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NUCLEAR REGULATORY COMMISSION

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UNITED STATES

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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SAFETY RESEARCH PROGRAM SUBCOMMITTEE

US NRC

11545 Rockville Pike

Room T2-B3

Rockville, MD

Wednesday, November 1, 2000

The subcommittee met, pursuant to notice, at 8:30 a.m.

P R O C E E D I N G S

[8:30 a.m.]

CHAIRMAN POWERS: The meeting will now come to order. This is a meeting of the ACRS Subcommittee on Safety Research Program. I'm Dana Powers, Chairman of the Subcommittee.

ACRS Members in attendance are Professor George Apostolakis, Dr. Mario Bonaca, Mr. Graham Leitch, Dr. Tom Kress, Dr. Robert Seale, Dr. William Shack, and Jack Sieber is here.

As I said, Graham Wallis is out ill today and Professor Uhrig had a tragedy in his family. So they won't be able to join us, but they are important parts of our team looking at this research program.

Just as a point of reminder, the members have specific areas of assignment in this activity, and I think we can probably give you a list of those assignments, if you need them.

The purpose of the meeting of the subcommittee is to discuss with the NRC staff the 2001 draft ACRS report to the Commission regarding the NRC's Safety Research Program and related matters. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions, as appropriate, for deliberation by the full committee.

Dr. Med El-Zeftawy is the cognizant ACRS staff engineer for this meeting.

The rules for participating in today's meeting have been announced as part of the notice of the meeting previously published in the Federal Register on October 20, year 2000.

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 they can be readily heard.

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

Let me remind all the members that the objective of this meeting is really to have a collegial discussion with the managers of the RES organization about the future long-range research program that RES might be able to pursue to facilitate the agency meeting its obligations as this nuclear industry progresses and evolves.

All the members have gotten brief descriptions of the ongoing research programs and it's certainly fair to pose questions about those ongoing research programs for purposes of clarification. But if you find you're going to get into a major discussion on the ongoing research programs, I'd really suggest that you'd just arrange to do that on another forum.

We really want to focus today on what I've called the five to seven year timeframe, getting beyond the current planning horizon in the strategic plan.

This is really free-form thinking. Nobody is committing to these programs, nobody is staking their life and soul. It's very much speculative here. It's possibilities and less on probabilities. It's a chance to think without the constraints of politics and budget and political correctness and a variety of other things, about just what the possibilities are.

We're going to begin the day with a bit of an overview from the head dog at RES. He's fresh from conducting what I thought was a superb water reactor safety meeting. You missed something if you didn't get a chance to go there. It was a celebration of the 25th anniversary of WASH-1400, which was the seminal first step taken by Research in an area that nobody thought was possible to do and out of that research has come the entire risk-informed regulatory process.

So that was the kind of speculative step that we're looking for in this brainstorming session on the future.

With that, Ashok, I will turn it over to you and let you make whatever opening comments you want. Then you can tell us how you want to go after that.

MR. THADANI: Well, thank you very much for those very kind words. As I said earlier, I was quite pleased with at least the feedback I got. My own views, I thought the water reactor safety meeting went quite well. But we'll wait and see. I want to make sure we hear from various stakeholders and see what they thought.

We're going to try and give you our thoughts in terms of what we see as challenges in a few years from now, perhaps, as you said, five to seven years.

I would also certainly encourage that if there are issues on ongoing programs, certainly we'll try and address them, but it might be useful to make sure that we've had an opportunity to try to explore what some of the future challenges might be.

We're here as a team, and the team, with Margaret Federline, I think you know all the members of our team, focusing quite significantly in recent days almost on what we see are some future challenges. Some of them may be becoming more and more real almost on a daily basis.

So we will share with you our best understanding of those challenges. Farouk Eltawila you know very well. To my right, Tom King, and, to his right, Mike Mayfield. And I want to recognize Joe Murphy and Jim Johnson. They are very active participants in this effort.

Let me share with you two areas. I will touch on one and perhaps not on the other as I go through my remarks.

The first is that NEA, under Committee for Safety of Nuclear Installations and Committee for Nuclear Regulatory Activities, the CSNI and CNRA, are also looking at the role of regulatory research. They are planning to have a joint meeting June of next year, and Jim Johnson and Joe Murphy are involved and working with various countries and trying to develop the content and form of that meeting.

I think that will be an important meeting, not just for us, but for the international community.

Let me begin by sort of looking back a little bit. A number of points that I'll make are perhaps -- you all know the history, but I think it's important to go back.

If you look at why was the Office of Nuclear Regulatory Research created, it was mandated by Congress, as a matter of fact. The key there was to make sure we had the ability, the capability to develop and analyze, both parts, develop and analyze the safety information that would be necessary for both licensing and in terms of whatever regulatory decisions the agency had to make.

And as you know, since then, the NRC has been actively engaged in both looking to see if there are new challenges, new issues, and to make sure that we understand those, what the resolution paths might be, and to fully --

to certainly reasonably understand what the uncertainties and gaps in our knowledge might be, and to work in those areas.

I'm not going to go through the successes of the Nuclear regulatory research. I think you know them and there are plenty of those.

The key point, in my mind, here is that it was expected that the Nuclear Regulatory Commission was going to be a technically very strong organization, that it would develop appropriate bases, the scientific bases for some of the regulatory decisions.

DR. SEALE: There was a corollary in there or an implicit resource in that allocation of responsibility; namely, access to the national laboratories, which remained under the Department of Energy.

MR. THADANI: Yes.

DR. SEALE: As you go along, I don't know whether you're going to tell us or not, but I can certainly remember from experience that there have been some rather draconian reductions in capabilities in national laboratory, capabilities without, at least from my perspective, an iota of input from the NRC, in some cases; in some cases, perhaps a bit.

It strikes me that in relating your tale of woe, if not in deciding where you go from here, you need to keep track of the lost capabilities that are no longer at your beck and call if you got the money to pay for them.

MR. THADANI: Bob, you just -- that is my central message today. If it doesn't come through, then I would have failed. And as part of that message, you will see in the briefings -- we want to be careful that we're not talking about maintaining facilities just for the sake of maintaining them. There has to be some sort of nexus to what we think the future challenges might be.

And as part of the briefings, we will show you where we were, where we are in terms of the facilities that have been shut down, the relevant facilities.

DR. SEALE: Yes.

MR. THADANI: I mean, I don't mean to say all the Department of Energy facilities. But then we will also identify some of the facilities which we believe are at risk of being shut down in the next couple of years or so.

And in my mind, it's not just the issue of facilities. It's a much bigger issue than the facilities, and I will touch on that. And then as we go through our briefing, hopefully, some of the points I'm making would become clearer with detailed information that we hope to share with you.

If you go back, again, sort of looking back to history, because I think -- I'm a very strong believer that we need to learn from history, if you recall, pre-TMI environment, focus, an inordinate amount of focus on loss of coolant accidents.

I remember it well. Severe accidents were incredible, really couldn't happen, in spite of WASH-1400, the environment was still totally focused on large break LOCAs.

CHAIRMAN POWERS: Having lived through that era, I think you're right. The focus was 100 percent on LOCA. But I think it was really 95 percent, because the research management sewed enough capacity that they were dabbling in the severe accidents, aimed at regulatory action, but they knew enough about it that they ought to go touch it and see if it quivered, if it shook.

That proved to be extraordinarily valuable, that they would at least be willing to spend some of their resources and not associated directly with any licensing action, but go out and press the envelope a little bit.

So, again, I think here it's right. It also proves the value of pressing the envelope a little bit.

MR. THADANI: Yes. And I think there was some rather useful information, as you said, that research had developed. If only we had paid more attention to some of that information. But there was the sense, and I use the word complacency, there was a certain amount of complacency and we were not prepared.

I was part of the first team that went to TMI with Harold Denton and I can -- there is no doubt, in my mind, that our views about the so-called incredibility of severe accidents is squarely verified by the ad hoc things that had to be done following that accident.

Again, as you all know, that our reaction, which was, I think, probably, fair to say now, certainly, in recent years, in light of our better understanding of risk, that we certainly overreacted. I think many of the requirements that were imposed, some of which we're now looking to see if they're needed at all and perhaps they should be eliminated.

So there was a certain amount of overreaction; to a certain extent, because we were -- we didn't -- probably didn't take the time to develop a good technical basis for all those requirements that we imposed.

And certainly the Chernobyl accident, in addition to the post-TMI era, really switched the research focus to the whole area of severe accidents. The aging program began around that time period, as well, and greater interest -- when I say risk analysis, I mean not just level one, but a great deal of interest in trying to make sure we understand the containment performance and so on.

So there was, as some would say, not only, I think, very relevant research, but a very challenging research period in the '80s and early '90s. And, again, I would say since the early '90s, the direction changed once again, mostly because of the advent of some of the new technologies that the industry was interested in and probably largely the advanced light water reactor program, Electric Power Research Institute, where we worked with them and then, following that, with General Electric, Combustion Engineering and Westinghouse.

I would say that got the bulk of the attention from the Office of Research and we managed to continue some of the aging research work.

I would be remiss if I left out what I think, as I said, experience, operating experience is absolutely essential, critical. And as you know, approximately two years ago, because of the reorganization, AEOD was dissolved and the responsibility for independently looking at operating experience was moved to the Office of Research.

It made sense to a lot of people that that was the right combination for research to really be taking an independent look at operating experience.

CHAIRMAN POWERS: Just to inject here, Ashok, that we -- you want to write a research report on the things you want to say, but sometimes you have lots of people giving you help on things that you ought to address in that report, and one of the topics that we have to address in the report is exactly that.

Having made this move, the AEOD into becoming part of the research organization rather than having it as completely separate, we're asking is that working; are we still getting this kind of independent assessment of operational data that, in some sense, can be used to validate what goes into the probabilistic risk assessments and risk arguments, in general.

Is it still working, and that's one of the questions that, in fact, Professor Seale has the lead responsibility on exactly that question.

MR. THADANI: There are several aspects to that question, in my mind. First of all, I think we're doing the independent analysis work. I think much of that work is being utilized, for example, in the reactor oversight, revised reactor oversight program.

I personally think that we are not utilizing that independent analysis to the extent that I would like to see it utilized, and I will give you some examples.

The first one is David Lochbaum, at the Water Reactor Safety meeting, put up a chart on reactor core isolation cooling system unreliability, unavailability, and he showed what was done in the individual plant examinations and what the so-called research report was showing in terms of unavailability of RCIC.

He asked a very fair question; he said, if the IPEs -- incidentally, the experience was showing that the reactor core isolation cooling system unavailability was significantly higher than that assumed in the IPEs. The question he asked, what is the agency doing about that.

Now, of course, we also know from some of the other research studies, such as on high pressure injection systems, that we found the reverse, which was the assumptions in IPEs were more conservative than what the experience was showing.

Where I think we are lacking and we need to do better is to really mind the experience and apply it in many different places and not just selected areas, like the revised oversight, reactor oversight program.

And we in research are working to make sure that different parts of research are, in fact, utilizing that type of information.

Another area where we need to do better is we have been criticized by the public interest groups about the non-visibility of the old AEOD reports that AEOD used to put out, and certainly the annual report and so on.

We are -- I accept the responsibility. I think we were too premature in trying to save resources and saying that perhaps we shouldn't issue such a report. We are going to issue such a report. It will take some resources, but we'll make sure we have the necessary resources.

It is important. This issue came up at the last stakeholders meeting that the Commission had and I participated in, and so I took away the message, I listened to the concerns and complaints. We are going to be developing an annual report which will also be very important to not just in terms of AEOD function, but to the agency and NRR in assessing whether safety was maintained, so-called maintain safety performance goal, or if there were -- if there are some significant adverse trends from operating experience, which, if they are, we're supposed to report to Congress as part of our performance plan.

DR. SEALE: We had heard about Mr. Lochbaum's revelation, if you want to call it that as a part of his letter regarding the safety program and a response from the committee was crafted and in the process of doing that, we talked to some of the people from the old AEOD organization and got a fairly concise explanation of what the Commission is using and, indeed, the fact that these numbers from the IPEs were flawed in a rather systematic way and were not being used by the Commission for making certain kinds of assessments.

It strikes me, though, what we've gotten here is a case where your research program or your research assets are being reallocated for you, if you will, because somebody is chewing on your ear and forcing you, if you will, by virtue of this enhanced attention to move things around.

Now, when you talk about a five-year plan, and I think Dr. Powers mentioned that as we started, that we're looking more toward the future and so on, and as we examine where we think information is going to come from that are going to tell us where we're maybe skating on thin ice and where we have, in fact, confirmation of the assumptions that we have made in developing certain regulatory positions, and I certainly hope that we've got more of the latter than the former, it strikes me that the old AEOD type activities, based on operating experience, are probably the richest source of information for the simple reason that the basic information is not being funded out of your budget.

It's the evaluation of what that information means that's coming out of your budget. So a strong continuation of the understanding of what operational experience means, what it's telling us, it seems to me, has got to be a very important pillar of any long-term program you have. It's the only real lab you've got.

MR. THADANI: I couldn't agree with you more. I think a related issue, and I know that's not the purpose of today's meeting, but David's point, I think, is -- you can look at it in a narrow way and you can look at it in a much broader way, and the industry has made a lot of changes to their IPEs.

We don't really know what those changes are, to what extent these IPEs have been updated, what information is publicly available. These are issues that I think we're going to have to address as we move forward in the arena of risk-informing our activities and regulations.

DR. BONACA: I like to just ask one question regarding that, however, because we are talking about these differences and although it's out of probably the subject of the day, but it's an important issue.

When we looked at the effectiveness of the station blackout, one issue that came clear was that the industry is counting unavailabilities in different ways than the NRC is using, and that ultimately brings up a bias and the bias can be interpreted either that the industry willingly is defying proper approaches, and I don't think it is.

When I saw the results that Mr. Lochbaum presented, there was a systematic bias that would suggest the same kind of issue. I think that before we have a record with recognizing that we are not doing things right, we should just go back and try to check to see if, in fact, those biases are due to the fact that they're counting in a different way than they should, and I think that's the situation.

DR. THADANI: I think, Mario, that's right. In fact, I have asked Tom King, and Pat Baranowsky, as you know, works for Tom, I've asked Tom is there a document, is there a place where we can all say we agree that here is how you define unreliability, unavailability, and this is, in fact, how the industry and NRC is conducting its business.

So when we talk about values and numbers, we're saying the same things, rather than talking pat one another.

I don't know if there is a need for a standard in that area. Perhaps there is. But I have asked Tom to really look into this issue.

DR. APOSTOLAKIS: I wrote a memo with five or six definitions some time ago, which disappeared in a black hole somewhere. The industry, before I wrote it, said, well, gee, we'd like to have it. Then they came back a few months later with the old definition.

There was an effort to do that, Ashok, and I guess it was dismissed or failed or maybe I used an integral somewhere and people got scared. But there is a disagreement and in PRA we define unavailability in one way. The industry, as Mario said, defines it a different way. We discussed it here and then they said, well, gee, we define it differently, and nothing happened.

This was maybe two years ago.

DR. BONACA: But even the station blackout was recommended.

DR. APOSTOLAKIS: And then we did it again there. It was in another context, first, and they just --

DR. BONACA: The reason is that it defies any reasonable efforts. I mean, you can work for years at improving understanding and capabilities, but if we don't agree on the simplest terms --

DR. APOSTOLAKIS: The elementary stuff.

DR. BONACA: -- immediately, these biases are going to be viewed as manipulation of data to presume whatever, and instead, as you pointed out before, in some cases, the estimates of the industry are conservative; in some cases, they're non-conservative with respect to the way that you are counting unavailability or reliability.

But it's so easy to then make an accusation of that kind when you have those kind of discrepancies. Yet, if I look at the data of Mr. Lochbaum, again, the consistent bias is so consistent that it's telling me that there is a counting issue there.

CHAIRMAN POWERS: If we come back to the original point on the invisibility of the operational data, the report, that's been of concern to this committee, even when you had the AEOD as distinct, that they were issuing reports, but we weren't seeing consistently the staff using that in making their arguments to us.

That was distressing, but even within the professional PRA community at large, people might acknowledge that, oh, yeah, it's right on my shelf and it's been there since the day it arrived. They weren't using it regularly. And it's one of the challenges, I think, that the research organization really faces, is to find a way so that the currency of exchange throughout the country in probabilistic risk assessment for reactors uses this agreed upon unbiased data set as the foundations for any analysis that they undertake.

It's one of the things you've just to work on and I don't know how to do it. What I do know is issuing a report in and of itself is only a first step.

DR. SEALE: In a way, it's almost a paralyzing step because once it's in a report in black and white, it has a lifetime which is entirely inappropriate to its value. It's very difficult to upgrade a number that's in a report.

I think in another context, we talked about the desirability of doing certain things in a loose-leaf format and that may be of concern here; the fact that you put a number out, it takes on a life of its own, and it's very difficult to modify it.

MR. THADANI: There are two parts, it seems to me, to what you've said. First is when we develop these reports, in the office we have developed a process, I know for a fact that for many years, there would be lots of really good technical work done by the Office of Research in either NUREG or NUREG-CR documents, and they were on bookshelves. They looked good, but I'm not sure people use the information contained in them.

About a year ago, I issued a memo to all our staff asking that for each major effort that we have underway, when we develop our documentation, that in the cover memorandum or transmitting letter, we lay out what was the purpose of the research that was done, briefly, what were the results, how might those results be used, and being interested in getting some feedback on that.

There's six or seven such questions that each person is to address. I think the staff, by and large, is, in fact, following through on that.

Now, in many cases, we would make recommendations, suggestions, but in the end, it's the users who make certain decisions on to what extent should one apply the results of this research in the ongoing activities.

I think we need to -- as you know, we need to improve in that area, both in terms of working internally within the agency and with external stakeholders, and I will say a few words about external stakeholders. I know I have blown the time I had allotted to me.

But as you know, Margaret has been very active.

She chairs the Research Evaluation Review Board, and some of these questions and concerns that many people have about the use of information and making sure there is some mechanism in place is part of what the board is working on, amongst many other issues.

We have some ways to go, I think, to get there, but it's something we need to make sure we focus attention on.

MR. KING: If I can add two things. There is some progress being made in this area. I'll give you two examples. As a result of the summer safety course at MIT, Steve Mays, from Baranowsky's branch, gave a presentation on operating experience. There were some utility people that heard that and he got invited out to the Perry plant, he went last week, and they had utility people from Perry, from Beaver Valley, there were Region III people there, he gave basically the presentation he gave at MIT, on this is what we're doing, analyzing operating data, this is the value we see it, the uses we think people can make of it, and he got a very positive response back from the utility folks and from the Region III folks.

Hopefully, more of that will -- I mean, we'd be glad to go elsewhere if other people want to invite us out to talk about it.

DR. APOSTOLAKIS: Most of the participants in that course are utility people and Steve's presentation is Friday morning, the last day, and I must say there is a hell of a lot of interest.

When people see actual data, and these are practical guys, I mean, they got out there in the field, five minutes into his talk, you can see they're animated, they're asking lots of questions. So I'm not surprised that he was invited to give the talk.

MR. KING: I think four or five Region III people and about 20 utility people sat in from the two plants.

DR. APOSTOLAKIS: Did he tell them to come to the MIT course?

MR. KING: I'm sure he did. The other thing is we've now -- we work closely with the NRR inspection folks and the results from the operating experience is sent to them directly with a cover letter, like Ashok said, saying, hey, this is what this information means in terms of how you can improve the oversight process.

They have now invited us to come help them incorporate this into the oversight process. It's a much more collaborative working relationship. So there is progress.

CHAIRMAN POWERS: That seems like it parallels so many things. Our experience with PRA, for instance, in the Department of Energy reactors at Savannah River was they did they analysis, it sat on the shelf, nobody used it, until the analyst said I've got to quit speaking PRA-ese and start speaking maintenance-ese. So they went out to the trouble to convert the results from probabilities and things like that to maintenance directed activities, maintain this one twice as often as you do and this other one you can do half as often.

And suddenly the work of that PRA group was totally subscribed by the maintenance organization. I think that's the same thing you're saying here, is once you turn these data into something that inspection and monitoring people will understand, then they will make heavy use of it.

Maybe that's the whole trick, is to just start targeting audiences for these reports and use their language instead of your language, and they will quickly be able to make that translation, as well, and you can move on to another target audience.

DR. SEALE: And as we look at the impact of budget limitations and so on within the utilities, and clearly that's a safety-related question, too, anything that can enhance the sense of ownership of a utility activity by the operating people, whether they're maintenance or whatever, enhances the support for doing that activity within the utility.

That was certainly the experience with the training programs and it would certainly be the experience with the PRA-related activities, as well.

So there's some symbiosis here, too. If the utilities can use that information more effectively, then they will have more effective input in that area.

MR. THADANI: I'll try to move through very quickly.

MR. LEITCH: Just one question about the operating experiences. Data from the maintenance rule factored in in part of that operating experience?

MR. THADANI: Yes. And as you -- you know, we are working -- we have an agreement with the industry, through INPO, on getting what's called the EPIX, the data that we get and we have, and we convert that data to reliability and availability estimates ourselves.

And the database covers the more significant safety systems. Safety, I don't mean in the context of safety-related, but important safety systems. And so I think we -- if we can agree on consistent basic ways of converting the data to reliability and availability, I think we will have had quite a bit of progress.

MR. LEITCH: I'm not sure, for example, that one utility has information about what another utility's A1 systems are in the maintenance rule. I think it would be interesting to somehow compile that data and be aware that, hey, we're not the only ones that are having trouble with RCIC, that's an across-the-board type of problem.

MR. THADANI: That's true. That's true.

MR. KING: INPO is taking the lead to have the utilities input data in a consistent fashion to the EPIX system and what systems and what components feed that system.

We're on sort of a management oversight group that participates in that, Pat Baranowsky and so forth. A lot of that data is proprietary data. In other words, we'll get it, but we can't publish plant-specific data on specific systems and components. We can integrate and publish overall reliability trends and so forth and how much the utilities, through INPO, share that among themselves, I don't know. That's a good question.

MR. THADANI: Also, to Graham's question, at least in my mind, the industry, under the maintenance rule, they'll have categories A1, A2 and A3, and ultimately A4, the revised rule. They are based on industry IPEs and conversion of SSEs from A2 to A1 establishing goals and so on.

We are really -- we're not -- research is really not engaged in that and that's something we need to think about in the context of the database and so on. So I'll certainly want us to give it some thought.

MR. LEITCH: Thank you.

MR. THADANI: Okay. I will try my very best. I talked about pre-TMI, there was complacency, I think, and, again, I hear things that, while I think they are valid statements, but we have to be on guard, I think. You hear a great deal about the industry's mature. Yes. However, there are lots and lots of changes taking place out there and there are all kinds of pressures under this deregulated environment that we're in and we need to make sure that in this sort of good operating experience, good performance indicators, with time, that we not become overly confident perhaps, is what I'm looking for; that we need to challenge ourselves when we make changes in a way to be sure that we have developed good technical basis for many of the changes, whether they're technology-driven changes, economic factors that go in changes, power up-rates and things like that, that proper database and, in this case, whether it's operating experience or experimental database, proper database should be developed such that we have the right analytical tools, ones that we have confidence in.

Now, with what I think is all kinds of changes taking place in the industry, and I will share with you some areas in a minute, the biggest concern I have is going back to what Bob just said at the outset.

Are we slowly eroding away our infrastructure?

The Office of Research, as you know, the agency has six-to-one ratio, over 60 versus under 30, 25 percent of people in research can retire today. You will see about the facilities going down.

DR. SEALE: I'm going to shut up in a minute, but I hope there is one other thing that you mention in here, and it has to do with the fact that from the very beginning, the utility mixture that has been involved in nuclear power has included advanced thinking utilities, sort of average we buy our subscription to EPRI utilities, and what I've called in the past the troglodytes. And some have been interested in learning in the engineering area and so on, enhancing their operations and so forth. These are the people that supported the evolution of PRA activities and so on in the industry and all.

And others have done the minimum necessary to satisfy their perception of the regulatory requirements and, by the way, we'll argue about that.

Now, at the present time, there is an enormous amount of compression going on in the industry. Hopefully, my optimistic side says that the consequences of that will be among, other things, the ability to afford a strong questioning, perceptive engineering organization in each of these larger utility groups.

I sure hope that my optimistic perceptions are correct, because if not, then we've got problems and they're even bigger problems that they used to be.

MR. THADANI: I would hope that your optimism would, in fact, become reality, but I think it's something that would need watching.

DR. SEALE: That's the reason we need to do things like experience and so forth. We need to continually challenge people what that means to them.

DR. APOSTOLAKIS: I think we should also -- I want to say one thing about this issue of maturity, because people are using it a lot. I think it's a relative concept. To say that the industry is mature doesn't mean much. You have to look at the kinds of frequencies that PRAs produce.

If your frequency of core damage is on the order of ten-to-the-minus-five every 100,000 years, the fact that you've had experience on the order of a couple of thousand reactor years does not make you mature.

So in that context, I think the argument goes away, because people say we're mature now, we've been working for so many years. Yes, but look the kinds of things that you worry about, they are truly rare events.

So you can't really claim that on the basis of a statistical record, now we can abandon analysis.

MR. THADANI: My opinion, now I'm speaking just for myself, my view is that the industry business models that they talk about, business models, decisions, there would be a fair amount of attention given to making sure that the more likely events and initiator frequency is reduced.

It seems to me the regulator has a responsibility to poke and probe in areas of low frequencies. Those areas of ten-to-the-minus-four to ten-to-the-minus-five per reactor year are not going to get as much attention, I believe, from the industry and the regulator has to make sure that they are paying attention to those.

DR. APOSTOLAKIS: Right, but the statistical record doesn't help you there.

DR. BONACA: The other thing I would like to add is that maturity doesn't give me comfort if we said, okay, it's a mature industry, we're going to stay steady and run these plants until their end of life and do that.

I don't see that happening. There is a paradigm taking place. We are mature as an industry; therefore, we're going to increase power to the reactors, we're going to run for 60 years, we're going to increase the fuel cycle, et cetera. I mean, these issues we have raised on synergies of this -- potential synergies, it certainly is a concern.

It may be a mature industry, which also implies some age in it, and we are squeezing out margin, and I think that this issue of margin reduction is a very important one that certainly we would like to talk about sometime today.

MR. THADANI: Yes. In fact, I think you have covered probably one or two slides that I have coming up.

I want to emphasize this. We would -- and since today's discussion is five-seven years from now issue, we need to think very hard and we need to be able to look over that horizon and say what are the challenges and what are the implications of the direction we're headed in and is there a way to make changes, what those changes are and we need to be thinking and planning now.

That means we need to make sure we get the support to be able to change certain directions. I'm very pleased. I can tell you that the Commission is very strong support for the Office of Research and the concerns about resources and so on.

I will touch upon that in a minute.

DR. KRESS: Ashok, while you're on that subject, I may be out of order here, but I'll say it anyway. One of the things that concerns me is the pressures to curb or limit NRC Research from various outside sources because research is, quote, not needed. I think that stems from the fact that the research is lumped in with the rest of NRC in this full fee recovery type of funding.

I think that's a mistake. I think the whole system would be better off if research, which benefits the broad public more than just specific plants, if it were separately funded by taxpayer money that doesn't come from the fee recovery from the plants.

Now, I don't know if there's any possibility of that ever happening, but if that would ever happen, to me, that would cure a lot of the ills on the research program.

MR. THADANI: We can talk about it now. It's coming up on one of the charts, because the external expert group debated quite a bit on that issue of where should the funds come that support research.

There were a number of recommendations made. One, for example, suggested that 50 percent of research budget should not come from licensees, but should come from general revenues, for the reasons that you indicated.

But the panel discussion at the water reactor safety meeting, Commissioner McGaffigan threw out his point perhaps our research budget should come from general revenues.

These things need to be thought through carefully and I know the Chairman is focusing on this issue, as well.

One thing that's very important is particularly if the long-term research is to come from general revenues, there has to be some sort of stability to the availability of resources if you're going to plan four or five year research programs.

And if it's coming from general revenues, there are some risks in those. But I think, Tom, your views are shared by many, I think, and the tide is rising, it seems to me.

We may be mature, but we're rather dynamic. So power up-rates, let me tell you, you know, five, six, seven, eight, nine percent, I think a great deal of good work had been done that sort of paved the way for that, but I just read Inside NRC the other day, Brunswick, which got about six percent increase, is now talking about additional 15 percent for each unit, a total of 230 megawatts electric, which would be about 22 percent increase in power.

CHAIRMAN POWERS: Take a look at the things that were in the queue or proposed to be in the queue and it amounts to adding eight new units for an extra five years. So people say we aren't building nuclear power plants. That's true, but not quite true.

DR. SEALE: That's true.

MR. THADANI: So I have asked Dr. Eltawila to put his smart hat on and step back and see what safety issues there might be that need to get some attention.

CHAIRMAN POWERS: I find it remarkable that Mr. Eltawila ever takes his smart hat off.

MR. THADANI: Well, you should spend your time with him. There have been occasions, very few. Since you're speaking after me, I suspect you're going to have a zinger.

On these issues, I don't really want to get into, but this is why I believe, when you look to the future, you really have to focus on what will be needed, why and when, and plan programs.

So we need some help and I will tell you where we need some help. We know some of the short -- we don't have a -- in my mind, short-term issues usually there is not a big problem. Sometimes, there may be some small issues. Generally, we are able to reach agreement on those.

Where the difficulty comes in is looking down the road, the horizon. How should we be prioritizing what we work on? How should we weight what may be problems five to ten years from now versus what we do now?

As you know, we have this 80/20, 80 percent confirmatory, 20 percent anticipatory, but it really doesn't end up that way. Usually it ends up probably 90 percent confirmatory, because we sometimes have to -- research results come in and they are actually being used in confirming some decisions and so on.

But we also get challenges during the year and so on. So when the challenges come in, you scratch your head, I need resources, well, where can I go get resources.

