plutonium carbide kernels or fibers. And here comes the interesting part, or ceramic coated solid solution metal fuel. In fact, we are still looking at several types of fuels for this gas fast reactor. There's a lot of uncertainty as to what -- how you would actually design this thing. There's a lot of great studies going on, and preconceptual studies.

The issues are (a) in order to get a fast spectrum, you have to increase the power density. When you increase the power density, you lose the really -- the real advantage of gas reactors is that they're very passively safe. Well, at these power densities, you can't depend on passive safety probably. You probably have to have a mixture of passive and active safety systems, so that -- you know, the configuration for the core in this system is being --

MEMBER ROSEN: The guy you have standing next to the core there wouldn't stay there really long.

DR. VERSLUIS: Not very long, no. Well, there's a whole list of things, and these are only the main issues that I put down here. Fuel forms and materials for both in-core and structural components, because not only is the temperature high, but also you now deal with fast nuclear damage, which is -- you know, leads to larger DBAs than thermal, so core design is not fixed. Safety improvements, decay heat removal systems, a lot of studies going.

Fuel cycle technology, if this is a fast reactor, it only makes sense if you can recycle the fuel, so that's not going to be so easy, necessarily, depending on the fuel that's being selected for it. The turbine again, and energy coupling techniques.

MEMBER RANSOM: What kind of reactor vessels are they considering for these reactors, like pre-stress concrete reactor vessels still under consideration?

DR. VERSLUIS: No, the references I use, this is still a type of steel, and there are different types of steel being looked at for that. And it depends also on what they finally come up with for the decay heat removal, what the temperatures are going to be. So those were the two, where we are. We're focusing on resources first.

But in addition to that, there is the sodium-cooled fast reactor, supercritical water reactor, lead-cooled fast reactor, and a molten salt reactor, and I'd run through them quickly and entertain you a little.

The sodium-cooled fast reactor, obviously there's a lot of experience with sodium. The ultimate temperatures are around 530 to 550. They are anticipated to be used for electricity production and actinide management, and it can be either an oxide or a metal fuel. Both are potential candidates, and this, you know, this is a schematic of a sodium reactor, the pool-type.

Actually, there aren't that many viability issues with sodium reactors. There are some potential viability issues really with closing the fuel cycle. Can we, in fact, get a sufficient separation of the fission products and the actinides to achieve what the goals are, and can we do that in a sufficiently proliferation resistant manner? With aqueous or advanced aqueous systems you can recycle, you can probably do it, but we'd much rather use pyro processing, because that way the radiation barrier will always be there.

But in addition to that, we know that sodium reactors, the current designs are expensive, and not economically competitive, so there are also issues of capital cost reduction, and there are some idea on reducing the number of loops using different steels for the vessel. And in addition to that, there are still some lingering questions about the passive safety response improvement and accommodation of bounding events.

I mentioned the fuel treatment. Then, of course, once you have the fuel treatment, you have to refabricate it into minor actinide-bearing fuel. That's been done in the lab, but really not on a large enough scale, so that has to be tested and demonstrated. And in-service inspection and repair are other issues that are known to be somewhat touchy.

Supercritical water reactors, these are -- what's shown here, basically a BWR type of configuration with no pressure, no pressurizer and steam generator, so it's a direct cycle. The size of the vessel would be about that of a PWR vessel. There's a fair -- by going through supercritical water, there's a fair amount of simplification that you get on the primary site. And as you see, the control rods are in the top rather than the bottom, at the current BWR, so there's some good simplifications. But there are also some real questions as to, you know, ultimate temperature of 510 degrees. The spectrum can be thermal or fast, depending on how much moderation is in the core. It could be used for actinide management, the fast spectrum anyway, and it's fueled by a convention LEU fuel.

MEMBER WALLIS: It's a very strange turbine. It has steam on top and water at the bottom.

MEMBER ROSEN: Well, actually it's -- supercritical is one phase, a never-changing phase.

MEMBER WALLIS: Yeah, but it's still got the cold stuff on the bottom, and the hot stuff on the top.

DR. VERSLUIS: The really critical issues are the potential for instabilities. There's a tremendous rise of enthalpy through the core of the supercritical fluid, and changes in -- and the density changes very rapidly, so we know that there will be issues there.

The plant design itself has not been settled, and particularly the materials and structure. We know water is a very corrosive environment, and now we're going to higher temperatures and higher pressures. And in case of fast spectrum, again fast neutron, so there are a lot of issues having to do with corrosion, cracking, embrittlement, creep, all the things that we already know about a little bit, and will just get worse. Dimensional and microstructural stability and stability in high radiation fields, so there will be a lot of R&D focus in this area. And then fuel cycle.

MEMBER RANSOM: What kind of pressures are they talking about?

DR. VERSLUIS: It's -- the pressure is around, what was it, 300 --

MEMBER LEITCH: Critical pressure is 3206.

MEMBER ROSEN: Yeah, that's the number. Thank you, Graham, 3,206 psia.

DR. VERSLUIS: And you'll be operating above that.

MEMBER ROSEN: Or above. Correct.

DR. VERSLUIS: Another concept that was selected is the lead-cooled fast reactor, and we don't have much experience with that in the west, but there has been -- a number of those have operated in the former Soviet Union. It's a fast spectrum lead-cooled reactor, or sometimes lead bismuth. That temperature is between 550 and 800. These are the missions. The higher temperature version. Lead, of course, has a very high evaporation temperature, so it could go up to fairly high temperatures. And it would be fueled by either metal or nitride fuels.

Now one of the things that's interesting about this concept is that this part here, which is really -- this operates, first of all, at low pressures, I mean, because of the vapor pressure of lead at these temperatures is quite low, so that's an advantage. But this part here would be in its entirety replaceable, and one of the advantages you get with this fast spectrum is that you can -- since it basically operates, it's self-breeding, you get very long fuel cycles, something like 15 to 18 years. So this thing could be, after 15 years, simply replaced with a new one, and where's the idea of a battery reactor comes from. This is also called battery reactor.

MEMBER WALLIS: It's a natural circulation.

DR. VERSLUIS: It's natural circulation, and it has --I can't really read all the small print here, but these are --

MEMBER WALLIS: What's the working fluid in the turbine?

DR. VERSLUIS: In the turbine it could be -- I think the current favorite to try out first is supercritical carbon dioxide, but it could be helium. But in any case, this shows a direct breaking cycle turbine.

CO-CHAIRMAN FORD: Just for interest, are all these turbine generator sets vertically mounted, as shown there, or that was just a schematic?

DR. VERSLUIS: No, this is a schematic.

CO-CHAIRMAN FORD: Oh.

MEMBER SIEBER: I don't think any of them are.

DR. VERSLUIS: Well, yeah, some of them are, but there are different configurations. The PBMR, for example, and the GT-MHR have different configurations for them.

CO-CHAIRMAN FORD: Okay.

DR. VERSLUIS: The R&D needs are fuels and materials, nitride fuels development, including fuel clad compatibility and performance, high temperature structural materials. We know that lead, and particular lead bismuth interacts with the structural materials, and there's -- so there's an issue of finding the right structural materials and chemistry regimes to stabilize that. Systems design, we've done very little here in the west in actually designing those. Energy coupling technologies, making them cheap enough, and the fuel cycle technology for nitride fuels.

Molten salt is the last of the selected concepts, and again, there is a fair amount of experience with it. And on paper, it has tremendous advantages. It's safe in the sense that if there's an overheating or anything like that, the valve opens and the molten salt with the fuel will just simply go into these vessels.

There is a continuous cleaning-up or processing of the fission products, so that this can just -- there is no need, in other words, to reprocess the fuel. The actinides just stay in there and burn. There's no need to take out and reprocess the fuel, and then refabricate it into some kind of a fuel form. It just stays in there, and any new fuel that's needed, you add in fluid form. There's a lot of conceptual advantages to it, but it's also known to be very difficult to realize.

MEMBER SIEBER: They actually built one of those, didn't they?

DR. VERSLUIS: Pardon me?

MEMBER SIEBER: They built one of those years ago.

DR. VERSLUIS: Oh, yes. There are -- Oak Ridge has operated one of these. They had, I think two different types, and the breeder, as they called it, operated for a number of years.

CO-CHAIRMAN KRESS: It ran very well, very stable.

DR. VERSLUIS: Yeah.

CO-CHAIRMAN KRESS: Extremely nice reactor.

DR. VERSLUIS: Yes.

MEMBER SIEBER: It's a lot of machinery for the power you get though. Right?

CO-CHAIRMAN KRESS: Yes. It's a pump and a pot.

MEMBER SIEBER: Yeah, I know. A big pot though, right?

CO-CHAIRMAN KRESS: Yeah. We threw away the heat. We didn't have an electrical generator.

DR. VERSLUIS: There's a lot of viability issues, and you will be able to confirm that. Once you start getting the fission product dissolved in the salts, you get a very corrosive mixture, and you get lanthanides and other nasty things in it. And they attack the structural materials, and it dissolves and resettles in other places, and so there are some interesting safety problems.

But at the same time, the people who are the proponents for this system say well, we -- you know, we have a lot of experience with salt. High temperature salt is something that they use in all sorts of processes and it can be managed.

So lifetime behavior of the salt, materials compatibility, the salt processing. There is a need for cleaning up the salt and taking out fission products, so there's an on-line chemical factory going on which there's some experience, but not nearly enough. And then there are performance issues of the fuel development. What is meant really is what type of salts you use. There are different choices that can be made, and the materials performance and stability.

CO-CHAIRMAN KRESS: One of the issues I don't see up there was how to get rid of the xenon.

DR. VERSLUIS: Right.

MEMBER SIEBER: Well, that was my question. It looks to me this cartoon shows the two control rods at the top. But if you look at the xenon transients the activity changes that are taking place, I imagine that there is a tremendous --

CO-CHAIRMAN KRESS: We had to continuously take out the xenon, but we didn't use control rods.

MEMBER SIEBER: What did you do?

CO-CHAIRMAN KRESS: This is temperature

controlled completely.

MEMBER ROSEN: What Rob has done is spared you a lot of the detail. There's a ton of it on the website.

MEMBER SIEBER: It makes it look better without the detail.

MEMBER ROSEN: And some of the detail that he spared you is additional complications. He hasn't mentioned all of them.

DR. VERSLUIS: Right.

CO-CHAIRMAN KRESS: I think the major problem is this chemical reprocessing plant. That's where you deposit all the fission products, and take them out, and do something with them. And that's a major part of the whole thing.

MEMBER ROSEN: Well, the good news about this concept is the fuel is all in there. It's a fluid, and you never have to reprocess there. That's the good news. The bad new is the fuel is in there. It's a solid, I mean it's a fluid --

MEMBER SIEBER: And you never get a chance to reprocess.

CO-CHAIRMAN KRESS: But my favorite description of the thing is "No wing, no sting." There wasn't any way to get that fission products out to the environment, just could not do it, so it's a really safe. The salt won't burn. It had no vapor pressure. It's a very neat safety concept.

DR. VERSLUIS: A lot of the safety issues that you have with the other reactors aren't here, but then, of course --

MEMBER SIEBER: There's other ones, though. The size of the pot is critical.

CO-CHAIRMAN KRESS: Yeah, it had to be a critical pot. That's for sure.

DR. VERSLUIS: But, you know, a lot of the arguments that are being made is when people say oh, this -- can you imagine having a critical pot with this salt and uranium and stuff in it. When we talk about pyroprocessing, we're talking about, you know, a pot of salt with, you know, uranium and plutonium, and actinide and fission products dissolved in it.

MEMBER ROSEN: But it's not critical.

DR. VERSLUIS: But it's not critical. You hope it's not critical. The criticality part of it though is -- I'm now speaking off the top of my head, but it seems like the fact that if there's any kind of a temperature excursion at all, you automatically dump it into these vessels. It seems like a very good feature that you can't have in any of the others. It doesn't mean that something can't go wrong with it, I imagine.

MEMBER ROSEN: You know, if you show that to a utility guy who's running the light water reactor today, you know, he'd say I'm going to write down here on description of a reactor, that is different from anything you've operated, as I can imagine. That's what you'd get.

DR. VERSLUIS: Either that or the vapor core.

MEMBER WALLIS: Which a chemical plant --

MEMBER SIEBER: It's really a chemical plant rather than a --

MEMBER WALLIS: The chemical plant is many times bigger than this sketch you've shown here.

DR. VERSLUIS: Yeah, this is -- well, this is supposedly --

MEMBER WALLIS: A chemical plant is a huge operation.

DR. VERSLUIS: Oh, I'm sorry. Yeah.

MEMBER SIEBER: Now if this were used as a hydrogen, part of a hydrogen plant, the hydrogen plant would be about equally as complicated as this turns out to be.

CO-CHAIRMAN KRESS: There's interesting

safety issues with the hydrogen plant hooked to a nuclear plant.

MEMBER SIEBER: I'm not thrilled about having hydrogen as the energy --

MEMBER ROSEN: We already have hydrogen in nuclear plants, so --

MEMBER SIEBER: Yeah, but you have a little bit. You don't have train loads of the stuff, you know, all over like Hindenburg.

MEMBER ROSEN: Well, I don't think you'd keep an inventory. The whole idea is you'd make it and sell it.

MEMBER SIEBER: As quick as you can.

MEMBER ROSEN: Sell it as quick as you can, or hike it over the fence to a refinery. But hydrogen is not new to nuclear plants.

MEMBER SIEBER: I'm sure the older generation felt the same thing about oil, pretty bad stuff, burns.

DR. VERSLUIS: Well, one of the things that's clear, if you have a nuclear plant and the heat is piped over to a hydrogen production facility, this coupling has to be very closely examined. And it should be clear that, you know, they both have their own safety issues. You don't want any of the events that could happen here really become a safety problem on the reactor side.

MEMBER SIEBER: Or vice versa.

DR. VERSLUIS: Well, let me -- this is the last slide, and then the entertainment is over.

We've come up with a guess of how long the various phases of R&D would take. And the light colored is the viability R&D. This is the performance R&D, and then this would represent the demonstration part of it. And this is the best guess of the experts, best case, you know, full development resources as to how long these various phases would take.

For the sodium fast reactor, really the reactor site has very little in the way of viability issues left, so this shows only a short period having to do with the reprocessing, and they get gradually longer as you deal with the fuels and materials issues for these reactors.

Assuming that you could get all the show-stoppers taken care of, and all the viability issues resolved, then there's still quite a bit of research and development that has to be done in order to optimize the components and the system configuration, and to make it economic. Obviously, if it's not economic -- if it can't be made up economic, then you don't do it either. And then there's the demonstration phase, so this is currently what would be the best case guess.

CO-CHAIRMAN FORD: Thank you very much indeed. You've given us an awful lot to think about, tremendous challenges, I think, in NRC is these things, such as these high temperature reactors, ever come to fruition. Thank you very much indeed.

We have scheduled half an hour for public presentations, and we have one from I'm going to call it the AECL.

DR. SNELL: For the record, I'm Victor Snell, AECL. I have a few -- this is going more or less from the sublime to the mundane. I did have some remarks on the research presentation this morning on ACR, and I think although I'm very pleased to see that NRC is taking a proactive approach on research, I think what's needed more is a more thoughtful and more focused approach as to what research on the ACR needs to be done. And I would suggest that there needs to be about four steps in defining an appropriate research program on ACR. This is obviously talking about the U.S., not about Canada.

And as was pointed out, we've undertaken a fairly significant effort with NRC Staff in familiarization. And we feel it's important to ensure that understanding exists before we start getting into a lot of fine reviews. Part of the familiarization has been and will be a series of meetings on all aspects of the design, which would include the R&D program. And so, to me then the first step of the four is that we need to ensure that there's a fairly solid understanding of the design, and the associated phenomenology that goes along with it, much of which is common to light water reactors, and some of which isn't.

I would suggest the second step is to review what we've done for the generic CANDU in terms of R&D and co-development. We've employed 2,000 people at Chalk River for the last 40 years or so on average doing R&D in support of the CANDU product. As is pointed out, the responsibility for doing that is the vendors, and not the regulators, although the CNSC does some fairly modest R&D as an audit, but mostly R&Ds, not ACL. So I think this next step has been done by ourselves, by the Canadian utilities as part of the CANDU owners group, and by the CNSC as part of their audit function.