Oftentimes, what you end up with is where there is the least pain in the short term and so that means you go to longer-term. And we need to do better in that and I -- for example, when we plan ahead, we have AP-1000 potentially coming in for review, non-light water reactor designs. If you had asked me just a while -- some -- maybe several months ago, I would have not been very optimistic, but there's a lot of interest in the U.S., for example, in pebble bed reactor design. PECO has contributed ten percent to SCOM and we have had, as you know, dialogue with the Department of Energy on Generation IV reactors and Tom is going to talk about what we see some of the issues and where we might need to go.

Things like AP-1000, non-light water reactor designs, we don't have the operating experience to say even what did we learn and so on. To me, that means we must make absolutely sure that we understand phenomena challenges and perhaps do the kinds of things Farouk has done through PIRT panels and do so on to be able to identify what some of the issues are going to be and to make sure that we have sound -- we have developed sound technical basis for regulatory decisions regarding safety.

Now, it's very interesting. This report, I think, is either out or is about to come out. It's a pre-publication copy, Strengthening Science at the U.S. Environmental Protection Agency, Research Management and

Peer Review Practices, done by a National Research Council. There was a group that was set up and I was just reading it actually last night, you know, sleepless times, and I wanted to read you something, because I think it really -- it has -- we're not alone in some of the difficulties that we're facing.

It says in the 1997 NRC -- this NRC is the National Research Council -- report, building a foundation for sound environmental decisions, our companion committee in this study concluded that ORD, which is their research group, should maintain a balance between the problem-driven research and technical support for the agency's regulatory programs and the core research to better understand and anticipate environmental risks.

Our committee agrees these two functions are not unrelated or incompatible. They are mutually reinforcing. Core research is the indispensable offspring that prepares and enables ORD to provide better problem-specific research and technical assistance to the agency and the nation.

I read it because I think I see a parallel. That applies to us equally. And core research is not as well appreciated when you look at the prioritization that we go through. We have to figure out a way, I think, to somehow -- the agency has -- and I think I have a responsibility to help us in that direction. We have to come up with, I think, a better way to prioritize.

Our current scheme is too much driven by short-term benefits. I'm guilty of that. I was part of the group that worked on this prioritization. But I have certainly changed in the last year because I do see the different future of nuclear power in this country than I perhaps saw a year ago and it's very likely going to be part of the mix, an important source, and it is going to be -- I think people are, again, going to be challenged in many different ways technically and interest is, I think, going to grow and we have a responsibility to make sure that we not make that much more difficult than it ought to be, and I'm afraid the direction we're going in will make it much more difficult, unless we find a way to turn that around.

MS. FEDERLINE: Ashok, could I just say one thing on that?

MR. THADANI: Please.

MS. FEDERLINE: I attended DOE's meeting with the deans of the School of Engineering and it was a great tragedy to see these deans really talking about how do we preserve and sustain the transfer of knowledge within the country, and that's something that's not popular in this agency, when we say doing research for research sake. It's not research for research sake. It's an effort to sustain the transfer of knowledge from one individual to the other, and we've always been able to do that. We've had that luxury in the agency because we've had a number of solid people who have worked in the same fields and we've transferred knowledge.

We now, I think, have to face the concern within the agency about how do we transfer knowledge, how do we sustain our own capability over time, and any advice that you can give us on how we can sell that would be much appreciated.

MR. THADANI: Thanks, Margaret. Well, I think we have covered this, but one or two points I would like to make. There's been a lot of discussion about the role of regulatory agency and the role of the industry in the development of the information and, in fact, the external expert group that looked at the role and direction of research also had some statements and I will share them with you.

Some of these points that are on this chart come out in the review that the external group did, so no point repeating. But just very briefly, research has to reach out. That's very important.

DR. APOSTOLAKIS: Who was the expert panel? Who were on the panel?

MR. THADANI: There it is, the list. I will get you copies. It was very important to us that we work on both fronts, our internal stakeholders and our external stakeholders.

We have to get out, we have to talk to people, we have to tell them what we're doing and why. There has been a problem of non-visibility of research, research efforts, results of those efforts, and the value of those efforts.

So we're working on both sides to make sure that we are, in fact, reaching out and learning from views that other people may have. You see in front of you, we made sure that we have all the interested stakeholders part of this external group. Certainly, Congressional staff, public interest groups, utilities, academia and so on. We tried to cover the spectrum.

DR. APOSTOLAKIS: Ashok, is there anything in the law that stops you from sending a number of questions, say, to the heads of departments, nuclear engineering departments around the country asking them to comment on research?

MR. THADANI: Nothing, as far as I know, in the law would prevent us from doing that and one of the things we are trying to be sure we're doing is get external input on what those future challenges might be.

DR. APOSTOLAKIS: See, that's my problem -- and it's not a problem. The point is that perhaps we are limiting the input we receive to a number of very senior people and this is -- you know, their input is certainly needed, but it seems to me that every now and then you should hear from the guy out there who is actually trying to write a paper, who is actually trying to do something.

Now, obviously, you cannot invite all of these people to Washington, but give them a chance somehow. Don't expect that people will go to the NRC web site and look for it. I mean, if you have a list of e-mail addresses of chairmen of departments or maybe even other organizations.

Now, I don't know to what extent the national lab guys can do this, but you might --

DR. KRESS: Yes. Yes.

MR. THADANI: We do it all the time.

DR. APOSTOLAKIS: But then you may get some -- a lot of these are -- the input that you receive, I guess, would be this guy's complaint about this little detail, but you can dismiss those very quickly.

You may get something --

DR. SEALE: If your inquiry goes to a dean, you've already very drastically pre-filtered your response.

DR. APOSTOLAKIS: It should go to the chairmen, I think.

MR. THADANI: Now, let me make you a commitment here, because I am a very strong believer in getting external input to what we do, and internal. At the last all-hands meeting of the research that I had with the staff here, I have invited all research staff to feel completely free to propose what they believe are important research areas.

DR. APOSTOLAKIS: Good.

MR. THADANI: In that spirit, I think you're exactly right. Unless I find out there's some legal problem, which I don't see why, I don't think so, we'll do just what you say. It's a good idea.

DR. APOSTOLAKIS: The American Nuclear Society already, I believe, has a list of all the chairmen and their addresses and they meet as a group. NEDO, it's called, I don't know. Do you know? You can go through those guys. MIT will be more than happy to send you something.

MR. THADANI: I think even if we find one or two nuggets, I think that's great.

CHAIRMAN POWERS: From MIT, don't anticipate too much now.

DR. APOSTOLAKIS: Because I will not participate.

MR. THADANI: Let me quickly run through and what this -- this is a -- by the way, this group was put together as a non-FACA group, so it's their individual views and not attempt was really made to come to consensus.

But it was interesting. While there were obviously some differences of opinions in some areas, but there were also a lot of common elements that came through.

I'm reminded of Harold Ray's statements about he said "Ashok, everything you put up there, I support you, basically." I think those things ought to be done.

But the industry shouldn't have to pay for all of that stuff. And I think to a certain extent, this whole issue of 100 percent, up to now, now that the Congress passed, approved the two percent per year off of fee base up to ten percent in five years, but still research budget is going to be coming from fee base, is going to be fee-based.

I think this is becoming an issue that is clearly on the minds of a lot of people, is there a better way to fund research or part of research. It's an issue of today, I think, we have to work on.

DR. APOSTOLAKIS: I think all of these things make sense, except the penultimate bullet. I don't know why a single strong center would be beneficial. Is the idea of diversity applicable here?

MR. THADANI: I think it was --

DR. APOSTOLAKIS: Unless you want to have the center in the northeast somewhere. Otherwise, I --

MR. THADANI: I think it really gets down to you have to decide, as the budgets go down, you have to decide how one can be most effective and efficient, and I think this group -- and I don't -- I mean, I think this group had some individuals with sort of strong views that some of the research that's conducted outside of the Office of Research should perhaps be brought to the Office of Research.

DR. APOSTOLAKIS: I think, Ashok, you know, I've been on the outside for a very long time, one of the biggest complaints of people outside the establishment of the NRC is how hard it is to get NRC money. It's awfully hard, unless -- so the law, it seems to me, creates a contradiction here.

On the one hand, by wanting you to be independent, it puts all these constraints on you. But on the other hand, it's awfully hard for people who have ideas to come to you. The standard answer is we can't do that, I mean, unless you have a cooperative agreement, which takes X months to put together and your staff would be unwilling, in general, to spend the time to do that, or a national laboratory gives you a subcontract, which is an extremely inefficient way of doing business.

There is no way, there is no way. This is a real problem and people just give up. They know they cannot -- you are probably the only agency -- one of the very few agencies in the Federal Government that does not make announcements for a request for proposal in the Federal Register in a regular basis. NASA does it all the time. The EPA does it all the time, gives deadlines.

The NRC is shining by its absence. I think it's not because you're bad people, it's because of all these constraints that have been imposed on you. If you want stakeholder input --

CHAIRMAN POWERS: And I really question whether it's a topic that we're going to delve in in the research report. I mean, it's -- I mean, call your Congressman if you don't like what's going on.

DR. APOSTOLAKIS: There is all the input from the panel.

CHAIRMAN POWERS: The panel is uninhibited.

DR. APOSTOLAKIS: The research report would not address that.

CHAIRMAN POWERS: I think that's just kind of outside our domain of influence. This question, though, that the penultimate point brought up does strike me as an interesting question to pursue, and I don't know whether it's part of the research report or something else, and I'm wondering is that something that maybe we should have one of our fellows look into.

Is it -- what's the history and the utility of having centers of excellence for research for particular topics and clearly Nuclear Regulatory Research would be a particular topic.

Is that something we ought to look into? Would it be useful? I'm right now posing that to you, Ashok. Would that b something useful for us to look at?

MR. THADANI: I think it would be useful. At this stage, for example, high level waste research being done from NMSS, we need to also recognize practicality. It's been going on for many years that way, since 1996, I believe, '95 or '96, and what efficiencies would be gained to reconsider an earlier decision that the Commission made.

It is not clear to me that in our case, NRC's case, that one can make any significant changes at this stage. There have been some issues about the technical assistance work that's done from NRR. Would that be more efficiently done through research? That's what this expert group was talking about. Some of the Congressional staffers were asking those kinds of questions, driven, I think, mostly by is there a -- you know, some people can take what the Congress said every literally that the Office of Research is to conduct research.

So if you go back, one can -- and, in fact, David Lochbaum sent a letter saying that is the agency doing what Congress mandated for the agency to do. Why is all research not being done in the Office of Research? So I don't think that -- while it may be useful to give some attention to this issue, but at NRC, I'm not sure that we will accomplish very much through such an evaluation.

But in the broader scheme of things, it might be a useful study to see and maybe learn to see is there a better way to structure research organization and so on.

I think you see the list, not a lot of this is surprising. The last two bullets on this page reflect, I think, general view amongst most, if not all the members of this group that budget trends were very alarming about research, and that the NRC was not doing enough to talk to Congress and tell Congress about some of the concerns about the trend and the potential implications of those trends, and in that context, again, Tom, there were many, many members of this group who felt at least some of research budget should come from general revenues, because this is public health and safety we're talking about, so unique in terms of NRC versus other agencies.

Now that I have taken up Mike Mayfield's time, I guess we'll go past -- I'm just kidding. As you know, we structured these presentations for me to really give you sort of overview and thoughts on what some future challenges may be, and then each of the division directors will lead discussions through some selected areas, not necessarily that they have responsibility for everything under that area, but they will have lead responsibility, with input from other divisions.

So when Mike makes his presentation, I expect others to be very active participants on the operating reactors issues.

MR. MAYFIELD: They better be, or this will be real quick. The first piece of this is looking at challenges from the currently operating plants over the five to seven year timeframe. We wanted to start by talking about some of the underlying assumptions that we have made as we look at this. The first and foremost that Ashok has talked about already is the impact of deregulation, the economic pressures that's bringing about on the licensees, their need to get more from the existing plants.

At the same time, they have to balance the financial bottom line against the need to maintain current levels of safety.

DR. KRESS: Does that include reducing their staff?

MR. MAYFIELD: I'm sorry, say it again.

DR. KRESS: Does that response to that pressure include reducing staff?

MR. MAYFIELD: Yes, it does. We are seeing these things manifest themselves as a number of things, many of which have already been discussed. They are things that have been before the committee. We anticipate they will continue, if not increase. Ashok mentioned earlier the power up-rate business.

The license renewal activities, we're talking some 85 percent of the plants are anticipated to come in for license renewal. Higher burn-up fuels, going to longer operating cycles, responding to economic pressures will bring about human performance issues, expanded use of overtime, reduction of staff, a number of things in that general area that we'll have a little bit more to say about as we go.

Continuing with some of the underlying assumptions, changes in the plant design and operation are likely to be evolutionary rather than revolutionary for the current operating plants. Tom is going to have more to say about future designs, but for the ones that are out there operating today, we're anticipating some evolutionary change as we go along.

There will be some fact of life changes made in virtually all the operating plants. Expanded use of digital technology, some changes in systems, materials and operational to mitigate effects of aging.

CHAIRMAN POWERS: What comes immediately into mind when you mention that is the switch from INCONEL-600 to 690 in a steam generator. Could you give me some more examples?

MR. MAYFIELD: I think you're going to see some concerns come out in the changes in piping materials.

CHAIRMAN POWERS: Like going from?

MR. MAYFIELD: The feed water line from the erosion/corrosion. As we continue to go along, are we going to really start changing out more piping systems. The recent crack at Summer, I certainly wouldn't want to pre-judge where that's going and I don't want to leave any impression that I have any insights into where the failure investigation will go, but will that -- pose it as a question -- will that lead to some need for wider changes.

CHAIRMAN POWERS: I think the whole point is better cast in that light. It's saying I've got this good example of people going from 600 to 690 with stainless steel support plates and things like that. Are we going to see anymore of that, and feed water erosion/corrosion issues is a candidate for that; now, are there any others that might come along, rather than saying it's going to happen.

MR. MAYFIELD: That's part of what we're looking at, will there be any changes in reactor internals due to radiation assisted stress corrosion cracking, particularly in the PWRs. As we get to higher and higher fluences, plants looking to get out to 60 years, are there going to be surprises, and that's part of what we're already trying to get ourselves to look at.

It's tough to do. The test reactor irradiations, at least in Dr. Shack's lifetime, you know, it's --

CHAIRMAN POWERS: He's willing to live forever.

MR. MAYFIELD: So there are certain practical limitations that we face in the research program, but we're looking at how to get out there and try and get ahead of the issue rather than wait for us to start seeing service-induced failures.

CHAIRMAN POWERS: I think it's similarly important and it's just for the reason that you said, that the kind of research information that you need on these materials for the NRC tend to be very different than the users. Usually pretty good, from normal operating conditions, they'll get that kind of data, and then you'll start asking questions about, well, what about fatigue with thermal cycling and as soon as you start raising that, now you're talking about things that take a long time to correct, and there's no way to accelerate it. You've just got to go through the number of cycles.

MR. MAYFIELD: You've just got to be patient and then you're also left with the concern about going from the test specimen to the real service argument.

CHAIRMAN POWERS: From uniaxial fatigue to biaxial fatigue and things like that. That seems like a thrust area that we need to spend some time talking about because the long-term planning on that is really long-term. I mean, if somebody came in with a new alloy today to use in steam generator tubes, at what point would you think that you had sufficient data to use something like an alternate repair criteria on it. You would be talking about seven years or something like that.

MR. MAYFIELD: You're talking years worth of work.

CHAIRMAN POWERS: Yes, many years worth. You raise a point that really we need to communicate with the Commission about this, because they need to understand that you can accelerate some of it, but there's an awful lot that just doesn't accelerate.

MR. MAYFIELD: That's right.

DR. KRESS: Mike, your bullet on the fact that changes are going to be evolutionary rather than revolutionary for operating plants, I think, is very much correct, but it's a disappointment to me and I'll tell you why. I've felt for a long time that the fact that we have fuel clad that is chemically reactive with steam and air is about 80 percent of our risk driver. It's the energy you get that drives you into fuel melt and it does it quickly, so you don't have time to react. It's a source of hydrogen, it's a source for continued core-concrete interactions.

It's probably the culprit in DCH, if you have a culprit. It's probably the driver for fuel-coolant interactions.

I haven't seen any research on new fuel designs and ever sine we've had the zircalloy clad fuel. Now, this may be a function for DOE to do -- in fact, I think it is -- or industry to do, but I think NRC has a stake in that because that would drive the risk way down, if we just had fuel that didn't have this chemical reaction in it. It would be a real risk improvement in the whole population of plants if you could do that.

DR. SEALE: That certainly is a confirmatory research item and ought to be shopped somewhere.

DR. KRESS: Yes.

MR. MAYFIELD: I agree it ought to be shopped somewhere, but maybe Farouk or Tom have --

MR. ELTAWILA: Actually, I'm going to discuss that in my presentation, so maybe you can wait until we get to it.

DR. SEALE: Could I make another point? I've raised a question with my colleagues and I've gotten an unsatisfactory answer, and maybe you guys can help me a little bit.

Your last bullet down here talks about analytic and experimental support for regulatory decisions. You earlier talked about evolutionary versus revolutionary. There is a group of plants in this country that represented a revolutionary upgrade of a design that took advantage of, in quotes, a primary coolant pump design that had already been used in another plant overseas.

The reactor internals design was somewhat different, as well, and as a result, in the first test for commercial operation, the 100-hour test, where you make sure you got what you bought and all that stuff, they so damaged the pump and the internals that Unit 1 wound up being after Unit 2 in coming on line in that plant.

The changes that were involved were specific, but relatively low profile. The changes in the phenomenon, the evolutionary changes that drove that problem, in part, were of the order of magnitude of the kinds of changes you're talking about in some of the power upgrades.

I'm concerned that we may induce some vibrational problems in some of these plants that have been operating for a long time now without difficulty and suddenly we're going to have a problem.

When I raise this question with people, they tell me that's a balance of plant problem and not a safety issue. It scares, if you'll pardon the expression, the hell out of me, because if it happens, it's going to happen at a nuclear power plant and all of these semantic trivial differences are just going to vaporize when that happens. We're going to have a nuclear power plant that was damaged because of the things the industry was doing to it.

And is there any intent to talk about the kind of intensified instrumentation that was in the 100-hour upgrade, when we have these significant changes -- I mean, the 100-hour qualification -- when we have these significant changes in operating conditions that accompany some of these upgrade proposals.

Now, that's an immediate problem.

MR. MAYFIELD: We periodically talk about being a learning organization. I suspect the industry would characterize itself as composed of learning organizations.

Have we gotten smarter as we've gone along and know to watch for some of those things, to think about them more carefully? I believe the answer to that is absolutely yes. The distinction between primary and -- well, primary and secondary, balance of plant, yes, it's there; yes, responsibilities are a bit different, but we've also -- we pay more attention.

I think the Surry feedwater rupture was one good example where, yes, the primary responsibility was with other organizations, principally the licensee.

But you saw coming out of that, I think, a fair bit of interest from the staff and this agency in general to those kinds of issues.

So yes, the distinctions are still there; yes, the responsibilities are still different, but the lines are less clear that they used to be. Do we ask more questions, does the industry ask more questions of itself? I believe the answer to that is yes.

Will these kind of things crop up again?

Probably, but we know to watch for them now and to try and watch for them at least.

MS. FEDERLINE: That's why depth of knowledge is so important, the depth of experience. If we lose that experience and can't recognize it, that's an intangible that we don't recognize all the time.

MR. THADANI: I think there is a related issue here, and that is the technology issue. Mike and I have been involved in this interagency working group on wire safety, cables and concerns about cables, and aging effects, for the country, because of some of the accidents that have taken place outside of the nuclear industry.

Over the next several years, there will probably be all kinds of smart sensors, diagnostic capability, maybe even wireless environment down the road. I think that those developments will have a very -- could have a very positive effect on safety in that they could tell you a little bit earlier about potential problems that may be creeping up.

I think that's an area where we, as an agency, probably need to be more active than we have been. I certainly learned from participation in the interagency working group that the Department of Defense and Transportation are doing all kinds of very interesting research and some of which would be not only valuable to us as a nuclear regulatory agency, but I think to the nuclear industry.

So we're going to try and encourage industry to be part of it, after the report goes to the President. I believe that's planned for November 15, from the Office of Science and Technology, but I think there's some positive things that we can build on.

MR. MAYFIELD: And we'll come back to that basic idea in another few bullets. I did want to touch on the use of the PRA is going to become more routine. We've seen that just in the last few years. We believe it's going to continue. That brings --

CHAIRMAN POWERS: Within your own staff, and maybe the bullet was not intended to mean your own staff, what I see is a lot more use of the language of PRA, but it's usually cast in terms of we learn from the IPEs or something like that, and not so much from I've done a PRA analysis of a particular plant using the latest model they have.

So I guess what I'm asking is do you really mean the use of PRA or use of the language of PRA?

MR. MAYFIELD: It's actually both, but I really do mean the use of PRA and an example I will give you from current experience is the reevaluation of the PTS screening criteria in 1061. Is it plant-specific? Well, yes and no. It's got three or four specific plants we're looking at, we're trying to use their latest and greatest models, but there's also a generic spin to it because they are intended to represent the fleet of PWRs.

So there's this mixture and it's that combination of getting people more comfortable with the language of PRA to think in those terms. When we've got a -- the revised embrittlement model that Mark Kirk briefed you on a couple of weeks ago, the notion there is to do a sufficiently robust uncertainty analysis so it can be embedded in a real PRA if we get around to doing vessel -- including the vessel explicitly in the PRAs, but that tool will be there or will be an input.

It will have been done in a sufficiently robust way that the PRA practitioners can actually pick it up, use it without having to go back in and redo a piece of work that the old deterministic bar busters took and were perfectly happy with.

So the idea is to try and embed that thinking so it just becomes a second nature to what the staff is doing.

DR. BONACA: I would like to just ask a question a little bit regarding the use of PRA here, and maybe, I guess, it's a different question and I don't know where to place it. I would like to place it now.

When I look at many of the efforts and the way you're going to address them and I think they're all valuable, all the research seems to be focused on what's happening, and, of course, it should be, in part. The industry wants to go to power up-rate. We need to understand what are the deterministic limits of that and do research to see how we can approve it or whatever.

The industry wants to go to license renewal and we know how much we have invested in that and we are investing in that, and so on and so forth.

And it seems to me that if tomorrow the industry says I want to fly a power plant, we will make research to see how we can fly a power plant and maybe we will say it cannot be done, but I'm saying that everything seems to be focused on addressing each individual initiative and the changes that they place there, but when you talk about a regulatory decision, in the last bullet, I would expect, at some point, you would want to be able to understand how all these things, an eroding margin, how you enable yourself to say, at some point, no, it cannot be done, because for plant X, which has a very -- doesn't meet today's safety goals, I mean, we should think about also that non-deterministic perspective of that. This plant really would go through a significant margin reduction because of aging, because of life extension, because of something, and things are going to be done in a certain way.

It would be, I think, a service. I just don't see that anywhere, and maybe I'm missing it in my review of the program that I've been looking at in the past few days, and I don't see it here. I understand it's a very tough issue, but yet this issue of synergies, for example.

MR. THADANI: Yes, I want to address that issue.

DR. BONACA: Just one last statement. The reason why I'm so concerned about it is that I don't see anymore anything being done about representation of aging in, for example, PRA models. We really have forgotten about them because we decided that the license renewal is deterministic and, therefore, every effort was to attempt to simulate aging into the PRA, it seems to have disappeared.

And maybe I'm wrong, but I would like you to point me out to that as we go through the presentation.

MR. THADANI: I had a chart earlier and I didn't go through it. I just had the list of issues. You might recall it had license renewal and aging. They were shown separately. There was a reason. I did that because I also have this concern about synergistic effects. When we take a parameter at a time and just try and understand its effects, we are not doing, I think, we haven't thought through well what are the implications of aging at the same time, increasing power level, at the same time something else being done through deregulation maybe, how does it really come back.

The issue, in my mind, extending license is not just the effects of aging, but combined impact of the various changes that are made. Are we going to be developing a database that will allow us, at some point, to be able to do this kind of synergistic evaluation? I think we have some individual research programs which are looking at the effects of aging and trying to come up with some better understanding of the fragility models and structure, for example.

We're doing a little bit of work. It became an issue, in my mind, when we were working on reactor vessel internals and particularly in the BWRs, when there were concerns about cracking, not just the core shroud, but other components. We were always analyzing those with one effect at a time.

I think in this area of aging, I think you're right. We need to find a better way. How do we -- as you say, it's difficult. How do we consider these synergies, how can they be then converted in some probabilistic way? If you have ideas, we would be very interested, because this is an area that needs attention.

DR. BONACA: There was a lot of initiative until a few years ago and then it died, because there was no drive behind it. The main issue I have with all this is that like in license renewal, we rely more and more on inspections. We will inspect, we will inspect, but we will not inspect for severe accidents, for example, or let me not call them a severe accident, there's no licensing basis, and I really don't want to make the distinction here.

You can't assess the capability of a plant to withstand a severe accident from inspections. You may infer some capabilities, but oftentimes performance monitoring, I mean condition monitoring, for example, for cables, we are seeing that now, is not really a good predictor of future performance, but in certain accidents.

And that's why I think we have to be able to understand somehow how these things all come together and also have certain models that say, for example, that plant X can do that and maybe plant Y cannot, because I think probably it comes down to that.

MR. KING: The issue of aging has been a low key effort. It hasn't been forgotten and we've spent effort trying to figure out how to model and detail one aging mechanism, I think it was flow-assisted corrosion, and we're about to issue a report on that. But I have asked my staff to go back now and take a broader look at the aging mechanisms and maybe do a scoping study of particularly the passive components, the structures, the cables, the things that really aren't going to be corrected by maintenance in most cases, and try and come up with an estimate of which of those things really contribute most to risk and then maybe we ought to go focus more on those, whether it's PRA model development or inspection or whatever.

I would hope this year we would have that scoping study done. But you're right in terms of the synergistic effects. You add that along with power up-rates and new fuel, high burn-ups and all that other stuff, it's an important issue and I think we have had some discussions internally on it and it does need some further work.

MR. MAYFIELD: I guess I would -- Tom's staff and my staff have been talking about the aging issue in particular. There has also been dialogue on how to embed the digital I&C in the PRAs and to do that in a way that is going to be seen as technically credible.

There have been a number of issues put on the table, there are a lot of people talking about it, and the staff's talking about it. So is it sufficiently mature that you would have seen the efforts yet? Probably not, other than anecdotally, but there is work ongoing, there are people actively talking about this, and that's, I believe, a positive improvement just in the last couple of years, that people have started actively talking, that the barrier between the hardware guys and the PRA guys is pretty well broken down.

DR. BONACA: I know there are a lot of naysayers about the possibilities of doing that and I would like to remind you that there were a lot of naysayers before WASH-1400. I mean, everything was believed impossible that you could possibly model a plant, and yet that was important and successful, and I think this can be done, too.

MR. ELTAWILA: I agree. Can I make a comment? Farouk Eltawila, from Research. I agree with you. For example, if you look at all our severe accident research, they were done for a brand new containment, brand new vessel, fresh fuel, all this information based on the plant age have not aged at all.

If you start to take degradation in the containment and the vessel and assess it for severe accidents, you might come up with completely different results.

So I agree with you that the license renewal was based on an inspection and not assessing the plant for severe accidents, vulnerability might be weakness.

DR. APOSTOLAKIS: Well, I have to add something. Since we're talking about margins, and, of course, the Regulatory Guide 1.174 requires that, as one input into the integrated decision-making process, we have to maintain sufficient margins, and the implementation, PRA implementation plan that I read recently does talk about common -- I mean, defense-in-depth and margins.

It seems to me that for defense-in-depth, PRA can already do a lot, because if you have redundant systems, you do that routinely. We don't seem to be paying much attention to the quantification of the margins and I think life would be much easier, addressing Dr. Bonaca's concerns and also improving on Regulatory Guide 1.174 processes, if we attempted to quantify those margins.

Now, there is already talk in the development of the thermal hydraulic codes to demand that each code come with some sort of estimate of model uncertainty, which is a very important step towards that.

But I think approaching the problem of the quantification of margins itself would be a good step forward. It's not going to be something that can be done in a year or two, but I think a lot of the issues that we have been discussing in the implementation plan will be easier to address if we had some quantitative estimate of what the margins were.

I think the margins would include thermal hydraulic analysis, fracture analysis, all the margins, something like what is being done for the containment.

MR. THADANI: For the containment part, though, I think Farouk raised some issues about aging effects, which are information-based. We need to make sure we understand what these things mean. Then we need to make sure we understand, as we're going to this risk-informed regulation, more and more, we need to make sure we understand what models are used and that whatever uncertainty margins there might be, we need to make sure we understand.

That means we need to make sure if the industry analyses are based on MAAP, whatever version of MAAP, then we need to understand which in MAAP, how well do the analytical models in MAAP represent our base understanding and where the limitations may be and so on. That's an area that came to the front, if you recall, on the Callaway issue when the steam generator tubes, when we trying to get an understanding of what's the temperature of the tubes; that means, the inlet plenum temperature, and we were calculating different temperatures. We did some, thanks to Bill and Argonne, we got some data on temperature effects and developing the creep failure mode model.

That's one example where we know there are differences. I don't know, sitting here, are there other areas. I suspect there are. And so I think we have not, I'd say, systematically looked at these issues and tried to develop some plan to move forward.

It's another area that I think we need to do better on.

MR. ELTAWILA: Since this is intended as an oral discussion, I would like to add something to what Ashok said. We made a decision on the Callaway base on this

RELAP-5. I'm going to be the devil's advocate here. Is the MAAP calculation wrong? I don't think so. Is the NRC calculation right? I have more confidence in it, but I don't think it's right. I don't think we have done enough calculation to make a decision and we ended up having to make a decision, might be conservative, based on our own information, even though that we know that the model we used for the analysis lacked information about the lower plenum of the steam generator.

Now we are doing that in a more systematic way, but at the time we needed that decision, I think we have to rely on our own tools, even though I'm really -- I'm not saying that the industry tools were bad or even ours is better, but I have more confidence in them.

DR. APOSTOLAKIS: It all comes down, Farouk, to quantification of model uncertainty.

MR. ELTAWILA: Absolutely.

DR. APOSTOLAKIS: Because that forces you to look at the assumptions behind the model and maybe some applications and it takes a brave man, after he does all these things, to say, well, this is my uncertainty now. But there are very few brave men.

MR. MAYFIELD: Okay. Why don't we go to the next slide? For the next three or four slides, what we want to do is to talk about some of the things that we believe will be challenges. This is a continuum. I don't think there is anything on these slides that we're not facing today. Will we face more of it? Will it be somewhat different over the next five to seven years? That's what we've tried to put on the table, but I don't think there's anything here that we would say, oh, well, we don't have to deal with that today, it's a tomorrow issue. So there is a continuum here.

CHAIRMAN POWERS: Go to your second bullet there, the square. It says radiation protection guidelines, recommendations are likely to change. I guess two questions come to mind. Are really likely to change in that short of a period of time? But more important than that is what does NRC and maybe even just the Commission think their responsibilities are to participate in that change or is radiation protection something that gets wished upon the agency by things like ICRP and NCRP and things like that?

In other words, I think this is a crucial research question. Do you get involved in this or just wait for other people to sort it out?

MR. KING: I think, in general, we take, for example, ICRP recommendations and factor them into our regulations. There's a question now, ICRP-60 has formed a basis for some of the stuff in Part 20, but we haven't taken everything from ICRP-60. Should we? That's been a question discussed internally.

We also participate in things like the BIER-7 study that's ongoing, looking at the linear no threshold hypothesis. Do we actually fund independent research, like DOE is doing, for example? No. But we have people that try and keep abreast of what's going on.

My view is primarily looking at it from the standpoint of what are the implications for the way we regulate based upon the results of work that others are doing.

MS. FEDERLINE: There are some implications for internal -- I'm sorry. Margaret Federline. There are some issues for internal consistency between our regulations, Part 61 use total effective dose equivalent and calculates it in different ways than other regulations do. So there are some internal, plus public confidence issues.

I think we're seeing European countries relying on ICRP-60. We appear to be behind the curve on that and I think there are some public confidence issues that get raised in the waste arena particularly in that regard.

CHAIRMAN POWERS: ICRP-60 has some changes in the way they do things that can be interpreted as being more demanding than the old way of doing things. I can certainly see the public saying, gee, maybe I ought to do these, maybe the NRC ought to get with it and get in behind this.

Suppose that ICRP 2010 came back and said there's a threshold. Would you see an outpouring of public sentiment to, say incorporate a threshold in the regulations?

MR. KING: I'd see an outpouring of industry sentiment to put a threshold in. I can't speak to the public what the outcry would be. It would have major implications for a lot of things we do.

CHAIRMAN POWERS: It has a lot of things to do with how you handle the level waste coming out of plants and individual exposures and things like that. But because you put a cap on your law, it's not clear to me that it has as huge an impact as it would, for instance, on DOE. ALARA is unlimited. You always keep going as low as reasonably achievable and it doesn't matter what the cost is.

MR. KING: And, clearly, one of the questions would be does the way we apply ALARA today make sense if there were a threshold. That would, to me, be a legitimate question.

CHAIRMAN POWERS: Yes, it would be a legitimate question. But I've often said that the nice thing about -- I know it has a threshold, everything is linear. You don't have to do a lot of calculations to carry out the ALARA analysis.

MR. KING: To me, one of the big differences in ICRP-60 is regulation to cancer incidents versus cancer fatalities. WE chose cancer fatalities. If we adopted everything in ICRP-60, we'd go to cancer incidents. That would have a major implication, as well.

CHAIRMAN POWERS: This committee has certainly written and said you need to expand your risk metrics. I don't know that the committee has strong feelings about whether the Commission should change its safety goals, but as far as evaluating risk, I think it's true. Not only do you need to have more risk metrics, but, in fact, you do have more risk metrics than just cancer fatalities.

MR. THADANI: I think there would be additional issues, it seems to me, that as we get better understanding, not only in the context of fatality and incidents of cancers, but also our ability to do a better job of modeling all the consequences, including environmental effects.

It seems to me then we may have to revisit the issue of safety goals and address some of the issues, areas we're not able to address today.

CHAIRMAN POWERS: It clearly has some impact, but I get from your response that really research sees its role as staying abreast of the field, not as a major player in this ongoing debate.

MR. KING: It certainly is not a major player in funding independent research that would contribute to answering these technical questions.

MS. FEDERLINE: I just wanted to raise one other systems issue, where I think that research can play a role, and this is in the handling of spent fuel. We're making a number of independent regulatory decisions, looking at spent fuel pools and then looking at licensing storage and transportation, and then licensing disposal.

One key element is to make sure that the assumptions, that we understand the assumptions that are being made in each of those arenas, and that we can explain any inconsistencies, because that's going to have, as we get deeper and deeper, a big impact on public confidence if we assume that there's very conservative basis in pools and yet a very realistic basis in disposal. The public is going to have real questions about that.

So I think that's a place where research can pull threads and --

MR. MAYFIELD: Why don't we move on, Tom, just in the interest of time. If there are any questions, we can, of course, go back to these things.

Deregulation of the supply, the electricity supply, and the economic pressures, we've already talked about some of those. Tom had asked a question about reduction in staff, so downsizing and out-sourcing are issues.

Elimination of apparently non-productive functions without proper recognition of long-term contribution to safety. So it's questioning changes that are being made, hallowing of competency, overloading key staff. We see that on our staff. We hear about it in the industry. So what's the long-term overview of crucial safety activities, keeping those kinds of issues in proper perspective and what does research -- what can research contribute in addressing those, what do we need to be doing today to be prepared for the five to seven year timeframe.

Managers will be less tuned to technical aspects of design and operation. As there is more focus on bottom line, there becomes more emphasis on spending time to manage changes, planning how to do more work with less resources, emphasis on those kinds of issues, and to make sure that there's still somebody in the plant staff that's looking at maintaining the appropriate level of safety.

Quantification of the human reliability for severe accidents, there was some talk earlier about the severe accident piece of that. That's a piece of it that we believe warrants some research.

CHAIRMAN POWERS: I guess I don't know what your -- the language is too coded for me.

MR. MAYFIELD: Farouk, do you want to --

CHAIRMAN POWERS: I mean, in severe accidents, it's -- severe accident analyses tend to be done by assuming the operators took a powder someplace.

MR. ELTAWILA: But after the severe accident occurs, what is the operator response and how the -- we did not quantify these activities in the past. The simulation activity and things like that focus on the design basis accident and when it comes to the beyond design basis accident, which has been credited in the PRA, you don't find too much work done in this area.

DR. APOSTOLAKIS: Is ATHENA a part of this?

MR. ELTAWILA: That's in cooperation with ATHENA, yes.

DR. APOSTOLAKIS: Is the agency's senior management happy with ATHENA? Has it produced anything useful?

MR. KING: In the trial applications, I think it's produced some useful insights for the particular problem they were looking at. We haven't applied it broadly. We are going to apply it in the PTS, looking at the PTS issue. We are going to apply it looking at dry cask storage, the PRA we're doing there.

Right now, we're not thinking about going back and re-baselining the HRA portion of a PRA using it, but --

DR. APOSTOLAKIS: But the bullet sys quantification. How can you apply something that does not exist? ATHENA has not produced anything on quantification of human reliability.

MR. KING: No. It's just produced insights into things that are going to cause operators problems.

DR. APOSTOLAKIS: And we all know that when a project produces insights, the project has failed. Isn't it time that the senior management of the Office of Research questioned the value of ATHENA? I mean, they've been at it for a while now.

MR. KING: We've been at it for a while. I think it's a tool that is ready to be used for quantification. It might be a little expensive to use and we haven't made any decision at this point to use it, other than in PTS and in the dry cask storage area.

DR. APOSTOLAKIS: But, Tom, the agency staff, when they talk about human performance and so on, rarely, if ever cite the ATHENA models. Doesn't that tell you something that your own people don't believe that ATHENA has produced anything of value?

MR. KING: No.

DR. APOSTOLAKIS: I mean, I looked at the summaries of the various human factors projects and those guys, you know, they will do this, will do that. Where is ATHENA? ATHENA spent all this effort developing these models. Why aren't your own people using ATHENA?

MR. ELTAWILA: I'm not going to defend ATHENA, but sometimes what you see is not really the truth, because you don't see anything in the PRA tell you that we use the RELAP-5 code or the MELCOR code or any of NRC developed tools, but somehow they are used, but not that visible.

So I think if the issue is to make more visible, I think that we ought to do that in more --

CHAIRMAN POWERS: I think what Professor Apostolakis is telegraphing fairly clearly is that we're going to have to discuss ATHENA and its impact on the human reliability issues here in the course of today's discussion. I think we really need to discuss it, because that was the very clear thing to me that came through in reading your ongoing program summaries in connection with human performance and human performance like topics.

I didn't see the word ATHENA once in the -- in everything that I read. It has other impacts that we're going to need to discuss and one of those impacts is you're participating heavily in the Halden project. They produce information on human performance. I mean, their lab is -- I mean, you can't get away from it. As soon as you go up there, they're throwing viewgraphs and pretty pictures and stuff like that, but we don't see a lot of transfer of that data showing up anywhere, least of all in ATHENA. So we need to discuss that.

MR. THADANI: Yes, I think we do need to and it's an issue of very significant safety implications. And when you go to quantification, particularly, George, we've been talking about the same issues for a long, long time, it seems, and I just received a letter from Mr. Lochbaum and he looked at our evaluation of anticipated transients without scram and the analyses, I guess, in the IPEs, the PRAs that were done, and he pointed out that for ATWS, where you have to reduce the water level and then inject boron in minutes, that there were quantification values that ranged by, I think he said by three or four orders of magnitude.

So maybe you have pointed out an area that we need to really see what is the real value to ATHENA and how is that value, in fact, being realized.

So we can come back and talk about that.

DR. APOSTOLAKIS: Ashok, I may sound a little bit harsh, but I really want us to prevent these issues from reaching Mr. Lochbaum and other people. We should ourselves resolve some of these things before somebody else from the outside points out to us that -- and I really think we have a problem there.

MR. THADANI: I think we have been reactive, generally. We have not been proactive. That's the central issue here for today's meeting. How can we be proactive and what are those areas for future that we need to be proactive?

MR. MAYFIELD: Unless there's some --

DR. APOSTOLAKIS: And one -- yes, there is.

MR. MAYFIELD: I knew it wasn't going to be that easy.

DR. APOSTOLAKIS: The emphasis --

CHAIRMAN POWERS: George, maybe in the interest of keeping to some schedule, we could break at this point and then come back with this slide firmly in mind and we could resume our discussion. I don't feel any particular need to stay exactly on schedule, because we're bouncing around on topics that need to be discussed and my entire objective is to have a very collegial discussion here and let topics come as they will, and without -- because we're not trying to resolve a specific point. We're trying to understand --

DR. APOSTOLAKIS: Unless we have a time limit, I don't know. Are you constrained in time?

MR. THADANI: No. But I agree with you. What I don't want to do is to be defensive, try to be protecting things.

DR. APOSTOLAKIS: No, you don't have to be.

MR. THADANI: So I want to make sure that we have this open dialogue.

CHAIRMAN POWERS: What we have to do is have no surprises in our research report to you guys. Maybe the rest of the agency will be a little surprised, but among us, this will just be a frank discussion of what we think we ought to be discussing and not discussing in our research report. But it's very clear that this area of human performance is a crucial issue for this agency. It's a real part of the whole safety strategy, and so we have to be very careful what we're doing here.

What I would like to do is take about a 15-minute break and stretch lets, whatnot. Then we'll come back. Before we break, I'm happy to mention that Jack Sorenson is sitting here. He is Mr. Human Reliability for the research report. He is our fellow and if you have not had a chance to read his paper on organizational factors in PRA, you ought to. It's pretty good reading, and he has a longer topical report that's going to appear one of these days. Right?

MR. SORENSON: Yes.

DR. KRESS: Is he a reliable human?

CHAIRMAN POWERS: He's very reliable.

DR. SEALE: And he may be at high risk for a fresh cold, the way my head is feeling right now.

[Recess.]

CHAIRMAN POWERS: Mike, you're still on.

MR. MAYFIELD: Actually, the human performance and human reliability issues are, by and large, the providence of Farouk and Tom, so Dr. Apostolakis --

DR. APOSTOLAKIS: You are smiling.

MR. KING: I think your points are legitimate points. I think the two programs haven't gotten together and had the interaction they should. I think the future plans for the use of ATHENA haven't been worked out yet and I think that's an action item we need to take away from this meeting.

MR. THADANI: Let me ask at this point, just since we're still on the issue. I want to be absolutely sure that the idea, George, you raised, it's so fundamental that if we're not doing it, then we better be doing it.

But I want to make sure that Jack Rosenthal or Jay, if they have any comment to make, it might be appropriate to make that comment now in terms of the integration of the information that comes out of ATHENA with our plans in terms of quantification of human reliability estimates.

If there is any comment you want to make, it may be worth making it now, and then we can move on.

MR. PERSENSKY: Jay Persensky, Office of Research. Tom did say that, in fact, historically, we have worked as close together as we should. But I will say that currently we are in a lot of discussions, Nathan Siu and I have been working together almost weekly on trying to bring these programs better together, both in terms of how we could better use ATHENA and how we can provide information to ATHENA.

If you remember, in the human performance program, we talked about primarily about use of operational data in assessing the risk to look at our programs. ATHENA didn't have much of that. We went back to the ASP and the SPAR analyses, but we're looking as to how we can better improve on both ways in terms of how we can provide information to them from a data standpoint, from places like Halden.

Jack is going to Halden next week and one of his main topics is going to be on use of the data that has come out of their simulator experiments.

The other thing is how we can say, hey, here's some information that's missing from the models or modeling that we're not being able to show based on our operational experience.

So we are having a lot of sharing in that area right now.

MS. FEDERLINE: If I could just add one thing about the Halden project. I'm Chair of the Halden Management Board this year and one thing we're trying to do is do a focused top-down look at what the member country needs are, and one of the needs that we've expressed from the U.S. perspective is this tie between the man-machine data and the risk assessment technology.

One thing we've been kicking around is how could Halden serve as a central clearinghouse for man-machine interface data from all the countries, not necessarily just from the experimental efforts.

So we are aware of the concerns and we're at least taking some steps to move in the direction we think it needs to go.

DR. SEALE: That reminds me of something, if I may. In previous reports, we've made great -- well, we've referred to the fact that for the amount of money that the NRC actually now has or even this country has in international programs, that actually the NRC has had an unusually significant amount of influence in planning of a lot of these programs, primarily because of the history of activities and so on.

I think if you could, in the interactions where there have been international inputs from NRC that, in the planning effort and so forth, if you could make us aware of that, that would be helpful as we put together some of our comments on any of the programs.

MR. THADANI: I think we have been fortunate, because of the many past accomplishments. We still enjoy, I think, extremely good reputation in the international community. But I will also share with you that this external group that was looking at research programs, one of the members was from the international community, from France. He reflected a concern that if NRC research is going to come to the table with only one dollar and save two dollars, you will get one dollar's worth of information back.

DR. APOSTOLAKIS: I don't want to get into the details of the models, because this is not the appropriate place, but it just strikes me as a little odd that according to the memo I received back from Mark Cunningham, the staff plans to review existing methods used by other HRA development activities, for example, EDFs, and the industrial, Maryland's dynamic -- what they were -- dynamic PSA.

Is anyone asking the question why is this happening now after all these years and is this consistent with the idea of the error forcing context which was advertised so much as being a revolution in the field? Are these methods consistent with the idea of context? I mean, this committee was supportive of ATHENA, when we were told that we will identify the context and then we'll quantify the probability that the context will exist, and it seems that this promise has not been kept.

I don't recall seeing the word context in the papers I've seen from France or from Maryland. So essentially you are starting anew and you may still want to call it ATHENA or call it something else, but this kind of thing, it seems to me, should have taken place six years ago.

And another point --

MR. KING: Don't take that as starting anew.

DR. APOSTOLAKIS: I think it is. De facto, it is, Tom. I mean, of course, people are more experienced now, they have these ideas about context and so on, but maybe it was a little harsher than it should have been.

MR. KING: I mean, we're trying to keep abreast of what others are doing. There's a lot of international interest in --

DR. APOSTOLAKIS: My problem, Tom, is that you are starting to keep abreast too late. There are written criticisms of ATHENA that are a few years old now that were completely ignored by the people who are doing ATHENA. It's beyond me why, but anyway, that's getting now dangerously close to the management of the project.

Why are you interested only in operator misunderstandings and so on, when there is evidence from the field that the operators have acted very smartly in some cases, saving the day? Shouldn't that be part of what we're trying to do here or it's the safety approach that things that can save you we don't include?

MR. ELTAWILA: I think you are absolutely right.

I think we should include both the positive attribute of the operator as well as the negative attribute.

DR. APOSTOLAKIS: Also, it seems to me there is extraordinary emphasis on human actions after the initiating event has occurred and the ACRS letter of last December pointed out that there had been instances where crew actions have actually started initiating events and I haven't seen that being addressed anywhere.

Anyway, I don't have anything else to say on this.

MR. MAYFIELD: Why don't we move to the next slide? The first three bullets here address fuels related issues. We think there will be continuing emphasis on both the storage and transportation of spent fuel. There is increasing dialogue on that even today. We don't see that going away in the near term.

A lot of interest in the long-term storage of higher burn-up fuels than have been in the demonstration programs today.

CHAIRMAN POWERS: When I looked at the planning programs for the future, I saw something that smacked of setting up a storage cask and monitoring and whatnot. Can you tell more about that? Let me predicate that by saying, first of all, the scenario that Dr. Kress is in charge of and that when he and I looked that brief summary, we were both singularly enthusiastic about that.

In fact, words like "this is the best damned program I've seen that group plan in a long time."

MR. MAYFIELD: There has been a demonstration program out at Idaho over the last 15 or so years, where they had or have four different cask designs with fuel from various plants in them.

The burn-up on the fuel was representative of what you saw coming out of the plants 15-20 years ago. The one cask that we have done some detailed examination on, we pulled the cask in, pulled all the fuel assemblies out, looked at them, looked at the cask, both internally and externally. We have no extracted 12 rods, had them shipped from Idaho.

So there were 12 individual rods that were pulled from an assembly, shipped off to Argonne West, although they don't call themselves that these days, I think, where they will do profilometry and that part comes into Farouk's program on fuels, but they'll do profilometry, they're going to do puncture tests.

They will ultimately section -- what is it, Farouk -- five of the rods and ship those sectioned pieces off to Bill's folks in Chicago, where they will do the destructive examinations, getting material properties on the cladding, the whole bit.

CHAIRMAN POWERS: What do you monitor while the fuel is sitting in these casks?

MR. MAYFIELD: What they were monitoring were temperatures and pulling some periodic gas samples. Now, the program that we've started talking about will involve higher burn-up fuels than you -- the level that you would anticipate seeing coming out today and going into representative casks, and the long-term -- I wouldn't want to say too definitively today what would be in the program, because it's still in the early planning stages, which is why it didn't have a lot more definition in the write-up you saw.

But the intention would be to monitor the environment inside the cask and cask temperatures.

CHAIRMAN POWERS: Do you monitor galvanic fields?

MR. MAYFIELD: Monitor what? I'm sorry.

CHAIRMAN POWERS: Galvanic fields.

MR. MAYFIELD: Galvanic fields.

CHAIRMAN POWERS: Corrosion.

MR. MAYFIELD: Corrosion. You're in basically an inerted environment and unless you manage to get some gas, some air intrusion --

CHAIRMAN POWERS: I guess my real reaction is how inert is inert.

MR. MAYFIELD: They're helium environments, I think.

CHAIRMAN POWERS: Trying to maintain a helium environment for 30 years is a challenge.

DR. SEALE: It sure is.

MR. MAYFIELD: So there is an issue in terms of long-term degradation. One of the other interesting ones was potential for the zinc chromate coatings to interact with the cladding at higher temperatures. That one was probably more interesting, and there is some ongoing work, in fact, at Argonne now. We had some initial work at NIST, which said if you've got a lot of zinc available, then it degrades the cladding material.

The question is, is it possible to have that much zinc available. So the follow-on testing is to have a more representative zinc source and representative temperatures to see is this a realistic concern.

I think you have to also look at what would happen if you had more severely degraded cladding, degraded in the sense of higher burn-ups.

DR. KRESS: Are these casks fully loaded?

MR. MAYFIELD: The ones that are on the pad today are fully loaded. They -- because of some additional instrumentation that you wouldn't see in service casks, the clearances in the one we have opened, the clearances were much tighter between the assemblies and the support structure and they actually got -- and temperatures were a bit higher than they had anticipated.

So you ended up with some cracking in the dividers that you wouldn't -- it was clearly related to the very close tolerances and the higher than anticipated temperature.

CHAIRMAN POWERS: Do you monitor natural convection within the casks?

MR. MAYFIELD: That's what they were trying to do and at some point, the program ran out of money, so the level of monitoring over the whole experiment varied with time. The intent here would be to try and get enough money put together up front that you wouldn't get ten years into the demonstration and say, ah, well, this is too expensive to do.

So that's what we're trying to lay out, going to the higher burn-ups and set these on a pad somewhere and keep an eye on them.

This is somewhat like watching grass grow. Not a whole lot happens real quick. But--

CHAIRMAN POWERS: You hope.

MR. MAYFIELD: We hope. But that's the intent of the program.

CHAIRMAN POWERS: When you do that, you have a cask, maybe you have a couple of casks, relatively small number of casks. Are the kinds of things that you're looking for sufficiently stochastic that you won't see them?

MR. MAYFIELD: Well, that's a potential. We don't think so. We think -- well, first of all, we're not expecting to see a lot, but we feel like it's important to at least look.

You have to -- well, there is an element of risk that you will miss something, yes. The other side of it is to try and plan the experiment to look far enough downstream to try to anticipate the kinds of things you might see and then include enough variability in the experiment.

CHAIRMAN POWERS: I get the impression from your response about the helium inerting that you're looking at kind of a representative case and not looking at the worst case and things like that.

MR. MAYFIELD: That's correct.

CHAIRMAN POWERS: Is there merit in thinking about doing a parallel experiment and say, okay, I've put all these restrictions on these guys, let me relieve a bunch of them and see if it really makes any difference?

MR. MAYFIELD: I don't think we've rolled that into the thinking today. It's a take-away from this meeting.

CHAIRMAN POWERS: It seems to me that -- I'm thinking five to seven years, I'm not thinking about this particular program. But maybe that's what the Commission is really looking for, is saying, okay, we've got a whole bunch of regulations here, how many of them are really buying anything for us, and this might be a good object example to say, okay, we've got this thing and it's been going on for a few years here, and we kind of know how those requirements are behaving, now let's throw away the ones that seem, on the face of it, to be the least efficacious and see if that makes any big difference and whatnot.

DR. SEALE: You're still on the front end of the expenditure curve, really, in that area.

CHAIRMAN POWERS: It's an interesting approach, Ashok, and maybe we could get some of the Commissioners to sign up on this one, because otherwise, how do you know. You now your regulations did okay, you just don't know that -- they were certainly sufficient. Were they all necessary? Unlike nuclear reactors, where you would be kind of reluctant to throw things away, just in case they were important, here it might be okay.

MR. MAYFIELD: This is an area where we've -- there are a lot of ideas coming up. This is one that obviously we hadn't thought about much. We have, just in the last few months, put together a program looking at a PRA for storage. It brings about some interesting thoughts.

This is perceived as a pretty low risk issue, to begin with, and so what other things does that bring about, other concerns, how low does the risk have to be before you quit thinking about it.

CHAIRMAN POWERS: The first concern you have is what do you use as a risk metric; I mean, how many people can you possibly kill with one cask falling off and doing things like that. Well, maybe several, but most likely it's going to be site workers and things like that that you don't -- but that's not the risk metric you want to use on these things.

MR. MAYFIELD: And that's some of the dialogue that's ongoing.

CHAIRMAN POWERS: Sure.

MS. FEDERLINE: Dr. Powers, we're taking that approach in our approach to burn-up credit for transportation. Farouk can talk better than I can talk about the details, but we're trying to systematically look at the existing limitations that are placed, look at where it makes a difference through some sensitivity analysis and understand where we can back off and what experiments are needed to prove the concept of --

CHAIRMAN POWERS: If you have anything written on that systematic evaluation, it would be useful, because I think that's the kind of question that Commissioner Diaz is asking a lot, is are there requirements that are burdensome without a benefit commensurate with the burden, and, boy, is that an area where research could shine, if you could come in and persuade all parties involved that you've looked at it now and you have some quantitative data, it's not speculation and it's not whining about how much it costs, here's cause, effect, now you can compare that against whatever burden you associate with it and do you really want to do this.

It seems to me that that would be as big a feather in your cap as you could get here.

MR. THADANI: I started out early on about really the importance of doing good technical work, developing good technical basis, and I refer to the concept of, in some areas, the approach of doing PIRTs as being very, very useful way to go forward.

This may be an area where it may well be appropriate to collect a group of very knowledgeable people, identify the key areas, and then do some sort of perturbation evaluation and see if there is a way to -- I personally think it should not be too difficult to be able to home in and see if there are actually requirements that we're imposing that may not be yielding a big value in terms of safety.

So this could well be an approach we might consider.

DR. SEALE: The second and third bullets you have there both are areas where there is potentially need for additional criticality data as you go to higher burn-ups and to mixed oxides and different claddings and a variety of other things.

I know that the French have been doing work in these areas for quite some time now at Valduc and I also know that both the French and the Japanese, competitive as they area, have been very careful in how much of those data they release for public consumption, and my experience has been that you don't buy those data, you trade those data.

If you've got something that's worthwhile, they will talk to you about swapping it. Now, I don't know what the internationalization of the fuel cycle community is going to do to the availability of these data, but it strikes me that we ought to look very carefully at maintaining the capability to trade.

MR. THADANI: Yes.

DR. SEALE: Now, the other thing is that our friends up in downtown in the Defense Nuclear Facility Safety Board have told DOE that they need to maintain the capability to do criticality safety measurements. I wonder if the NRC couldn't help them define a program that would be the necessary ingredient to maintain a program that's -- a capability that's viable that might also address some of our needs.

MR. THADANI: That's correct. Farouk just came back -- I mean, not just, but he was in France talking to the French. He might be able to give you some information.

MR. ELTAWILA: I think you hit on the facilities and the data that's available now about burn-up credit and we have discussed that with the French and our contact is willing to give us this information, except for one thing, this information is called on by COGEMA, too. So they have to give their permission.

Their feeling that they are getting, that COGEMA will give us this information, because we are cooperating in a lot of areas.

DR. SEALE: And the internationalization of fuel cycle, also.

MR. ELTAWILA: That's correct.

DR. SEALE: For a while, it wasn't available, I know.

MR. ELTAWILA: And since the criticality issue is not on the agenda today, I might want to add that we are part of another program and that's conducted by Belgonucliare, called the REBUS project, and that's going to take an assembly and put it in around subcriticality test and calculate the net worth reduction of reactivity between fresh fuel and burn-up fuel, and from that, we can use that for validation of our computer codes.

But with regard to DOE or the Defense energy, I would like definitely to get -- this is new information for me and I think we'll get together.

DR. SEALE: Maybe we ought to get together.

MR. MAYFIELD: Okay. One thing that Dr. Powers had mentioned, the water reactor meeting, one of the sessions we had dealt with this, the general cask and fuels criticality issues, and the burn-up credit issue was one area that pretty loudly was characterized as something where it's ripe for more work, as well as more collaborative work.

DR. SEALE: Lots of those.

MR. MAYFIELD: Lots of feedback, echoing the same theme from different approaches. The last bullet on the page is one that we've spent a good bit of time on early on as the evaluation of operating experience and how that gets rolled back into all of these issues for the current operating plants.

CHAIRMAN POWERS: Let's go back to the ultra high burn-up and use of MOX fuel. I think we know that MOX is coming down from the DOE side. That will play out as it does. Let's talk about high burn-up. There was a lot of talk four or five years ago about the industry wanting to go to, say, 75 gigawatt days per ton, but they were uninterested in going above five percent initial enrichment.

Have things changed in that front?

MR. ELTAWILA: From the industry point of view, that is still their position, but DOE is a sponsoring program to look at developing different types of fuel with high enriched uranium. So their effort is mainly DOE. There is another program that Ashok will tell you that if I don't have a single complaint per day, he will send me day because of sick or something like that.

CHAIRMAN POWERS: You're doing well. That's what your job is. His job is to listen to it. You're doing well.

MR. ELTAWILA: So the industry has their own program that we are not privy to it, and really for commercial reasons, they are keeping it secret. So there might be activities that are conducted by the industry that we are not aware of it, but this definitely -- one of their goals is to eliminate any limit on burn-up. That's what we call ultra high burn-up. But the information is very few to come by to make a decision really.

CHAIRMAN POWERS: What I think you're saying is because of the unclear nature of where the industry is going, all you can say for sure is that you need to maintain competence and expertise in the fuels area.

MR. ELTAWILA: That's correct, yes. It's even more than that.

DR. SEALE: Is there a limit on the extent of the plutonium content in mixed oxide?

MR. ELTAWILA: Right now, the European experience indicates that up to one-third of the core is the limit.

DR. SEALE: You mean one-third of the enrichment?

MR. ELTAWILA: Oh, you're talking about the enrichment?

CHAIRMAN POWERS: Specific rod enrichments. You run into a problem, control problems above seven percent or so.

DR. SEALE: Okay. But that's --

CHAIRMAN POWERS: You can go higher, if you want to.

DR. SEALE: But that's more than five percent, the equivalent of more than five percent.

MR. KING: I think they put in enough plutonium to be equal reactivity to the U02 fuel. But as Farouk said, only a third of the assemblies are MOX assemblies because of metal problems.

DR. SEALE: That's equal reactivity relative to K equal one, not equal reactivity relative to what the dollar is.