And as part of that, to also go through

what's planned for the ACR. As you mentioned, there are differences. We do have a evolutionary R&D program planned for the ACR over the next three or four years. The director of that program is sitting in the front row there, Dr. Dave Wren. He is actually -- his position is in charge of the R&D for ACR, so the model is you take the existing base, and then you look at what's changed, and you make sure that you've got R&D to cover the changes, so that would be the second step.

I think based on those two steps, understanding the design and phenomenology, and understanding what's been done and what's planned, it would then be possible for NRC to identify what the issues are for their regulatory review in the U.S.

Now as Mr. Flack pointed out, we have been here before, about seven years ago, and there was a review done at the time by NRC of the CANDU III, the R&D supporting CANDU III, and I think it's a fairly good review. Things have changed since then. We've had eight years to do a lot more work, some of that in response to the comments we got from NRC on the CANDU III review, particularly in terms of the rigor of code validation. So I think based on that information, the NRC Staff could then follow issues they wish to pursue in the U.S., and then based on that, define a program. So I think, although I'm glad to hear the NRC Staff is being proactive in sort of grabbing issues, I think in the long run a sort of more systematic approach would be the right thing to do. That's the end of my remarks. Thank you.

CO-CHAIRMAN FORD: John, do you want to comment?

MR. FLACK: Well, yes. Again, as we stated earlier this morning, we are trying to get out in front, and we're certainly looking over the domain. I believe the trips that we'll be making to Chalk River will go a long way in helping us understand what's all been there, what's all been done. And it -- you know, when you do research, and I understand the issue about being structured, and I think it's important to have focus, understand what work you're doing, and why you're doing it, and where it's leading you. But it should also have an element to probing for beyond what's on the table, asking questions. Are we asking the right questions from a different perspective? And so having a bit of flexibility there is important to us, and at the same time, I think it pays off in the end, because as we learn more, we get more confidence in the plant, and I think that helps the process.

So although we will certainly try to capitalize on much as we can, there'll always be this element of questioning, kind of a questioning attitude as we go through it. But again, it's a new design to us, and we certainly have a lot of catching up to do. There's no question about that.

CO-CHAIRMAN FORD: There was some talk the previous meeting I think, John, about interactions between the NRC and the regulatory bodies in Canada, to have Lessons Learned, rather similar to that which we were just talking about.

MR. FLACK: That's right.

CO-CHAIRMAN FORD: Is that --

MR. FLACK: Well, that was a trip for us recently. I was not on that trip personally, but again, it's to see what has been done, the basis for decisions, and whether we can use some -- review some of that material, and to understand it better in making our own decision. So yes, it's certainly capitalizing on this work, as well.

CO-CHAIRMAN FORD: Any other questions? Dr. Snell, thank you very much indeed. Are there any other questions from the general audience on what we've heard so far? In that case, we're going to recess for quarter of an hour. I think that is what is scheduled at this time, so we'll reconvene at just after 2:45.

(Off the record 2:38:30 p.m.)

CO-CHAIRMAN FORD: I'd like to come back into session. The next presentation is given by NEI, led by Adrian Heymer. The topics are the NEI proposed new regulatory framework, anticipated new applications and current schedules, and NEI's views on expected research needs and NRC's role in sponsoring research. I hope you came prepared to talk about all of that.

MR. HEYMER: Well, I came prepared to talk about some of that. The slides talk to some of that. And I can speak to some of that verbally.

CO-CHAIRMAN FORD: Fantastic.

MR. HEYMER: Up here with me is Gary Vine from EPRI, who will be giving the EPRI presentation.

CO-CHAIRMAN FORD: Oh, so we're combining two?

MR. HEYMER: Yes.

CO-CHAIRMAN FORD: Yes.

MR. HEYMER: Also Victor Snell, who spoke a few moments ago, from AECL; and Mike Corletti, who is here from Westinghouse on AP1000 on IRIS. So if you have any questions from a technical issue or of a technical nature, we'll hand off to these folk here.

CO-CHAIRMAN FORD: Okay. Good.

MR. HEYMER: As you said in the introductory remarks, I am trying to focus this on the new regulatory framework, where we see that going, the need, some issues that float out of that, which I think might have either need for some research or application-specific work to be done at this section, some criteria. And I may talk a little bit in general about research needs, where we need to focus our effort.

I think when you talk about research, there is research in the industry side of the house. And that is true for any industry, whether it is oil, aerospace, or the nuclear. Then when you get into the regulatory as regards NRC's application, I think it really has to be linked to a specific licensing regulatory need associated with a licensing application or a design approval application or preapplication.

And that gets us into sort of a little bit of a scheduling issue because sometimes -- we will get to that towards the end of the presentation, but I want to bring it up now just to make sure that people realize it. When we say it is linked to an application, sometimes you may need to do some research or, as Dr. Snell said, familiarization work ahead of time. I think that what he outlined as his four-step program is something that we very much support as a definite need.

They obviously see that there is a prospective market within the United States. And, therefore, they want to come along, get a product approved in the United States. And to do that, they need to make the NRC more aware of what that product is, more familiar, so that they can do a proper review. But also in doing that, I don't think that we should lose sight of the fact, and I am glad to see the NRC has not, the fact that perhaps some of these designs or components have been reviewed and approved in other countries by other national regulatory agencies and that we shouldn't step back and step away from that, we should take advantage of those reviews.

That's not necessarily to say that just because it is being reviewed and approved in France or Canada that it's automatically approved in the United States, but I think we can take either credit or at least build on some of the work that has already been done there. So, with that, I will move ahead.

I guess when we talk about a new

regulatory framework, often the question comes up "Why do we need one?" And when we started to think about this and discuss it within NEI, we said, "Why do we need one?"

Part of the process, the first couple of meetings that we had is to try and convince people that we actually need a new type of regulatory framework. And some of the reasons that we came up with -- and they're listed in detail, and I don't know whether you have seen a copy. If the Committee hasn't, we can make them available. We can send them a copy of NEI 02-02.

CO-CHAIRMAN FORD: We have that.

MR. HEYMER: Okay. I just wanted to make sure before I got too far into this. And we thought after something like 40 years of operating and regulating commercial nuclear facilities in the United States, we have an opportunity now perhaps to sit back and perhaps adjust and improve the regulatory focus based on the risk analysis that had been done, the IPEs, the IPEEEs, and that work, the work that the NRC has done in reducing risk-informed regulations, new technical information that has come, advances in technology or operational feedback.

And when you look at all of these in

general, we get certainly more than just a feel that perhaps in some cases, one, in fact, today we are safe and we have a very good safety record, that, in fact, we could improve the focus in some areas and, in fact, in some matters where we haven't had a substantial focus on safety, there is a safety significance and in other areas where we have thought that equipment and activities are important, they aren't perhaps as important as we first thought. So that's the first part.

The second part is the regime that we have at the moment, the process we have at the moment is based on light water reactor technology. And, as you are well aware, in the last few years, there has been a growing interest in non-light water reactor designs. I think that begs a policy question in itself, do we have a completely separate set of regulations for those and then another completely separate set for some of the more advanced regulation, reactor types that we have discussed a little bit earlier this afternoon, and then the light water reactor, or do we try and develop what we call a technology-neutral regulatory approach?

We really came down on perhaps let's try and go for a technology-neutral regulatory approach.

And I guess the final thing is that a number of people have said, "Well, the Option 2 and Option 3 activities are, in fact, introducing risk concepts and risk insights and why can't we use those?" I think, one, because of what I just spoke about a few moments ago, the non-light water reactor issues; and, two, is we have struggled to change what is in place today through change management and cultural issues. And we are struggling a little bit to make the step as rapidly as we would like to.

Perhaps we need to take not necessarily a clean sheet of paper but build on some of the successes of the past and come up with a new approach that incorporates what we have got in place today, which is good, and introduce some new ideas and new thought processes. And perhaps we can get there a little bit quicker than we can by just doing --

MEMBER WALLIS: Are you proposing that NEI develop a new framework?

MR. HEYMER: That's what we proposed in NEI 02-02.

MEMBER WALLIS: Yes.

CO-CHAIRMAN FORD: Could I ask at this point, has the staff reviewed NEI 02-02?

DR. SAVIO: We haven't as far as I know.

Now, it must be both offices. We haven't done any formal review of it. Of course, we do it internally amongst ourselves. We discuss it amongst ourselves, to that extent.

MR. HEYMER: There is an activity going on called regulatory coherence and convergence. And there was a meeting a few weeks ago. Another one has been scheduled for early December, which starts looking at some of these concepts about how to take what we're trying to do in the risk-informed world, what regulations we've got in place today, what's coming along new, and flame them into a single structure.

Some of the thoughts and concepts that we discussed in the first meeting and I think we have been discussing in the second meeting from our perspective are based very much on NEI 02-02.

Back in October 22-23, when we had a discussion at the workshop on non-light water reactor policy issues, which I think was an excellent NRC workshop, by the way, most of the concepts and the thoughts that we had that were provided input to the NRC staff in that workshop were really based on what is in NEI 02-02.

How we went about developing that I think is worthwhile. We just didn't sit down as a staff member of NEI and write it. We had GE, Westinghouse, Entergy, utilities, independent consultants, and people from the codes and standards community help us in drafting the outline; Exelon, example for the pebble bed. We had General Atomics for the HT-MHR along with Westinghouse, GE, Entergy, Exelon, The Southern Company.

We came up with a document that defines the need that tries to actually define the safety benefits, outlines what we believe are a set of principles and acceptance criteria because there is a performance-based element in this, provides a regulatory basis and an outline and a framework. And we went ahead and we drafted a complete set of regulations, what we called a new Part 53.

The real purpose of doing that wasn't to say, "This is what we think everything should be" but was really to frame and emphasize the policy and technical issues that came out of these discussions and as a catalyst to start the discussion process.

So, really, what we have got in NEI 02-02, the proposed rule language, is really secondary to the main purpose of trying to force and focus a discussion on some of the issues that are embedded in that document.

When you read the document -- and I know more than a few people have -- some people have said it's perhaps a thought too far in some areas. And that was the intent. The intent was to stretch this and ask the question, "How far do we want to take PRA?"; for example, "Do we want to put PRA numbers in the regulations?" and those sorts of issues that come out, "At the moment, can we get a common set of criteria for all types of regulations?" And the answer was that we can't.

We still have to do some work in some certain areas. So it's really to start the discussion process. That's why we're somewhat pleased to see that the NRC is moving forward with a set of discussions, public discussions, on coherence and convergence on matters that perhaps will help us get a regulatory framework that is applicable to all designs.

The framework itself has a very strong PRA emphasis. We believe that you come down to two equipment or activity categories: safety-significant and industrial. We think the equipment and activities would be categorized using a process based on risk insights similar to what we have outlined for Option

2. That's the implementation of 10 CFR 50.69, risk-informing NRC special treatment requirements.

Naturally there is an issue there dealing with importance measures and criteria.

MEMBER WALLIS: We heard this morning that it may not be so much equipment that determines the PRA but sort of the interaction between systems --

MR. HEYMER: Right.

MEMBER WALLIS: -- and how well you can describe those, which is going to influence how good your PRA is. So you need something about that as well as well as talking about equipment.

MR. HEYMER: Well, equipment. And I was talking about equipment in the real general terms of structural systems and components. And that's why I termed it "equipment and activities." It's really structure systems components, operational maintenance, and design activities.

I agree with you that it's just not components. It is equipment. It is systems. It's the way they interact. And it's the way the operator interacts with the systems. And so there is a human interface issue there.

And also, naturally, since there is a strong PRA emphasis, we believe that you're going to need a good-quality PRA to support such measures.

MEMBER WALLIS: Which includes model uncertainties as well as the active system reliabilities and things like that.

MR. HEYMER: Yes. And we're going to get to that. That is an issue that is open, and we think that needs some work. The regulatory programmatic requirements would only focus on the safety-significant equipment leaving the balance-of-plant licensees, balance-of-plant processes dealing with industrial.

The way equipment is designed in configuration control, we will see perhaps very much of a change the way you design valves. You would still use codes and standards. So we didn't see that changing very much.

The focus is on new plants, but there is no reason why parts of the regulation couldn't be or portions of the new part or the set of regulations couldn't be used by existing plants provided they satisfy the provisions. And one of those provisions that we just spoke about, for example, would be does it have a good-quality PRA? And I think that is important.

MEMBER WALLIS: Do we know what should be in the PRA? For conventional plants, we have a good idea of what ought to be in the PRA. Take some of these new plants. We don't know yet what is a really good for PRA for a pebble bed reactor.

MR. HEYMER: That's a point that was raised in the workshop that we had back in October with the NRC. And, to be quite frank, I sort of shouted a little bit because having gone through a fairly healthy debate for four years on what is a PRA standard, when someone suggested we need another PRA standard, I wobbled a bit. But I made some very good points, that, in fact, the criteria for a PRA that covers a pebble bed or the high HT-MHR may be different, some of the aspects of that. Now, whether that is an appendix to the PRA standard or whether it is an implementation guideline, I don't know, but that needs to be recognized.

We modeled the actual framework on the new reactor oversight process and the cornerstones in there. And we came up with a list of areas that encompass. And the reason why we based it on there is that is a framework that has had a lot of public debate and discussion. It's been generally accepted as an improvement and a way to go. And it's the way we're performing inspections.

So one way is to get the regulations in line with the inspection framework, if you like, and the oversight framework. We think that would help the coherence. And it also sort of puts things in -- since we have been talking about these issues in these boxes for a number of years now, I think it is a little easier for people to understand. The issues that I spoke about that need further work, be it from actual research or development, is in the area of mitigation, functional barriers to radionuclide release, which is the area of containment performance and defense-in-depth. The framework also obviously covers design, operational, and some administrative elements.

I want to take a few moments not to sort of drag you through step by step on what's in NEI 02-02 but come up with some of the areas like mitigation.

MEMBER LEITCH: Could you talk about emergency preparedness there for just a second?

MR. HEYMER: Yes, certainly.

MEMBER LEITCH: It looks as though the section on emergency preparedness, there are a number of actions that are based on the core damage frequency. Would it be your intention, then, to eliminate those things which now drive one to certain emergency actions that are of no direct linkage with core damage frequently, I mean, like storms, security events, fires, where there is no clear relationship between those particular events and the core damage frequency or would some of those deterministic criteria still remain in your vision of this thing?

MR. HEYMER: I think there would be some deterministic criteria as regards when should one thing about taking additional action, either to inform the local community or take action within your own site boundary; for example, if you have got a hurricane coming through, securing loose equipment, making sure that, as much as possible, nothing can fly around.

MEMBER LEITCH: I'm not talking about preparation procedures. I'm talking about declaring an unusual event, for example, based on a hurricane.

MR. HEYMER: Yes. I think those would still be in place.

MEMBER LEITCH: Okay.

MR. HEYMER: We saw it very much along the lines of going down the path that perhaps Part 72 or in the decommissioning world, where the extent, the level of detail in the emergency plan would be commensurate with what the risk is to the public, and sort of be like a graded approach. So emergency preparedness is still there. It's still retained. But how far you take that depends upon the design and what is the risk to the public.

Now, some of the items which you mentioned which are more deterministic I think would still be put in place just as a contingency measure bringing people just to a higher state of readiness.

MEMBER LEITCH: Okay. Good. I just use that as an example to try to understand where you are heading. Thanks.

MR. HEYMER: On mitigation, -- and I'll explain some of these acronyms here -- designed to shorten the initiating events that say anticipated operational occurrences. And PDBEs are plant design basis events which are fundamentally the internal events. Plant protected events are the external events.

What we tried to do is we split them into two groups there, mainly because the external events -- and in that, we included fires. And I will talk about some of our thoughts on fires in a moment. You have equipment, and you have events that are caused by plant transients and plant activities. And then you have a series of events where, if you like, you protect the equipment from what is going on, like a hurricane, an earthquake, a tornado, et cetera. And so we kept them in two separate categories.

I guess from our perspective, the external events, we see them at the moment still being more deterministically defined, as opposed to the internal events, which are more frequency and PRA-based.

I think the rationale behind that was really that we have got a pretty good handle on internal events. We have only just started to do some work in developing standards on external events. And there are some areas where perhaps do we really need a PRA in some areas, like fire, where if you look at a new design, you should be able to just about design out the risks from fire by having rigid separation. So that's why we came up with those two areas.

For light water reactors, we already have core damage frequency less than 10^{-4}. Mean large release frequency -- and that's not a typo, I didn't miss out "early"; that is "large release" -- is less than 10^{-5}.

We know what those are, but then when you get into the non-light water reactor category, what are the equivalent measures? There are no real equivalent measures at the present time that have been suggested to us and we think may need to be developed based on the application or the interactions on specific design approvals or perhaps just grouping types of reactors together. But that is an area where work needs to be done, and I think it really needs to stem from what is the surrogate safety goal for a non-light water reactor.

MEMBER WALLIS: Why should it be any different from the LWR?

MR. HEYMER: Because the mechanism, you might get a large release, but you might not have a core damage event in some designs because you have radioactive material or contamination around the system. What gets you is release the contamination, rather than what we traditionally know is the core damage frequency.

MEMBER ROSEN: You know, Adrian, the Commission has expressed its expectation that future reactors will be safer than the current set. And, yet, those numbers look very familiar to me as numbers that we have kind of used as surrogates for the current set. So are you just -- well, let me ask you. How did you come to those numbers? Did you consider the Commission's expectations?

MR. HEYMER: Yes, we did. We had a discussion about that, and we went back to the events that took place when we were developing the design certifications for the ABW or AP600 and the system 80-plus, the three ALWR certifications.

The Commission statements were in place then, and there was a lot of discussion at the time of should the regulations reflect an enhanced level of safety? The answer came back as no.

The Commission expects and the industry went forward and developed engineering specifications for designs, which provided an increased level of safety; in fact, reduced the core damage frequency and the release frequency there by an order of magnitude, I believe, Gary. And that's what we put in the engineering specifications.

What the industry said to the Commission is "We will meet those, but there is no need to regulate to them because we are safety today. What we are talking about is adequate protection. And today these numbers for light water reactors provide an adequate level of protection. We will design the plants and operate the plants to a lower level and subsequently have increased margin that way. So there will be increased operational margin, but there is no need to regulate to those." And that is the way we achieve a higher, if you like, level of safety and the Commission's objection is attained.

We went forward in those discussions. And at the end of the day, those redesigns have been certified and are safer than the existing fleet. If you look at the core damage frequency, if you look at some of the components and design criteria that were in there today for the AP600, the ABWR, they are more stringent than what we have got today, but they are still regulated to the same level.

Does that help answer the question?

MEMBER WALLIS: Yes, thank you.

MEMBER SHACK: This notion that you are restricting these events to the design basis events, it sort of indicates that as long as I keep my frequency of PTS, for example, less than 10^{-5}, I wouldn't have to include that. Right?

MR. HEYMER: Well, what I missed off here, there's a fourth area, which is emergency preparedness basis events, which is, if you like, the beyond design basis events, which would be what we said is 10^{-5}, 10^{-7} frequency event. And you have to analyze for those to be sure you met the large release frequency, but from a pure design basis as we know it today, you wouldn't have to design to those. So you didn't get core damage. So that's --

MEMBER SHACK: I was also interested in your comment that it would design fire out so it would have negligible contribution to CDF. That sounds like famous last words to me.

MR. HEYMER: Yes. Where I am coming from there is that when we built the column plants and you go into certain plants, you go into the cable spreading room, everything comes together. But if you look at the designs that we tried to do in the ABWR and I think we should focus on it, we get hard separation between divisions. So you do have the three AFR barrier between divisions. And I think that is what we should strive for.

Now, whether we can get there or not, I don't know, but it sort of begs a question, do we need a very detailed fire PRA to address that issue when perhaps --

MEMBER SHACK: Then I don't see very many strong deterministic requirements for fire either, you know, I shall have a plan.

MR. HEYMER: That is from a fire protection perspective. That's assuming that the design and the design approval are taking care of the separation and the fire --

MEMBER SHACK: Oh, I see. That's taken care of in the design approval.

MR. HEYMER: Right.

MEMBER SHACK: But what would I use for my criteria for design approval, then?

MR. HEYMER: Well, can you have a fire, at least, to a core damage event and then have some probability numbers around that so it's a --

MEMBER SHACK: Should those design criteria be built into these regulatory requirements?

MR. HEYMER: We think our thought process is you have a high set of requirements and performance criteria that you have to meet. And then under that, each specific design, specific criteria, that you're talking about, such as what you've got in perhaps the general design criteria today, would be put in the reg guides and review plans, standard review plans. So that's where the detail should be.

Now, that's a legal and licensing issue that needs to be examined, but we think if you look at what we have done under the maintenance rule and if you look at Appendix B, it depends on who you talk to on Appendix B, but if you certainly look at the maintenance rule, that is a very high-level regulation. And, yet, there have been a number of violations issued against that regulation.

If you look at Appendix B, some people think it's high-level. And it, in fact, reflects what is a good industrial program. But there have been numerous violations cited against Appendix B.

So we think it can work. The process is there. I think that is one of the things that is going to roll out in the discussion process that we have. You make a good point.

MEMBER SHACK: I am also interested in your comment that perhaps we don't understand external events and fire well enough to put them in the PRA but we are going to have a PRA for a plant we have never built.

MR. HEYMER: What I meant by that was if you take fire and you take external events, there is a way that is out there today for determining what the extent of that event would be. We say that perhaps we should still use that event at the moment, until we get a better understanding of what goes into a seismic or a low-power shutdown-type PRA or a fire PRA.

Now, once we've got a better understanding of that, I think we will be in a better position to answer that question.

MEMBER SHACK: Where was that covered in the framework? That's just sort of this protection against natural phenomena?

MR. HEYMER: Yes, which is very similar language to what I believe you got in the GDCs that are coming.

MEMBER SHACK: Yes. A lot of this you sort of built part of the GDCs into here, instead of as a separate --

MR. HEYMER: Appendix. Okay. The next topic, which always gets a certain amount of discussion, we call it barriers to radionuclide release. Other people call it containment.

There is an issue out there today that we discussed in October called containment versus confinement. In our mind, it is having sufficient barriers in place to protect the public from a release of radionuclides that could endanger the public. And so we have switched it around and made it a functional requirement.

And in doing that, we mentioned the frequency of a large release and we said what a large release is there. We have attempted to produce a definition for that. That includes early and late because some of the releases and threats to the public from the non-light water reactor designs come later on in the cycle.

So there is an issue there dealing with late containment or what we would call now late containment failure or a late release. That is something I think we need to work on on what are the methodologies for determining that, but it is no -- it doesn't say "containment." And the reason why we stayed away from containment is because we were concerned that if you say "containment," that means a three-foot reinforced concrete wall. And what we are talking about is making sure the radionuclides stay where they are or don't get out and threaten the public.

So that's why we worded it in that way, but I think there is an issue dealing with half the methodologies for dealing with a large release. And that is a release within 24 hours or a release later than 24 hours depending upon the design.

MEMBER RANSOM: Would you consider the threat of terrorist activities as a part of that?

MR. HEYMER: We wrote the document, really, in the latter stages of last year and the early part of this year. At that time, there was still a lot of discussion on safeguards and security.

And there still is.

I think if we were to look at it today, I'm not sure that we could come to any different conclusion. The conclusion that we have reached is that the document would need to be amended once we have reached a better understanding on what we are going to do as regards security. And there's a number of measures and thought processes out there that have a wide spectrum.

That is an open issue. We didn't get into it because it's fluid. It's still fluid and probably will remain so for some time.

MEMBER SHACK: Now, could I build an LWR without a containment if my CDF is 5 times 10^{-7}?

MR. HEYMER: Oh, the large release, yes. If your large release and you've got a high confidence in that number, I would say could you build it without the containment that we know today, the answer would be yes, but you would still need barriers of some sort, I think, I mean, obviously one that is around the cladding and you have a reactor cooling system and then going on out.

But if you had an increased confidence in the fuel-manufacturing process and the cladding and in the retention within reactor coolant pressure boundaries for some reason, perhaps you've got a new type of design that was built or whatever. And you could make a case. I think you could come in and make the case. I'm not going to say it is going to be an easy case at the moment, but I think you could make the case.

I think those are some of the issues that we are talking about and working through that came up in the pebble bed. And that was sort of the icebreaker. I think that is what we have got to look at, is what is the risk to the public and how confident are we about that. That leads us into defense-in-depth and the processes that --

MEMBER WALLIS: It's not just pebble bed. I think that AP1000 might not need a containment if you just simply go on CDF.

MEMBER SHACK: I don't know that that is what I had in mind.

MEMBER WALLIS: Are you proposing that or is that --

MR. HEYMER: As I said, if you can make the case that --

MEMBER WALLIS: I'm not making the case. Somebody is.

MR. HEYMER: If a vendor comes in with a

design to the NRC and presents it and makes the case to the NRC that they believe or they say, "Based on these reasons, A, B, C, and these design attributes, that there would be a very low probability of a large release, late or early," and we have to define what we mean by "late," and what that means, then I would say yes.

MEMBER ROSEN: You just have a great big tank of water up on a steel structure.

MR. CORLETTI: Speaking for Westinghouse, at this point in time, we are not proposing to go in the containment for AP1000. But I think we would have to think of a different way of dealing with containments. I think that is not a good example there, but --

MR. HEYMER: I mean it is really retention of the radionuclides. That's what we're talking about. I don't think anyone has proposed that at the moment.

Yes?

DR. SNELL: I'm saying this not as an endorsement but just as a matter of information. The Russians had a heating reactor design. It's very low pressure. This is a double pressure vessel. I think they made a very convincing case you couldn't uncover the core because of the two vessels. You couldn't really tell both of them.

There are designs out there that have tried to explore this concept.

MEMBER SHACK: I might buy it if the number were something other than 10^{-5}, you know, if you told me the probability of a large early release was 10^{-8}.

MEMBER SIEBER: I think you would have a better chance of making your case.

MEMBER ROSEN: The trouble with 10^{-8} is I can't believe numbers that small.

MEMBER SHACK: Then you have a different problem.

MEMBER SIEBER: I guess the regulations in my mind encompass two things. One of them is engineering principles, including probablistic. The other thing is the politics of regulating an industry in the interest of the public. The Commission will decide based on everything they know what they will allow and what they will not.

MR. HEYMER: Yes. And what we are getting into at the moment will expand on that discussion where we talk about uncertainties and what we really mean by 10^{-5}.

Defense-in-depth. We believe it should be defined somewhere, preferably in the regulation. At the moment when you talk about defense-in-depth, it depends on who you talk to. You get a different story.

We believe, and I think the next graph shows it. It is like a programmatic process that you build on and take into account probablistic insights and uncertainties and also apply deterministic and design and operational features that compensate, in part, through events that have a high uncertainty and significant consequences.

What we have tried to do here is develop a process, a flowchart. This is a little bit complex, I think, but perhaps for a high-level discussion. What it shows here is you develop the design, you do a PRA, and you determine what are the key uncertainties and then say, "Are those uncertainties acceptable or unacceptable?" That's where we need to do some work and work needs to be done, be it research or further development work by us at NEI.

I think the end story is if we want to make this happen as it is shown on here, we have to sell it to the NRC. So I think they are going to have to at least have their owns views and opinions of what that is if they actually buy into something like this.

What are those uncertainties, and what is an acceptable and an unacceptable uncertainty? If you come out with no, you then say you can apply additional risk management activity, like perhaps we have an (a)(4) dimensions rule.

We can increase the performance monitoring, what you are monitoring, and the frequency of monitoring. You can actually adjust the design and add perhaps safety margin. You can add additional system as regards redundancy and diversity or you can do additional testing and analysis to reduce the uncertainty.

If you do all of that and you've still got unacceptable uncertainties, you go back and tweak the design some more and repeat the process. That is how we saw it coming out. And that we felt incorporates probablistic approach as well as keeping that some more of a deterministic defense-in-depth.

It comes down to how do you define key uncertainties, and that is probably not as difficult as when is an uncertainty acceptable.

MEMBER WALLIS: We need measurement. You need measures of these uncertainties. To do testing, you need to have some idea of how much uncertainty that has removed in some quantitative way. You need to have safety margin defined in terms of uncertainties. So it all has to tie together in some --

MR. HEYMER: That's right.

MEMBER WALLIS: -- logical way which can be computed and people will agree to.

MR. HEYMER: That's right.

MEMBER SHACK: You also have to have faith that you can identify --

MEMBER WALLIS: Faith is not part of this. Faith is not --

MR. HEYMER: You have to have measures that both sides agree that how you identify the key --

MEMBER SHACK: My favorite example for this week is electromigration is a damaging mechanism for instrumentation and control in nuclear reactors. Until it happened, how many people would have anticipated it in the design?

MR. HEYMER: Yes. Anyway --

MEMBER ROSEN: My favorite example is when you get done with defining parameter uncertainty and all the other kinds of uncertainties that you can define and work on, you may say, "Well, I've got all the uncertainties now. I, therefore, don't need any defense-in-depth except for one problem." You've got model uncertainty, which includes that which you don't know.

So you cannot reduce that which you don't know by knowing it because once you know it, you're back to a smaller set of things you don't know. So you will always have the unknowable or unknown, and you need some defense-in-depth for that.

MEMBER SIEBER: Unfortunately, you don't know what you don't know.

MEMBER ROSEN: Yes. That's the real tough part. You have to take it as a matter of faith that there are some things we don't know. Now, I know that is not true with you, but for myself and other members of the panel, I think there are things I don't know.

When you are done with the design process, you are really in that spot all of the time. You think you've got it, but you've got to believe if you are an experienced designer that there is stuff you don't know.

MR. HEYMER: We're in that position today.

MEMBER ROSEN: That's right. That's why we have defense-in-depth.

MR. HEYMER: And this is perhaps another way of saying this is how we are going to add additional features in somewhat perhaps a measured process or see if we can do it.

And so that's why I put it out here today because I do think it is an area. If we go down this path, this is something that we need to focus on to see if we can get there.

MEMBER SIEBER: Unfortunately, the process that is described in that chart deals with things you do know. And so you go and do a risk analysis and say part of the uncertainties are acceptable, which presumes that you know what the constituents of those uncertainties are, you say, "I need" this or that.

But if it's really true, which I believe that it is, you really don't know what you don't know, whether it's model uncertainty or what phenomena take place or failure frequencies or whatever aspect it is. Defense-in-depth becomes an add-on that says, "Okay. Regardless of what I don't know and what I haven't dealt with, I've got this extra layer of protection."

That's where it started out. I'm not sure you can just legislate it away on the basis of a risk analysis.

MR. HEYMER: Well, anyway, it's an idea.

MEMBER SIEBER: Okay. We'll move on, then.

MR. HEYMER: Some examples of what you probably if you read the document don't see, you don't see an equivalent of 50.49 or 50,46 because what we're saying is that if you produce a design that meets certain core damage criteria or other criteria as determined by the light water reactor and underneath that is a series of requirements, "Well, this piece of equipment or these systems have to operate in this environment," there is a design specification for that. There is an engineering specification for that. And you have to go out and procure it and provide some evidence that that equipment is going to function in that environment just as if you're in a North Sea oil rig out in the fortes field and you want to anchor it, you're going to do some testing on the anchoring.

MEMBER SHACK: Yes, but the question is who is going to set those requirements? Is it going to be the vendor, the designer, or is it going to be the regulator?

MR. HEYMER: We see that those requirements will be initially set by the designer, presented to the regulator, brand new type of design, for example. And then the regulator would incorporate those and say whether or not they agreed with them or not and develop a standard review plan. And in that,

that is where those requirements will be. And subsequent designs of that type would have to satisfy those.

MEMBER SHACK: But his acceptance criteria for judging whether those criteria were acceptable or not would be done on an ad hoc basis?

MR. HEYMER: I wouldn't say it is an ad hoc basis. There would be a engineering basis to it that would be either developed I would think by the designer and verified and approved by the regulator.

MEMBER SHACK: I guess I am still with the basis for the regulator to verify and approve them. Would it be his engineering judgment? They were good enough?

MR. HEYMER: Today there are databases out there which regards what material. It withstands certain temperatures, certain environments. And that is what both the designer and I would assume the regulator would use.

So it's a similar process today, but we don't be specific in the regulation. We keep the regulation at a high level. We keep the detailed requirements down in the regulator, if you like.

And you can still draw the string from, well, you haven't met this part, you're not meeting this part in the reg guide. Therefore, by inference, you are not meeting the regulation. And that has been done on numerous occasions in the past.