MR. THADANI: Farouk has -- really there is a big issue there. This is just an example of what we're talking about, and that issue has to do with we have agreements with the Electric Power Research Institute and Department of Energy and others to pursue cooperative research, where it's appropriate.

For us to be timely and not be sort of a bump along the way, we need to really have a clear vision of where the industry is going. At these expert group meetings, there has been a fair amount of criticism that NRC should have increased cooperation with the industry and generation of data, perhaps, and then we can do what we wish and the industry could do what it wishes to do.

But Farouk's point is that the industry has to be very forthcoming in identifying up front what direction they are going into, so we have an early opportunity to sit down and design what sort of information would be needed, and it's easy to say increase cooperation. It's harder to sit down and really come to grips with which direction you are headed in, how can we make sure that we're actually moving jointly, and, yet, maintaining our independence in terms of the technical decisions that we have to make.

Now, I am pretty sure that I will work harder with the industry, particularly the Electric Power Research Institute, to see if there are other areas, but it cannot work unless there is some fairly transparent way the public also understands what we're doing and why and how we might use the information.

That means the industry has to be forthcoming and has to recognize that some of the information will have to be made publicly available, and that may not be as easy as it might appear.

CHAIRMAN POWERS: The challenge that we face in the fuels area remains kind of the same, that the industry is pretty good at collecting operational data on these fuels. It's easy for one to do and put a few lead test assemblies in and collect some operational data and compile it.

But the NRC's interest is always in what happens in off-normal situations, which is much more challenging to obtain the data, and the industry is much more willing to address that question with a pencil and paper rather than with a reactor experiment.

DR. SEALE: And aren't you kind of falling into a trap whenever you agree that you will do a margins analysis rather than a detailed analysis of what's involved in a particular burn-up or whatever? A margins analysis limits the input from these somewhat more esoteric and longer time dependent problems and as long as you're not going to do anymore than a margins analysis, you're accepting your blindness.

MR. THADANI: I'll give you my -- maybe I'm misunderstanding your point. When I talk about margins, to me, it means, first and foremost, I must understand the fundamental issues and the fundamental challenges before I can even come to grips with what are the limits and what the margins might be in the limits.

So it seems to me that for me to better understand what the margins are requires a lot more information to be gathered than for me to say, well, I can make some conservative decision.

So for margins, I think you have to actually get more information, not less.

DR. BONACA: Just as a point of reference, from the perspective if the fuel efforts, from the industry effort, there is a major program and it was called robust fuel. I remember how that was initiated. It was initiated for two years. One is that there were events where there were fuel failures, particularly in Westinghouse plants, due to a number of issues. The other issue was data that came from France regarding the fact that burned fuel had less capability, for example, if you had enthalpy depositions above a certain criteria have been standardly used in rod rejection accidents.

And the plan at the time was we will fund sufficient research and development to improve the fuel, but then what target are we going to set for it; is it going to be 60,000 mega day for per metric ton, which is what really the industry had believed to the point, and they said, well, let's make a stretch goal of 75,000 and that will be an objective of design in the redesign of this fuel.

Now, all I know is I don't think the industry was ready to come up with answers, because this has been a major effort. It's been going on for years. And I believe they have spent -- I know it was funded at some point in excess of $10 million, but it kept adding money for that.

So I believe it's pretty extensive, but I don't think the industry is ready to yet say we have sufficient information to propose a burn-up limit.

MR. ELTAWILA: They actually sent an NRR recently to NEI a proposal for extension of the burn-up and we asked a copy of that proposal.

DR. BONACA: So there is already --

MR. ELTAWILA: They are already moving in that direction, but the robust fuel program is funded at $50 million and we finally got EPRI to agree, under a consortium, to agree to participate in the French Cabri reactor on the reactivity insertion accident to address the concern that you mention.

But in addition to the robust fuel program, which, incidentally, NRC did not attend the meeting of that program, so we have no idea what is going on in this, they have another program they call the NFIR, I think, I don't know the exact -- what this acronym stands for, but that's an extensive program and that is where they are trying to extend the state-of-the-art and try to develop new cladding and new criteria and so on.

That is where we feel that we are in the dark, because what will happen, exactly like what happened right now, they will make a proposal to NRC. NRC might look at the data and find that it's acceptable and grant approval and then we have to run a confirmatory test of the program.

The same thing happened with M5. NRC just extended the burn-up for M5. We don't have even a single sample of M5 to test it in our national lab. Same thing with zirlo. We don't have any sample to test.

So we are always falling behind the industry because we are not informed or have the fuel to be able to run the test.

DR. BONACA: I understand that. My only comment was to point out that there was not a minor effort. It was a major undertaking and you're confirming by the figures you're talking about that the industry realizes they had a problem.

MR. THADANI: I think there is a related issue that relates to this whole idea of cooperation between NRC and industry. As I said early on, the regulator has a responsibility to poke and probe at the fringes, so to speak, and understand safety implications, and the industry probably is not going to be as active in that area.

It took us 20 months, probably 21 months by the time we actually got there, to get agreement for EPRI through the robust fuel program to agree to participate in the Cabri program, because this was an example where we did not have enough resources ourselves.

We wanted to make sure that as a country, the contribution that we had to make to the Cabri program we could come up with, and we thought working together with industry would be a pretty good way. We can use data as we see fit and the industry can use the same database as they see fit.

The arguments were around what -- the probability is pretty low. I continue to push to say that probability, in fact, may well be low. The large uncertainties, as George said earlier, we have some experience base, but we are not able to get to ten-to-the-minus-five and ten-to-the-minus-six. So my view was, and is, that it may be appropriate to change some design base accidents.

However, before we do that, we better fully understand the consequences. Until we understand consequences to rely on probability argument alone, is, I think, somewhat inconsistent with what the Commission has been saying.

So it took us 20 months to come to an agreement for EPRI to participate and I want to increase cooperation with the industry, but we've got to come up with a somewhat more efficient mechanism.

MR. KING: I agree with everything Ashok said, but there is a flip-side to that. In my position, looking at risk-informed regulation, one of the regulations we have on our plate to look at is the reactivity insertion accident, which is the rod ejection accident today.

That's the accident that's driving the test programs worldwide and it's driving the failure mechanism that's being looked at, the pellet-clad mechanical interaction.

If risk information says, well, there are other reactivity insertion accidents that are certainly more likely, certainly may have more risk, they're not going to have the narrow pulse like the rod ejection accident and they're probably not going to have pellet-clad mechanical interaction as the failure mechanism, they're probably going to have D&B, should we be considering some D&B type tests on high burn-up fuel, particularly since the current test program is driving people to high ductility, low oxidation cladding. That may not be the best cladding to have when you're into a D&B type failure mode.

So there's these kinds of interactions we have to think about, as well.

CHAIRMAN POWERS: In that regard, the fuels research program engaged in an experiment where they were taking technology and approaches that had been fairly well developed in the thermal hydraulic community to develop these PIRT processes and from that, even going on to scaling experiments. I think the fuel program has a scaling problem, per se, but in an experiment, those kinds of -- that kind of an approach where you get a lot of expertise focused in and developing these phenomena and identification and ranking tables, looks like it would be applicable to a lot of things.

I'm thinking, for instance, in connection with the spent fuel pool fire, that one could apply those kinds of same technologies.

I guess my question is how is the experiment going and does it look like it has a broader applicability to the experimental efforts and even analytic efforts that the agency is undertaking in the research program.

MR. ELTAWILA: The effort of the PIRT on high burn-up fuel just concluded last week and we really gained a lot of insight. I think the reports are available, we'd like to send you copies of them.

CHAIRMAN POWERS: Please do.

MR. ELTAWILA: It's a massive amount of information that was developed. We entered into the process thinking that there are few phenomena that's controlling the fuel behavior. We came out with much more phenomena and defined by industry, not by the staff, by the industry themselves. They are scientists, they know what is important.

So we really gained a lot out of it and they -- in certain cases, we found that some phenomena that we thought that might be important, now they are not important. As a result of that, we are going to direct, redirect our research program.

As I mentioned earlier, one of the issues that came very loud and clear, that you cannot take the cladding properties from one cladding, zircalloy-4, and apply the results blindly to M5 and zirlo. So we have -- part of this stage, they need to get M5 and zirlo for the program at Argonne, because we don't have this information.

So there a lot of insights. One of the other insights that we were thinking about, trying to do more of an analysis and relayed reactivity insertion accident to the rod worth itself, and the indication from the people that are doing this work for the industry, that is not a proper word, because that would be cycle specific, fuel specific, core geometries. So it enters a lot of variables in it, that it will be very difficult to have a criteria in this regard.

So the exchange of information was very good and I think we should be using it more and we actually are using it in the burn-up credit that Ashok mentioned.

As far as the spent fuel pool, I really think if we had our way of doing the decommissioning work right now, we should have started this way, but unfortunately, we were driven by schedule and every time, just we'll do an incremental piece of work and we came to you. Unfortunately, you raised a couple of very important issues. We went back and we looked at them and if we do the PIRT process for that work, we might -- I think we are focusing on the wrong issue all together right now.

It's not thermal hydraulics, it's not the consequences analysis. We can do these in details. It's the onset of the oxidation fire; that if we don't have the initial assumption correctly, it doesn't matter, everything we do, and that's why we're continuing to struggle with that issue.

If we started earlier, we could have saved ourselves a lot of headaches and maybe time.

CHAIRMAN POWERS: I think the discovery, to my mind, first of all, I give you all the credit in the world for having this brilliant idea to take this PIRT technology out of the thermal hydraulics and apply it to the fuel. Nobody had ever done that before. And I'm delighted to hear that you actually learned new stuff out of it. That makes the lesson all the better, because there certainly was the potential to find out all the conventional wisdoms about these things, where you say, well, this PIRT idea wasn't too insightful. But it has proved to be insightful.

And now I think it sets the stage to say maybe this is a pretty good idea on any kind of complicated experimental program or analytic program that we're undertaking, because just for the reasons that you said, you find some things that you thought were important weren't so important and some things that you had never heard of before are important, and, of course, it's entirely possible for the experts to be completely wrong, but at least you can say I've gotten the best minds to look at this from a wide range of backgrounds.

And you'll recall, what was it, three years ago, we, the committee wrote on the research program that it was important to, on complex, new complex issues, to solicit a variety of inputs, and I think this PIRT concept that you came up with is just an excellent framework for soliciting those in some sort of discipline, so you don't get a lot of disconnected ideas.

DR. SEALE: Particularly if one of the products is an industry buy-in, because that's another three years after you finish normally and then convincing the other guy that it's worth doing. And if that comes out of it --

CHAIRMAN POWERS: It seems to me that we ought to

-- I will just toss this out for all concerned. It seems to me that in talking to the Commission about research, we need to make an object lesson out of this experiment that's gone on and say, hey, we've learned a way of doing this, because just as Bob says, not only is it a way to get a lot of expert opinion, but it's a good vehicle for getting buy-in from licensees and from the people who get called stakeholders, but may have an objection to some of the things that are taking -- for instance, MOX and stuff like that.

DR. SEALE: And it's that stakeholder community that we've had the biggest problem with; namely, the technical people in that field who are otherwise disinterested.

MR. THADANI: And I can tell you that I fully agree with what you said. That's a lesson I have learned. That's why I have been pushing the concept of PIRT really ought to be utilized for any major program we initiate.

Only some caution, I would add, would be that in the PIRT, the membership is technically renowned people. We still have a challenge to make sure that the industry, truly the industry is, in fact, supportive of the results that come out of the PIRT panel, and that's not a small --

CHAIRMAN POWERS: There's another codicil on it that maybe is implicit in what Farouk said, is that you can't straightjacket yourself and say I'm going to do exactly what the thermal hydraulics crowd does.

You've got to tailor it a little bit. But the general idea of getting all of these -- and the panel they assembled is just a who's who of fuel research around the world, came up with so many ideas and things like that, that it really makes for a very, very defensible research program, once you're completed with it.

DR. SEALE: Moving right along.

MR. ELTAWILA: I think Mike finished with his presentation and he focused mainly on the future challenges for currently operating facilities. I would like now to focus --

CHAIRMAN POWERS: Whoa, whoa, whoa.

MR. ELTAWILA: Not that fast, huh?

DR. SEALE: The digital I&C and the use of PRA.

CHAIRMAN POWERS: Like you said, expanded use of PRA and you didn't want Apostolakis to read that.

DR. APOSTOLAKIS: Has there been any progress in incorporating digital I&C possible failures into PRA? I know you guys have been working on this.

MR. KING: Not any substantial progress.

CHAIRMAN POWERS: What I see in the write-ups for the future program, and, admittedly, they're abbreviated things, but I see these words like qualitative risk assessment and whatnot, and, quite frankly, I haven't a clue how I put high, low and medium into a PRA and get anything useful out of it.

I mean, I see that just as orthogonal to incorporating digital I&C technology into the PRA.

MR. KING: I'm not sure we apply that to digital I&C. We certainly applied it -- if you remember risk-informed ISI, there were two methods. There was a quantitative and a qualitative method and you identified things high, medium or low in the qualitative method by could the failure cause failure of other equipment and so forth. There were some criteria you went through.

So the application of a qualitative technique is accepted in some places -- for some applications, I should say. Now, digital I&C, I think we're still struggling with how to do that.

I think we're still struggling with how to do that one.

MR. MAYFIELD: I would say that there are people, at least in the digital I&C community, that are talking with the PRA folks, Carol Schmidt in Maryland, Barry Johnson at UVA, there are some differing ideas. I wouldn't want to suggest to you that anybody has -- at least the people that I deal with, that have clear answers on how to do it, but the dialogue is ongoing and I think that's positive.

So it goes beyond just high, medium and low kind of rankings.

CHAIRMAN POWERS: When I see the programs, I see the qualitative, I don't see the quantitative in them.

MR. MAYFIELD: And at this stage, at least from what I'm seeing, it hasn't progressed to the point where I would go spend a lot of money on a single program that would rise to the level you would see it.

Is it embedded in tasks, is it implicit in some of the sub-tasks? The answer to that is yes. So we can talk about it, bring you some additional details at some point in the future, if you'd like. I think we were anticipating coming back and talking about digital I&C in the next few months anyhow.

DR. APOSTOLAKIS: I thought the University of Virginia was doing it for you already.

MR. MAYFIELD: Yes. Barry Johnson and his people at UVA.

DR. APOSTOLAKIS: Have you -- go ahead.

MR. MAYFIELD: Their scheme is somewhat different from the traditional event tree approach or fault tree approach and there is dialogue. Nathan Siu has been talking with Johnson. So there is some dialogue on exactly how to marry the approaches, how to make this thing consistent, and do it in a quantitative fashion.

DR. APOSTOLAKIS: Have they produced any reports?

MR. MAYFIELD: They have produced a number of reports. I don't know that they have one -- at least in terms of the dialogue, they have some notions on how to deal with it.

We can go back and take a look at what they've got to provide.

DR. APOSTOLAKIS: I'd like to see something on the quantitative part. Regarding the use of PRA, I think there is an issue -- there is a very interesting project that you have had for a number of years now, that's the common cause failure project, which raises an important question.

When do you declare success and terminate a project? I think, as an industry, we have been successful at reducing the rate of occurrence of common cause failures and we all remember the figure that we saw some time ago. I believe it was in a memo from Rich Barrett to -- I don't remember.

But it showed a clear decline of the rate of common cause failures over the years. So we have this project now that keeps adding data from the last three-five years, which apparently is already obsolete, because now we are doing a much better job.

The methods have not been touched in quite some time. There is an international participation, where I don't know what we're learning from things that happened in Sweden, but when do you decide that something has been successful and maybe we should take it easy for a while and revisit the issue maybe in a few years in case there is something else that we need to do?

Is there any -- do you have any criteria? Because this would seem to be a prime project to say, well, gee, you know, let's declare success and stop it, which is not going to please the people who do it, but when do we do that?

DR. SEALE: And can you do it in such a way that the better common cause failure numbers that you're enjoying continue to be upgraded as you get more and more experience in the program?

DR. APOSTOLAKIS: I agree. I agree.

DR. SEALE: That's the hard part. The trouble is if you shut it down, then that number is engraved in what amounts to granite until you get back to the research table.

MR. THADANI: I think there has to be a mechanism in place where my own sense of sunsetting a program would be some low level of effort at maintenance.

Now, what I mean by maintenance is continuing to look at operational experience in this country, common cause failure likelihood is fairly low, and that's good, and so hopefully we're not going to get large amounts of data.

And as you correctly noted, that those failures have been going down, because you learn from experience, you make improvements, so that's the correct direction, it seems to me.

And in addition to some low level of maintenance, I think it is important to look at these on an international basis. The CSNI effort in this area, I think, is fairly important. I can't tell you the level of resources we're spending and as a result of your comment, I will take a look at the level of resources to see if it is close to what at least I think should be maintenance level and not significant expenditures.

But I think you have to be also careful that you don't send the wrong signal to people about areas which have potentially large safety significance. Random failures are very unlikely to come together to cause you a big problem.

I suspect it's going to be more the common cause type of problems or failures. One has to balance that part.

Have we reached the right balance on common cause failures? I don't know the answer at this minute, but I'll look into it, but I can give you my views that I would not want to terminate the program because I think that we open ourselves up to a potentially significant issue.

So there has to be some sort of balance there.

MR. KING: To me, this is a valuable area. It's evaluation of operating experience. As plants age, maybe you're going to get some new mechanisms for common cause failure.

We spend about 500 K a year in this area, between the national and the international efforts. So that's the level of effort.

DR. APOSTOLAKIS: I fully agree with both you and Ashok, especially the words maintenance level. I like that. If I had $1,000 maintenance level, I don't know. For me, it would be paradise. For you guys, it's maintenance, it's wonderful.

MR. THADANI: By the way, for me, too, okay?

DR. APOSTOLAKIS: But I think the issue is broader than just the particular project. Now, since we are in this area, we're not going to come back to PRA, I suppose. There are issues that come up every now and then that the agency doesn't seem to respond the way perhaps one would expect. The Fussel-Vessely and RAW importance measures have become, in my view, as important as Regulatory Guide 1.174. They really are, because there are many important situations where we cannot quantify the delta CDF and delta LERF for certain contributors.

Yet, the industry, and rightly so, points out that that's where we're spending a lot of money, like special treatments. And yet, you know, there was an ACRS letter listing a number of problems with these. Then there is a utility, in fact, that comes here with a methodology, the top event prevention methodology, and there is nothing really that's happening.

I mean, I talk to people in private and they tell me, yeah, sure, but the expert panel will take care all of all these problems.

I think we should be a little bit more responsive than that and I know for a fact that when people who are proposing advocating the top event prevention methodology are very discouraged by the reluctance of the staff to take it seriously.

Not necessarily your staff, Ashok. Shouldn't we do business a little differently? I mean, here is a fundamental tool that is being used in very important regulatory decisions. There are questions being raised about its validity, because after all, when Bill Vessely worked on his thing, he never dreamed that it would be used to that extent. That was done way back.

Why is this happening? And the expert panel -- is it the pressure that is on the staff to produce a rule by a certain time and we can't afford to open up methodological issues at this time? We have enough problems deciding what to put in the matrix, like RISC-1, 2, 3, 4.

If we open up the problem now of what does Fussel-Vessely mean, well, gee, we'll never finish.

DR. SEALE: Don't ask if we're turning the wrong crank.

DR. APOSTOLAKIS: Right. So is that part of it?

MR. THADANI: First of all, let me be sure that I think research has an obligation on the methodology issues to be sure that what methods are being used are appropriate. And I'm sensitive to some of the issues about the importance measures that have been utilized and your concerns and some earlier issues, when actually I was at NRR then, I had asked that we take a harder look and I know Dr. El Basioni is actively -- he's in Tom's organization -- is actively engaged. Perhaps Tom can give you a status of where we are, either now or later.

DR. APOSTOLAKIS: Dr. El Basioni is doing this now?

MR. THADANI: He's been with us working on it for a while.

DR. APOSTOLAKIS: I didn't know that.

MR. KING: Actually, he just went back to NRR. He was over with us for about seven months and he has produced a report, taking a look at Fussel-Vessely and RAW and the other traditional measures and came up with a recommendation for what he thought was an approach for importance techniques that ought to be applied. We haven't -- in fact, we owe Ashok a briefing on it.

DR. APOSTOLAKIS: And maybe to some other people.

MR. KING: And maybe to some other people.

MR. THADANI: Yes. I'll tell you, I happen to agree that that's -- we sometimes -- people talk about thermal hydraulic codes being used in regimes that they were not developed for. I think we have to be sensitive to the probabilistic techniques equally.

MR. KING: And he's also included the top event methodology in his study.

DR. APOSTOLAKIS: By the way, just as a piece of information, I had a journal and I saw the last few months an explosion in the number of papers that I receive on importance measures, from France, from Korea, from Taiwan, form the United States. Something is going on. I don't think these people have read the regulatory guide.

But there is really a lot of interest internationally and I hope you guys are keeping abreast of these developments.

MR. KING: We have done another thing, and that is because option two is using the traditional measures and they're normally applied using mean values of CDF and so forth, we've taken a look at the effect of uncertainties on ranking of things and there is a nice report being prepared by University of Maryland that did this work, Olly Mosley and Muhammad.

The bottom line is the uncertainties don't make much difference. They shift things a little bit, but there are no drastic shifts in the ranking of things due to uncertainties, if you believe the method that was used.

I think we may want to talk about that at some point in the future, too.

DR. APOSTOLAKIS: I took at a look at that, too.

MR. KING: Okay.

DR. APOSTOLAKIS: And the interesting conclusion, independently of the methods, is that instead of saying that SSCK is in RISC-2, now you have a probability that it is in RISC-2.

MR. KING: Yes. And you want to make the boxes to -- you know, what confidence level do you want to have if you're making the right ranking, and this kind of information would be useful.

DR. APOSTOLAKIS: Speaking of problems in risk-informing special requirements, now, that's all we need to have a probability that the SSC belongs in a group.

MR. THADANI: Now, for your information, again, I think George certainly knows this and others perhaps do, too, that CSNI has -- one of the working groups is on risk assessment. Joe Murphy chairs that group and I don't know if you want to comment about what CSNI may be doing in the area of importance measures, but you may want to touch on it.

MR. MURPHY: We don't have anything active in the importance measure area directly at the moment.

DR. APOSTOLAKIS: The problem with international groups, since you raised it, Ashok, is that very often they produce reports that say in the U.K. we do this, in France we do that, and in the United States we do this other thing. And there is no way you can force consensus. In fact, people sometimes take it as a national pride to defend what they're doing, but I've read -- I'm not necessarily attacking the CSNI thing, but I've seen their report on fire risk assessment and some of the approaches in some of the countries, those people should be shot.

CHAIRMAN POWERS: Gee, I wish I knew where you stood, George.

MR. THADANI: But we do it this way, who are you to tell us to do it different.

But you look at it the other way. Where CSNI could do better is where this Office of Research could do better, which is to make sure that those results are getting to people who are making decisions.

And I think I can tell you there are many times I learn from those reports and I think there are things we can do better as a result of some of the work.

Similarly, safety cause is better served, in a way, worldwide, if the same information gets to those countries that you're talking about.

DR. APOSTOLAKIS: In fact -- I don't know. I wanted to praise the NRC, but --

MR. THADANI: We're waiting.

DR. APOSTOLAKIS: I've had opportunities to work with international groups the last year or so and the same people who three years ago were saying, oh, you Americans do it this way, we're doing it differently, are paying a price now for doing it differently. The approach of the U.S. NRC was a sound one.

CHAIRMAN POWERS: I have a sense that my committee is getting hungry. Maybe the presenters are getting hungry, as well. Should we go ahead and take a break for lunch and come back at, say, 1:00, and launch on a -- I'm sure we're not covering everything that the plan was covered, but I get the feeling that the conversation is going very well.

So let's come back at 1:00 and keep charging ahead.

[Whereupon, at 12:05 p.m., the meeting was recessed, to reconvene at 1:00 p.m., this same day.]

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

[1:00 p.m.]

CHAIRMAN POWERS: We are still on Farouk, right?

MR. ELTAWILA: Just to put my presentation in perspective, Mike may feel focused on the future challenges for currently operating facilities, and I'm going to focus on the for the future, maybe future design more than the evolutionary design, revolutionary design, and Tom King is going to eventually talk about the future design.

Like Mike indicated, there are some -- I call them licensing issues, but these are assumptions for the planning, and one of the assumptions that I made here in order to develop the thought is that the public was still concerned with the issue of safety and severe accident.

So regardless of the words that are coming out of the industry inherently we receive and there is no chance of severe accident and all this stuff, I think we will have to address severe accidents regardless because of the issue of public confidence.

There will be a pressure at NRC to -- one of the discussions that took place during the water reactor safety meeting, that they indicated that the utility will be interested in buying nuclear power plants right now, if the capital cost is reduced below a certain level. And some executives are already indicating that they are willing to buy for a certain number, I don't remember.

So there would be a lot of pressure how to make the nuclear power -- generation of a nuclear power plant competitive and, at the same time, how to make them safe.

Some of the lessons learned from the current activities, the decommissioning cost is very excessive, so that in the future, the design will keep the decommissioning option as part of the design or even replacement of equipment and things like that, so there will be no long downtime.

All this will create some kind of challenge for us in terms of how we write our own regulation. I made an assumption, too, collectively, we made an assumption that the mix of nuclear power plants in the United States is not going to be only for producing electricity.

I think the new generation will ask us to -- you created these stockpiles of plutonium, get rid of it. So there will be a design that's uniquely to burn the plutonium, not the MOX, current MOX for operating plants. I don't think that will get rid of all the stockpiles. So there might be a need for a design to burn only plutonium.

The transmutation of long-lived, highly active nuclides, that might be part of the mix of the design that would be put forth in front of NRC and there would be emphasis on minimization of the waste if we don't have a solution for the Yucca Mountain by then.

Again, we believe that the agency will maintain its defense-in-depth. We are not going to get rid of that. I think the four barriers will likely to be maintained. The requirement for each barrier might be different.

So if you have a plant that has extremely low likelihood of channeling or producing load that can challenge containment integrity, you still might have a containment, but it might have a different requirement than from what we have right now, but we will continue, I think, the challenges are the same, that we're going to maintain the defense-in-depth.

DR. SEALE: In talking about decommissioning measures and things like that, have you given any consideration in your analysis to the value of a site? People talk about decommissioning and walking away and so on, but if past is prologue, then if it's been hard to find sites -- if it was hard to find sites 20 years ago, it's going to be like real hard 20 years from now or ten years from now, and the fact that you got a site and the water that goes with it for cooling is -- that has value and you can't minimize that value.

And if the utility has that asset, then it seems to me that's part of any consideration they have to make for the future.

Has there been any thought about that in any of your assessments?

MR. ELTAWILA: No.

DR. SEALE: It might be an interesting thing.

MR. ELTAWILA: The next viewgraph, I'm talking about the use of the PRA technique is going to be continued through the design process, and that's not unique, because Ashok indicated, we have followed that in the AP-600.

But I think we will be looking at different types of reactors or pebble bed. We don't know what the design is going to be.

So that would create an additional challenge in developing the PRA technology and database for these new challenges.

So although the concept is not unique, the application will be different.

CHAIRMAN POWERS: Farouk, we have -- in the area of risk-informing the regulations, we had these option two, option three activities going on. With option three, which is part of research, you're kind of going in and looking at particular regulations, seeing how to risk-inform them, which is fine if you're thinking about the current fleet of existing plants and you're not -- because you don't abandon all the stuff that has showed up in the FSAR.

Now, when you think about a new plant coming along that's not a water-cooled plant, it's something different, all of a sudden you've got a challenge, because the regulations just don't fit.

Does Research have anybody looking at the idea of let's take out a clean sheet of paper and if nuclear technology just showed up yesterday and we were trying to figure out how to safety regulate it, what would we put into it, that safety regulation?

MR. THADANI: Let me ask you to hold that thought, if you will, because we're going to come back to it.

I would like to make sure Tom has an opportunity. He's going to talk about the future designs issues. He will give you a sense of our absolutely about as fresh as it can get, our thinking, and the steps that we would hope to go through.

We do not have agreement with the Commission yet on those steps, but we do have agreement generally that Research will initiate early interactions with the Department of Energy and probably with SCOM and the idea behind that would be to just go through what I would say is up-front and unencumbered thinking about what's the best way to proceed.

In parallel, as you know, there is an initiative which is looking at the whole idea of risk-informed regulations, not necessarily for light water reactors, and we are staying in touch with that group.

But Tom will give you a little more information about where we are and where we think we may be going in the near term.

CHAIRMAN POWERS: I will certainly wait for that presentation. I'll comment, in regard to the paper from that NARY program review the other day, the question I posed back to them was, okay, how do you guarantee I design the core with a negative void coefficient.

Their approach won't get -- I can put in a positive void coefficient. I also pointed out to them, the Commission doesn't say you can't do that. We don't do that very often. We really don't like positive void coefficients.

MR. THADANI: We know what happened on CANDU.

DR. SEALE: You can do it, but, boy, are you asking for trouble if you do.

MR. THADANI: Yes.

CHAIRMAN POWERS: Okay. Go ahead, Farouk.

MR. ELTAWILA: Again, we do not have any experience in licensing any of the procedures of any avertive technology. And I think it will create a challenge for NRC people that have been thinking light water reactor all these years, will be having a hard time adjustment to these new technologies.

So we really need to start developing the safety codes you need for that and I think your question, and hopefully Tom will be addressing that.

Again, things that will be a mistake, if we just take all the initiating events that we learn from current generation of operating plants and try to apply them blindly for the new design.

So it's almost like I'm endorsing starting with a clean sheet of paper about how to do the PRA, how to develop our review procedure and things like that.

Although the next star here is not unique to future challenges, but it's actually a challenge right now. If we are going to be truly risk-informed, we really should be able to model the accident or the operator interaction with the machine and the PRA and the analysis to see what situation he exacerbated the accident, which is the situation he will prevent things from getting worse, if we really want to quantify that.