On codes and standards, that is an area where I think you have spoken a little bit earlier today. You won't see an equivalent regulation to what is in 50.55(a) today. However, we think that the application would have the listing of applicable codes and standards that the design was designed to or that you're going to operate to. That would be put in the FSAR. And the approval process for the design or the license, the FSAR would reflect those. And they would be controlled through 50.59.

So 50.55(a) would become a much more streamlined, specific requirement than it is today. You try and read it today, and it's 15 pages. And it's very convoluted. We think that could be simplified. But the details would be put in the FSAR, and that is the place to control them.

That needs a certain amount of adjustment, both in the NRC and in the codes and standards community.

MEMBER SIEBER: I presume, then, that if the ASME or whatever identified a new problem and a solution and amended the code, it would no longer be a mechanism for the staff to impose that new requirement on a licensee as they are now under updates through 50.55(a).

MR. HEYMER: We would see that perhaps the language in 50.55, what would be 50.55(a) in the new process or whatever it is, 53 something, would have in there something that says that the licensee would update in accordance with the co-committee recommendations.

I mean, I think that is how that can be handled. Today if something new is identified and it is a safety issue, the NRC can take the necessary action to --

MEMBER SIEBER: Outside of 50.55(a)?

MR. HEYMER: Outside of 50.55(a), to impose that. We are looking at that now, that whole process, in codes and standards to try and simplify it somewhat, certainly as regards codes cases and then stepping on. And this was just taking a much bigger step.

MEMBER SIEBER: I think it is worthwhile to simplify, but I feel uneasy about eliminating a requirement to update when it's necessary.

MR. HEYMER: Well, when it is necessary, you have already got that ability with the regulations today to say if you need to update this as a safety issue, if you are talking about like a ten-year update to the codes, is that --

MEMBER SIEBER: Yes, which would reflect new inspection techniques and procedures and things like that, which you would not call a safety issue.

MR. HEYMER: No, but, on the other hand, that could be written into either the FSAR or into the regulations itself as a general statement, rather than going as we do today every time that you want to go and incorporate the latest revisions to the code. You have to go through a rulemaking to put it into 50.55(a).

MEMBER SIEBER: That is complex. On the other hand, that is a detail that is probably not worth discussing in a general discussion like that.

MR. HEYMER: Well, I think you've got a --

MEMBER SIEBER: You get my feeling.

MR. HEYMER: Yes. And that's why we believe that there is a process in place. We're not saying that codes and standards are not important. And if there are new measures and new techniques that come along, that should be incorporated.

MEMBER SIEBER: Before the NRC came along, somebody built buildings and bridges and all kinds of things that stood the test of time most of the time. So the codes I think are very important.

MR. HEYMER: Yes. And we would agree with you.

MEMBER SIEBER: Moving on.

MR. HEYMER: As we move, this part isn't in the NEI 02-02, but it does flow out of the last discussion aspect. I think it is an area where we are drifting into this where perhaps research needs to at least get involved or be aware of what is going on.

As we go to a new global marketplace, there are different designs being performed in different countries, different nuclear designs. And they have been approved by different non-U.S. national nuclear regulatory agencies.

As we have seen with the reactor vessel head, the problems that Virginia Power went through trying to do a full-scale reconciliation analysis between the French code and the American code so that they could use the head, I think begins to identify this.

And now we have, for example, in the table here, AECL. We have Framatome with their designs that they wish to come and have approved. And, as I spoke before I started the discussion today, I think we need to have a mechanism in place by which we can assess those codes, not necessarily take it as a rubber stamp but take advantages of those reviews that have been done and apply them.

I also think there needs to be reciprocity going the other way. And I think that may be an issue that needs to be resolved. And it could be harder. I think going to what I said before, the NRC review should take into consideration information made by other foreign national regulatory agencies.

A number of people spoke and said they need to have harmonization on a global between national regulatory agencies so that a design that is approved in France or Canada is automatically approved in the United States. I think that is a very long way off.

It's a nice thought, but I think that is secondary to sorting out the technical issues. And I think that is a challenge in itself before we even begin to start thinking about the last major bullet on that slide. I think it is a noble goal, but I think we are going to struggle getting the technical understandings in place. And there are legal and other issues associated with such a reciprocity of reactor designs.

I have spoken as I have gone through this, and I just tried to do a summary slide here a little bit of some of the issues that have been identified in the development and implementation of a technology-neutral set of NRC requirements.

We spoke about uncertainties. We have spoken about the metrics and performance criteria. We have spoken about containment, early and late radionuclide release. The issue on codes and standards, I think we are on the same page. It just may have come across that we are not, but I think we are definitely very much on the same page there in that regard. So I think there are areas that either research needs to be done or that needs to be a close relationship between the potential applicant and the NRC.

In previous discussions this afternoon, you have heard about, for example, material issues. There are operational issues. There are system interaction issues. And you are going to hear a little bit more about that in a minute as regards the IRIS design.

There are matters that EPRI interacts on a regular basis with the NRC research to talk about research that will benefit both sides, both the NRC and the industry. But I think the fundamental underlying theme here is that the scope of research from an NRC perspective should be defined by market interest and issues raised in the preapplication process.

I think we need to do something in the area of foreign codes and standards, mainly because a number of major components are now manufactured outside of the U.S. There is not that capability within this country. I think we have already got a reasonable handle on that, but I think we need to think about improving that process.

What I would like to do is to take --

CO-CHAIRMAN FORD: Before you get off that one, Adrian, maybe you weren't here when we had the discussion this morning about regulate as you go. Maybe you were here.

That last bullet, last media bullet, indicates that, really, the amount of research you do at any one period of time is defined by market interests. In other words, it is a large market interest of putting a particular design, large driver, particular design, on the grid. Then we go for it. And then we regulate if there are problems subsequently. Is that what you are advocating there?

MR. HEYMER: I didn't quite follow the last bit. Someone comes in with --

CO-CHAIRMAN FORD: Someone comes along. We will say Design X, rather than a specific design. Design X comes along. There is a buyer for it. They want to get it onto the grid at PDQ; i.e, there's a market interest. So you forego doing the necessary research to define the safety impact, et cetera, et cetera, and you shove it onto the grid.

Then you find something wrong. Then you do the research; i.e., the operational feedback. And then you regulate it; i.e., you regulate as you go.

That's what I read into that last media bullet. I hope it's not right.

MR. HEYMER: No, it's not right.

CO-CHAIRMAN FORD: Good.

MR. HEYMER: No. What I mean by that is I see as regards NRC research, there are four areas. There are emerging issues, such as material issues that we have got at the moment, vessel heads and cracks in pipes and perhaps aging mechanisms, et cetera. That's emerging issues, and that deals with the existing fleet. Really, I would say that is number one.

Then you have got issues that are

associated perhaps with direct licensing applications of "I want to operate" license applications.

Then you have issues dealing with an application for a design approval or design certification, but hopefully before you got to that stage, there had been issues identified in the preapplication on what I think is also in like the pre-pre or the familiarization in that someone, for example, as Dr. Snell said, comes in. I believe they have a market in the United States. They have some utility interest. They have some utility advisers there working with them.

And they say, "We are going to be coming in a year, two years with a preapplication. This is a brand new design. We would like to get the NRC up to speed and a better understanding of the design. And we are going to be doing some testing so that when we present the results of that test, those tests, and please come and witness those tests, then you get a better understanding of it. And then if you need to do more confirmatory research or more work" --

CO-CHAIRMAN FORD: I understand. And for the evolutionary and advanced light water reactors or the reactors like the ACR700, there might be some things we don't understand, but you have got experience already. That I don't have any problem with. It's more the gas-cooled reactors where there are some serious question marks on the core neutronics, a whole series of things, for which we don't have a big database.

There you might be talking five, six years to get that research. So what would you advocate? Would you advocate waiting to get that data before you start to get into any serious application situation? Obviously not. What would you --

MR. HEYMER: I think you go back and say what happens in other areas, where we have run into that problem before or that issue before. You go back to when we first started building reactors in this country. Did we just go and slam them on the grid? We didn't.

CO-CHAIRMAN FORD: No.

MR. HEYMER: There was research. There was some testing. And then --

CO-CHAIRMAN FORD: A couple of big safety margins.

MR. HEYMER: Yes. And there was a couple of research or prototypes developed. And whether or not you build those prototypes somewhere and put them on the grid, you still would have some form of safety mechanism there. So it's a small step as you go.

I also think you can take advantage of what has gone on elsewhere in the world on some of these designs and incorporate that into your research. But I don't think, as you said, I've got this urgent need if somebody wants to put -- I've just got to put it out there. And I'm going to regulate as you go.

I don't think the public is going to buy that, and I don't think you would last very long in the business community if you went that way because you only have to see a mind of wobble on the plan to cause a fluctuation in the business aspects of a plan. So that is the way we see it going.

MR. VINE: Adrian, let me just add to that. I can't imagine an owner operator or licensee having any less concern than the staff would have about taking an approach where you aren't just as assured as the staff is that that design is safe and should be operated.

When we talk about market interest, we are really trying to talk about answering questions associated with the allocation of staff resources, time, research dollars, and so forth, and that the market interest ought to guide the research allocation and prioritization process but not to go down that path you just described.

MEMBER WALLIS: If your judgment was exactly the same as the staff, we might not need a staff at all.

MR. VINE: There are checks and balances there that are of value.

MR. HEYMER: Yes, there are checks and balances. And I think what you have said is --

MR. VINE: Our interests are the same.

MR. HEYMER: -- a good lead-in, Dr. Ford, to the slide that Westinghouse asked us to talk a little bit about. And that is why Mike Coletti is here.

IRIS is an integrated design, as you probably well know, but there are some unique features, helical steam generators and what do we do about those. I think -- correct me if I am wrong, Mike -- Westinghouse with its international consortium has got a testing program going. I believe they are making the NRC aware of that testing.

Here is a place where they are going they are trying to develop, but they made a statement that they see them coming in for a design certification I believe in the 2006 time frame. And they believe that there is a market there.

So this is sort of their way of going about this, taking these small steps at a time. And this is where they see that there needs to be some research done and that they want to make sure that the NRC is up to speed in this area.

Now, perhaps when the NRC reviews this work or other work, they may have some questions or may want to do some additional studies. And that is part of the to and the fro of the understanding of the design and the interactions.

MR. ORLANI: Yes. If I can add something, that was supposed to be just a list of examples of -- oh, sorry. Luca Orlani from Westinghouse on the IRIS project. That was just supposed to be a list of examples of separate ethic and integral ethic tests.

Actually, our approach is, first of all, Westinghouse's position is that we don't want activities to overlap on AP1000 and on IRIS. So the schedule for the recertification on IRIS will strictly depend on when it is completed for AP1000.

From the point of view of testing, what we actually are going to do right now is to provide in the next few months -- we have started a first phase in our preapplication, provide the NRC with sufficient documents to understand the plans and understand our position and especially our phenomena identification and ranking table. After that, we will propose a test program differently from other reactors.

Well, there are probably more issues beyond the fact that it is a newer and younger design, but what we will actually want to do is discuss the testing program with the NRC before actually starting the testing program and selecting the facility.

So we will actually take those, these years, to actually from our point of view improve the way of interacting from the NRC from the point of view of testing.

CO-CHAIRMAN FORD: Do I also understand that there is a certain measure here of doing your PIRT based on risk? Is that not a possible way of doing it, taking the argument that if the risk is low, my potential risk in terms of not understanding thermal hydraulic behavior with a helical steam generator, I needn't put to it now because the risk of my being uncertain about the outcome of that was low. Is that a possible way of --

MR. CORLETTI: Luca, do you want to handle this as far as the PIRT?

MR. ORLANI: Probably for the PIRT I can say something, but I think that is the exact definition of the PIRT. The PIRT is a phenomena identification and ranking. It is done essentially for transience events. Those are selected.

Well, in the case of IRIS since we are doing it with a standard licensing approach using the same methodologies used for other light water reactors, the purpose of a PIRT is exactly identifying what are the phenomena that are more important in the analyses and in the outcome of a transient, rank those and naturally accepting larger uncertainties, less knowledge, extensive basis for those phenomena that are deemed not important.

Naturally the fact that the helical steam generators are indicated as first in that table means that from our initial activities and our PIRT right now, those are indicated as very important in several accidents.

CO-CHAIRMAN FORD: Okay.

MEMBER WALLIS: Well, they are important, but if you have a code which can predict their behavior very well, --

MR. ORLANI: That's correct, but --

MEMBER WALLIS: -- then you don't need more work.

MR. ORLANI: That's correct. The problem

is that we think that we need any testing campaign on helical steam generators because we consider that the present assessment base for validating the codes and our analysis tool are not yet sufficient.

MEMBER WALLIS: You have reason to believe that the phenomena are different that perhaps so far have been modeled in the code.

MR. ORLANI: That is correct.

MR. CORLETTI: Yes. The PIRT serves to then plan your test program and to identify which phenomena you need to follow up with more detailed testing.

MR. HEYMER: In addition to sort of component and system, inter-system, testing, there is also analysis, analytical codes. And in IRIS, Westinghouse will be coupling RELAP and GOTHIC for better analysis. And that is where they see that, just as Luca and Mike described, there is a need for good interaction between themselves and --

MEMBER WALLIS: This is the containment in the vessel and then the --

MR. HEYMER: Right. And then, in addition, although it is under operations, it is really testing new in-core types of in-core monitors and silica carbide and a process for measuring the consistency and thickness of the helical steam generator tube. These are new ideas. And, again, they need to be tested out.

These are an example of where do I actually start interaction with the NRC on this research issue because if you wait until the application, it's probably too late. The preapplication for some of these issues may again be too late. So you've got to really start thinking a little bit ahead and planning, which is what they are doing.

I think this just gives an example of though there is a priority scheme, you do have some of these new design concepts coming in. And if there is an interest by the power producers, then I think that is the way we should place our emphasis. And I think that it wouldn't be going ahead unless there was an interest by the power producers. Most of these designs that we mentioned this afternoon do have a group of utilities helping them in that area.

Sorry, Luca.

MR. ORLANI: I think it's complete. The only thing, the reason why those detectors and instrumentation were added in these slides is because usually testing programs are more focused than thermal hydraulics and structural analysis while if you look at IRIS, it is a pressurized water reactor, but it has an integral layout.

So there are some instrumentation issues that are typical of the constant. And we will consider that those are the things that we want to address very early in the preapplication at the time to actually validate and test all of those new methodologies and systems.

MR. HEYMER: With that, Dr. Snell, did you want to say anything? No.

With that, I will hand you over to Gary Vine from EPRI, who will give the EPRI presentation. Gary?

MEMBER WALLIS: You have 38 slides with a lot of writing on lots of them.

MR. VINE: Not a problem.

MEMBER WALLIS: Not a problem. Okay.

MR. VINE: I will be done before 5:00.

Since this is a joint meeting of two subcommittees, one of which has responsibility for reviewing all of the NRC's research activities, I wanted to spend a little time in this overview of what I am going to cover on how we work with the Office of Research and explain our MOU and the principles behind it and how we deal with the issue of independence and so forth because I think they are kind of fundamental to how industry works with NRC in the research environment and I think has some direct applicability to the advanced reactor issues we will be discussing.

Just a quick summary of what EPRI is, what its membership is, what its scope of activities are. This slide shows you that all U.S. and Canadian reactors are full members of EPRI. Blue represents full membership, full rights, and so forth. In Europe, about half of all the reactors in Europe are members of EPRI nuclear. Another 42 percent are partial members in certain programs that we undertake, Latin America, almost the same. And now with the recent joining of EPRI by TEPCO, we have about 25 percent of Asian reactors.

This all totals out to over 40 percent of all U.S. reactors are full members of EPRI nuclear and over 75 percent are at least partial members.

MEMBER ROSEN: All the U.S. utilities are now members?

MR. VINE: All U.S. utilities are now members.

CO-CHAIRMAN FORD: But no German utilities?

MR. VINE: No, not yet. We are working on it. I think some of them are partial funders.

This is kind of a schematic of our overall research program showing that things are really focused on management, cost management, aging management, asset management, rad waste management, and what we are now I think calling more and more in our approach to safety and risk-informed regulation the concept of risk management, which we are doing a lot of work on right now.

We have a strategic plan. I am not going to go through it in any detail. I have two slides to cover the 17 key objectives in our strategic plan. It's focused out to about five to ten years to give us a little bit of guidance on what we should be actually putting in our three-year cycle research plans, something that Steve is very familiar with. You will notice on the second page here there are there objectives associated with advanced reactors.

We have significant utility executive involvement in the strategic planning process that really allows us to ensure we have a market-driven plan for the future. And we have been very pleased at the level we get from the execs looking into the future, which is kind of opposed to the conventional wisdom that the industry is very, very short-term focused.

Our research program is short-term focused, but the planning is really stretching out there with a lot of work on scenarios and so forth and what could happen if certain things don't work as we expect.

It very much is aligned with NEI's Vision 2020. And because of the fact that it really is defining market needs in nuclear research, we think it has a significant opportunity to influence the way government R&D policy is developed in what it prioritizes, both NRC research and DOE research.

CO-CHAIRMAN FORD: Before you leave that particular slide, on NEI's Vision 2020, part of that vision is to put 50,000 megawatts electrical on the grid by 2020, which assumes that new plants will be going online by 2010, 50 new reactors or whatever it is going to be.

What feeling do you have from your customers as to the reality of that?

MR. HEYMER: Let's just talk about how we got the 50,000 for starters because a lot of people have the same reaction. We got that really working off the EIA-DOE national policy sort of suggestion, recommendation that we try and get 30 percent generation emission-free by 2020. And then if you look at that, you see that hydro, in fact, drops off somewhat.

There is a fairly substantial increase looking at the EIA projections on solar and wheat, but there is also a large gap and we think nuclear is going to fill that gap.

If you think about the fact that electricity generation grows as gross national product grows, advances according to the growth of the country, then we think something like 10,000 megawatts can come from power up rates and renewal, et cetera. But then there is like 50,000 megawatts that we think you would need to try and get to that 30 percent. So it's a goal, but --

CO-CHAIRMAN FORD: Of new reactors?

MR. HEYMER: Of new reactors. So it's a goal based on that emission-free generation. And we see that probably -- does that mean 50,000 in operation? No. We think that's 50,000 either built, operating, or in the pipeline, ordered, et cetera. So that's how we got the 50,000.

A number of people say, "Well, we could never do that." But if you go back 15-20 years, we were actually turning plants out close to that rate in the late '60s to late '70s, early '80 time frame.

CO-CHAIRMAN FORD: The 50,000 comes from an energy policy, of 30 percent non-emissions.

MR. HEYMER: Yes, and then we throw it back to that.

CO-CHAIRMAN FORD: It's a high level, but to actually do it, you need people who are going to build the plants and buy the plants.

MR. HEYMER: Right.

CO-CHAIRMAN FORD: The question is do you get a feeling from your customers that that is, in fact, going to happen?

MR. VINE: Well, there's a chicken and egg problem here. I think if you just do the simple analysis -- EPRI has done a lot of work with the EIA, NEMS model looking at a lot of different scenarios, looking at realistic codes for advanced nuclear, such as AP1000. We see significant market penetration. And we also see even if you take a look, for example, at what 50,000 megawatts really entails in terms of overall support of an increase in energy capacity in this country with some pretty conservative assumptions about load growth.

That 50,000 really equates only to about

10 percent of all new capacity additions between now and 2020. So it's pretty modest compared to what one might expect given the pressures on fossil fuels over the next 20 years and what they are going to be facing in terms of challenges to meet our new capacity requirements.

CO-CHAIRMAN FORD: So the bottom line is that from a nuclear businessman's perspective, you fully expect that there will be 30-40 new reactors on the grid by 2020?

MR. VINE: It's a chicken and egg problem again. I didn't really finish the point. The real issues here are getting over the hurdle of the economics associated with construction because of the high capital cost, the licensing hurdles, and all of those issues that are still somewhat unknowns.

We think that the industry is willing to attempt to make this work if, in fact, we can meet these hurdles and be satisfied that they could be managed with reasonable risks. And I think the idea here is to lay out a reasonable goal and start working all of the programs, research, and everything else to meet that goal on that time line so that we have got a way of measuring our progress against such a goal. And we have looked at it hard enough to think it is not an unreasonable goal.

MEMBER ROSEN: So the 30 percent emission-free equates to what percentage of electricity generation in 2020? What would you see?

MR. VINE: Of that 30 percent, 20 percent is nuclear according to NEI's Vision 2020.

MEMBER ROSEN: Twenty-three percent of the total generation in the U.S. would be nuclear?

MR. VINE: Right, which is slightly above what we have, which is about ten percent higher than what we have now. And the other seven is hydro. It's a little different than what we have.

CO-CHAIRMAN FORD: What you're saying is okay. There are some uncertainties. Maybe there are some breaks in concepts coupled with cost, et cetera. We would be absolutely foolish to say it's never going to happen.

MR. VINE: Sure. If you don't set a goal, it probably won't happen.

CO-CHAIRMAN FORD: I know, but some people are saying it will never happen.

MR. VINE: Right.

CO-CHAIRMAN FORD: But you are saying from a business point of view, it is. I like hearing that.

MR. VINE: We could if we can satisfy

ourselves that the barriers to deployment are being addressed. And I will cover those later in the presentation.

MEMBER WALLIS: On your previous slide, you said you had for many quantification of the value of R&D for decision-making. I say are those just words or do you have some secret of knowing how to do this? This is something that the NRC could benefit from if you have some insights into how to quantify the value of R&D for decision-making. That would help everybody.

MR. VINE: We've done some work in that area. And before we had full membership, we did a lot of work in that area simply to price and value our products, not dissimilar from what other companies would do to value their products.

We are beginning to look at how you can use tools like PRA to do in a concept of an integrated risk management approach -- you are looking at not just core damage frequency. You are also looking at costs. So you are really looking at the overall value of changes to designs and programs and so forth that bring high value.

MEMBER WALLIS: So if someone proposed a program to reduce the uncertainties in thermal hydraulic codes by a factor of two, you could quantify that value of that?

MR. VINE: Probably not.

MEMBER WALLIS: No?

MR. VINE: Not that precisely. But we try to look in a better than subjective way at research products when we prioritize them.

Industry linkage. We have a three-way MOU among EPRI, NPO, and NEI that commits each of us to full cooperation and sharing of information. We have a lot of coordination through common advisers, a lot of joint planning, and so forth. An example of that is today there is a meeting down in NEI of their executive task force for new plants.

The utility membership of that committee is identical to the comparable EPRI committee that guides our research in that same area for advanced reactor work. And they are meeting tomorrow. So the same advisers work with NEI on policy and regulatory interface issues and work with us on the R&D agenda should be to support it.

The next slide has to do with our relationship with DOE and NRC and how we have set up that relationship through three bilateral MOUs. We established one with the Office of Research in late

'97, one with DOE in '99. And there is also a bilateral between DOE and NRC that allows for sharing of information and so forth.

Our MOU with the Office of Research has developed over a significant amount of time and has really been shaped by the policies that have kind of impacted our ability to work together over the last couple of decades. This next slide kind of creates that picture for you.

I think you all remember back in the good old days when industry and NRC could really work together and solve problems together and the lawyers didn't stop us. In the '80s, they started to intervene in that process and not let us work together.

The independence thing became I think excessively applied to the point that we were really not even communicating on issues that were of common concern. We were in a position where we really couldn't come to agreement at the beginning on what the issue was we were trying to solve. We certainly couldn't work on obtaining the data necessary to solve it in any kind of a joint fashion.

The result was this lack of cooperation kind of forced on us by excessive interpretation of the word "independence" got us into situations where it would take ten years to resolve an issue that ought to take one year and in the process, of course, expended a huge amount of unnecessary resources in going back and forth and back and forth on "My data is better than your data" and "My understanding of the problem is better than your understanding of the problem" instead of sitting down at the beginning and understanding it and figuring out what we can do together.

I think this picture changed at about the same time that the Commission looked seriously at risk-informed regulation because when you sit down and try to figure out how to achieve regulatory improvement through risk insights, you are automatically into reliance on science and on data to get there.

That really brought us back to the table. The whole DSI process, strategic planning process that Shirley Jackson implemented in the '96-'97 time frame, opened the door to reconsideration of this independence issue. I think the result was very, very beneficial to the industry and the staff.

The issue of independence has I think been resolved in a very defensible way, as we explain on the next slide. It basically says that industry and NRC can collaborate during the data-gathering phase of any problem solution. And that data-gathering phase could include the joint collection of data, even the common funding of the collection of that data. It could certainly involve reviewing the data to make sure we have got all we need to solve the issue, its accuracy, validation, packaging it, publishing it, and so forth.

And then the next step is we part company. NRC's Office of Research gives the data to NRR and NMSS. We give the data to NEI. And they work together or argue or whatever they have to do to resolve the issue, but at least they are starting with a common set of data. And that cuts years and orders of magnitude of additional expense off the process. And it has worked very well.

Under our MOU, that explained the process I just described. Under our MOU, we now have a number of addenda that address specific areas where we are cooperating. The formal addenda addressed areas of, at a minimum, significant information exchange and at the other extreme involved cost sharing of joint research projects and a lot of things in between where "You do Task A, and I'll do Task B. We'll bring it together and solve the problem" kind of thing.

There are a lot of other areas where we don't have established addenda to the MOU but there is a significant amount information exchange and cooperation in support of what we think are mutually high-priority issues to address.

CO-CHAIRMAN FORD: The way it works is you develop or exchange equal value data?

MR. VINE: Yes. But it's really based on trust. We never require something like it has to be 50/50 because sometimes we can put more on the table than NRC can. And sometimes they can put more on the table than we can. Sometimes it varies year to year, but it comes out I think in a very fair way to both parties. It has worked very well.

The next slide talks about areas of research successes. I will only address the middle one here because it really kind of moves into the area of greatest interest to you. And that is advanced reactors.

This has clearly been a success in that over about a 15-year period from the early '80s to the late '90s, DOE and the industry cooperated on a program that spent over a billion dollars in going through a four-stage process.

The first stage was identifying and resolving regulatory issues applicable to new designs. We basically worked together with the staff to identify every single open generic issue, USI, TMI action item, or anything else that was an open issue for new plants. We went through a prioritization process to determine which ones were applicable to the future designs, which ones weren't, and worked that down to a point where we had a minimal set of issues that we felt needed to be addressed in future designs.

The second step was to develop a detailed owner operator requirements document for all-new plants. That was managed entirely by the industry, led by utility executives with some funding from DOE but not a lot. The DOE involvement really didn't start until we actually got into design implementation.

I will say a little bit more about the utility requirements document later. The third phase was joint cost share development of past safe designs, again jointly funded by industry and DOE. This was the AP600 and SBWR in the late '80s and early '90s; and then, finally, completion of engineering on ABWR designs. And that was completed in the late '90s.

CO-CHAIRMAN FORD: But these are not

collaborative programs with the NRC?

MR. VINE: No, but they had a significant interface with the NRC. I obviously described how that first phase worked. The development of the utility requirements document was, in essence, an attempt to achieve closure with the staff on the specifics of how each regulation would be met such that with a formally reviewed and approved utility requirements document with an SER, which we obtained, the designers would then come in and know exactly what they had to do to satisfy the staff and have that worked out generically for all designs, as opposed to having a negotiation for each individual design. Obviously this --

MEMBER ROSEN: To satisfy the staff and the utilities?

MR. VINE: Exactly, exactly. And our requirements were more stringent, but the idea behind the requirements document, of course, was that it represented an acceptable way to meet all of the regulations.

MEMBER ROSEN: Because the title of it was the Utility Requirements Act document.

MR. VINE: Exactly. It was, in effect, a bid spec by the utilities.

MEMBER ROSEN: Right.

MR. VINE: The third phase was a formal certification program of the two passive designs, one of which went forward through completion. The other one dropped out about halfway through. The SBWR dropped out. And the final one was FOAKE, which had much less direct involvement with the staff because it was really beyond the certification level with engineering.

The next slide just gives some other examples of R&D successes. So many of these involved close work with the NRC. Others are more on the industry side.

MEMBER RANSOM: What has happened to your thermal hydraulic code development? Is there anything going on in that area?

MR. VINE: It's interesting you would ask. We pretty much had to terminate most of that work about two years ago. The RETRAN review fee issue put us essentially out of business.

My boss, Ted Marston, and Ashok Thadani met last week during the nuclear safety research conference and began some discussions about how we can examine some possible ways we can get back into some joint work in this area. We don't have a lot of resources to put on it, nor does the staff, but I think there are some real common interests here in having some better integrated code development between the industry and the NRC. So we are going to start talking about it. It would be very mutually beneficial to do that.

This is just one more slide to give you a bit more of a flavor for what happened during the ALWR program. And it leads into a point I need to make about SECY-02-139. The whole idea behind the ALWR program was to establish a basis on which utilities could confidentially order new plants. And they wanted the designs to be much safer and simpler. We're not talking about just a little bit safer than current plans. We're talking demonstrably safer so that the licensing process would be assured and noncontroversial.

There was a very strong commitment to standardization. And there was also a commitment to competitive pricing, but we missed the mark a little bit because we were focused on coal as the competitor and worked through the whole prices and got ourselves where we were just a little bit beyond the market reach at the end of the program in the late '90s. So we ended up going from AP600, AP1000, and doing some other things to bring us back within the competitive band.

Obviously this was developed part and parcel to the development of Part 52. The whole concept of this program was intended to dovetail the new licensing process. At that time there was pretty strong support among the utilities for improving on existing technology as opposed to making radical changes.

We developed this utility requirements document that I described earlier. It really had to do with three things: to serve as a bid spec for the designers, to serve as a basis for achieving a high degree of standardization, and the inherent cost savings to the industry that would result from that standardization, common structure system components, processes. You know, it was a life cycle standardization concept, not just parts, and obviously regulatory stabilization coming from that process, as I described earlier.

There was an annual strategic plan to build new plants that was started in 1990 that incorporated both the ALWR and all the NEI activities, before NEI its predecessor organizations that dealt with communications, government interface, and so forth, to really have an integrated plan to do all of this, and culminated in '98 with really the completion of all the required tasks in a market that wasn't quite ready for new plants. And that is where we have kind of gone through this hiatus of both NEI programs and EPRI programs and kind of reemerged now behind Vision 2020 to bring a renewed focus in this area with a little bit more practical understanding of the marketplace under deregulation and what we have to do immediately.

MEMBER LEITCH: How do you deal with uncertainty in the data when you were talking about competitiveness with other forms of generation? It seems to me that one of the major drawbacks with nuclear is the uncertainty in the prediction of the price.

I mean, you can pretty well tell when you kind of build a coal plant. You know exactly what you are going to do and how to do it.

MR. VINE: Actually, it's the other way around.

MEMBER LEITCH: It's a pretty tight thing.

MR. VINE: The uncertainty that plagues us is the price of natural gas or coal. And I am not an expert in this area, but I think that the people who are are pretty confident in the models, the economic models and as we continue toward completion of engineering pretty confident in the cost numbers for our plants.

What is hard to guess is what the price of natural gas is going to be. And so there is a lot of hedge in the planning process for that and a lot of things that both industry and DOE are talking about to deal with that uncertainty. And it has to do with, as I am going to describe later, cost sharing and one-time costs, getting the federal government assistance in areas like stabilizing the marketplace level playing field in the rules and regulations under which new technology is put in the marketplace, equal treatment of environmental benefits, ability to look at things like power purchase agreements, long-term power purchase agreements, lots of things having to do with condition of the marketplace with the variations in deregulation that exist all over the country. So it's a pretty complex picture, but DOE is doing a lot of recent work in that area that is very good and supported by the industry.

MEMBER LEITCH: So you feel rather certain, then, about your ability to predict the cost of new nuclear generation?

MR. VINE: The designs that are either certified or are well enough along in the process, such as AP1000, I think the answer is probably yes. There are still some issues there. And they have to do with what we can assume in terms of DOE support. A lot of questions about the timing of completion of all of the design reviews by NRC, the SP and COL are big areas of uncertainty and the effect, time to market, and cost.

MEMBER LEITCH: If I heard you correctly, you are saying that you think that those uncertainties are less than the uncertainties of the fossil plants due to the variability in field price.