So our cause right now does not have this interactive capability and we need to develop them to be able to do this work.

There has been a lot of work in this area in the past and started and stopped and things like that. So we really are not going to propose a very extensive program. I think the first thing is to try to look at what exists out there and identify any gaps and if the gaps can be filled in a timely fashion, we'll do that or we'll look for alternatives.

So really it's not a very extensive research program. And the next few viewgraphs, I'm going to just talk about issues that we expect to be seeing different from the current generation.

I think Tom -- Dr. Kress indicated earlier that he was disappointed that the new cladding does not consider different type of cladding that will prevent these accident different from zircalloy.

The only other cladding I remember was introduced as aluminum cladding for the production reactor, which is worse.

DR. KRESS: Yes, that's worse.

CHAIRMAN POWERS: You have to be very careful with saying that aluminum is worse. I mean, it has some good features and bad features. The one thing you know about aluminum clad fuel or aluminum matrix fuel is that the core melt temperature is relatively low.

MR. ELTAWILA: And fuel-coolant interaction would become very interesting.

CHAIRMAN POWERS: Well, it's spirited. You want your coolant to be gas.

MR. ELTAWILA: So we really -- I'm almost certain that the industry is facing that challenge right now and some of the work that they are doing to have that edge, that there will be new cladding material that have an improved response to accidents.

So it is vital for their survival. The issue of ultra high burn-up fuel for U02 and higher burn-up for MOX, I think we discussed that earlier, but that will be one of the design requirements in the future.

Burnable poison instead of the boron core, that they delete the use of boron all together and rely more on the actual design of burnable poison in the core.

The issue of high level waste I think might be one of the important issues and the use of ultra high burn-up definitely will minimize the waste, but there are other things that people are looking at. It's not necessarily here in this country, but in other places, so different fuel cycle and so on.

The use of thorium cycle, which has the potential of reduced production of actinides, have been discussed by different people. So we expect in the future maybe one of the designs would be using this information.

CHAIRMAN POWERS: Do you think that people will think about future designs with metal fuels?

MR. KING: If it's a sodium reactor, definitely.

CHAIRMAN POWERS: I'm thinking about --

MR. KING: You're thinking about a water reactor?

CHAIRMAN POWERS: Well, gas or water.

MR. KING: I doubt if it would be in water and I doubt if it would be in gas. But definitely, if it's a sodium reactor, it would go metal fuel.

DR. SEALE: The IFR concept.

MR. ELTAWILA: Ashok indicated that -- I mentioned, also, before, the plutonium burning potential and so for this type of reactor, we'll have to look at how to control excessive reactivity for this design.

Again, we're not really coming with any major design shift here, but I think we need to pay attention to it because some of the information that might be generated in in the past either disappeared or is about to disappear, it might not be in a condition that we can utilize it. But I think we have to start to pay attention to it, try to get this information in-house and so when it's needed, we'll start using it.

Ashok indicted that there would be the pebble bed reactor design and that they are looking at coated particle, but all their work has been focused only on low burn-up. Eventually, for it to become competitive and things like that, they have to consider high burn-up. So we have to start looking at this issue.

CHAIRMAN POWERS: Just for your information, next week I'm attending a meeting specifically devoted to new coatings for ultra high temperature fuels for gas reactors.

MR. ELTAWILA: Okay.

CHAIRMAN POWERS: And the ones that they're looking at in particular is zirconium carbide and niobium carbide, I think.

MR. ELTAWILA: That's the DOE project.

CHAIRMAN POWERS: Yes. I guess saying it's DOE is a little bit of a stretch. It's one of these things that's like for the NARY program, only I don't think it's exactly NARY. But it's like that.

MR. ELTAWILA: The next viewgraph is on thermal hydraulics. I think the challenge is for light water reactors will continue to be improve the physical model of the two-phase flow and, again, if we really want to take advantage of all the conservatism in the code, we have to develop models that can better predict the phenomena.

As you know, right now, our codes rely on a flow regime map. So which really does not represent what's happening in the plants, but we started in the area of developing dynamic flow regime, but this is a very long-term effort. We're trying to replace the guts of the thermal hydraulic work that was developed over the past 20 to 30 years with a completely different concept.

And we are not spending a tremendous amount of money on that. We're keeping it at a very small level and we are capitalizing on international cooperation with Japan and France. So we're just moving it at a very even level, but this is one of the things that we're continuing to work on.

DR. SEALE: Our experience in the advanced reactors, the ABWR, the System 80+, and the AP-600, indicated that it was -- we didn't have time to do a rational examination of what the differences were in the thermal hydraulics regimes that brought into suspect previous computational methods which were strictly margin oriented rather than best estimate oriented.

And there was an awful lot of hours spent in this room and other places with Westinghouse particularly and others arguing about the use of PIRT and things like that to try to figure out whether or not -- or what would be required to get those old codes to have an acceptable measure of completeness.

It strikes me that as you go down this thing, one of the things you might want to look at is at least for these various kinds of coolants and performance regimes, that is, temperatures, single or multi-phase and so on, you might want to ask yourself what at least the initial elements of a PIRT analysis would be for that particular approach.

So that you would have that in pocket and you wouldn't get steamrollered like we were with these other things and to using what you already have rather than what you know you really need in order to have an analysis you'd have confidence in.

That might be a very appropriate component of this kind of looking.

MR. ELTAWILA: Those are very good comments and I agree with you. We will keep that in mind, definitely.

There has been a lot of interest in computation of fluid dynamics and as you know, that this work is right now focused on the single phase and we are not going to develop our own code. I think industry -- the general industry, general user of CFD are developing very good tools, but they will not develop the two-phase model, because the nuclear industry is very small and you don't see any value of putting these models.

So I think that we will be able -- we would like to develop the two-phase flow modeling for the CFD code, because the issue that is challenging us right now are going to become very important in the future design, too, because, again, we'll be looking at risk-informed, we'll be looking at shaving margin here and there.

So we won't be able to be in a position to try to resolve some of the existing issues right now and the CFD code will be the tools to be used in this regard.

CHAIRMAN POWERS: It seems to me the way we cast -- we discussed this issue. See if this tracks. We've got a whole bunch of these synergistic -- activities with lots of synergistic things potentially possible within the nuclear industry there that sound like they're chipping away at the margins we thought we had based on these conservative bounding thermal hydraulic models we used for 50.46.

There was some margin in there, we kind of knew what it was. These things are chipping away at that and if you go out into the public and say the plants are still safe, you have to admit that based on those old codes, you have reduced that margin.

What we know is there was probably more margin than you thought there was when you only had the very conservative codes to use.

What you're trying to do now is develop models that allow you to say what the real margin is, even after you've made these changes.

MR. ELTAWILA: I think I agree with you and that's what we're really trying to do and sometimes the margin that we thought that we have has shrunk tremendously right now over the past few years, with the power rate increase and things like that, and one of the experiences that we had with looking at just one parameter only, the decay heat in the Appendix K require 1.2 multiplier on the decay heat, and we tried to take -- get rid of that 20 percent multiplier and we started looking at analysis and we discovered a phenomenon that was not modeled in any of our code.

We started getting a boiling in the downcomer. That boiling -- having that conservatism in the Appendix K suppressed that phenomenon completely and what you end up that this information becomes very crucial if you are going to rely on accident management, because when you have a boiling core, you don't know where is the level going to be and at the same time, so you can activate your automatic system and so on, and at the same time, it will delay the injection of safety injection system and so on, because it will keep the pressure high in the downcomer.

CHAIRMAN POWERS: That particular example is worth its weight in gold, isn't it?

MR. THADANI: I want to add to what Farouk is saying, because we want to be sure that that is, in fact, the case about boiling in the downcomer. It illustrates to me, again, the risk, in a way, in sort of not having enough information to know what realism is and thinking that we are ending up with something that's quite conservative.

In most cases, I think that's perhaps pretty straightforward, but there are cases, and this is an example; in my mind, over the years, we have pared away and now, I mean, the simplest thing, and you sent a letter on this, on the decay heat issue, we thought that was going to be simple.

CHAIRMAN POWERS: Piece of cake.

MR. THADANI: We could be there soon. And why wait for Tom to take his time on 50.46. Maybe we can do something quickly.

And now we have potentially a very significant issue on our hands and I think what it tells me for all the thermal hydraulic improvements in codes that we talk about, we really have to make sure and say what will it take to be able to say we have reasonable confidence that this is a realistic assessment.

Any future code development efforts, I think we're going to have to make sure we're paying attention.

MR. ELTAWILA: As Dean indicated, it's realistic and to be able to quantify the margin correctly this time and not rely on conservatism, because conservatism leads to non-conservative situations.

CHAIRMAN POWERS: What's conservative changes as you move from application to application. So what you thought was conservative before may be non-conservative, as you say in your accident management planning strategy, if you're based on a simplistic view of core heat-up. Maybe that's not conservative when you -- apparently it's not.

DR. APOSTOLAKIS: When you two gentlemen say quantify the margins, what do you mean?

MR. ELTAWILA: The margin is -- if you're talking the true margin to getting, for example, in the situation that you lose your coolable geometry, that can eventually lead into a core melt accident.

DR. APOSTOLAKIS: But what is the margin? I mean, when you say quantify.

MR. ELTAWILA: Between what is the --

DR. APOSTOLAKIS: So you don't speak in terms of probabilities.

MR. KING: I think a good example is 50.46 calculations. It's a prescribed conservative calculation now and you have to be below 2,200 degrees. If you did a realistic calculation, you'd have a lot of temperature difference between, and that would be more like your real margin.

DR. APOSTOLAKIS: For me, margin is the probability that the temperature, the actual temperature in a particular accident will exceed the melting point or the damage point and that is not what you mean by quantifying the margin.

MR. THADANI: I think we are talking about a piece of the whole process that you're addressing. You are exactly right. In the end, a margin has to be in the context of the safety limit that you want to understand how close or how far you are from that limit.

There are two parts to that. The first part is the foundation, the analyses that you use to calculate the temperatures, are there some -- understand what the limitations might be and early on I think you used the term in terms of model uncertainties or some sort of uncertainties, and they may be driven by just our lack of information base.

The second part, and if you can understand that, then the second part is going to be to carry through the whole accident sequence in a probabilistic manner.

DR. APOSTOLAKIS: Right.

MR. THADANI: And that would include the assumptions we make, which is, for example, with large loss of coolant accidents, simultaneous loss of off-site power, unavailability of A/C power source, the worst conditions for -- initial conditions for analysis.

I think there is a lot of places we can look to get rid of some of those requirements. But the point Farouk was making we thought we had a simple place we could really get rid of unnecessary conservatism and now we find that the model that we had used for analysis didn't predict something.

DR. APOSTOLAKIS: Right.

MR. ELTAWILA: So I think foundation has to be strong. Once you have that, then you carry the whole process in a probabilistic manner.

DR. APOSTOLAKIS: I agree. Earlier today, we said that we will try to talk about things that you want to have five-seven years from now. So is the quantification of the safety margins in the sense that you just described something that you want to start working on right now, maybe do some exploratory studies first, because it's not an issue that can be done in two years. There's no question about that.

MR. THADANI: I was trying to convince my colleague here on the same point.

DR. APOSTOLAKIS: Because, you know, we get in the PRA, we do the event trees, we get the acceptance criteria, somebody comes from the mountain and says this is it.

Well, in this new regime, now, you will have to bring the probabilities from these criteria into the event sequences, and, again, that's not an easy task.

But I think a lot of the concerns that Dr. Bonaca raised recently and others can be better addressed if you try to quantify that. Then it will have a true -- and then 1.174 will be better served.

MR. KING: We take an attempt to sort of qualitatively define safety margin in the framework document we're going to talk about tomorrow.

DR. APOSTOLAKIS: And I would make the same comment tomorrow.

MR. KING: We have a probabilistic piece to that in the definition, as I remember it, but when we go risk-inform something like 50.46, we've got to ask ourselves what -- you now, one of our principles is maintain sufficient safety margin, what does that mean.

DR. APOSTOLAKIS: Exactly. Exactly. That's a question I'm going to ask tomorrow.

MR. KING: Thank you for the warning.

DR. APOSTOLAKIS: See, as I said earlier, we've done a lot on the defense-in-depth side. You know, if I have three trains or if I have two trains, whether I have three or two makes a difference in the PRA, because it's within the traditional reliability type methods.

But when it comes to the margins we're talking about, I don't think we've done this much.

MR. ELTAWILA: And that might be the area where the industry might get the maximum benefit out of it, because they can increase power.

DR. APOSTOLAKIS: Sure.

MR. ELTAWILA: Look at the AP-600. They are asking for a 40 percent power increase without any --

CHAIRMAN POWERS: Which would be great, except they also want --

MR. ELTAWILA: I think 60 percent, I'm sorry.

DR. APOSTOLAKIS: Inside NRC, didn't they report something in a recent issue that the French were surprised to find that -- you discussed it already -- that some rods were damaged at temperatures significantly higher than what they expected.

MR. ELTAWILA: In the Phebus project, yes, that's correct, which is good information, but we have to understand the way they have run the test and things like that before we -- but all this information will factor in our decision-making.

Some of the issues, again, related to the CFD code is the modeling of turbulence. I think everybody thinks that CFD codes are based on first principals, but when it comes to turbulence, it's not.

So this is an area that needs additional work.

DR. KRESS: But there are, with the K-epsilon, there are really no first principal turbulence.

MR. ELTAWILA: No first principal in this regard.

CHAIRMAN POWERS: But K-epsilon is like the dark ages.

DR. KRESS: That's going back pretty far, actually.

CHAIRMAN POWERS: It only works for isotropic turbulence. Have you really got isotropic turbulence in these situations that you have interest in?

MR. ELTAWILA: But that's what we are using right now in our calculation. So we need to look at the issue of turbulence. I'm not saying that we are going to develop the K-epsilon. I think we have to look at the application that we have and we'll try to see what kind of model will be needed to address our need.

CHAIRMAN POWERS: I think you'd want to -- and I don't think this is too difficult. I don't think you don't know it, but I think as a point of fact, we want to have models that can accept any of the common approaches to modeling turbulence, empirical though it may be, not restrict ourselves to K-epsilon, because every time people do that, they end up throwing a code away.

MR. ELTAWILA: That's what I'm saying that everybody is focusing on. That is what we are using right now and that is not the right way. So we need to devote some effort in addressing the turbulence right now.

Although that we believe that the TRAC-M code is going to be the future horse at NRC and it's really developed -- I think Jennifer will be coming in front of you in November to discuss the advancement that we made to the code. Again, it's still going to be, regardless of how the improvement, it's going to be a slow code for the type of analysis that Tom King would be needing.

He will be asking for hundreds and hundreds of analyses and --

DR. APOSTOLAKIS: He always does that.

MR. ELTAWILA: He better be asking me for hundreds of analyses.

CHAIRMAN POWERS: I see how this works.

MR. ELTAWILA: Seriously, because if he is going to make a decision to relax a regulation or get rid of margin or our perceived margin or something like that, as Ashok indicated, we have to be certain what we're doing and the only way is to run a lot of sensitivity analysis. We cannot just rely on two or three analyses and we'll say we know everything that we know about how the plants are going to behave under these conditions.

DR. APOSTOLAKIS: I was trying to raise the issue at the very end, but since you have used the words decision-making several times, maybe this is appropriate.

MR. ELTAWILA: Maybe I should not use that word.

DR. APOSTOLAKIS: Well, you did already.

CHAIRMAN POWERS: You're going to learn to regret it.

DR. APOSTOLAKIS: It seems to me that we have paid very little attention to the decision-making methodologies. We focused almost exclusively in the last 25 years on quantifying the input to the decision-making process, which is PRA and so on, but the decision-making process itself is largely ad hoc.

Take 1.174. There will be increased management attention. There is an integrated decision-making process. Well, at some point, we have to start making that a little bit more formal and what I would like to suggest is that perhaps we start thinking about exploring the possibility of using some more formal methods.

In fact, right now, my students come all the time to me and say, well, this package does not influence diagrams and you press a few buttons and you get the answer.

So that tells me that these methodologies have reached a level of maturity that they can be marketed now in computerized days.

CHAIRMAN POWERS: Do we have examples of where people have used formalized decision-making processes successfully?

DR. APOSTOLAKIS: Yes. What do you mean successfully? Because you can always make a decision. See, that's the perennial problem.

CHAIRMAN POWERS: Usually, I mean, what I'm thinking of, there was something in the Harvard Business Review that essentially pointed out that every time they had gone through formalized decision-making, they ended up with a

Worldcomm or something like that that -- a failed company out of these things, and that their essential point was that you really can't use these formalized -- a complete -- you can't use a computer to make a decision, that there are too many unquantifiable facts that have to be borne in mind.

DR. APOSTOLAKIS: Right, and that's exactly why the National Academy recommended the analytic deliberative process, which is a different name for what we're doing here with the expert panel and the quantitative analysis.

In other words, the decision will not be made by the computer. This will be like your PRA results that will be fed into the human decision-makers, who will have to ponder these unquantifiable issues and so on.

So the process is there and we are familiar with it. All I'm saying is that perhaps we can formalize a little better the part of it and then give it to the expert panel, who will make the decision, just as we do with importance measures or with everything else.

We have used it in severe accident management under the sponsorship of this agency, when I was at UCLA, and one of the successes, if you want to call that success, is that Ivan Catton was extremely hostile the first time he saw it and he loved it at the end, because he saw a way of putting all the dependencies between the various phenomena on a single diagram and maybe convince others.

CHAIRMAN POWERS: It looks like a Chef Boyardee factory. It doesn't clarify anything, except that I don't understand things.

DR. APOSTOLAKIS: I completely disagree.

CHAIRMAN POWERS: I know you completely disagree.

MR. THADANI: Just a comment. We could discuss this for a long time. But we're not doing very much, you're correct, Office of Research. But I'm pretty sure you are familiar with what DOE is doing. Victor Reese has been having a number of workshops in terms of the whole -- the models of influencing diagrams, and then trying to simplify them to be able to turn them into what I would call a little easier to use.

DR. APOSTOLAKIS: With that inference diagram, we did some sensitivity studies using reasonable ranges of the parameters from NUREG-1150 and we identified regions where the preference order of the options changed.

I mean, that would be of tremendous value to someone who wants to make a decision. Tremendous value. You had a number of options at the end, accident management strategies, and then you did it on the basis of the point value and you got one ranking. Then you did it in terms of mean values of distributions and you got one ranking.

Then you said, well, gee, let's see what happens if these parameters are in this region and a lot of this stuff is computerized. They call them tornado diagrams, where you see regions and the order changed.

Now, what kind of insight does that give you? Okay. You have to sit down and think about it. The computer will not tell you that. The computer will just tell you that if these numbers go there, what you thought was the best decision is no longer the best decision.

MR. THADANI: This work, SAIC work, actually, I think DOE was supporting it, my point simply is what it does, in my view, is up front it forces you to do a lot of thinking of what are the key elements that you need to be paying attention to and it does it in a fairly -- I think it's impressive, actually. Once you get done, you realize that a lot of very complex things, you can get down to some potentially manageable number of elements.

DR. APOSTOLAKIS: All you have to do is go back 20 years ago when people were arguing that PSA has no value and use the same arguments that people used. It's exactly the same thing. It helps you structure the problem. It's exactly the value of the former decision-making methods is the value of fault trees, event trees, for PRA.

CHAIRMAN POWERS: The value that you see is making distinctions, which is the hallmark of the academic community, whereas anybody designing procedures and processes wants consistency, not distinctions.

DR. APOSTOLAKIS: And the methods -- that's what they do. They guarantee consistency.

MR. KING: But, in effect, the revised plant oversight process has a decision process in there, with its greens and yellows.

DR. APOSTOLAKIS: Yes, and what is the basis for that?

MR. KING: Well, I'm not going to explain the basis for it, but there is supposedly a decision logic behind that, so that you know -- plants know and the agency knows where a plant stands in terms of its performance rating.

DR. APOSTOLAKIS: In terms of providing guidance, yes. That's what I would like to see at the end. I don't want the --

MR. KING: You're thinking of something along those lines.

DR. APOSTOLAKIS: Yes. I don't want the practitioner to start formulating inference diagrams, for heaven's sakes, no, but the decision-making methodologies will help you develop matrixes like this and have a rationale behind it. That will be more convincing.

It's one package, guys. You can't have benefits by doing the PRA, from doing the PRA and not having benefits from the decision-making approach. It's the same thing.

I remember experienced engineers telling us I don't need your event trees. A good guy can figure it out. Who won? Okay.

It's the same thing with decision-making. A good man can make a perfect decision. Now, all you have to do is go find him.

CHAIRMAN POWERS: Move ahead.

DR. APOSTOLAKIS: It's very unexpected of these meetings. I thought the resistance was going to be from in front of me, it came from my right. But that's okay.

CHAIRMAN POWERS: If I could put up an influence diagram, you'd get resistance from everybody.

DR. APOSTOLAKIS: Again, I'm not talking about giving that to the practitioner.

CHAIRMAN POWERS: No.

MR. ELTAWILA: The point that I was trying to make is that we really need to increase the speed of our codes to be able to produce --

CHAIRMAN POWERS: That's exactly right. I mean, you've got to be able to produce lots of calculations. But it seems to me that it's more than that.

DR. APOSTOLAKIS: I would like to ask a question at this point. Does the operating experience show any accidents that are due to the fact that the codes were not very quick, very fast? Why is the agency spending money on this?

MR. ELTAWILA: You are going to analyze hundreds of scenarios. You don't have a single scenario that would be dominating.

And you need to analyze these in a timeframe that will be able to produce the answer that you will be inserted in the risk-inform of the regulation itself. So that is one element.

The other element that quite often that we -- when we are in the incident response center, that you will be called upon to respond to what if situations. So we will try to give them this answer.

Investment in these things, the computer technology itself is moving too fast right now that you want to take advantage of these machine.

The worst thing to have is to have an engineer that -- the cost actually is the engineer that you're paying the salary. The worst thing is to have an engineer sitting in his workstation or her workstation waiting for two or three days to get a single answer.

That's not practical. So if you look at it from that perspective, if you only worry about do we need the answer today, no, I don't need the answer today. But how much money I'm wasting through an engineer that cannot do the analysis or -- I will give you an example. During the electrosleeve issue, we made a decision based on insufficient information. We did not run enough sensitivity analysis to see if the design that was proposed is adequate or not.

We took a conservative number, because we had a decision to make, we did not have the time to do the analysis, we ended up with a very limited number of analysis.

So it comes to haunt us every now and then that the inflexibility of our codes and the slowness of these codes.

CHAIRMAN POWERS: There can be no question that the approach we adopt toward resolving particular questions is always influenced by if we have to do a bunch of calculations to get the kind of data we'd like to have, it takes too long. The window we have to keep somebody happy on making the decision is too short to accommodate this.

And so in speeding things up, it becomes -- it allows you to use better data to make your decisions.

But it seems to me that the problem is even bigger than that. Its' that right now, if I want to do a thermal hydraulics analysis using the new integrated code, I've got to go over and get Jennifer and I've got to twist her arm and beg and plead to fit it into her schedule and whatnot.

What you would like to do is have a code that is sufficiently easy to use, sufficiently fast, that the guy that's having to make the decisions can, in fact, do the calculations himself.

Maybe he needs a little help, especially if it's a very innovative thing, he needs a little help, but basically he has a tool that is readily available to him that he can say, okay, look on the NRC internal web page, it says I need a thermal hydraulic tool, he can pull it, there it is, and there's instruction on how to use it and it's straightforward enough that he can run 50 calculations and get an intuition on how the thermal hydraulics are sensitive to whatever he's making a decision about, without having to schedule it through Research.

It seems to me your goal is very big over there.

DR. SEALE: If we're going to really begin to honor the implied commitment to risk-informed regulation for making the kind of choices that are covered in 1.174, then we're going to have to start being able to make the calculations that tell us what the differences and the options are.

Right now, we're hand-waving all that stuff and so, George, I guess you're the last guy that could possibly ask the question you just asked, except that it was undoubtedly in the rhetorical sense.

DR. APOSTOLAKIS: Which question? About the speed?

DR. SEALE: Yes.

CHAIRMAN POWERS: Let me ask you another question, Farouk. I just sat through three days of presentation in which people told me the horrors of a blow-down accident, with vibrating structures and sonic booms and things like that.

When are you going to have a code that's going to be able to calculate those things?

MR. ELTAWILA: When I have a code that can calculate the simplest stuff first.

These are serious questions. I think a lot of flow vibration induced issues are the ones causing fuel failures and fatigues and pipes and liquid and pumps and so on. Even without an accident, just change in the flow condition in the reactor itself, based on the thermal hydraulic condition, you can introduce a lot of problems.

One of the future -- although it's not really unique things, that there will be more load following kinds of production in this country. We have not used it for a long time and I think from the point of view of economics, a lot of utilities will be interested in that.

What the type this load following, what kind of stress and effect it will have on the different component, on the fuel itself. These are issues that we are not used to it. We just assume that we are running at steady-state power during the whole accident.

So when you start reducing and increasing power continuously for demand and things like that, that is going to introduce different challenges for us.

CHAIRMAN POWERS: We've got to get this stuff down in writing, because here is the challenge I see we're facing here. A few years ago, Research went in front of the Commission and said give us five years and we will create this magical code for you that will bring these multiple codes that we've been using all together in one consistent format.

A pretty good idea, and the Commission bought off on it. The challenge we face is convincing them that -- and that's not the end of the story here, that there is a lot more we have to do, and so we have to communicate a vision on the kinds of things we're going to need and the ones you bring up that we've got different modes of operation that can affect things, we've got different sets of questions coming up for us here, plus what we would really like to have the people in the decision-making capacity, the line organizations able to do in thermal hydraulics, we've got to get that all across to the Commission, because I'm not persuaded that they all understand that.

I'm pretty sure Commissioner Diaz does, but I'm not sure all the Commissioners understand that this pervasiveness with which thermal hydraulics has in the reactor regulation area and that it's not a case of we're just running at steady power and nothing ever changes on these plants.

Somehow we've got to get this across.

MR. THADANI: I think you're exactly right. In my periodics, once in a while, the whole issue of thermal hydraulic models and our commitments to deliver something in five years has come up and I have always maintained that there are -- I mean, that's not nirvana. We need to understand that and recognize that for what it is, but it's a giant step forward, it really is.

CHAIRMAN POWERS: It is. This committee has done everything but applaud every time Farouk comes in front of us. The way we applaud, by the way, is just harassing the hell out of him.

MR. THADANI: But I wanted to add to that, and I think we also have to think about analytical tools beyond thermal hydraulics, what we do. I think there's -- I suppose the emphasis on thermal hydraulic codes.

There is under-emphasis, I think, in other areas and now we're going to potentially go into non-light water reactor technology.

And what does it mean in terms of the development of the necessary tools that we would need? I would certainly -- you're going to hear a little bit about it, but we have a long way to go pull our thinking together. So I think perhaps collectively we can share our views and so on.

CHAIRMAN POWERS: This is just an area that we've got to spend some time on in the research report, it seems to me, because I think these ideas that are coming forward, coupled with a vision, really needs to be communicated carefully here, because there's a milestone sitting there that's coming up very closely that's going to be reached and reached rather well, based on what Jennifer has been sending to us.

But that's not the end of the story there and there's a lot more that we need to be thinking about just for the existing reactors.

MR. ELTAWILA: It's unfortunate that we set a goal that we are going to meet and everybody thinks that's going to be the end of that. I hate to get George on my bad -- be on his bad side here, but I think the things that make things difficult for any deterministic kind of analysis is the assumption that's made by a lot of PRA practitioners that you can do back of the envelope calculations and you finish and you put it in your PRA model and see what is the effect on risk, and that is the danger that I am trying to get Tom, although that he understands it, but some people in his organization that truly PRA can think that they can do everything based on risk alone, without doing any deterministic analysis. And that's what will be the dangers, that can be the Achilles' heel of risk-informed regulation.

If we make a mistake because of removing a piece of equipment or reducing margin here or eliminating procedures or something like that, based on risk information that was not supported by a deterministic calculation.

DR. APOSTOLAKIS: Sure.

CHAIRMAN POWERS: All the good PRA practitioners that I have ever spoken to will testify to you and they will actually foam at the mouth over it and they will say that no PRA begins without having a good deterministic analysis of the situation. I mean, that's why this committee is so anxious to see a good deterministic analysis of the spent fuel fire issue, because we see that as the first step in being able to do probabilistic decommissioning studies.

DR. APOSTOLAKIS: That's the reason why we've had so much trouble with human reliability models. The beginning - I'm serious -- the beginning, maybe you can go back to the human reliability handbook, there was just a curve, it was somebody's opinion, using only time, and then people realized that the deterministic model was not there to justify it.

So they started looking more deeply into it and this idea of latent errors and all that kind of stuff came as a result of that. This is equivalent in that field of the deterministic mechanistic calculations that you make.

Mike mentioned earlier the efforts on the I&C side. Again, in that field, they are developing the mechanistic models that would allow you to go to the probabilistic calculations.

So PRA really builds on the mechanistic models and does not exclude them. However, if there is a very good PRA analyst, the same guy who makes decisions perfectly without any support, he can take your back of the envelope calculation and put the right uncertainty distribution and it will be perfect.

MR. THADANI: Let me make sure. I just want to be sure that that same issue of having good sound technical basis before one starts to assign probabilistic estimates applies to structures and materials and particularly the kinds of mechanisms that we're seeing, if, in fact, those are reasonably accounted for, or do we understand the impacts on failure rates, either -- when I say failure rates, I mean particularly under some demanding environment and so on.

So I have -- I have been pushing Mike, as well, that he's got to get actively engaged, and I know you've been talking to some people, Mike, about this, that we need to get, as these plants age and a certain amount of degradation takes place, we need to go at it from all sides, not just from analysis point of view, but also from what are the underlying assumptions in the database and so on.

I think it's going to take us a while, to this risk-informed regulation, where we really change the fundamental fabric, it's going to take a long time.

DR. APOSTOLAKIS: Yes. And I hate to be on Farouk's bad side, but it seems to me that just as there are PRA guys who are willing to use simplified models, simplistic models to do their calculations, I think there is a bigger problem with the mechanistic guys who refuse to put uncertainties on their models.

MR. ELTAWILA: I agree with you 100 percent.

DR. APOSTOLAKIS: The problem is worse there.

MR. ELTAWILA: I agree. But let me just go -- I'm sorry, I know I've taken longer time, but let's debate this issue a little bit longer.

Look at how some decisions at NRC are made. When somebody proposes something, I can't think about something right now, the first question that comes to you, but NUREG-1150 did not show that as a risk significant issue.

Let's look at -- now, we start extrapolating NUREG-1150 to every plant. We start using NUREG-1150 as a gospel, knowing that it was based on expert elicitation. It was not based on specific analysis, and we tend to make decisions based either on the IPE or based on the NUREG-1150 results.

So the PRA has to help promote the work by trying to identify some of the limitations in their approach to it.

MR. THADANI: I think George was saying -- I don't think you would disagree. I have met many, many people who are actually entrenched in only deterministic thinking and, by God, I do a calculation with this code and that result is correct and you're trying to hide beyond numbers and so on.

I think you're right, there are a lots of people like that. What we must do, and I think this is what Farouk is trying to say, is as we move in the environment that we're moving towards, that we do it in a very sound and thoughtful way.

And I agree with him. I have seen also many PRA analysts, and I've had some heated discussions with them, about the kind of simplified thinking that they go through to make some potentially significant safety decisions.

And it's dangerous. I think that's where I believe Farouk is coming from.

DR. APOSTOLAKIS: And, in fact, it is hurting the whole field, in particular, digital I&C, I guess, when they were writing the report from the National Academy, some of the members of the committee who come from the computer science community found a few examples of cases where people assigned ten-to-the-minus-four probability to this piece of software failing. Ever since, wherever they go, they say PSA is garbage, look what they do.

So that's what we do. All the PRA guys were assigning ten-to-the-minus-four to software. But it can hurt a lot, in other words.

MR. ELTAWILA: That's the point, really. I think that the two approaches will compliment each other better and would be -- will make a better decision this way.

DR. APOSTOLAKIS: You don't need to convince me.

MR. ELTAWILA: Okay. Last bullet on this is I really think we should be open-minded and even consider the retention of multi-reactor material, might include somebody that will propose a core-capture something like that.

I know it's a bad word here at NRC, but there has been work done in Europe dealing with this issue. They are spending a lot of resources. Somebody might come with a design.

So we should not really, because it's core-capture technology, we dismiss it, we are not interested. I think we should stay abreast with these kinds of designs and philosophies.

DR. SEALE: The day after Halloween.

MR. ELTAWILA: The day after Halloween.

CHAIRMAN POWERS: An executive from one of the nuclear steam supply companies talked to me about -- the subject of core captures came up and he said, no, he was not opposed to them. He said I don't think they'll do any good, but, boy, what an advertising token that would be.

So you're right. They may actually think of it. They may not think of it as particularly enhancing safety, but it might enhance public confidence.

MR. ELTAWILA: Public confidence issue, that's true.

CHAIRMAN POWERS: One of the issues we're going to have to address in the research report, is you have some studies going on with retention of molten material in the vessel and vessel head failure.

That was an issue that had some currency when we were doing the AP-600 review, because they at least came in with the idea that they were going to draw their safety line there rather than ex-vessel.

They quickly abandoned that when they got some substantial resistance.

What's the research -- I mean, why do it now? What is the carry-on there for us?

MR. ELTAWILA: I don't think that the -- when the AP-600 came, I don't think we had all the information that we had from the RESPLF program, and although the RESPLF identifies certain areas that we still need to do more work on, the intermetallic phases and things like that, it indicates for lower power reactor, like the AP-600, you might be able to cool the core from the outside, because the issue that caused the separation is the carbon which does not exist in AP-600. But having said that, but we did not look at other material, control rod.

There is carbon if you use P4C, for example. So we cannot dismiss that completely offhand. It depends. You have to look at the whole design and what is the constituents of the melt that would be interactive with the --

CHAIRMAN POWERS: That's what I'm asking you, do you think anybody else is going to come in and try to draw a line at the vessel head?

MR. ELTAWILA: There is no doubt that most probably all the advanced designs, that they won't save on containment issue, that they are going to say that they will retain the molten material in the vessel.

MR. THADANI: If you sort of think ahead, based on what we're hearing, that the need to cut capital costs for new construction, the numbers that have been floating around are somewhere in the range of 30 to 35 percent reduction in capital costs.

Probably that means one has to start paying attention to large structures, civil structures, and so on and the concrete --

CHAIRMAN POWERS: Concrete's damn cheap.

DR. SEALE: That's right.

MR. THADANI: Pre-stressed concrete containments are not that cheap.

CHAIRMAN POWERS: They are still damn cheap. They are cheap. What costs you money is complexity and in containments, what costs you money are penetrations.

MR. THADANI: Penetrations are expensive.

CHAIRMAN POWERS: Concrete doesn't cost you anything.

MR. THADANI: It seems to me that they're going to have to start looking at major cost areas, capital cost I'm talking about, and then that may well influence them to pursue certain types of approaches, and I tend to agree with Farouk that I think there will at least be some pressure to try and make sure we understand in-vessel retention.

DR. KRESS: The trouble with in-vessel retention is I don't think it buys you very much. By the time you get there, you've released a good fraction of all your volatiles anyway and a molten pool doesn't release very much anyway, unless you've got sparging gases going through it.

So let it fall on the right kind of concrete with the spreading and cooling down there, it's probably superior than to sit there and hold it inside the vessel, in terms of risk.

I'd never propose that if I was --

MR. THADANI: Don't misunderstand me. I would think that dual approaches will be considered. It's very clear to me, and Farouk can tell you, that under the severe accident research program, the top priority issue was the coolability issue. It's the most important issue that still needs attention.

DR. KRESS: And I think it certainly does.

MR. KING: I think the long-term cleanup after the accident. If you can keep it in the vessel, you're in much better shape.

DR. KRESS: That may be well worth it. If that's your objective, then I may change my mind.

MR. KING: Otherwise, you're going to end up with a sarcophagus like Chernobyl has got.

DR. KRESS: But still I wouldn't give much risk reduction potential to it. In fact, I would invoke defense-in-depth and say I need a .1 containment anyway, probably, because the uncertainties -- there's huge uncertainties in that retention mechanism.

MR. THADANI: The next slide --

DR. SEALE: Moving right along.

MR. THADANI: Farouk, a comment. You have 13 more charts before we get to Tom.

MR. ELTAWILA: No, no. Okay. I am going to go very fast here. One of the reasons --

MR. MAYFIELD: Just as you get to the good stuff.

MR. ELTAWILA: The good stuff, yes. There will be some challenging in the material issue that we were just talking about here, that there would be maybe a requirement for consideration of material that can withstand the severe accident temperature.

Some of the equipment or material that will be used have to be able to withstand the harsh environment conditions for the severe accident. There might be interest, and I think Mike alluded to it, that look for material that has the potential of reducing the aging degradation, corrosion and embrittlement effects.

There might be a tendency to use a material that is commonly used by other industries, but does not have nuclear record. All these are new challenges in the material area that we need to be prepared to address, and I don't know if Mike wants to add something.

CHAIRMAN POWERS: No, no, let's -- because he'll turn to humans again.

MR. ELTAWILA: I think one of the important issues that we'll be dealing with is the instrumentation and the control, and the bottom line that I think we have to keep our pulse on what's happening in the industry, this area is moving so rapidly that trying to predict how a control room is going to look 10-20 years from now is going to be very difficult.

But there would be a tendency for -- in the new design, to have more instrumentation, non-intrusive kinds of instrumentation, maybe wireless, smart sensor and things like that that can perform diagnostic as the plant is running, so they can minimize the maintenance outage and so on.

So these are some of the thoughts that will be happening in the future, and we need to keep an eye on them, that we don't have any specific program right now.

CHAIRMAN POWERS: This has always been part of the I&C program that I've never understood, the research program. There's always this component that says keep an eye on what's going on within that highly dynamic area. Just because somebody might use it.

And I've always questioned that, because I said by the time somebody makes a decision that I'm going to use radar-based transmission of signals through wave guides or something really different makes a decision to do that, designs a system, starts talking about it.

Isn't there adequate time in there for the NRC to spin itself up?

MR. MAYFIELD: That's been exactly the problem, Dana. The technology and its implementation, the pace at which it goes from concept of people talking about it to hardware that people are wanting to use in an application, that time window is narrowing every day.

I was in the Air Force in '67 and at that point, we were dealing with radar systems that were vacuum tube technology. In the few years I was in the service, they had gone from vacuum tube technology with a few transistors thrown in just for good measure to replacing whole chassis with large-scale integration.

Today, those same radar systems that took up two 40-foot trailers now will on this desktop. But the time for implementing these changes is narrowing every day and we need the ability to move quickly to have the review guidance, so that when a licensee shows up with the next great idea, they're not held up waiting on us to decide what the review guidance should be.

So that's the part where we need to be looking ahead and we're not trying to get out on the real cutting edge, because that's not the technology that's probably going to show up in the nuclear plants. This is more at the applied technology and to make sure we know what kind of things are out there, so that we can help our colleagues in

NRR understand what the review issues are and make sure we have the technical basis to support their reviews.

CHAIRMAN POWERS: Some of my difficulty is this, that yesterday I sat in on a discussion of the Seimens and the Westinghouse digital, electronic control systems. There was nothing in there that I hadn't known about for five years.

Five years ago, I knew that they were going to start putting these into -- that's a long time. It's not the digital folks that live in Silicon Valley and up in Massachusetts and I guess even around here. I mean, they're dealing with things that I don't know anything about.

But by the time the nuclear industry gets around to saying, hey, this is a good idea and actually creates an implementation for it, there's a big lead time there.

MR. MAYFIELD: There is a big lead time on things like full reactor protection systems. There is not so much lead time on smart sensor, smart devices embedded in other things, auto transformers, relays, the software reuse issues.

So rather than the whole reactor protection system -- and I agree, there's a time window that will always be there, but the problem is the individual sensors that are being embedded in other things.

Some of the examples, we had motor control centers, the auto-step transformers, and so on. Those things are showing up more and more and we think with time, particularly by the time you go to the new, the next generation of reactors, it's going to be widespread.

CHAIRMAN POWERS: That's where I was making the mistake. But now let me ask this question. The fellow gets up and he's describing one of the systems, I think it was the Westinghouse system, and he says, okay, here are all the NRC requirements that we complied with and there were lots of them and he came down and there's an IPEEE standard on MI/RFI things, and I think it was Jack said, well, how about smoke. And he said, no, we didn't do anything with smoke, there's no regulatory requirements about smoke.

And Research had done experiments and whatnot. I mean, what's happening? Why aren't research results going over and showing up somewhere in the requirements?

MR. MAYFIELD: That is another aspect of the work that we've been taking on with NRR, and it's very much a joint activity.

If I had Jack Strosnider sitting here at the table, he would be saying the same kinds of things. Are we there yet? No. Those kinds of issues, smoke is one where, yes, we'd like to get that incorporated, we've got requests from NRR to help them develop and update the review guidance to pick up exactly those kinds of issues.

One of the other ones is whether the EMI/RFI guidelines are appropriate and what needs to be done there.

So there is -- and that's really what underlies what we're trying to do with the research program, at least big pieces of the research program, is to make sure we're providing the technical basis for the review guidance so that they're picking these things up more rapidly and picking them up on a pace consistent with the implementation pace.

So there are some disconnects today, absolutely, and I think Jack Strosnider and his guys would agree wholeheartedly. There are some disconnects. We're trying to get them fixed as we go along, but at the same time, this also is evolutionary. We're not going to do it overnight.

MR. THADANI: Since this discussion is five to ten years what we might be faced with, I think it was last October, I was -- John Taylor gave a talk, I believe it had to do with digital technology and information technology, saying, nuclear industry, get on with it, join the bandwagon, get on with it.

Do we have, A, the capability ourselves and the environment that would be conducive to the industry more aggressively moving in that direction? I expect, in spite of the slowness that you described, which is true, and, as Mike said, when you get to engineered safety features, actuation systems, and protection systems, it's slow.

But I'm fairly sure that in five to ten years, and as more and more plants go for license extension, I believe you're going to see radically different control rooms. I believe that. I think you're going to see big changes. People are going to push and go to these more multi-train safety systems. I just think it's going to move faster with time, the change.

CHAIRMAN POWERS: We're still going to rely on qualitative risk assessments for these new systems.

MR. THADANI: Well, I'll tell you, when it comes to software reliability for these protection systems and SFAS, I agree. The process -- I don't know that we can actually come up and say it's ten-to-the-minus-X minus four. The kind of testing and so on that that would entail is tremendous.

On the other hand, for many of the other systems, in my mind, that includes certainly feedwater control system, sequencers for diesels, and other areas, it seems to me that we have an obligation to pay very close attention to, A, from the design, try to get best understanding of what the reliability might be, but also to collect data and to analyze data and understand so that in terms of risk analysis, I believe, in some cases, we ought to be able to make quantitative assessments.

But when it gets to areas such as protection system, I think we're going to be limited by the difficulty of trying to quantify errors in software. It's not a random process, to begin with. So I don't really know how -- one has to characterize it appropriately. But qualitative in some areas may not be so bad, until we get better understanding.

DR. APOSTOLAKIS: This is an issue of design error. We don't do that in hardware either.

MR. THADANI: That's right.

DR. APOSTOLAKIS: We don't handle it.

MR. THADANI: I don't know how to do that.

DR. APOSTOLAKIS: It's the same thing.

MR. THADANI: That's right.

MR. MAYFIELD: The one encouraging thing, at least in the software testing, is there are a lot of other industries that have had safety critical applications that have very similar interests and there's a lot of coordinated activity ongoing and looking at that issue.

The one point, and I know I'm going to regret having brought this up, but I'm going to do it anyhow, in the water reactor meeting, when we were talking about the digital I&C area and where are the weak spots, things that need more work, the human interaction with the new digital systems and equipment was an area that was identified repeatedly and how that goes into the PRAs once we figure out how to do a quantitative PRA.

So that was an area that the people from the industry that were in the meeting identified as a weakness. There was a fellow that was a licensing examiner for the nucs that was in there, he identified it as a weak spot, the human interaction with the digital equipment.

The operators tend to see it as a black box, without a lot of appreciation for what it does and how it goes about doing it, and the other things that it could end up doing to them.

So there was a lot of interest in how the human is going to interact with this new technology and how you go about getting them trained and making -- what level of understanding do they need to have and how that goes into the risk assessments.

CHAIRMAN POWERS: We went up and investigated an incident that was held at one of the DOE reactors. They had had a transient over-power situation and the operator had just sat there while the reactor went over its power limits by quite a bit.

I was over there because they had installed a digital I&C system in parallel with the analog system, because they were going slow on this process, and the operator was so distracted, paging through things, that he didn't notice that it was on a power up ramp that went up and went to like 500 times power or something like that, till it alarmed out and scrammed itself.

So the operator interaction with these things can be unusual.

MR. MAYFIELD: I think it also goes -- there is an element at the designer stage and the engineering stage where as you're transitioning folks from analog technology to digital technology, there are some things along that line that can get lost in the translation.

So it's a good thing, but it has some caveats that need to go along with it.

MR. ELTAWILA: I think that was a good lead for the next issue, human factors, and I --

CHAIRMAN POWERS: Before we go there, could we come back to the materials that we skipped over a little bit?

MR. ELTAWILA: Okay.

CHAIRMAN POWERS: This is an issue that I think we need to discuss just a little bit.

A guy comes in and says I want to use a new material anywhere, something that fatigues a lot. I want to use a new material someplace in the reactor to get rid of a particular problem.

What does the NRC say to this fellow, come back and give me all your -- give me fatigue data over the lifetime of this or does NRC say, no, I've got to go initiate a research program and I get the fatigue data on this?

It says here new reactor designs may rely on materials that have industrial experience, but no nuclear experience. I guess my reaction to that is, yes, okay, if you guys want to use those materials, go get the experience from them.

MR. MAYFIELD: There was a specific example that -- actually, there were several, but one in particular that caught my attention was some interest from some of the industrial folks to use HY-80 for the next reactor pressure vessel, if there ever is one.

That's a very interesting material, it's been great for submarines, but I'm not sure how it would perform under light water reactor conditions, the radiation environment and so on.

So who would bear the responsibility? At least in my opinion, I think it's consistent with what the agency has been saying for some time, is the person that wants to use it bears the responsibility for providing the data. We would almost certainly do confirmatory testing along the way to make sure that we believed what showed up, but the basic database would be the responsibility of the folks wanting to use the material.

CHAIRMAN POWERS: I guess that's what I want to pursue just a little bit. Suppose it's HY-80 and he came in and he says, okay, I hired the good folks at Oak Ridge and they irradiated this thing for a long time and I got all this data, and it comes up and it has certain scatter and he maybe has ten data points along this whole curve, gets him up to ten-to-the-22nd kind of fluence numbers and whatnot.

Would the NRC feel an obligation to do a lot of confirmatory research on this or is the technology well enough developed for these things that you could look at his test protocols and say, yeah, you did a good job here or, no, go get some more?

MR. MAYFIELD: I think you'd almost have to see the specifics of it. It's always dangerous to climb into these hypotheticals, but I'll do it anyhow.

If they came in, they were using a capsule design that we knew, a test reactor design that we knew, and a test lab that we knew, where we have experience with them, and it wouldn't have to just be Oak Ridge, but your example was using Oak Ridge.

CHAIRMAN POWERS: Let's not do that. Let's go the other way. Let's take it the other way. I went off to Russia and actually I went off to Kazakhstan and I had those guys get these data and here they are.

MR. MAYFIELD: Now I think we'd want to see a lot more inter-lab comparability, so that we have some reason to -- some confidence that, in fact, those data are consistent with our understanding of the effects of test reactor radiation on the materials and, by inference, power reactor irradiation on materials.

I don't think we would go into it blindly and it doesn't just have to be new materials. When we start straying off and introducing new variables now that may stem from just laboratory variability, we want some confidence how it's going to go.

MR. THADANI: I'd say more than some confidence. It's got to be driven by what's the price you pay if you make a mistake, what's the potential consequence and if it's the reactor pressure vessel itself, then I think we have to have very high confidence that the material we rely on we understand the fundamental basis.

And if it came from Kazakhstan, I would think that would have to be factored in because of the potential consequences if we're wrong, and we have to have -- now, if the application were something else, where you have additional protection and so on, maybe you have to take a different tact.

So I agree with Mike. It's very difficult a priori layout ground rules that say if the information comes from a certain place, by God, we would have to do independent testing or whatever, but I think we would certainly want to push for new concepts if the consequences are significant, think hard about, as a regulatory agency, what is the expertise we have, what is the knowledge base we have, and sometimes that deep understanding comes from actually doing some work, not reviewing somebody else's work.

CHAIRMAN POWERS: That's really the issue I'm getting into here a little bit, because the question is when have we built up enough understanding of something that I don't need guys that are actually doing research in the field to review these things, because the knowledge is secure.

Another example. You've got a guy who comes in and says I don't want to inspect my welds because I've done this probabilistic fracture analysis of this thing and it's ten-to-the-minus-45th per year probability that this thing is going to break.

Is that something that you have to look at with experiments and independent analyses or are we in a position we could review that and either bless it or reject it?

MR. MAYFIELD: Right up until two, maybe three weeks ago now, I would have said we got that in hand. Then we had a crack in the Summer pipe that we don't quite understand. So I think today I would say I'm going to want to look at that real hard.

Now, it could be that we discover something out of Summer that perfectly explains this and it all makes perfect sense. The problem is something caused that crack to go through the wall and we weren't anticipating it, because all of our prior fracture analyses had postulated large cracks.

We weren't relying on the notion that they didn't initiate. We postulated large cracks and we couldn't identify a mechanism to cause them to grow through the wall.

Something caused that crack to grow through the wall. And that's the part we don't understand. So I got to tell you, I've lost some confidence and you're talking to somebody that did those calculations. So I've lost some confidence in my ability and my colleagues' ability to guess at all the damage mechanisms.

So just because I got a low probability number, I think we still need to ask some more questions, but I also think Ashok's characterization of it would depend on what happens if we're wrong, potential consequences.

So it's right now a bit mixed, I think.

CHAIRMAN POWERS: I'm just trying to understand. There is this question that we really have to address at some time. We're maintaining expertise in areas that we know we use and we need, but maybe we don't need them right today and are there limits to that sort of thing and where are they, and this is just one area I need to understand better about.

MR. MAYFIELD: I think that the Summer experience, we have given away most of our pipe fracture capability. We're on the verge of losing our last big facility for breaking pipes. Do I still need that? Well, probably not, because we've broken a lot of pipe over the last 15 years.

So I know pretty well how it breaks. What causes cracks to grow through? Well, yeah, we've got a handle on that. Now, coupling that bit of -- bits of information with what really goes on in a plant, actual fabrication histories, actual operating histories, that link we still need the people that can go from the research data to the in-plant experience and that's a piece of expertise that I'm going to fight right up to the bitter end that we don't lose that.

CHAIRMAN POWERS: Good.

MR. ELTAWILA: I think the issue of human factors, again, will -- as Mike indicated, with the new trends in the control room and use of smart sensors, there will be -- considering that in conjunction with the reduction in capital costs, there will be less operator running plant and there will be more reliance on automatic systems and things like that, and the interaction between these few operators and the complex system that they might be running several plans at the same time, that needs to be looked at.

There will be -- in the area of artificial intelligence and fuzzy logic, there are people who are talking about being able to try to predict the overall system behavior, from their point of view, and to try to come up with a way to be able to manage the plant and to try to identify, if the problem happened somewhere else, what will be the consequence.

So there will be use of these technologies and we are not really there right now.

DR. APOSTOLAKIS: Fuzzy logic. For Heaven's sakes. It took PRA to get into the regulations 25 years. I don't know. Networks, I think, has a promise, but fuzzy logic. And don't tell me the Japanese run their trains using fuzzy logic.

DR. SEALE: Well, they'll come up with a different name for it, so they won't be so -

DR. APOSTOLAKIS: It's a qualitative method, like anything else.

CHAIRMAN POWERS: Let me ask this question, Farouk. You mentioned the control room. I expect to have glaciers in New York before I see NRC changing the requirements of control room staffing.

But what I would see is there will be the out-of-control room staffing is going to take a quantum drop.

MR. ELTAWILA: That's correct.

CHAIRMAN POWERS: There I can -- and, in fact, when I go in and look at the numbers of people in the chemical part of the plant, chemical sampling and whatnot, typically 20-30 people in those organizations, I'm just stunned it would be that high nowadays. I would expect that number to -- I mean, that's one of the areas that, if I was a plant manager, I'd go how can I think that crop down.

Those are the areas that I would expect real major changes in the staffing, people outside the control room itself.

MR. ELTAWILA: I think it's both of them. Ashok and I were in Japan actually and visited the advanced ABWR, I forgot the name of the plant, and it was amazing that you walk for a long time and you don't see a human being.

So these are all -- I don't think the United States can stay behind that long. So you might see the glacier in New York City, but I think that it will change.

MR. KING: In future plants, they're going to run multi-module type plants from one control room with three people. They've already done it. Ten years ago, DOE, when they were working on the MHTGR, had that in front of us.

MR. ELTAWILA: They are doing it in Japan now.

MR. THADANI: Just for the record, it was Kashazaki Karina plant that we visited, and Farouk is right.

And I don't know about timing in terms of glaciers in New York. I think we're going to be faced with the issues. We're going to have to deal with it.

Now, whether we end up with disagreeing and saying, no, you need to have the same compliment of people in the control room and the same number of shifts and so on and so forth, I don't know how it will come out, but as the research organization, I think we have an obligation, if that's a reasonable future challenge, that we need to make sure technically we're developing the right information base.

CHAIRMAN POWERS: I think I can see this, that the research organization knows that 30 percent of the cost of running a plant is manpower. So after you have refined down your fuel costs and everything else, the manpower clearly is one of the areas to go look, that a clear responsibility of the research organization is to make sure that there is a strong technical basis for any resistance that the line organizations might want to throw up by reducing that manpower.

It seems to me that makes perfect sense, to me.

MR. ELTAWILA: It does. You want to say something?

MR. ROSENTHAL: Rosenthal, Research. I'm biting my tongue to some extent, but to some extent, I'm also proud of some of the work that we've been doing. Dana, you brought up the idea of management interface and how much time do you spend looking at the computer displays versus running the plant, and, in fact, we've been doing some work and some of that's indicated in the human performance program plan in that very area of interface allocation.

So that's an area that we anticipated. We did do some work in conjunction with Halden and are publishing a report -- right now it's at the printer -- on the size of the crews that you need and as you get more and more automated control rooms, you actually -- an optimal number will be somewhat less.

You can't have seven guys all crowded around the same CRT and then arguing on what it means. So that from a safety standpoint, some optimal number may be somewhat less than you have now.

But the point is that we're trying to anticipate that sort of thing.

And then we did do some work on deregulation and consolidation and I will tell you that you used to see $160 million on a dual-unit site for non-fuel L&M. The current number is about 120 million and the goal is about 100 million, and that's all fewer people on the site and that's a real issue.

Now, should we regulate it? Maybe not. Should we understand the ramifications? Yes. And so I'm glad that we are doing the kinds of things that you --

DR. APOSTOLAKIS: Would this argument apply to other things? Shall we regulate it, no, but should we understand it, yes?

CHAIRMAN POWERS: It applies to everything except for safety culture.

DR. APOSTOLAKIS: Okay. Jack wants to say something.

MR. SORENSEN: I'm interested in the fact that the human performance issues or human factors issues are all driven by something very specific, a change in design, a change in instrumentation, and no where in this program is there any mention of a general approach or general interest in improving human performance.

You've got some preliminary data from INEL, EEL, I guess it is now, that says the contribution, the human contribution to core damage frequency is in the range of ten to 50 percent in certain instances.

We are current spending about three percent of our research budget on human factors related issues. That doesn't seem like the right balance to me.

It would seem to me that we have to give some consideration to the interaction between the regulatory process and improving human performance and I see that nowhere here.

MR. THADANI: I think your observation is valid in terms of contribution certainly to core damage frequency in the range of ten to 50 percent and research budget being three percent.

It doesn't mean it needs to be 50 percent, but three percent does seem a bit low, if it's about ten to 50 percent contribution to core damage.

This is an area where various experienced people have different views. We have had significant cuts over the last few years in human factors research and we have some constraints imposed by the Commission that we must live by and we also -- and let me just say, just speak for myself, and I think generally I speak for the office, I think there is a concern that our attention to human issues perhaps ought to be greater than it is in the context of when you think of potential impact on safety.

But there are lots of different views. Some people think that we can really -- we probably couldn't influence that risk or core damage frequency contribution very much by what we do, but it's largely what the utilities have to do.

So there are some differences of views there as to how much influence or impact we can have in that area.

DR. APOSTOLAKIS: But, Ashok, a lot of the stuff that's on this viewgraph are the utilities' responsibility really.

MR. THADANI: Yes. Yes. Yes.

DR. APOSTOLAKIS: So if you're improving human-systems interface, for example, really there is what we're trying to understand.

MR. THADANI: Yes.

DR. APOSTOLAKIS: Would someone tell me what the human factor issue is, what the human factor is? What is human factors?

MR. KING: It's a general term that covers a lot of things. It's human performance, what things drive human performance, either good or bad.

DR. SEALE: And what things are driven by human performance.

CHAIRMAN POWERS: I guess the question that would come up, to me, is what is the Fussel-Vessely or RAW for a human being in the plant.

MR. KING: If you assume he always makes the wrong decision?

CHAIRMAN POWERS: Yeah.

DR. APOSTOLAKIS: No, no.

CHAIRMAN POWERS: The way you have to do it is does he always fail to take the actions that are caused -- that are in the event tree that you've set out and that would give you something about his risk achievement worth and if he is all -- that would be the risk reduction.

Then what happens if he is 100 percent reliable, I mean, he's the greatest operator in the world, do we have those numbers for the operators?

DR. APOSTOLAKIS: They should be part of the --

MR. KING: I don't recall ever seeing them.

MR. ROSENTHAL: Yes, we've done them and we did present that information to you and we took it out of both classical PRAs and we've also done that work based on the operating experience in the ASP and written reports on it, presented it.

And the numbers are -- risk achievement worths can be quite large for people. And then we've -- and then you'll see it again on such an issue like ATWS, where you ask the operators to reduce the core water level in a perhaps oscillating situation.

The IPEs have a range of success likelihood -- well, failure of between .5 and ten-to-the-minus-umpthasquat, depending on whose IPE. It's a major source of uncertainty and knowing whether we've been successful in implementing -- in achieving the desired outcome from the ATWS rule.

So yes, we've done that more than once.

MR. THADANI: There is another part, Jack, that at least I've been interested in getting some information on, and hopefully we will, and that has to do with taking the sequences rather than ten to 50 percent in the end, take sequences and do just what you said.

Let's use RAW for humans, for the sake of argument, and see what the results come out. So now you're only looking at hardware failures not induced by operators and so on.

And let's see now which systems and components turn out to be more significant. There are several sequences where 97 percent of the reliance may well be on the performance of the human and we need to make sure we understand what those are and how well those elements are, in fact, addressed, through looking at database, and so on, failures.

We have -- Jack, you may correct me -- it's an area that we have been wanting to get some information pulled together. I don't think we have it yet, or do we? Because that's another component that needs to be looked at, I think.

CHAIRMAN POWERS: It seems to me -- I would love to see what Jack's information is. He says he's presented it to us, but I just don't remember it, Jack.

MR. ROSENTHAL: I'm basing it on the INEL work and the work that we did in support of the human performance program plan, SECY-00-53, but it's not the SECY, but the documents. But fair, enough, we'll drag this --

MR. SORENSEN: That's what I was quoting from.

CHAIRMAN POWERS: I think then you look at those numbers and you say, now, is that what I want it to be, I mean, is that good enough for me, and if it's not, then you ask the question of what should I do about it.