MR. VINE: There are big questions, of course, about where the government is going to be going with deregulation. It has a big impact. And we know less, of course, about the more advanced designs in terms of cost.

MEMBER LEITCH: Yes.

MEMBER SIEBER: I guess the other factor is there is a difference in timing. You make a commitment with up-front money further in advance of commercial operation with a nuclear plant. So you're subject to wherever the finance markets go and where all of these other costs go while you have that commitment.

MR. VINE: Right.

MEMBER SIEBER: That was a major uncertainty in the late 1970s and early '80s.

MR. VINE: And it is much more difficult now because of deregulations.

MEMBER SIEBER: That is right.

MR. VINE: And, again, DOE has chartered a study called the Scully report that has looked at some models from the transportation sector. And how to do that is a public-private partnership. It is a very good study.

A quick summary of our current plants and how we have kind of gone through this hiatus. We, first and foremost, support NEI in any of their required activities, such as early site permit documents, which I will cover later.

MEMBER ROSEN: Gary, what page are you on?

MR. VINE: I'm sorry. Oh, I missed enhanced safety. I'm sorry. The whole point of this lead-in on utility requirements document and so forth was to make the connection back to Steve's earlier question that has to do with enhanced safety.

This was a critical question at the point in time when the utilities were first kind of responding to the survey and deciding whether or not it even made sense to consider new nuclear again. This was a few years after TMI and there were real doubts as to whether or not we would ever build new nuclear again.

The utilities, as I said, were absolutely committed to significant increases in safety, but they felt that if those increases in safety were simply absorbed directly into regulation; in other words, the cross bar was brought up to right where we achieved the enhanced level of safety, that we were in a non-starter situation, that that just wouldn't work.

So there were a lot of discussions early on. And it had a direct bearing on the advanced reactor policy statement, severe accident policy statement that came out in the mid '80s, where it was very clear from the Commission, as I say here in the slide, that they expected new plants to be safer and they expected the industry to deliver designs or review by the staff that were significantly safer. But they did not expect and they specifically went through a Q&A process of the policy statements that said they don't want to ratchet the regulations out to that higher level of safety that is being delivered by the industry.

This whole thing really got debated and discussed over the course of probably close to ten years from the mid '80s through the mid '90s. This slide documents some of those interactions and, first of all, why we felt on the industry side that we needed to have that extra margin. We needed to be able to have the flexibility to design the plant in the most optimum way to meet all of the regulations. We needed to have the ability to design in extra margins to deal with a lot of things that I list there, including uncertainty. And we wanted to be able to preserve those margins as a basis for assured licensability.

The Commission continued to support this concept through a number of SRMs that very specifically said that these higher-level goals that the industry sets should not be imposed as requirements. They disapproved, specifically disapproved, the 10^{-5} CDF, which was our requirement, on the designers. And you can go on down there.

The Commission basically said that if you raised the requirement on the regulatory side up to 10^{-5}, you are basically invalidating the safety goal or avoiding the safety goal. If we set the bar at 10^{-6}, would the staff move the bar up to 10^{-6}, you know, that kind of a question.

There were a few attempts to look at how advanced reactors could be regulated to a higher level of safety. All of them failed, including ESBWR, a rulemaking for ALWRs, the applicable regulation process we went through for about four years. All of those failed.

We think that the record is very clear. Enhanced safety is our responsibility. And we have proven that we can deliver it. And it gets certified into the regulation by basically certifying the design features that meet that. So the staff is assured that enhanced safety is provided without having to change the regulations to get it. So that I hope clarifies any questions you may have about the number one item in SECY-02-139.

In our current programs, we have some technology programs that are generic to all future plants. And we are making significant progress in both information management systems and a construction modeling; in particular, in partnership with the AP1000. And basically for all of the things that NEI needs done, like early site permit work, COL work, that generically supports the industry, we will support NEI in the cost of developing those products for NEI. And we have done for early site permit products, which I will describe in a minute.

We are working specifically with Westinghouse on AP1000, with GE on the ESBWR. And we are working in gas reactor technologies in areas where we can identify a technology need that is generic to both the HT-MHR and the pebble bed. There is another slide later that gets a little bit more into detail on that.

The budgets for our advanced nuclear programs average five, maybe a little bit more than that, per year, five million per year, out of a total EPRI budget of about 90-95 million dollars a year. So we're spending a little over a million each year on these generic programs, a little bit over a million a year working with Westinghouse on AP1000, similar for ESBWR, and then a little bit over a million on average each year on gas reactor technology work.

I am not going to spend a lot of time on the information management and construction modeling. Suffice it to say that we have made significant progress in applying technologies that are really state-of-the-art in both information management and construction technologies. Just to give you a flavor -- and maybe you have got the details on this better than I do, but I think in the case of construction technologies, we are really pushing the envelope to adapt CAD-CAM technology, 3D technology, with the time element embedded in it such that you can construct the plant online with the level of sophistication in that time element, that you can actually come back and redo the construction sequence and optimize the construction sequence in a way that saves significant time in the construction process.

I think we work together to the point we probably saved I think close to six months off the construction schedule for AP1000 with this technology. So it is really valuable.

MEMBER SIEBER: What does it mean when you say you are resolving the integrity issues?

MR. VINE: Which slide?

MEMBER SIEBER: It's right there, "too costly to manage and resolve."

MEMBER SHACK: Second sub-bullet below the first one.

MR. VINE: I think that is database integrity. I don't think that refers to --

MEMBER SIEBER: I sort of presumed that, but I'm not exactly sure what the problem was that you were saying it was "too costly" to fix.

MR. VINE: I think that is data integrity.

MEMBER SIEBER: So what does that mean? Does that mean you aren't going to use the advanced data management system? It's too costly to make it right?

MR. VINE: Let me think about that.

MEMBER SIEBER: I am not sure what to conclude or why you said it. So AIMS is fixing it?

MR. CORLETTI: Yes. AIMS is attempting to address the management of this information that makes up the licensing basis.

MEMBER SIEBER: For AP1000 and beyond?

MR. CORLETTI: This is the issue that they are trying to address for operating plants. And we are looking at it for AP1000 as well.

MEMBER SIEBER: Thank you.

MR. VINE: Thanks.

MEMBER WALLIS: Let me try to understand this. There are four different plants or four different views of the same plant or --

MR. VINE: I think this is another one of those things where I have to hit it a few times to get all of the pieces in here. I don't know if that is all of them or not. The idea is to have an integrated database that captures and maintains in a very retrievable way all of the information from physical plant, record plant, the analytical plant, and license plant.

MEMBER SIEBER: It's all one plant.

MR. VINE: It's all one plant.

MEMBER SIEBER: Three or four virtual plants.

MR. VINE: If you have been through a construction project, you know that these things can diverge. And you have really got to maintain integrity in the process. And we are starting in the design phase and not trying to do it as an add-on as we have had to do at different points.

MEMBER LEITCH: Does this have the flexibility to be expanded into the operating phase as well for maintenance records?

MR. VINE: Yes, yes. Absolutely, absolutely. Life cycle. And hopefully with the family of plants, standardized plants, the ability to transfer data from plant to plant, you are looking for an engineering solution and the other plants worked out. It's all retrievable. I get highlights of construction benefits.

ESP products we have developed for NEI and the NEI ESP task force, the industry guidelines for preparing an ESP application, basically a template, and also the siting guide, which is kind of the business tool for evaluating for an individual utility evaluating all of its potential sites and evaluating what the pros and cons are of each site and their optimization of site selection. We are beginning to think through the process of an overall program plan for COL as well.

A little more detail on LWR design-specific projects. Again, as I said before, we are working with AP1000 and ESBWR. We provide direct financial support to Westinghouse. GE is indirect because the funding to ESBWR is based on the royalties we are getting back from the sale that was set up as a condition of the LWR program sand the royalties that come back on sale of ALWRs. We are folding that back into ESBWR R&D.

Average between Westinghouse and GE designs, we are projecting costs about 30 degrees lower, 30 percent lower than the estimated costs we have for the certified design. So that's this. It brings us back into the ballpark we need to be in.

Interactions with DOE. Let's see. I skipped HTGR projects. We covered these a little bit on an earlier slide. These are the kind of generic issues that are being faced by both the HTGR and the pebble bed. We have done extensive work in all of these areas, published reports, shared most of them with NRC. I think we still owe them one that has been recently published.

We are continuing to work a little bit more on the helium seal issue, working with Russia now because of their interest, of course, in the gas rector. And we are just beginning to continue for quite a while a number of projects in the area of hydrogen production, both technology issues and economic analysis.

Work with DOE. We have a long history of cooperation with DOE. Obviously the overview of our program is a very close 15-year partnership. Our current collaboration with DOE is, first of all, the NEPO program, which is focused on current plants. It's about a $5 million per year program from EPRI and from DOE and significant involvement in some aspects of the NP2010 program, which Rob described to you earlier.

We have had a significant role, advisory role, in a lot of these DOE activities. John Taylor has served on the NERAC. My boss, Ted Marston, served on RIMS that oversees both of the road maps, the NTD road map and Gen IV road map. And we have had significant input into those road maps and have participation in the oversight and advisory committees for both of these programs, both the NEPO coordinating committee, which Bill Shack sits on and I know Steve used to sit on, and on the NERAC side through the operating plant subcommittee that looks at the same program.

We face an uphill battle, though. This shows you what the funding has been to nuclear R&D by DOE over the last decade. Every year we fall another $300 million behind the competition in terms of having a level playing field for equitable federal investments in energy technologies. It hasn't varied a lot in the last ten years. That is what we face. That is just one of the inequities that we deal with in the nuclear R&D area.

MEMBER WALLIS: They're still spending all of this money on fusion over there.

MR. VINE: Yes. Lots of universities are doing fusion research. And they all have lots of friends in high places.

CO-CHAIRMAN FORD: And, yet, nuclear is part of their strategic goal to achieve 30 percent less emissions by 2020?

MR. VINE: That's right. Federal investments are not there, and they need to get there. The LWR program, as we said, costs about a billion dollars. Of that, industry put in two-thirds. DOE put in one-third.

I am going to use about six slides to describe briefly the near-term deployment road map. These were slides that were presented last year by Lou Long and Tony McConnell, the chairman of the NTD group, the near-term deployment group, to the NERAC. Rob already covered briefly the NTD road map. So I am only going to hit a couple of highlights that he didn't mention.

These are the designs we reviewed. I think he on one of his slides told you which ones were likely to make it by 2020 and which ones weren't. That's pretty much right out of our road map. You will notice a couple of them are missing the CANDU design and the -- what's the other one that came in? -- the NPR, Framatome NPR. The Framatome boiling water reactor made it, but the PWR did not. Those simply didn't make the RFP cutoff time.

We looked at gaps and issues. That was the specific request of the charter for the group to identify what the gaps were. The biggest gaps were obstacles to near-term deployment are in the areas of economics and licensing.

The traditional obstacles to nuclear energy that are more frequently associated with nuclear we looked at very, very closely, safety spent fuel management and public acceptance and nonproliferation, and deemed all four of those to be, although important and something that needs to be monitored and managed, not really major obstacles because we have got a very good posture for all four of those issues today.

Jumping to conclusions, new plants can be deployed this decade with some pretty creative work on the time lines and very aggressive owner operators willing to go forward which are coming out of the woodwork now but are not working quite at the pace that we were assuming in kind of a success-oriented road map. We think that new plants could be in operation by 2010. That goal could slip away if we continue at kind of the slower pace that we are at now, but it is achievable.

The commitment to orders by 2003 doesn't mean the order has to be placed next year. It means that an owner operator really has to commit as a business decision internally by next year that he is going to go forward and place the order at the appropriate time, which really is at a point in time during the COL process, either at the end of COL or at an appropriate time during that process where he feels he has got the risks low enough to make that major business decision. Obviously officials --

MEMBER WALLIS: This would only be the large owner-operated groups, their effort, that would be doing this?

MR. VINE: The large ones, Entergy?

MEMBER WALLIS: Yes.

MR. VINE: The large companies. With risk sharing --

MEMBER WALLIS: Do you have an indication that they will commit?

MR. VINE: Not yet. You will see in the next slide we talk about a phased approach. And that is the only way we think it can be done. There are still significant risks here that just aren't manageable at this point. And so the road map was pretty -- this is pretty obvious stuff. I'm just going to skip to the next slide.

We are pretty adamant about the need for a phased plan of action. I am going to into the phases in a little more detail on the next slide, but it basically says we need to move through this in a step-wise manner such that the utilities gain confidence at each step that they can go to the next one, a opposed to just placing an order today, which no one is ready to do.

We also emphasized dual-track. There were at the time we wrote this report obviously varying avid proponents of both the water option and the gas option. And we felt it was important to maintain both tracks as an option through the whole process, especially the regulatory approval and design work, until you really get to a point where you can make an informed decision as to whether or not one or both can, in fact, make it to the objective of deployment by 2010. We, of course, preferred that they both make it because we think there are market needs out there for both large and small designs.

And that kind of varies by state. You know, the states that deregulated more probably need smaller designs. The states that have done less deregulation can probably handle larger plants. There are all kinds of conditions out there that warrant a dual-track approach.

We emphasized DOE cost-share of all one-time costs, all the design work, all the regulatory work through the SP and COL and so forth.

And, of course, the final recommendation was development of a national nuclear energy strategy. The Cheney report has a high-level goal of expanding nuclear in the United States but doesn't really lay out -- it's pretty specific to NRC on what NRC should do in terms of efficient regulation, but it doesn't really give DOE much of a challenge to do anything other than get Yucca Mountain licensed.

So we think a more integrated strategy between industry and DOE to actually get the work done that needs to come forward for NRC review is warranted.

MEMBER LEITCH: Have you thought about the down side of a dual-track approach?

MR. VINE: Well, if you are talking about the issue of spreading the resources too thin, --

MEMBER LEITCH: Yes.

MR. VINE: -- we looked at that very hard. Our thought was that in a cost-sharing mode with DOE, the marketplace would take care of that. We wanted to make sure that the path was open for both water and gas and that we did everything we could to facilitate and encourage at least one option, at least one water option, at least one gas option, to move down through the process because we thought that it was in the national interest to do so.

If you within one of those tracks get two or three, four, five designs moving together, you are obviously going to face that problem. We think that is self-correcting.

We saw the same thing in the OBR program. Utilities wanted to minimize the number. They wanted to have some competition, but they wanted to minimize the number of designs that were invested in so that they could focus their resources and really get enough designs to completion that would really support their needs. So, for example, we only did a first of a kind engineering on one evolutionary design and one passive design.

MEMBER LEITCH: It just seems to me that in trying to keep both passive, you will wind up with neither. I mean, there is some burden in my mind of just making a decision that we are going to press forward with the advanced light water reactor.

MR. VINE: How do you decide that? At the time we wrote the report, there was more expressed market interest, real expressed market interest, by U.S. utilities in the gas reactor than there were in the water reactors at the time we wrote the report.

And that picture, of course, has changed now.

You just can't pick one and say that that is the right answer and then find out a year later that it was the wrong one. So you need to proceed down the path a little bit further before you make that kind of decision.

MEMBER RANSOM: Do you understand why that interest changed so suddenly?

MR. VINE: We think it was coming for a while. I think there were a lot of factors involved. I don't want to speak for Exelon, but I think the --

MEMBER RANSOM: Well, was it --

MR. VINE: Part of the reason was that they felt that they did not want to be a reactor vendor, which was really the role that they were assuming. They wanted to stay as an operator. They still have a high level of interest in the design, but they didn't feel they could --

MEMBER RANSOM: I guess I am interested in was that a single interest that drove the focus on the gas reactors, as opposed to what does the whole industry say?

MR. VINE: There was really only one U.S. utility with a strong interest in the pebble bed. There are close to half a dozen utilities that have expressed some interest in the MH-TGR, one of which has shown significant interest in the MH-TGR. So if you look at both of the designs togethers and --

MEMBER RANSOM: How about interest in the evolutionary water reactors?

MR. VINE: Broader. But, again, you have only got three utilities that are currently formally engaged in the ESP process moving down the street. But there is a larger, much larger, number of utilities that are participating in the NEI committee, probably about I think six or eight right now that are watching it very closely and participating in a lot of industry activities.

Phases I, II, and III, obviously approvals and design completion can be done somewhat in parallel, but we have split them out for obvious reasons because of the different nature of the programmatic approach to each.