I mean, you can't very well tell the licensees to get better operators.

MR. THADANI: You made your call. Tom has defined some key attributes of defense-in-depth in the paper that Joe referred to earlier.

One element in that was -- I forget the words, but some sort of excessive reliance on programmatic aspects. It's exactly the same point; is there excessive reliance on humans in terms of their actions.

I think that's a very good question. I'm not sure that we really have a good answer.

CHAIRMAN POWERS: If we can take that logic, beginning with what do they achieve and what do we want then, is it excessive, or there may be the situation that was mentioned over here, it's basically okay, except there are these three or four sequences where, now, your operators are nothing and then you formulate your human factors research following that kind of logic. Then I think it becomes much more palatable to the people that are basically very suspicious of human factors research.

DR. APOSTOLAKIS: No, I think there is a problem with that approach. You cannot rely on Fussel-Vessely and RAW when it comes to humans. The reason is what Farouk said. You don't have a good mechanistic model, you don't know the dependencies yet. So by finding the RAW of an individual action, I'm not learning very much because there may be a latent condition that affects 16 actions and that is not in the PRA. Therefore, you will never be able to find its Fussel-Vessely and RAW, because it's not there.

CHAIRMAN POWERS: Then put those things into the model. It's the same thing that your Stan Kaplan says. If you're trying to make a decision and you have a quantity of information, quantify it.

DR. APOSTOLAKIS: But the problem is that -- well, that's not the problem. I think a good first step was this INEL work, which looked for latent conditions, and so I would do that first and try to identify possible dependencies through latent conditions and then find the RAW and Fussel-Vessely of the latent condition, which seems to me would be a good place here to say ATHENA a few times, to talk about contexts several times.

That's exactly what these guys are supposed to do and the other thing is when I read in Nuclear News that Duke improved its operations tremendously by doing a number of things, I want to know what these things are.

Now, these things are not these. Then Duke did other things, which, for some reason, this agency doesn't care about; namely, organizational issues. That's what they did. I'm sorry. You go and read it. They organized themselves better and in that new context, their people function better.

So you might say, again, ATHENA, the context is important. But for some reason, we worry about man-machine interface, we worry about whatever, but we don't worry about the processes that are going on, the management issues.

Now, Ashok mentioned that we have to live by what the Commission says. But have we made a good case to the Commission that human performance depends a lot on these things and you don't really have to go out to management and find out what the vice president knows, but that's what the industry is telling us.

I mean, there are cases after case after case where the changes have not been in improving the man-machine interface, they have been in doing other things.

MR. THADANI: George, I think we could have probably made a better case than we did. However, nevertheless, the Commission really gave us not only general direction, but rather firm direction and it was effective immediately direction.

I am willing, and I think you know me enough that sometimes I'm foolish and keep pushing in areas when I should say I learned my lesson. But let me tell you the other thing the Commission has also told us is that when the Commission has made a decision, it don't try to come back periodically arguing with that position.

Now, maybe this is the right time for us to rethink that issue.

DR. APOSTOLAKIS: Yes.

MR. THADANI: But I do want to make sure and let you know both pieces. First, the Commission made a firm decision. Second, the Commission also has sensitized us in the past that we went back and we were not really listening to the direction that we were being given.

Now, here is an area, enough time has gone by and maybe we need to take a hard look.

DR. APOSTOLAKIS: But at the same time, Commissioner Merrifield read James Reason's book, got excited by it, and urged everybody to be vigilant not to have latent conditions.

Maybe I think it has to do with -- it has to do with the terminology.

MR. THADANI: I agree.

DR. APOSTOLAKIS: If you say management, you're dead before you even go there.

MR. THADANI: Yes.

DR. APOSTOLAKIS: But if you approach it from the latent condition point of view and try to see what factors contribute to that, then I think you have -- in other words, you are limiting yourself to the technical aspects. The Commissioner got excited, so there must be something to it.

MR. THADANI: We had an opportunity to do a little better job than I think we had done initially, and you're exactly right. We tripped over ourselves by improper and incorrect terminology, actually.

We did talk about competence, we did talk about management, when, in fact, that isn't really what we were planning to work on.

But even though we explained that what the program was to look at was at lower level information than that, I think the minds were made up. It was very difficult to change.

DR. APOSTOLAKIS: But let's look at it from a purely technical perspective. I mean, it's fruitless to ignore by fiat what may be a very significant contributor to latent errors and look at other things because we're allowed to.

MR. THADANI: Let me take that message back from you and we will --

DR. APOSTOLAKIS: Back where?

MR. THADANI: Back to the 10th floor and then we will see how we are going to --

CHAIRMAN POWERS: I understand that the Commission's advisory committee has one of the freedoms of advising and we have the freedom of advising them on things we think they ought to hear, whether they want to hear it or not.

DR. APOSTOLAKIS: Yes.

CHAIRMAN POWERS: Sometimes the Chairman gets to hear things that he would just as soon not have to hear about that advice, but I don't think the committee feels itself constrained on that.

I want to take about a 15-minute break at this point.

[Recess.]

CHAIRMAN POWERS: We'll come back into session here. I'm just doing planning exercise right now. And, of course, it's never the problem of Farouk being slow.

DR. KRESS: It's us.

CHAIRMAN POWERS: But all that does is reflect how much interest there is on these subjects. So let's do come back into session. Dr. Kress, you wished to make a floor statement on --

DR. KRESS: Human factors, and this is partly just to see what kind of reaction I get from George.

I have been known to have defense-in-depth as one of my hobby horses and when I invoke defense-in-depth in my thinking is when we have things that are not well calculated or not even included very well in PRAs, and what parts are included have very large uncertainties in them.

It seems to me like it perfectly characterizes the human factors we're talking about and the question of how much is over-reliance on human actions is going to be a tough one to decide, because that ought to depend on those particular things.

And it seems to me like the scenario where you ought to get the human factor contribution to risk so low that it hardly matters anymore, because it's a huge uncertainty in it. You ought to be able to either get the risk level low enough that the large uncertainty doesn't matter or get him out of the equation somehow. I just wanted to see how that -- what the reaction to that is.

CHAIRMAN POWERS: It certainly resonates with me as a possible strategy; that is, what we were talking about earlier, you go in and you do the Fussel-Vessely evaluation and whatnot and you get the number and you come away saying, well, it's important, maybe not in the integral, but in at least isolated instances.

And one of your strategies for addressing that would be to get that down to the point that it's no longer recording numbers that are bothersome to you.

DR. APOSTOLAKIS: I think the new designs are trying to do that. The pebble bed reactor is advertised as one where you can just walk away. The advanced reactors, if you remember, one of the requirements in the utility requirements document was that for a number of hours, there should be no need for operator action after the initiating event.

So yes, but for the current generation reactors, let me give you an example. In the small LOCA sequence, at some point, you have to worry about bleed-and-feed, which is now a decision left up to the crew.

Would you automate that?

DR. KRESS: I wouldn't automate that particular one.

DR. APOSTOLAKIS: That's the thing, that you have certain situations with a current design where you really are reluctant to take the human out of the equation. On the other hand, there may be other things you might be able to do, which I can't think of right now. But these are the kinds of issues that -- it's clear that the industry is sensitive to it. So even with that document, it is the requirements document -- is that the name?

MR. THADANI: Yes.

DR. APOSTOLAKIS: Which was issued a number of years back.

MR. THADANI: '88, I think.

DR. APOSTOLAKIS: Yes. They had that as a requirement.

MR. THADANI: Yes. That's correct. But I might note, even on that issue, the AP-600, in that design, you, for many cases, you do go open up, depressurize, open up stage four, so you could have long-term cooling.

DR. APOSTOLAKIS: And let's not forget that the PRA does not have in it the good things that the operators have done and if you take them out completely, are they going to still act in such an intelligent way as they did in Brown's Ferry or in other places if they are told that they are not needed.

So there is the downside of it, too, that they have acted very, very intelligently in certain situations.

MR. KING: But the PRAs take credit for operator actions.

DR. APOSTOLAKIS: That are expected of them.

MR. KING: That are expected.

DR. APOSTOLAKIS: Not initiatives.

MR. KING: But not things they make up, innovative things.

DR. APOSTOLAKIS: And that's what I'm referring to.

MR. KING: That's true.

DR. APOSTOLAKIS: As I recall, using the control rod drive pumps to cool the reactor in Brown's Ferry was not part of the procedures and so on.

So this kind of thing you're not going to see in the PRA.

DR. SEALE: And those generally got you out of -- if you'll pardon the expression -- hot water before you got to to the point to where you had to have your emergency full capability and all. Dissuading these guys is a risky business.

DR. APOSTOLAKIS: But, you know, this business of extending the time where no action is required, I think it's an excellent example of a solution where you're looking at the models that people have developed for human performance and they are all over the map.

I mean, you have ATHENA, you have the human reliability model, you have all sorts of things that take different factors into account. But an engineering solution was to look at -- they didn't do it that way, but that's what happened -- to look at what are the common factors that all these models consider as important, and one is, of course, the time.

So they say let's try to engineer it in such a way that you have much longer time. Then all these models will show some improvement, even though they will be all over the place again, but the whole thing will move. And I thought that was a very good solution.

Maybe that's defense-in-depth.

DR. KRESS: That is.

MR. THADANI: I think allowing time for understanding and taking action is very -- certainly a very important factor. There is, I believe, a design, I think on some VVR-1000 design, that there is actually a restriction on operators intervening in the first 30 minutes and they have to go out of the control room to disable certain interlocks, to be able to take actions when parameters exceed some criteria.

My own reaction was, my God, you know, operators can do wonderfully good things, you're tying their hands up, is that the right thing to do.

DR. SEALE: That's right. Isn't there a wonderfully appropriate story about the sailor who saved his ship, but had to be hung because he did something that was against regulations to do it?

DR. APOSTOLAKIS: Is that a movie or what?

DR. SEALE: No, I think it's a classic story.

MR. THADANI: Farouk.

MR. ELTAWILA: I will take a few minutes to address the test facilities, because that's important topics to the office, and Ashok personally has a strong interest in that.

I gave you a colored copy because there is a scheme here. The blue color mean that the facility are operational and there is a program to support them right now.

MR. THADANI: He didn't give me a color copy.

MR. ELTAWILA: So I have to keep looking back here. And the red one is that the facility is shut down and the orange one, which does not look orange on the screen here, is the facility in eminent threat of being shut down.

So the need for experimental facilities bound. There are a lot of issues, from the issue of electrosleeve and the test that we ran at Argonne, Bill Shack can tell you about that, help us make decisions.

People can argue all the time about is it going to fail or not to fail, but the only way is to do the experiment.

The use of new fuel, all these are the limitation in our codes. Some of these questions are in page 31, but I'm not going to go over this, but I am going to give you the status of each facility.

In the fuel cladding area, I grouped them based on the different barrier that NRC tried to protect or the industry has tried to protect. In the fuel cladding area, in the LOCA, we have a very good program, and in the international community, there are program in France, Japan, Russia, and the Halden.

What's the problem here, and I have to -- is that we are dependent on the industry. If they don't give us the fuel, we cannot try and test the program. So we have to keep that in mind in order to -- and it was a struggle getting the fuel from the industry and we still have a problem, we have not received the fuel.

In the area of, also, cladding, the reactivity insertion accident there, we used to have two facilities, the TREAT and PBF. I missed the PBF in here. Both of them are shut down.

We are relying on data from Cabri in France and SRR in Japan and IGR in Russia. There are efforts underway to try to restart the TREAT reactor. I think that will be -- I will give you the pros and cons of it, and I hope you don't -- the pros, I think we need the facility in this country to test the reactivity insertion accident, particularly if Tom King come up with a different kind of scenario from the scenario that we are testing right now in Europe.

The use of MOX fuel, we will not be able to ship MOX fuel to Europe to be able to test it. The use of advanced cladding material, it would be proprietary. There is no way we can send proprietary cladding or the vendor will not allow us to do that, to send the cladding overseas to be tested.

All these are reasons why -- BWR oscillations. All these are reasons why we should have a test facility in this country. I think what we need your help in, it will be if we start a program like the three-track, you have some costs at the beginning, very expensive.

So if the trends to sink all these money initially and you come later on and you cancel the program, it will be wasted money. It has to be a long-term commitment to maintain that facility. Otherwise, don't go there.

In the area of thermal hydraulic, I think we have the APEX facility. The Puma, I'm struggling year after year to try to justify its existence.

DR. APOSTOLAKIS: Farouk, will you tell us what the code is with the colors?

DR. KRESS: He told us.

CHAIRMAN POWERS: He told us?

MR. THADANI: Yes.

DR. APOSTOLAKIS: I guess I wasn't paying attention.

MR. THADANI: You're on Farouk's bad side now.

DR. APOSTOLAKIS: Because I was trying to absorb the comments.

MR. ELTAWILA: The APEX facility, we have immediate use for it. One of the things that we were discussing with the Chairman yesterday, for example, and I think Graham Wallis made the briefing to the Commission, that there are a lot of tendency for people to use the code outside their assessment base, and we've seen it here at NRC.

We are working on the PTS with Mike Mayfield and Tom King and we need to do thermal hydraulic analysis. We never assess the codes for these scenarios. We're lucky to have the facility right now to be able to run these scenarios, get the data, assess the codes, so when we do analysis, we will have some confidence in the analysis.

DR. SEALE: How well does APEX scale to existing PWRs?

MR. ELTAWILA: As it happens, it scales very well to the Palisades plant and we are trying for -- because that's one of the plants that has an immediate concern with the PTS.

The ROSA facility is about the only other international facility that's currently operating and PKL, if international support is not available, it will be shutting down, although I hear that the Japanese might consider -- they are questioning their support for the ROSA facility.

In the area of fuel degradation, I think thermal hydraulics address the up to the time of you get to phase boiling in the core and things like that and the core uncovery, but does not extend beyond that because of limitation on the heater rods.

The only facility in the world that addresses what will happen if you flood a degraded core is the quench facility in Germany and that facility is going to be shut down.

Again, in the area of fuel degradation, fission product release, we used to have the hot cell at Oak Ridge and HI and we are a test program that provided most of the information that is in use internationally right now and we are going to have this information. We are getting information from Phebus and the VEGA and VERCORS facilities.

Again, we have a need to look at some of the issues that you raised yourself in terms of the situation when you have a core melt in the air environment and the effect of that on ruthenium release and different fission products.

Again, if we have to start the Oak Ridge facility, again, we should have, because there will be an initial cost associated with that, we have to have a viable program so we can attract the right researcher to do the work, not just to have funds to start the facility and next year somebody will cut it immediately and we will waste our money this way.

There is the issue of the steam generator tube failure is a very important issue and we've seen what happened at Indian Point. For that minor tube leak, I think the whole world was up in arms about it. And we don't have any facility to look at the fission product or aerosol deposition in the steam generator tube, and we are relying on the ARTIEST program to get some information in this regard.

This, we're going to have to have that capability, but I'm just showing that there are international facilities that we are relying on and we don't have to have a facility in each area. Correct me if you disagree with me.

Again, for the thermal loading and corrosion, I think the facility at ANL came very handy. If we did not have that facility either, NRC would have made a wrong decision and approved the electrosleeve, or we could have continued to debate the issue indefinitely about is it really -- would it withstand the severe accident condition or not.

For the reactor pressure vessel and internal material, irradiation and the environmental excessive cracking, the work -- let me look at the color.

The Oak Ridge facility, I think it's supported. Do you want to add anything, Mike, about it?

MR. MAYFIELD: Well, the Oak Ridge hot cells are supported by about a third each us, basic energy sciences, and the fusion program. If any one of the three programs loses funding, the hot cells will likely be shut down.

So we're very much contingent on those other two programs and without those, the only other cells we've got to do that kind of fracture testing would take us to Argonne, which not necessarily be a bad thing, but they don't have the size facilities that we already have up and running and have had for a good many years.

DR. SHACK: What is FNR?

MR. MAYFIELD: Foreign nuclear reactor. It's the test reactor at University of Michigan.

MR. THADANI: Let me go back to the previous issue that Farouk was talking about, just to let you know another challenge, and Farouk and Mike are working on it, is going to be the steam generator tube issues are going to be with us for some time to come.

Effects of degradation on the performance of the tube material under severe accident conditions. What we have not done is to really do a pretty good assessment of the whole reactor coolant pressure boundary. There are different materials, surge line, pump seals, and I could go on, to see there is going to be a race, so to speak, as to what is the first part that fails.

We have done some analyses and so on, but what we don't have are some data that would help us better assess the whole pressure boundary, and it could be that our assumptions about going to steam generators is fairly maybe incorrect.

CHAIRMAN POWERS: One of the things that emerged during the DPO effort that the subcommittee there, which four of the members here were attending, was a spokesman for NRR said, yeah, we've seen these analyses that Research produces of failure of the surge line or the nozzle or the steam generator tubes, depending on timing and things like that, but what we have not seen from Research is an examination of all the other places where failure could -- and he cited about six of them that came to his mind immediately.

I thought that was -- it was certainly not something that had dawned on me, that, yeah, when they did that work-up at INEL, they just picked three, three obvious ones. They didn't go through and do a survey of here are the things that are hottest at what time. And so you're right.

MR. THADANI: That's an area where we're going to have to pay attention, because I think it's going to be around.

DR. KRESS: Except when you fail the steam generator tubes, you are outside containment. When you fail any of these others, you're in containment. And since the finding was generally that you fail the in-containment ones first, all you're going to find out is maybe a little cushion in that, if it fails somewhere else earlier.

MR. THADANI: I think I wouldn't conclude what you did. I've seen the same analyses. I wouldn't conclude that the surge lines would fail first.

MR. ELTAWILA: There is some margin.

MR. THADANI: I would say the time difference is small, but more importantly, those cases had clean tubes. No initial flaws and degradation and so on.

If you start to assume a certain amount of degradation, I don't think we can say that.

DR. KRESS: And besides, it would be a lot more comfortable if that time was --

MR. ELTAWILA: Is longer, yes. That's within the uncertainty of the calculation.

CHAIRMAN POWERS: The other thing is what else do we discover when we find something else fails first. Failing the surge line may be a fairly benign thing, but suppose the thing that fails is the seals on the pressure vessel. Maybe it's a different story there.

MR. MAYFIELD: One of the other complicating factors is if you, for example, lose the seals on the steam generator manway, that may actually exacerbate the temperatures that the tubes see.

So that's one of the other reasons it gets to be important to sort these other things out, to look at timing, and then to feed that into the thermal hydraulics analyses.

DR. KRESS: You could get a small failure that could lead to a big failure in the steam generator.

MR. MAYFIELD: If you blow the cover, if you blow the manway, that's one thing. If you just lose the seal, which is a good bet, that could actually make it worse. Losing all the CRDM seals, how much leakage does that give you out of the top of the vessel, and is it enough. So those are some of the things we're starting to ask, reactor cooling pump seals, how credible is that, operability of the safeties, operability of the continued cycling of the safety through the PRVs, how credible is that.

So some of those things are issues that we're wanting to pick up as part of this program.

MR. ELTAWILA: Continuing with that, the lower head failure mode and the timing and so on, we have the only facility is the Sandia OECD cooperative program, and by the time we're finished the test program, I think two more tests are left, I don't see any interest in continuing this work.

So, again, another facility that's been producing good results is going to be shut down.

The MASCA program is a follow-up to the ROSPELOF program and the emphasis, hopefully they are listening to us, will be initially on the separate effect tests and, at the end, if there is a good -- got good information about the material properties and the interaction between the different material and so on, and there is a need for an integral experiment, we will run it over there.

But the emphasis on a year-by-year right now to go over the separate effect small-scale test.

For containment integrity, the only remaining unresolved issue is the debris coolability and we -- regardless of the -- although that it has not produced any good results up to now, I think it's the only facility that can melt and look at the issue of core-concrete interaction with overlaying pool of water on top of it, and the facility after this test is in jeopardy of being shut down, although that there are indications that member countries might be interested in pursuing additional tests as a cooperative program under OECD umbrella.

The program proposed by ANL is expensive, it's $1.2 million per year, which means that U.S. has to pay $600,000 to be shared equally between NRC and DOE, and we'll try to maybe get EPRI involved in that program, too, so the cost to NRC will be less.

CHAIRMAN POWERS: I guess the question that comes up, Farouk, I've just got to ask on this, when they did the MACE test, they did a bunch of calculations, said this one is big enough, we'll either see fragmentation or it doesn't occur. They did the test, they did not see fragmentation, and now they're saying they need another test, a bigger test, or --

MR. ELTAWILA: Again, it's a bigger test and I was on the committee that met in France to discuss the test program and they came with a bigger test and I refused to accept that. I said go back to the drawing board, come up with a proposal that can solve the problem, bigger and bigger, every time they go to a bigger test and we see the outcome, I was not about to endorse that.

So ANL is working on coming up with a proposal for OECD and NRC. I have not seen the details of the proposal, but, again, it will include a lot of separate effect tests before we go into a major integral test.

CHAIRMAN POWERS: It seems to me that we have satisfied ourselves that a water pool overlying core debris does a substantial attenuation of the fission product release; that if somebody wants to make a case on its ability to cool the debris, isn't it their responsibility to present that test data?

There's nowhere in our regulations that say you've got to be able to cool the core debris ex-vessel.

DR. KRESS: I don't think I'm satisfied that the overlying water will --

MR. ELTAWILA: The water has to be very deep, if I remember correctly, and the temperature, too. You have to have sub-cooled water to get the attenuation that you were looking for and both of them, if you have a very hot molten pool, you will not get that attenuation.

CHAIRMAN POWERS: Well, I have poured more water on top of melts than most people, I suspect, and I am here to attest to you that it doesn't take much water and it shuts the source term off like crazy.

DR. KRESS: Well, I think it depends on the internal conditions of the water. If it's boiling and gases are hot enough that it creates boiling into the bubbles, I think that's sort of a reverse --

CHAIRMAN POWERS: I think that if you only look at things like diffusion and interception, that you will come to that conclusion.

DR. KRESS: I think --

CHAIRMAN POWERS: If you also look at the fact that the bubbles are oscillating like crazy under vigorous boiling, that you will find that you get a substantial amount of attenuation.

DR. KRESS: But I think also if the water is relatively shallow, which it generally is, you get sort of a channeling, it bypasses. So I'm not sure that it's all been delineated yet on this issue.

CHAIRMAN POWERS: But that's not what they're going to do in this experiment.

DR. KRESS: No. They're not going to look at fission products or anything coming off at all.

CHAIRMAN POWERS: They look at it kind of incidentally, but they're not going to try to characterize things like you're talking about, the channeling issue.

MR. ELTAWILA: I can assure you, if we're going to have a program that it has the potential of addressing all the lessons learned from the previous test program and how this test program is going to be different and going to address the issue, we're not going to support the program.

But I would like maybe to answer your question in a different way. From usually -- I remember from TMI, and I'm not trying to invoke it to scare people or anything like that, one of the first questions that was asked for Harold Denton, I believe, have we reached a stable condition, and his answer was yes, and I think at that time, the public had a good confidence that NRC is on top of the issue.

If we have a situation that the core is going to melt and it will have a core-concrete interaction, and the question comes to NRC, do we have a stable configuration or have we reached a stable condition, I don't think anybody at NRC would be able to assure the public, yes, we arrested the accident.

And so for looking at the public confidence issue, we really need to resolve that issue. If the cost is too expensive, I have to delegate the decision to my boss; he makes more money than me, so he can make the decision.

CHAIRMAN POWERS: Yes, but he's not nearly as good-looking, so.

Another issue that you -- in thinking about these collaborative tests, and I've spent a little while talking to individual Commissioners on this subject, is there may well be things that, yeah, if I have to justify this collaborative test on specific regulatory needs now and foreseen at the NRC, I have a little hard time, but if I integrate over the entire international collaborative effort, I justify it based on I've got to do -- the U.S. has to do something besides just participate in other people's programs and we've got to bring something to the table, because of the way the funding thing is.

It's 50 percent for the home country plus all the other countries kick in. Well, if you're always a kick-in-ee, people start being not so anxious to have you participate.

So is there that kind of thinking here that --

lots of people in Europe are very interested in the precise question that MACE is addressing, for their own purposes.

MR. ELTAWILA: That's correct, yes.

CHAIRMAN POWERS: And the U.S. started this program and so that just makes it easier for us to participate in other joint exercises.

MR. THADANI: Absolutely. In fact, I said earlier, I used words like if you keep bringing one dollar to the table, we're sorry, and pretty soon --

CHAIRMAN POWERS: And pretty soon you're not invited.

MR. THADANI: Exactly, you're not going to be invited to the table. So it's a real, real issue and worldwide, it seems to me, we are okay. What Farouk didn't say, also, is that sometimes we are slaves to the priorities of those countries, because they are footing the majority of the bill.

If I had my way, I would like to see Cabri results a lot sooner than the current plants. TREAT, if it were to be activated, I suppose, we could get data in a much more timely fashion for us, because I think the industry is going to move fairly fast here. They're not going to wait for five, six, seven years to go to higher burn-up levels. I think they will go sooner.

So the two factors, number one, we must bring something to the table, and, number two, there are just times when we need to lead the way because those are the needs that we have.

DR. KRESS: On this MACE issue, I hate to keep coming back to it and don't want to solve the problem here, but the problem, when I was associated with that program a little bit, was that as you got bigger and bigger, it cost a heck of a lot more and you had to have a whole lot more melt and you never did reach a state where the melt didn't tend to -- I mean, the crust didn't tend to bridge and then give you problems.

It seems to me like the issue is how thick the crust gets before it can no longer carry up the heat that's brought up from below. So it's really a heat transfer problem and those kind of problems, in my mind, are amenable to small scale separate effects experiments.

You want to know what the heat transfer is, you want to know what the thermal conductivity of the crust is. You can make these things artificially and answer questions like that and then you ask the question of how strong is this crust, will it bridge over a given time, and you can even talk about how the effect of gases going through would affect that.

I think you could do every one of those things on a small thing, separate effects, and is anybody thinking along those lines?

MR. ELTAWILA: But use reactor material. I think we are thinking along the same line, but using reactor material, and we are going to address each part separately, exactly, as you mentioned. We look at the effect of gas sparging, we're going to look at the heat transfer.

I think I am going to make an assumption that there will be things in the cavity that will bridge the crust. It will bridge. There are walls here, there are different elevation of boxes and things like that, that will -- the crust will anchor to it.

So let's make that assumption and let's proceed about calculating it along the way that you are talking about, and I think that's direction we mentioned to the Argonne people, to propose a separate effect program and after we get enough data to see the need, if we need an integral test program.

And the ex-vessel fuel-coolant interaction, there is no facility operating right now. In the area of hydrogen, we don't have any work in the United States. There are some work overseas. In the cable area, I think there are still work facilities at Sandia and BNL. Wyle is still operational.

DR. KRESS: But, Farouk, on the ex-vessel FCI, at one time, I remember Ivan and I went over to Germany a few years ago and they had a very ambitious ex-vessel FCI program. Has that been shut down?

MR. ELTAWILA: The ALPHA program?

DR. KRESS: Yes, the ALPHA.

MR. ELTAWILA: That's after they had that explosion.

DR. KRESS: It was shortly after that.

MR. ELTAWILA: That's completely scrubbed.

DR. KRESS: That's scrubbed now.

MR. ELTAWILA: Yes. The only facility that was available is the FARO facility in Italy and the European Commission decided not to fund it anymore.

For subcriticality, we do not have any work in this country and we are relying on data from France and other countries in this regard.

Decommissioning, do you want to say something about this?

MR. KING: We do have some field sites where we look at radiated nuclide transport through actual on-site measurements.

DR. KRESS: Is this during the cleanup process?

MR. KING: These are either simulated fission products or I think one of them had some actual natural uranium in the ground.

CHAIRMAN POWERS: Ask the DOE to give you the data on Fernald.

MR. KING: We could get that, too. But these are sites where there's holes drilled and there's instrumentation where you can actually measure, and I forget exactly who runs some of these sites. I think the Naturita is owned by USGS and we get information from it. Alligator Rivers was in Australia and it was an international program. That's no longer -- that program is over.

Apache Leap, I think, is run by the University of Arizona.

CHAIRMAN POWERS: Why don't you just go up and get the data that they collect up at Hanford? Lord knows, they've got every fission product. They've got cesium, strontium, technetium, and they got it in the ground, it's leaking right out of the tanks.

MR. KING: Well, we can try and get that, too, but part of this is to look at different geologies. I mean, Hanford is one geology. These are other different geologies, so we can test our models and our codes. There's also some work at NIST looking at the long-term behavior of buried concrete for things like low level waste disposal or entombment, if that ever gets used by anybody.

There is infiltration and lysimeters. That has to do with groundwater motion, measuring where does the groundwater go in various types of geologies, how fast does it go down to the ground, does it spread out, does it go straight down and so forth.

CHAIRMAN POWERS: You guys must have -- the Y-12, those guys must have data like crazy on uranium in the ground.

DR. KRESS: I don't know what they do with Y-12, but you're probably right.

DR. SEALE: And mercury, too.

CHAIRMAN POWERS: Mercury they got in space, but these guys probably don't care about that. But they buried more uranium around that site than you can -- than I'd care to think about.

DR. KRESS: They can probably have some data.

CHAIRMAN POWERS: I mean, there are fields that I have seen that are practically yellow out there from all the uranium that's been turned into the trioxide.

DR. KRESS: We use it to pave roads.

MR. ELTAWILA: What I would like to do, just to save time, let me summarize. I really think the situation with the facilities is critical and I don't think anybody here is advocating that we have to have facilities in every area and as you mentioned and Ashok indicated, too, we have to have some experimental program in a critical area when we need it, and in order to help us exchange information with the rest of the world.

To save some time and allow Tom to give his presentation, the information on maintain readiness is just questions and answers, why do we need facilities, why we need independent codes and so on, and I think you can read this. So I'll finish my talk and I will be happy to answer any questions.