Phase III, the idea is that if we can achieve cost-share with DOE between industry and DOE to get through design completions for design-certain FOAKE, that these plants ought to be self-sufficient at time of construction completion and deal with the going to the rate base without any subsidies or anything like that. So we are really looking to the government to help on Phases I and II.

I am going to skip this slide. I think it is self-explanatory because I want to try to finish up here and give a little bit of time at the end to talk about summary observations.

These are the last four slides. This one kind of explains in response to the request to talk about EPRI views on the advanced reactor research programs, to show you what the references were that I have drawn these points from. They come from my boss, Ted Martson's, significant involvement in the expert panel that came under Ken Rogers and Ray Durante as the guy who wrote the report about two years ago and also this year's Federal Register notice that requested industry or stakeholder input on what should be involved in the NRC's anticipatory research program. So all of those letters I have kind of pulled out of them things that relate to advanced reactors, and I am presenting them here.

The first point I think is that industry's priorities seem to be very, very clear to be focused on near-term deployment and not on long-term options that are beyond the immediate horizon of a minimal number of water and/or gas reactors that could achieve near-term deployment.

We think that NRR and RES should focus on those options based on market interest and put as a low priority designs that are beyond that, even if a particular designer is interested in engaging with the staff. If it doesn't have a high likelihood of near-term market interest, it should go to the bottom of the heap. There is quite a bit of policy precedent for that approach to the problem. You have got to manage the resources somehow.

I know that Chairman Carr was pretty adamant about this way of prioritizing staff resources back in the late '80s, early '90s. And clearly that is what we think should be the way that both NRR and RES approach the problem.

CO-CHAIRMAN FORD: And both have high market interest from your knowledge?

MR. VINE: Well, not necessarily. I think you can see from the industry activities significant utility interest in proceeding with AP1000. There is less visible but probably significant interest in ESBWR and right now also in the GT-MHR. Beyond that, we are not aware of any major utility, U.S. utility, interests in any of these designs. I know that --

MEMBER ROSEN: What was the last one you gave out of the three?

MR. VINE: The GT-MHR. The CANDU design I know has been working very aggressively in discussions with individual utilities around the country. And I honestly can't speak to where they stand on that, but AECL may want to comment.

I think the point here is that if that market interest isn't significant, the mere fact that there is a design out there that has a fan that wants to come in and begin to work with NRC doesn't necessarily mean it has to go to the top of the heap.

It's not a first come, first served thing. It really ought to be, "Is this design likely to be deployed in the foreseeable future in the United States?" because if it's not, you're essentially expending resources on an option that won't be used. So you wait until you're more confident that it will be used before you expend those resources.

That's the logic, easy to say, obviously a little bit more difficult to manage practically because the degree to which all of these business interests are being shared with the staff.

MEMBER ROSEN: What's a more appropriate test for a utility interest that we should apply?

MR. VINE: I think one very clear test will be as we proceed on the future, the degree of industry cost share put on the table to match DOE to bring these designs to fruition. That is really a very valid measure.

There are other ways to measure it. For example, in license renewal, especially in the early days, where utilities were a little less reluctant to formally state their license renewal intentions, there was a mechanism for confidential discussions with the staff to discuss some of these business interests that were being considered. So there are ways to communicate the interest, but I think cost-share is a clear indicator.

So here are some areas where we think real priorities should be placed, again by both NRR and RES, anything to support ESP and COL application needs. Obviously if NRR says, "I've got a technical issue I need some research on to resolve because it's going to be a generic hurdle for all the applicants," that's something we all ought to jump on, either RES on its own or industry and RES together and jointly and resolve that technical issue.

We have already talked about NEI 02-02. That is clearly what we think is an important priority. And we have recommended in one of these letters that NRC rely on the proposed PIRT redeveloped by NRR.

We think a priority should be on supporting designs that are under global design certification review. That clearly shows an intent because of the significant costs associated with design certification, there's clearly an intent to get through and deploy that design. There are obviously some generic -- there is a research where it's appropriate to collaborate.

You know, I talked about things like AIMS and construction technologies. Those are probably not appropriate for NRC research, but there are certain technology hurdles or opportunities, for example, in the I&C area, where there needs to be some clear area, if not actual work, done by RES to prepare the staff for some of these advanced technologies as they come through the process. So that is clearly an area.

And then you're out into this murky area beyond design certification where designs are engaged in preapplication reviews and you really have to decide to what degree do I expend NRC resources in that area. Again, some market interest ought to be a measure there.

And the final point, which leads into my next slide, is the issue of research not getting out in front of the applicant's own design development research work because it is really the applicant who is primarily responsible for making a safety case. And it doesn't make a lot of sense for NRC to have research programs running out ahead of the design program.

MEMBER WALLIS: On the other hand, there is no research falling too much behind.

MR. VINE: Right. So there is a balance there. This last question about getting out in front of the designer became a major point of discussion on this expert panel that I talked about that was convened a couple of years ago.

I am on this slide trying to share what the results of that debate were. There were, interestingly enough, some members of that expert panel, both on the industry side and on the public interest group side, that felt that NRC had no business doing research on advanced reactors at all.

Some of the utility executive feelings in that direction kind of went like this, "I think the Office of Research ought to be working on problems with current plants," "I don't intend to buy a new plant," "The NRC research budget is paid for out of my user fees. Therefore, I don't think NRC should be doing research on something that I don't need." I mean, that is kind of the logic that some utility execs have expressed. And I am sure there are others in the industry who feel that way. So there is a sensitivity there that needs to be appreciated.

On the public interest side, I think, if I remember correctly, it was Paul Leventhal who articulated very strongly the point. And I think he was probably involved in the legislation in '74, where they modified the Atomic Energy Act and split NRC and ERDA. He argued that all research responsibility was left on the DOE side and NRC had no research responsibility.

So he dug out the references. And you can see the quotes here. The point if you really look at the words that really establish the Office of Research at NRC, it does give NRC a specific responsibility for verifying the safety case made by the designer.

I think the next to the last bullet says it most succinctly. It says basically that the concern is about licensee submittals and the potential that the Office of Research could get in a position of assuming any part of the burden of the applicant to prove the adequacy of the license application.

The sole burden for proving the adequacy of the design rests on the applicant. The NRC must verify that that case has been made properly, but if the NRC is paying for and conducting the research to make the safety case, they can't turn around, then, and be the judge of whether that case has been made properly.

MEMBER WALLIS: The NRC doesn't do design, but I think the NRC needs to have tools --

MR. VINE: Absolutely.

MEMBER WALLIS: -- which are as good as the industry. We shouldn't be playing catch-up all the time.

MR. VINE: I don't disagree at all. And I think you see that embedded in the quotes. I mean, we debated this and I think convinced those who felt that NRC had no role here and convinced them that the charter for the Office of Research does, in fact, give them that responsibility.

I think there are some phrases I would -- the bottom bullet I think helps enlighten that. And it's paraphrased. The actual wording kind of runs as follows. It says in keeping with the concept of confirmatory assessment, it is not intended that the condition build its own laboratories and facilities for R&D or try to duplicate the R&D responsibilities of ERDA.

So the point there is it gets to your earlier comment about collaboration between NRC and DOE. This clearly encourages that. It is just trying to prevent a situation where DOE has a test facility, NRC builds a separate test facility when they could be doing a lot of work together and saving a lot of resources.

MEMBER WALLIS: Well, let's see now. We had a lot of discussion this morning about uncertainties in models and codes. It may be that industry is not doing the intellectual work necessary to develop a proper framework for handling these uncertainties. It would seem that then the NRC has to take some responsibility to provide some intellectual leadership, not wait for industry to come up with something. This isn't unimportant.

MR. VINE: There is a fine line there. I am not quite sure how to answer, but I think it is probably fair to say -- let's take a new design for which there is not currently an adequate, let's say, thermal hydraulics or maybe a core neutronics code that models that new design, there is nothing available. I think the first responsibility to develop that code rests with the applicant. If he doesn't take the initiative to develop a code sufficient to make the safety case, I don't think it -- and he may be able to obtain assistance. And maybe DOE as a partner will help in that development. I don't think it should fall on NRC as their first responsibility to develop that before the applicant does.

You know, it is also very possible that particular design may never make it to the marketplace. So the NRC --

MEMBER WALLIS: Yes. But there are certain cases where NRC is responsible for safety. So there are some certain aspects of safety, such as uncertainty in the spaces and how you incorporate it into decision-making. That would seem to be their prerogative.

So they may in certain areas want to stay ahead of it because that is their bailiwick. I mean, how do you make decisions in the presence of uncertainty? That is their job to make decisions.

MR. VINE: Right. I agree with you they have to stay ahead in terms of knowledge. But, again, I will argue that if that particular design never makes it to the marketplace, NRC spent $10 million developing a computer code that is wasted resources until you have greater assurance that that design is going to make it --

MEMBER WALLIS: Knowing how to make use of the computer code to determine uncertainties and how to fold them into your decision-making process may well be something that NRC needs to do ahead of industry.

MR. VINE: And I think maybe implied in your comment is perhaps an area where there may be generic benefits to that effort that go beyond a particular design phase, going to get insights from one that apply to another.

You know, you're into some qualitative areas. And I think you are right. How you define that line is really a management decision that the staff and Commission and you all have to struggle with.

I am just trying to alert you to the discussion and what it resulted in in this sense that at least some of the utilities are pretty sensitive about prudent use of NRC resources because they look at it as money that they're contributing to part of the cost of the --

MEMBER WALLIS: The framework issue, the framework, the technology-neutral framework, is an interesting case. You would think that it ought to be in NRC's interest to develop a framework.

MR. VINE: Absolutely.

MEMBER WALLIS: But it seems as if NRC's developing the framework.

MR. HEYMER: No. We're making the proposals. And then the NRC is going to look at those and say, "We agree with this," "We don't agree with that." And they will be responsible for --

MEMBER WALLIS: It seems a bit strange, though, that you should be telling them how they should regulate the industry.

MR. HEYMER: No. We're just giving them an idea to improve the way it is regulated.

MEMBER RANSOM: Well, I think the original act was to prevent the situation where the NRC generated the data and the utility or the vendor would come in and say, "Well, we used your data. So you should approve it," which puts the NRC then in a position of criticizing their own or having to judge their own result.

CO-CHAIRMAN KRESS: I'm reminded of all of the severe accident research that NRC did during the past decade. That was to assure themselves of the safety of all the operating reactors.

They were all licensed. They had a license. They were operating. They had met adequate protection. Now, should they have done this research or not?

MR. VINE: I would say yes up to the point where you're satisfied that there is not a significant safety issue here that you don't know about. At the beginning of that --

CO-CHAIRMAN KRESS: I think the same comment applies to the future reactors. They have to be ready to assure there is no significant safety issue that they haven't overlooked.

MR. VINE: I agree with you, but you just said the future reactors. My point is we don't know what those future reactors are.

CO-CHAIRMAN KRESS: Well, you have an idea.

MR. VINE: Yes. And you can't just guess that these 15 reactor designs are going to be built and, therefore, we need to start a research program. I think the industry would probably object if there were a big research program here on molten salt reactors.

CO-CHAIRMAN KRESS: Oh, I agree with that.

MEMBER BONACA: I dare say for future

reactors, actually, the framework will specify some need for that work to be done by the industry. I think for the past reactors, they were licensed with no specific commitments to beyond design basis.

And that's why the NRC ended up trying to get whatever they could of information to ascertain that there wasn't a safety issue that would require to go after the core licensing basis and expand it. I expect that for future reactors, -- at least that is what we heard this morning -- a licensing basis will include design basis and beyond design basis to some degree.

MR. HEYMER: And that's why we had a set of what we called events which are design, what we call design basis events. And then there is another group that we called emergency preparedness basis events, which are those things which are what we to date now call design basis. And we didn't have that up front in the current plant.

So I think that is how you deal with those issues, is that you identify a series of beyond design basis or potential accident conditions that could occur and how the designs address those. I think that was done and, in fact, in SECY-90-16, the staff made some recommendations. And they were incorporated in the ALWR designs dealing with these beyond design basis activities. That's how it was done there. We see it being a little more structured.

Should that research have been done? I think it was a good idea to do it then because we just had it on a design basis. Would it be done now? I think that is already incorporated into the process.

MR. VINE: Let me try to reduce this down to a simple issue of communication. You know, the industry is acutely aware that the staff has limited resources. And we have and can foresee a lot of future needs in the area of advanced reactor development, research, licensing, and so forth. I think it is certainly in our interest to have maximum communications between the industry and staff to project as best we can what the needs are going to be, what the priorities are going to be, what the timing is going to be so that they can meet those needs. That is all we are saying.

Maybe we don't have a good process for doing that yet. Maybe the industry is not ready to engage in that kind of a discussion yet. But as we move forward and we get to a point where that kind of a discussion is appropriate, it would really help both industry and staff to make sure we are not wasting resources in an area that will never see a plant that uses that particular technology or that particular computer code.

MEMBER BONACA: But you don't disagree with the fact that the staff needs to have some independent ability to evaluate the case the licensee is making?

MR. VINE: Absolutely. Now, whether that has to be a separate computer code or not is a separate question. I think we are beginning to talk now about the possibility of having more joint codes between industry and NRC in areas where we have high confidence in the models for a new design for which there are high degrees of uncertainty. Maybe that is not possible.

But, again, you know, that is where ACRS is very important in helping advise on those kinds of issues, where you draw the line.

MEMBER LEITCH: You had a slide about 12 or so back about issues and gaps, gaps and issues.

MR. VINE: Right.

MEMBER LEITCH: You briefly mentioned public acceptance and nonproliferation. It seems to me that in the whole issue of safeguards and security, public acceptance is going to be one of the major hurdles that we have to get by construct a new reactor. I didn't hear much of that coming out in the presentation.

MR. VINE: Let's keep the nonproliferation issue separate from the security issue.

MEMBER LEITCH: Okay. Yes. They are really two things.

MR. VINE: I think the view of the public was based primarily on data that NEI provided to us that the public acceptance issue is very well in hand. It's something that has to be constantly worked on and improved on in terms of our communications. The most recent NEI data shows greater public acceptance today than we have ever seen. And that is after 9/11. Okay?

MEMBER LEITCH: As I talk to my friends and neighbors, I don't get that sentiment at all.

MR. VINE: That is what the data shows. The issue of nonproliferation is a legitimate and important issue as we look at international deployment, but it's not an issue for U.S. deployment. And then the whole question of how we move forward post-9/11 in advanced reactor development is an issue that the staff and industry have to talk about. But it's probably going to be done in the context of the kind of discussions that are going on right now on what the appropriate measures are for the current plans and, again, with the same falloff we have used here with enhanced safety not heading down the path and creating a double standard that says "This class of plants has to be able to do this, but this class of plants has to do something completely different."

Where is your constant philosophy of adequate protection if you've got different standards? We have got to work through all of those kinds of questions.

MEMBER LEITCH: I am sure your view of construction costs and so forth -- well, maybe I should ask the question, rather than say "I am sure." Does your view of construction costs have any estimate of costs of hardening some of these?

MR. VINE: The utility requirements document had as one of its 14 key policy requirements enhanced sabotage protection. That was focused primarily on plant layout and not on the major, major hardening activities.

Now, the designs are for various reasons, severe accident management reasons and others, more robust than our current plans. So we think that the safety is going to be even better than our current plans. But we haven't engaged in a detailed discussion with the staff on it.

Adrian, do you have anything?

MR. HEYMER: Yes. As Gary said, the utility requirements document and the three certifications did incorporate some additional features. But the whole issue of security barriers, measures to be taken, and how we deal with that is still playing out. I think that still has to be assessed and estimated, and it is an issue that needs to be looked at.

I think as regards the public confidence, when something happens of an event of the magnitude of sort of 14 months ago, there is uncertainty. And people get concerned.

But I think if you look at the results of recent exercises that have been done by independent organizations, it shows that the nuclear plants at the moment are very well-protected compared with some other industrial facilities that might present some hazard to the public. But that whole issue has got to play out. You make a good point.

MEMBER ROSEN: Gary, I would like to come back to your earlier comment about the staff and the industry having the same codes, working towards just having one code. Would that extend to PRA codes; in other words, if you believe that the staff and the industry could have one thermal hydraulics code, work on it together and jointly, jointly use the same code, rather than two separate codes to do the same thing?

MR. VINE: In theory. I need to kind of step back.

MEMBER ROSEN: Would that extend to the staff and the industry having one model for, say, South Texas rather than having the SPAR models to -- you know, the South Texas, very advanced South Texas model and the SPAR models that are probably at 30 percent of the South Texas model.

MR. HEYMER: There have been several discussions about that very issue. One point is perhaps the NRC needs some sort of independent look at it. But, on the other hand, if I am a licensee and I give NRC the complete PRA and say, "That is what I am using. These are the assumptions" and they may agree or disagree with the assumptions but reach some understanding between you both, "These are the assumptions. We are going forward," then you are working from a common document, I think it would help enormously in some of the discussions that are going on with the SDP determinations, where you seem to get into "Well, that is what the SPAR model says, but this is what my model says," et cetera. So I think that is a good observation.

MEMBER ROSEN: Well, I'm just using Gary's point.

MR. VINE: I need to clarify my point. This was just a beginning informal discussion about "Is this possible?" We have no plans. We have made no formal proposals. But I think in areas where we have reasonably high confidence, it is certainly something we ought to discuss.

MEMBER RANSOM: In the past, these issues, it seems to me, have been taken care by the fact that the NRC information is public domain. Then the utility or vendor wants to protect his information as being proprietary.

So, consequently, there have been cases where the vendor has taken, say, NRC products, worked on them to their own needs, and then made them their own proprietary property. But it seems to me if there is a completely collaborative type area, then it has to be shared by everybody.

Would that be acceptable, I guess?

MR. VINE: And that was one of the obstacles to our attempts two or three years ago to try to get on the industry side a willingness to get down to a single set of codes. Vendor proprietary issues were an obstacle.

Looking at the whole issue now, there are significant similarities between RELAP and RETRAN, similarities with severe accident codes. We are being very open with our codes. All the utilities have it. NRC is licensed to use it. We give royalty-free licenses to all the universities. Anyone who wants to use it can basically have it. So we're pretty open with our codes. That is an area we can discuss.

(Whereupon, the foregoing matter went off the record briefly.)

MEMBER BONACA: It would give me concern, however, if I knew that all it would depend on is one methodology, particularly for thermal hydraulic analysis, for example, and there is no diverse approach, analysis that at least helps me put into context where the uncertainties are and issues.

I've got to tell you I can tell you one fact. We went from one vendor to another vendor for fuel. And we got the local analysis results. Both of them are credible vendors. What we discovered in a way is that the peak flow temperature versus the charge condition for one vendor was going down with increasing break size and the other one was going up. That was the first pretty interesting trend. I mean, we were comparing things.

If you tracked flow to the core during the blow-down, one vendor was showing flow upward. The other was showing flow downward. Everything was different. And then, however, as you began to compare and to look, you realize there was something built in conservatisms that gave you some confidence that if you had the best estimate calculation, which you didn't always perform, you had a very large margin. Much of these differences were really tied to probably some artificiality in the model, whatever.

But the fact is that I don't have the confidence that any one of these computer codes gives you the true answer. So I think it is important that a regulator is able to in my judgment view independent of the dollars to do some verification. I think it is important that, particularly examining the dollars he has, have a different root, some different approaches and something of that kind. I think it is essential for the certification of this price.

MR. VINE: We have the same concerns. So does RES. We may look at this very closely and decide we can't do it. I think we will talk about it.

CO-CHAIRMAN FORD: I'd like to bring this --

MR. VINE: There are ways of going it that solve your issue and give us more efficiency in the way the management goes.

CO-CHAIRMAN FORD: I'd like to bring this topic to a close. Are there any last questions for Gary and Adrian?

I would like to finish up. We started off this meeting today essentially just to let the members be aware of the changes in the infrastructure report so that we could go into writing our report on that document for the full information base. Plus, we had all of these gentlemen in this afternoon to give us more background.

Could we just go around the members and see if there are any last minute questions either for these gentlemen or to John and his colleagues? Graham?

MEMBER WALLIS: I don't have more. I learned some things which I think will help me in revising drafts of the research report that I think were very helpful on thermal hydraulics and model uncertainties. I think I learned about this framework.

I think we have encouraged the staff to develop a technology-neutral framework and language to some extent. Maybe we have got more material for encouraging that. Those are the three things. We have made a lot of notes.

I have done quite a bit today. It's been too much. I will need to go back and review it.

CO-CHAIRMAN FORD: Vic?

MEMBER RANSOM: Well, the main thing that I guess I have been puzzled by is there didn't seem to be much relationship between what is really going on and what is written in the advanced reactor research infrastructure assessment, which presumably we are writing a document assessing this, --

CO-CHAIRMAN FORD: That's exactly what we are doing.

MEMBER RANSOM: -- which was the HTGR focus. So it's almost inverted from what has really happened. And I am a little concerned how we are going to deal with that, I guess.

In fact, I have learned that this came from Graham Leitch, which writes it up pretty much the way it actually is in terms of this inverted structure. And, yet, I don't see very much of that in the current draft.

CO-CHAIRMAN FORD: John, would you like to respond to that?

MR. FLACK: Well, of course, things have changed since this document had begun with Exelon, as we discussed earlier, being withdrawn from the preapplication.

Nevertheless, I think the issue is how much do we do on this, recognizing these other things are coming along, which we briefed you on today. So the question, I guess, is is there a balance between this one versus the other and how seriously do we need to move forward, for example, in understanding TRISO fuel and the graphite and all of these other things? I guess that is something the Committee has to come to grips with as well as ourselves and the Commission as we move forward, you know, to look at these advanced designs.

So I think it is all in front of us. It's just a matter of sorting it out and again placing priorities and understanding on what is happening in the world today and what we think is going to happen tomorrow. And it's not an easy thing to do.

MEMBER RANSOM: Well, I think my comment was more along the lines not necessarily attacking this report but what are we reviewing.

CO-CHAIRMAN FORD: We're reviewing that report in its entirety with all appendices, which include advanced light water reactor. We will discuss this tomorrow. In the current draft, we do do that in the current.

Graham's comments are exactly on line, which is I think the way the majority of us feel. And that's the way the report will be written, our report will be written. It is on the floor for structure assessment.

Mario?

MEMBER BONACA: I cannot comment on the second part of the meeting. I wasn't here at the afternoon meeting, but I felt that this morning's presentation was helpful. I think it provided some insights in the work. I thought Steve's presentation was very informative. It was limited to the thermal hydraulic issues, but I think it is important to step into the PRA and actually analyze these issues, although there are other issues that we need to cover.

I think still that I second what Vic said, that we got information today about three advanced light water reactors that will have to be part of our evaluation. So I don't know how we are going to form it or where we are going to put it here but would like to discuss it tomorrow.

MEMBER ROSEN: Just a quick one. Given the lateness of the hour, a discussion with Gary about what test do we apply to decide where we should advise the staff to apply their resources, we need some information about who is cost-sharing? His answer was you should help, especially the research areas where there is an applicant who is cost-sharing.

We don't know who is cost-sharing. So if we knew that, it would be useful to us writing the report.

CO-CHAIRMAN FORD: In the infrastructure report, -- John, you please correct me if I am wrong -- in most of the areas, primarily for the gas-cooled reactors, there is a fair amount of reference to where collaborative programs will be occurring. There are with the United Kingdom, with Japan, with Germany, whatever. And the details of those collaborative programs in terms of cost-share or whether it is equal information, value information share, that information is not given.

MEMBER ROSEN: I think you're getting to a bigger problem than I am trying to solve. I think what I was wanting to know is which domestic licensees are cost-sharing.

CO-CHAIRMAN FORD: Oh, I apologize. I didn't understand.

MEMBER ROSEN: And if there is a list of that that somebody could provide us and maybe a little detail of how much cost-sharing there is if that is the test to apply? We are not prepared to apply it because we don't have that.

MR. VINE: I'm not sure that that information is available, but we could find out for you.

MEMBER SIEBER: Individual licensees. I don't know that you will have it available. They don't advertise that.

MR. HEYMER: Yes. There are some licensees who may be cost-sharing who may not want to go public with that information, which that is the problem Gary is relating to.

MR. VINE: I think if your question is which designs are obtaining either from licensees or from other sources, if the issue is a question of which designs enjoy market interests, you don't have to identify the individual licensees by name. You can just total up and say, you know, there is --

CO-CHAIRMAN FORD: Five, ten.

MR. VINE: -- roughly this kind of money

supporting AP1000, roughly this kind of money supporting this design.

MEMBER ROSEN: If I could get some sort of information like that that I knew was valid, I would be satisfied.

CO-CHAIRMAN FORD: Can you do that with Vic?

MR. VINE: It's a challenge. We can work together and see if that kind of information is available.

CO-CHAIRMAN FORD: I appreciate that.

MR. CORLETTI: If I just may add, I think if you really, though, look at the list of which plants are getting interest, part of that is due to the maturity where they are and how much closer they are to market.

I think when you are considering where you need research activities, that is not always the only element of who is getting market interest. You have to look at what are the safety issues associated with each one. What is the basis for your understanding of each plant design as well.

CO-CHAIRMAN KRESS: I'm glad he said that because that was going to be my comment.

The other comment I have -- I wasn't here most of this afternoon either, but I think we have to recognize that the document we are reviewing started some time ago. And the fact that conditions have changed changes our viewpoint should not be a criticism of the document. We should just recognize that. I think the staff recognizes it.

And we shouldn't be a slavish reviewer of the document as it is. We should recognize it. The staff knows these changes change. And our recommendations, research, and priorities ought to recognize the current situation, not just be a critique of the document.

MEMBER ROSEN: Just trying to use the test that EPRI suggested.

CO-CHAIRMAN KRESS: I think that is just one input. I'm in agreement with Mike. We should have other criteria. What we ought to do research.

MEMBER ROSEN: And what our criteria are should be clear to all of us. We should debate that.

CO-CHAIRMAN KRESS: We should have some criteria, yes.

MEMBER ROSEN: We should discuss that. Maybe we can this Saturday.

CO-CHAIRMAN KRESS: In our criteria, we should decide whether or not we agree with those criteria.

CO-CHAIRMAN FORD: Graham?

MEMBER LEITCH: We already reviewed revision one of this document and sent a letter on it. And there were those ten comments that I guess it was you, John, who had listed them there. And revision two is not --

MEMBER SIEBER: It's not different.

MEMBER LEITCH: -- is not radically different except that now we have two addenda -- really, three addenda. I mean, the original document becomes one. And there's ESBWR, and there's ACR-700 and then the last single page, which is just the schedule of 2003 activities. So the document has to a certain extent been updated, and we have to do that.

I think the purpose for going around the room now for comments is not really to work on the research report. That will be a future effort here in a couple of days. So I have a number of comments about that, but I will defer those until that time.

I would like to say, however, that I think the NEI document, 02-02, is really a good start. I think NEI should be complimented for taking this initiative and getting this document into this form because it was hard for me to conceptualize exactly what this framework would look like.

I think this is a good effort at getting started, not to say that, I mean, I am sure there has got to be a -- what I am saying is viewed in the sense of being, if you will, a strawman or something that we can begin discussing. I think it is an excellent starting point.

The last time we talked about this, we were talking about vague generalities, and it was hard to really know exactly where were headed in that. I think now we have got at least something to begin discussing and begin taking exception to. I didn't want to put it quite that way, but perhaps that's the case. So I really think it is a good piece of work.

That's about all I have to say, Peter.

CO-CHAIRMAN FORD: Jack?

MEMBER SIEBER: I guess when I was doing the review work and preparing the write-up for my assigned section of our response to the research report, I was wondering what it is that research is trying to accomplish.

I came to a couple of conclusions. Of course, my area is limited. It's not specific to any reactor type. So it makes it a little different than all of these others because, really, if I look at the

29 tasks in my area, most of them seem to be for the staff to maintain its knowledge base and improve it to the point where they can deal with these advanced concepts. I think that is a worthy goal myself.

I think that if the staff has to stay up-to-date has to stay familiar with the evolving technology, not necessarily do the work, not necessarily do the research, but be able to be knowledgeable or not with what is going on in the industry to be able to make judgments as to whether licensee submittals are acceptable or not.

My perception of what I read in my area leads me to that conclusion. And I think that is important. The area I reviewed was instrument and control. And there was a lot about the hardware which engineers always love, but they forgot the most important element -- didn't forget it but didn't play it up enough, which is the human being who is supposed to interpret all of this stuff that they see in the control room so when it comes time to write the final report, they will be able to comment.

My perception is I think that research is pretty much on the right track. On the other hand, when the time comes to say -- some licensee comes in and says, "I am ready to give a letter of intent," I think the research is going to be tremendously busy getting ready to review that application.

And I think it is extremely important that the industry, vendors, and the staff work together so that they can readily resolve emerging safety issues and ask the right questions. I think that my sense is that we are sort of headed in that direction.

I do think it's a mistake to pick out of six concepts or eight concepts that out there one advanced reactor type and say, "I think this is going to be the one" and then spend a lot of resources and somebody else buys something different. I think that is a mistake. I think you have to be patient and wait and build your expertise and resources in the process. So I guess that would be my comment.

CO-CHAIRMAN FORD: Bill?

MEMBER SHACK: I don't think I have anything to add after everybody's. The last man is worn out.

CO-CHAIRMAN KRESS: Next time we'll start on this side.

CO-CHAIRMAN FORD: Joe? Where is Joe?

MR. MUSCARA: Just a brief comment. Joe Muscara again. The discussion going along the lines that when we started out this plan, we were, of course, concerned with the PBMR. Now things have moved. Now we are interested in advanced light water reactors.

I would like to say that with respect to the materials work, we are still on the right track. I think with advanced light water reactors, we are looking generally at the same materials, same environments. There is not a great deal of need for additional data. On the other hand, for the gas-cooled reactors, these are the areas where we need long lead times to get our work done.

So I think the emphasis for the materials work still is get that work doing for the gas-cooled reactor so that when they come back three or four years down the road, I think we have been lucky. We had this breather where we can develop the information we need so we can ask the right questions when it comes back on the table.

CO-CHAIRMAN KRESS: I think with the respect to the question of wasting money on concepts that never come to light, I think you just have to accept that that is going to happen.

You can't be completely prescient and know what is going on. You just have to anticipate. And if you have good enough reason to expect something is coming in the near future and there are long lead times, I think you just have to go ahead and do it.

MEMBER BONACA: I have just one question I want to ask, if I could, because I wasn't here and I am very intrigued. You talk about the framework and this overhead that you presented regarding strong PRA emphasis to us in these categories.

All we are doing, option two, now, I agree with the approach that it has to be very much risk-informed. But if it is technology-neutral, it means that it would be applicable to light water reactors, advanced light water reactors, as well as advanced any plant out there that was presented this morning.

Do we know enough about those plants to really develop an adequate PRA as well as sufficient database to support the risk-informed approach? I mean, I am trying to -- I am sure you had this question before from somebody and I wasn't here to hear the answer.

MR. HEYMER: We acknowledged that we have done a lot of work in light water reactor PRAs. And there is a standard out there for the internal events. There is some work going on on external events.

It is also recognized that a PRA for the

HT-MHR may be a little bit different than a light water reactor PRA. And, therefore, perhaps there needs to be an appendix or a guideline on a gas reactor PRA, one of the things you should look at. So there is that issue.

There was also the issue that we discussed and acknowledged that important measures and the risk metrics and the performance measures for a gas reactor or the ACR700 may be different. We need to look at those and reach a determination what are those for those different types of reactors.

And you are quite right. You can't actually do something like an option two type categorization unless you have got a new understanding of those. And we acknowledged that work needs to be done in that area, but we think it's work that needs to be done based on the fact that we know that there is an application coming in.

We know that there is an interest in this area. Okay. That's something that we can have confidence that we can work on. We're going to get there. So I don't know in a short period of time if that answers your question.

MEMBER BONACA: No, I understand as long as there is the recognition that you can go to PRA as much as you can. It depends so much on experience at the basis.

MR. HEYMER: And we also had a discussion about defense-in-depth and the application of deterministic measures where there is uncertainty and the consequences are significant. And we went through that process.

CO-CHAIRMAN FORD: I would like to thank all of the speakers. John, thank you and your team. And thank you, gentlemen. We are adjoined.

(Whereupon, at 5:52 p.m., the foregoing matter was adjourned.)