MR. KING: I propose we go to slide 37 next and talk about future reactors. As Ashok mentioned in his opening comments, a year or two ago, there probably wouldn't have been three slides at the end of this presentation on future reactors. Now, instead of three slides, there may be 13 slides. Things are moving fast.

You heard of the DOE Generation IV program. That's a long-term program for advanced reactor development. It's in the initial stages now of trying to look at requirements and goals. There is the pebble bed project in South Africa. There's AP-1000, even though that's a shorter-term.

DR. KRESS: Is Gen IV likely to be a PBMR? Is Gem IV likely to end up being a PBMR?

MR. KING: There could be a PBMR concept in Generation IV. It's not clear to me that Generation IV is limited to one concept. Generation IV maybe limited to several concepts that look like they would meet all the goals.

It's still too early to tell. We've had some people attend a couple of the Generation IV meetings, more as an observer than a participant, but Ashok also mentioned, Bill Magwood from DOE has been in to try and work out a little more formal arrangement as to what our role would be in Generation IV, and that's one of the things we're going to be working on over the next year or two.

CHAIRMAN POWERS: I've heard Magwood is interested in funding the NRC to have a guy stay on top of the pebble bed.

MR. KING: Funding was discussed, as I understand.

MR. THADANI: We did discuss the issue of funding and you are correct. Bill Magwood has said that they can support NRC involvement in this effort.

We are now, and I don't know, Tom, if you were going to say this, but we are preparing a piece of paper to go to Commission in the next few days. It's very early, very early thinking, and after that, we will try and understand the DOE road map and to see where we fit in, how we fit in, and the function of time to identify technical issues relevant to safety.

Bill Magwood has indicated that as soon as we are able to tell him what kind of effort we can afford to put in this as a function of time, he indicated he has the resources to support us.

MR. KING: Generation IV is basically setting goals and criteria in four areas; safety, economics, proliferation resistance, and waste.

Clearly, it's the safety area that we would be interested in, but there is interrelation among all of them.

Dr. Powers, you mentioned, in your opening remarks, about should we start with a clean sheet of paper, given the fact that what we have on the books today is pretty much LWR-specific. I've been thinking about that, as well, and I think the answer is, to me, a lot of what we have on the books today is not going to apply. There might be a few pieces that apply, for example, the reactor safety goals, when you start with the QHOs, they're generic, they could apply to any plant.

But then you look at the licensing framework, the requirements, the infrastructure, like the thermal hydraulics codes and the PRA tools and so forth, the risk guidelines, they're all LWR-specific and if you want to develop something that's generic for a different kind of plant or if you want to develop something for even an advanced LWR, I think you need to start re-thinking all that stuff.

Even things like the regulatory analysis guidelines that we have are based upon LWR accident analysis. So there's a lot of work if we're going to prepare ourselves to license a very different design in the future. Research has a role to take a look and prepare the agency for that kind of activity.

That includes sort of the first step of figuring out what is coming down the road, what are the safety issues we're going to have to deal with, what would this licensing framework look like.

In the past, we had done pre-application reviews for some of these advanced concepts under what the Commission's advanced reactor policy statement, which still is out there in effect, and that encourages NRC to have these early interactions with designers to identify issues, to do pre-application reviews, to develop a framework for licensing, and I think what we're thinking about now is basically what do we need to do to implement the Commission's desires in that policy statement on these future designs.

You look at these future designs and even look at the designs we looked at ten years ago, the LMR designs and the MHTGR designs, there's a lot of new things we're going to have to deal with. They make heavy use of inherent and passive safety features, they try and reduce or eliminate reliance on human actions, they reduce staff. I mentioned the old MHTGR concept was ten modules on one site, one control room, three people. Certainly, non-LWR technology, which new coolants, new fuel, different temperature range, different materials, source term issues, what are the accidents that could occur in these types of plants, non-traditional approaches to defense-in-depth. The old MHTGR didn't have a containment and neither does the pebble bed design. Emergency planning was one -- at least off-site emergency planning was one of the goals of the advanced designs ten years ago. I suspect it will probably be a goal for the ones coming down the road in the future.

DR. KRESS: I guess we've come far enough that we wouldn't dismiss the concept of no containment out of hand at this point. At one time, five or ten years ago, we'd say you're going to have a containment regardless.

MR. KING: I don't think we dismissed it out of hand ten years ago.

DR. KRESS: Well, maybe not.

MR. KING: I think we proposed some criteria by which we would make that decision and we were going to use those at least the MHTGR concept to get the Commission to make a policy decision.

DR. KRESS: You had some criteria on how to make that decision?

MR. KING: We had some criteria on how to make that decision. The program at DOE got canceled before the Commission ever got the opportunity to make the final call.

DR. KRESS: I guess I'd like to see what that criteria was. I wasn't aware of it.

MR. KING: There were some SECY papers that went up probably 12 years ago that had some proposed criteria in there.

DR. KRESS: Maybe you'll resurrect those.

MR. KING: Maybe.

DR. APOSTOLAKIS: Now, when you say potential key safety issues, you really don't mean that. You mean potential -- actually, they're not even potential. There are differences from the current systems, so that you have to look at them, but they are not necessarily key safety issues.

MR. KING: I think they're both.

DR. APOSTOLAKIS: Why would the use of less reliance on human actions, that's not a safety issue. When people read this, they think that there is a concern and that's not what you mean. You mean that this is sufficiently different from what we are doing today so that we really have to do something about it.

MR. KING: That there is a concern. You're stepping out of your comfort zone of where you've been for the past 20 years and you're saying, okay, here is a new way of doing business, am I comfortable with that, is there a basis for that.

MR. THADANI: These charts, I think, are giving mixed signals. I think you're right. Some of these reflect differences and, therefore, we need to understand. Others are actual concerns. For example, reduce staffing may turn out to be a safety concern. On the other hand, reduce reliance on humans, you just have to make sure you understand that that is really what is going on.

So I would sort of say it's sort of a mixed signal there.

MR. KING: Non-traditional missions. Farouk mentioned some of those, waste reduction, continuing to burn MOX, weapons grade plutonium, enhanced proliferation resistance kinds of things, new core design issues that would need to be looked at that we haven't looked at today.

Again, these are just examples based upon what we know about the programs today and some of the things we faced ten years ago.

I mentioned the modular design seismic isolation, at least one of the designs ten years ago had the whole primary system on these mounts that they called seismic isolators, that the ground would shake and --

DR. KRESS: That was the liquid metal reactor.

MR. KING: Yes. It as the Prism design. Those are kinds of things that may come back. These new designs, what accidents should they be designed for, what is the licensing basis of these designs.

DR. APOSTOLAKIS: Actually, the first question is does the question make sense. In other words, that implies design basis accidents and a lot of people are questioning whether, for the new designs, the Generation IV, if you want to have a truly risk-informed system, whether you should have design basis accidents to begin with.

DR. KRESS: If you can't do a PRA because it's such a new system, you better fall back on design basis.

DR. APOSTOLAKIS: That is a counter-argument, but all I'm saying is that people have put that on the table, because you may be able to look at the PRA and do other things. I think people are a bit optimistic regarding the amount of review, because they think that if you eliminate design basis accidents, you look at the accident sequences, the review from the staff would be less than before.

But I think you can make a good case that if that is what the staff if supposed to do, then they will question every single assumption that's behind the accident sequences, which then you conserve the amount of effort.

MR. KING: But at some point, I don't think the two are inconsistent. At some point, you've got to decide I'm designing my plant for this size earthquake, this size pipe break or whatever, and you use PRA to help make that decision certainly.

DR. APOSTOLAKIS: But you are not necessarily going to have a large LOCA as the --

MR. KING: No, this doesn't --

DR. APOSTOLAKIS: -- design basis event that covers a spectrum of accidents.

MR. THADANI: Not at all. That's why, George, I think the key words here are accidents. I hope we are going to get away from one or two or three key sort of design base accidents and devote all our energies to those.

Presumably, it will be some spectrum that we would have to look at and pay attention to. So internally, when we have discussed this, we never really got to the point, by God, follow the same traditional philosophy. No. In fact, I think we ought to think hard about some alternate approaches.

MR. KING: What startup testing should be required? There were some concepts, the old MHTGR, ten years ago, and I think, to some extent, the pebble bed is planning to build that first module and demonstrate its inherent safety characteristics through testing that first one. How reasonable is that as a licensing approach?

DR. BONACA: About designs, going back to accidents, I mean, I would expect -- you know, in the past, the single failure criteria had been a keystone of every analysis you make and you make a thousand different variations to address which one is the worst.

Now, here, the likelihood of a single failure to occur would be driving. So that's where PRA, I think, comes in so powerfully.

MR. THADANI: Absolutely. But even there, Mario, early on, there was implicit probabilistic thinking because it considers single active failures, not passive. There was that thinking.

DR. BONACA: True.

MR. THADANI: We have matured. Now I can say mature. And we can do better than that.

DR. APOSTOLAKIS: Are you including anywhere in here this concept of license by test, which I don't know much about?

MR. KING: What startup testing should be required.

DR. APOSTOLAKIS: That's part of the --

MR. KING: That is intended to cover that. If you recall, Part --

DR. APOSTOLAKIS: When you reach startup, you have already licensed it, though, haven't you? No?

MR. KING: No, but the -- the idea, at least on the MHTGR ten years ago, and I think it's the same on the pebble bed they're talking about in South Africa, is build one module, use it to demonstrate the safety of the design through some pre-approved testing, and then if the testing goes well, then that would be the data that you would use to certify the design and allow construction of other --

DR. APOSTOLAKIS: So this is license by test only?

MR. KING: No, not only.

DR. APOSTOLAKIS: You will do some analysis, as well.

MR. KING: There would have to be analysis and you can't test to the point where you ruin the fuel and ruin the whole module, but you can probably test to the point where you've got enough data to validate your codes to show that if it went further, that things would be okay.

DR. APOSTOLAKIS: Maybe they would be willing to destroy the module if that would be convincing evidence to you and you would not review anything else. You never know.

MR. KING: You never know. But 10 CFR Part 52 sort of encourages testing of these unique designs and using that information to help support certification, and I think people are thinking about taking advantage of that.

DR. KRESS: It's certainly a good idea, but you wouldn't want to do one test and destroy the thing, because these things are stochastic and you've got one data point then. You want to do a lot of testing of different types of upset conditions, I think.

DR. APOSTOLAKIS: Defining the test, I think, is the problem.

DR. KRESS: Defining the test would be a real hard thing to do here.

DR. APOSTOLAKIS: And also understanding the difference between epistemic and --

DR. KRESS: Absolutely.

MR. KING: I think it's a possibility that in the future, there will be more reliance on that kind of approach versus what is done today.

DR. APOSTOLAKIS: And it has to be combined with risk.

MR. KING: It has to be combined with risk. I mean, risk in the design is going to be -- risk assessment in the design process is going to be iterative. On the MHTGR ten years ago, they came in with a risk assessment.

They made certain assumptions on fuel performance, on the performance of some of the other equipment that they really had no experience with, and then their goal was to say okay, to make this PRA come true, I've got to go develop and prove that my circulators have this reliability, my control rod drives have this reliability and so forth, my fuel can perform up to this level, and they ran into trouble on some of that.

DR. KRESS: Particularly on the fuel performance.

MR. KING: But one can drive the other. You make certain assumptions that you need in your PRA and you set up a program, research development program to see if you can do that, and if you can't, you've got to go back and adjust your PRA.

So, again, it's an iterative process. Some of these issues, what I call key issues, I think are going to have to be policy issues the Commission is going to settle. The containment is issue is one, emergency planning would be one.

And then there's infrastructure issues. What tools does this agency need to be able to review and license one of these designs? I just yesterday dug out, back when we were doing the SAFR and Prism, and even Clinch River, we used a code called Super Systems code for analysis.

DR. KRESS: I remember that.

MR. KING: This was Super Systems code. It was a 1D lump parameter, very crude model. It was probably good enough to look at the end state of the transient, where you would end up, but certainly is not anywhere near the kind of tools you would need to look at some of the details of an accident in Farouk's thermal hydraulic area.

What does this agency need to do to take some code like this and improve it, expand it, to meet our needs to actually do a review that would cover all the points we think ought to be covered.

So there's a lot of internal work, as well.

CHAIRMAN POWERS: That raises the question. Presumably, the licensee would have developed a code of some sort for either his safety analysis or even for his design work. Why not just take his code?

DR. KRESS: There certainly would be one for the pebble bed reactor.

MR. KING: That's a possibility.

DR. SEALE: The Argonne people have done a lot of code development.

CHAIRMAN POWERS: Say we just take his code.

DR. KRESS: I think you have to do a peer review of it or something.

DR. APOSTOLAKIS: What happens to the independent --

CHAIRMAN POWERS: You take his code and you fix what you don't like.

DR. APOSTOLAKIS: What happens to the independent verification?

DR. KRESS: Yes. That's why I think you need a peer review.

MR. THADANI: Should we go revisit history and if these are new designs, and truly new designs, where we don't have experience and so on, I think that NRC having had the independent capability has been invaluable for safety and I would think extremely hard before just saying why don't I use industry tools.

I think the value of the agency's independent capability is well documented. Before we walk away from that, for new designs, without any experience, I would think pretty hard.

CHAIRMAN POWERS: Look at it this way. A typical code is going to have a balance on the mass and a balance on the energy and then a bunch of other stuff. If I say, Ashok, you can change any of the other stuff you want to, I presume you wouldn't want to change the balance on the energy and the balance on the mass, you can change it any way you want to, but at least this saves you from having to do all those little nitty-gritty details and whatnot. But if you don't like our heat transfer correlations, change them, put anything you want to in there.

Why not?

DR. KRESS: Some of these codes, the ones I'm familiar with, the ones that would apply to the pebble bed reactor were developed at national laboratories and you might make a case that this is not industry-specific, although the funding probably came from DOE in this case rather than NRC, it's a little bit different animal than an industry code, I think.

DR. APOSTOLAKIS: But if the South Africans are going to build the first module and they have their own --

DR. KRESS: They'll use this code, probably.

DR. APOSTOLAKIS: You will use this code, they will?

DR. KRESS: They will purchase -- they've got it.

DR. SEALE: They've got it and they're using it.

DR. KRESS: And they're using it.

DR. APOSTOLAKIS: They've got which code?

DR. KRESS: It's a code that Oak Ridge created.

DR. APOSTOLAKIS: An Oak Ridge code. I see.

DR. KRESS: And I forget the name of it, but --

DR. APOSTOLAKIS: It's an American code.

DR. KRESS: Yes. They'll probably --

DR. APOSTOLAKIS: If it's a national lab, you're right.

DR. KRESS: They'll have to modify it to fit the pebble bed code set, but --

CHAIRMAN POWERS: This strikes me as an issue we've got to really think hard about here on where we stand on this, because suppose it's purely an industry code, they developed it, they've used it.

DR. KRESS: That's a good issue.

CHAIRMAN POWERS: They're going to give it to you. They may put some strings on it, but they really don't mind if you want to go in and change the things that get changed.

DR. KRESS: In my thinking, that makes it an NRC code, if they do that correctly. If they do it in such a fashion that they're satisfied with the final result, then --

CHAIRMAN POWERS: Suppose that they come in with a nice lump parameter code and NRC says we think we ought to go to a CFD on this.

DR. KRESS: As long as they can justify what they do and validate it and give it the peer reviews and so on. on the issue of --

MR. KING: We didn't come here to answer these questions today. I just think there's a lot of questions out there.

DR. KRESS: They're real questions.

CHAIRMAN POWERS: This is a question I'm going to have to answer.

MR. KING: CANDU, we started that review using the Canadian codes. They gave us their codes and we exercised them to look at the various events of interest to us. Whether we would have gone on and developed our own, I don't know, but maybe Ashok knows.

MR. THADANI: I think we were not planning to.

MR. KING: But we were using their codes.

DR. KRESS: You raised two issues about new reactor design. One of them was containment and the other one was emergency response.

It might be useful to look at the decommissioning reactor's spent fuel pool risk study, because there is a case where you had the risk equivalent to operating reactors and there's no containment and they want to relax the emergency response, and they have bases, criteria and bases for doing that, and it may be possible, because basically they're doing it there.

DR. BONACA: I have a question that comes to you really gave us a convincing list of needs. I mean, one could envision $200 million here rather than 50. But you are confronted with a budget and you gave us, in the morning, your presentation on the short-term needs, essentially it's operating reactors and what they need to support the immediate challenges.

And then you have the future need is really the ten-year plan, looking at the future. How do you apportion this limited budget every year to -- how do you prioritize it? I mean, clearly, I view operating plants right now aging, all the issues that come from that, the capability of structures to sustain challenges as a driving force that really challenges the NRC now, because you have all these initiatives of the industry to use the margin that there is for their own purposes.

Then you have this challenge of the -- how do you go about that? I'm trying to understand how you do that. That's not an easy task.

MR. THADANI: Well, we developed a prioritization scheme for initiating any new work that considered things like if we didn't do this research, what would be the impact on core damage frequency or what would be the impact on containment performance, does it impact a large number of plants, is there some reasonable likelihood of success if we initiate the research program and so on.

And what I believe now is that that prioritization scheme is somewhat flawed in at least the environment I see today. I am going to show you a chart, and it was actually Marty Gant from Sandia National Laboratory -- or Randy, Randy Gant from Sandia --

CHAIRMAN POWERS: I will quickly inject that as soon as he puts this chart up, that I have an organizational conflict of interest on this chart, which I've never seen before, but I have an organizational conflict of interest.

MR. THADANI: There was only one point I was trying to make. Let me tell you why I'm re-thinking our prioritization scheme, but to answer your question, typically, we have been using some guidelines of not going above 20 percent of our budget on anticipatory or longer-term issues and 80 percent on short-term issues. What has been happening lately is that 20 percent is diminishing in two different ways. The fact that the absolute value is going down, that means the amount that goes towards forward-looking research is going down.

The second way it's been going down has been that we have to justify in the budget process, planning, budgeting and monitoring our efforts, we have to justify every little project, no matter how small it is, it's got to be justified, tied to one of the four performance goals.

Generally, it's harder to do when you're looking at longer-term research. So during the year, new challenges come up from operating experience or someplace else. So we're looking for resources to deal with those issues. There are only two options we have at that point.

One is what we call mid-year allocations. We can go to our chief financial officer and say, well, you know, the money you've been saving on the side, we need some of that and sometimes we're successful, other times we're not successful. That can help.

And the other mechanism we use is to see if we can't take some resources out of longer-term research to deal with the shorter-term.

In the end, what seems to be happening is that 80 percent seems to have crept up many times to 90 percent in terms of addressing short-term issues.

Now, I want to show this chart for a reason and because I think the environment around us is changing. I like this chart. I saw it at the water reactor safety meeting.

I may quibble with details, but the big picture was what he talked about was periods of optimism, guarded views about nuclear power, and pessimistic views about nuclear power.

In the early '60s, there was still a lot of optimism about nuclear power, perhaps up to the early '70s, but you can see there were some reasons for some sort of concerns and guarded views about the nuclear power until we had accidents, both at TMI and then later on at Chernobyl, when there were really pessimistic views about the role of nuclear power.

We now seem to have turned the corner now. It appears from everything that I see there is a great deal of optimism out there about the role of nuclear power in the next 30 to 50 years in the nation's mix of energy supply sources.

This, of course, is partially because of the environmental concerns, but mostly I think because of the economic situation.

In this environment that we're in, Joe Colvin said at the water reactor safety meeting, just last week, that don't be surprised if the industry comes to NRC with not just one application, but maybe ten applications, six or ten applications in five years, and he said I may have to revise that, it may be sooner than five years.

DR. APOSTOLAKIS: Really?

MR. THADANI: Yes. That's what Joe said at the meeting. Now, as you know, and I said this earlier, that PECO is providing some resources to SCOM, ten percent. We have had meetings with Department of Energy here.

All indicators are pointing to optimism and that's not reflected in any way in terms of the way we prioritize our work and the role of research that's in our vision statement preparing the agency for the future to be able to make sound decisions in a timely fashion.

So we have to look at that process, how we prioritize. We have to make sure that there is an agency buy-in in that process and that's going to be what we'll be working on.

CHAIRMAN POWERS: I guess I'd feel a little bit more comfortable if I didn't know that Joe Colvin retires in a year and a half or something like that.

DR. KRESS: That shouldn't make any difference. That doesn't cloud your crystal ball.

MR. THADANI: I would hesitate to comment on that, because I know a lot of people who might be retiring in the next several years.

CHAIRMAN POWERS: And my point is that we've got one individual saying, okay, there are going to be five or -- I'd like to hear all five of them before I started getting too excited about this, because speaking of anecdotes, I had a distressing -- I had the most distressing experience, I think, in my professional career the other day. I was called in to talk to a vice president of Sandia who is supposed to think about the future.

And he said here's -- we'll bring some people in and you tell us about why nuclear power is so great, because he's thinking about a future in terms of Amory Lovins kinds of things, whatnot, and I said, well, no trouble at all. I went in there and the first thing I discovered is reasonably intelligent people, I thought were reasonably intelligent, I'm revising my thinking real quickly here, seemed to be able to recall for me every LER and newspaper article on some egregious error from memory.

I mean, they just pulled these things, well, 1972, some plant -- like Ducane Power or something, did some egregious thing, and --

DR. KRESS: Like we do these guys?

CHAIRMAN POWERS: I mean, they could go through Maine Yankee just -- I don't know, just story after story. Just every time I opened my mouth, they'd say, ah, but. And to my mind, with that, if I have these people who think about energy with this kind of hostility toward nuclear power, it takes a lot to cause me to turn those red things into even yellow things in forecasting.

One swallow does not a spring make, I think.

DR. KRESS: Can we get a copy of that slide, by the way?

DR. APOSTOLAKIS: Yes, I'd like to have it.

MR. THADANI: I'd be happy to.

DR. APOSTOLAKIS: Is it possible to e-mail it?

CHAIRMAN POWERS: We can probably get Randy to.

DR. BONACA: I would like to follow-up on another question, however, on that.

DR. KRESS: That one takes TID-14.844.

DR. BONACA: I was looking at the work that the RES is doing and there are many tasks there. I'm trying to understand the priority driving those tasks.

When I asked for priority, I was given essentially the four general categories, safety, regulatory effectiveness, public confidence and so on and so forth.

Now, that doesn't give me a priority still, because there are so many things important to safety, but some of them are pressing and some of them are not so pressing, and maybe I could also say that the probability of something is going to drive my assessment of how pressing it is and which one I'm going to put forward first.

So I look at this on the structural work and I see three categories. One is driven by assessing the capability of structures and components that are being degraded, and I'm saying this is -- especially for me, this is number one, because it's challenging us now, and that's very important work.

Then I see work to assess the capability of a new containment. Not a new design. I'm saying just a containment, not degraded. And there I begin to lose a sense of what is driving his assessment.

There is a concrete structure and also steel structures and there's quite an amount of work going on, and I was trying to understand is it for new designs, for new plants, and then there is a third category that says seismic work, and it's substantial and I really wasn't aware that seismic was such a big issue right now still.

And when I look at them, I really don't get a good feeling for what is driving the priorities that where you put the money in these categories.

MR. THADANI: Let me say a few words and then I'm sure Mike would want to also give you his sense.

DR. BONACA: And I just provide it as an example.

MR. THADANI: I understand the point you're making. We obviously didn't give you a lot of detailed evaluations that we do in prioritizing various activities.

We go beyond just the four performance goals. We have weighting factors for various goals. We do weight safety, maintain safety higher than reducing unnecessary burden, for example.

And we developed, under each -- it was sort of a hierarchical approach to prioritization. We developed, under each goal, certain attributes and -- well, for example, under safety, would it -- how does it impact core damage frequency. If it's a certain fraction, then it gets certain weighting factor; if it's very small, it will get a lower weighting factor.

So there were some -- under each goal, there were between three and four tiers that we looked at and we provided some weighting factors.

And then we used a simple tool to integrate all of that information and come up with a number. And last year, when we went through this process, I learned my lesson that that process is pretty good for what is really pretty important to safety, pretty high, it's pretty good for what's pretty low.

But there's a lot in between. They come out pretty close. So you struggle through as to which way do you go and so on.

Now, as for the structures, there are some very important, in my view, international programs, testing programs, sponsored by NUPEC on containments, as you referred to containment.

I think if we're going to go to a risk-informed regulation truly on sound basis, and I will keep saying this, because I strongly believe that's the right thing to do, to be risk-informed, but to do it in the correct way with enough information base.

We have, as you know, used, in the past, some models for using ultimate capacity of the containments to try and understand what the fragilities would be and how we might model those in risk analyses.

Tom would say, well, these are just single data points and so on and that's true. Nevertheless, they are very valuable. They are very useful to know how high you can really go in terms of let's say pressures.

What are some of the locations which might fail first? We know what happened with the steel containment, but for the reinforced concrete containment, there are different issues. And we are very, very fortunate in that our resource input is pretty small as compared to the total cost of the program.

And it is consistent with the direction the agency should be going in, but I'm sure Mike wants to add.

MR. MAYFIELD: Let me take them in the order you had them. The degraded structures and components, that's one that we've felt like even though it had limited user office support, it was one of the areas that Ashok agreed was good as anticipatory work.

We felt like it was important and we've continued to pursue that. Of the three areas, we felt like that was also the highest -- the most important of the three.

I would also tell you that subsequently, just this last year, we have gotten more user office interest in the outcomes from that piece of work, or the outputs that they have seen where they could, in fact, use that information.

So that was our ranking of those three areas. That one came in the sort of middle group that Ashok was talking about.

DR. BONACA: Middle group.

MR. MAYFIELD: In the overall office ranking, that one sort of fell in the middle of where a lot of things had very similar looking rankings.

The testing of the new design really had two purposes, and Sher Bahadur is sitting back here, he is the Branch Chief in that branch. So if I say something that is wrong, correct me here. But that work had two goals.

One was to sort of look at how much could you pump up a pre-stress concrete containment, just the ultimate pressure you could get to, but perhaps more importantly was to push the computer codes. We know that they do pretty well up to sort of the design pressure, but how far can you push them and still rely on them.

WE had seen with the steel containments that it was a design detail that ultimately led to the failure and that wasn't picked up in the modeling.

So with the pre-stress concrete, we wanted to see the same kind of thing and, in fact, that appears to be the situation.

That was one of the programs where if we were paying for it ourselves, we wouldn't have done it. But because we had some significant international financial leverage, and I don't know want to put a number on it, it was a significant leverage.

The third area is actually to the seismic work. There's actually two pieces. One is looking at how the earth moves given a seismic event and then lumped in that same heading is given that the earth moves, what happens to the structure, and those two things get mixed.

The piece of the work that looks at how the earth moves is at a maintenance level. If we're going to cut that any further, we're out of the business. We are down -- it's a small number and I don't recall it, off the top of my head, but it's basically with USGS and we're at the minimum level. The project managers came back and said if you're going to cut it, just get out.

So Ashok and Margaret looked at it and said, no, that's not a technology we're prepared to just get out of. So that piece is maintained at literally a maintenance level.

CHAIRMAN POWERS: Why did they come to this conclusion? I mean, a lot of people studying how the earth moves in the earthquake, why can't you just -- I mean, California, it's a major growth industry.

MR. MAYFIELD: Well, this is with USGS and you have to gain access to the detailed database, just saying, oh, gee, --

CHAIRMAN POWERS: It's a public institute. You can get it anyway. It's a public institution.

MR. MAYFIELD: Sher, why don't you come to the microphone over here?

DR. BAHADUR: This is Sher Bahadur, from Office of Research. Whatever Ashok has mentioned on this program and Mike has said, I don't have very much to add, but I just want to emphasize a couple of things.

Seismic research has been misunderstood from the beginning because it has been lumped with a number of other projects that we are doing in this field.

For example, the seismic work that we do for geology and in major earthquakes is a very small portion of what you see in the budget.

Most of it is spent in how these structures behave in terms of the seismic loading and the normal design and Mike alluded to that.

The work we are doing in the seismic right now is a very small amount that we bring with us to the table with USGS, so what we can delve into their database, and it takes millions of dollars to maintain that network all over the country.

We are just getting it for a couple of thousand dollars.

CHAIRMAN POWERS: It's a public institution. You ought to be able to get it for free.

DR. BAHADUR: The information that you can get free, and we are getting free, is more like where the earthquake took place and where was the epicenter or what was the density of it, what was the --

DR. APOSTOLAKIS: If it's a couple thousand dollars, why are we talking about it?

DR. BONACA: But I didn't see -- I lumped together --

MR. MAYFIELD: What you'll see out of the information you get was the lumped.

DR. APOSTOLAKIS: Let me propose something, because it's true that in most PRAs that are doing external events, I think the seismic contribution to risk is up there, it could be number one, number two, number three, but it's among the dominant contributors for most plants.

And I don't recall this committee being briefed on the activities of your office in that important area, and perhaps some of the questions you're getting now is that people all of a sudden see this major activity and they say what is this, why are we worrying about this.

Maybe we ought to schedule a briefing of the full ACRS on the program and where we are trying to go and so on, because I really think the committee should be on top of what is going on, and I believe the issue is important also to the spent fuel pool.

CHAIRMAN POWERS: The challenge we face right now, George, is that they couldn't break into our agenda between now and March.

DR. APOSTOLAKIS: That's fine. I'm talking about long-term, not about this particular --

CHAIRMAN POWERS: We've got to write on the seismic research program next month.

DR. APOSTOLAKIS: When I made that proposal, I didn't mean that that would be critical to our research report. I'm talking about long-term, that we never seem to discuss earthquakes in this committee.

MR. MAYFIELD: I think as a general matter, we would like to come brief you on that program. I agree, we haven't been down in a long time to talk about the seismic.

DR. APOSTOLAKIS: Regarding the report, though, that worries Dana, perhaps that can be done -- Dr. Bonaca can make a trip up there and understand it a little better.

MR. MAYFIELD: We'd be happy to come and talk to you.

DR. APOSTOLAKIS: Because I don't see how else we can do it.

CHAIRMAN POWERS: Right now, we've got the seismic research that involves the earth moving. That's the USGS and a couple K and --

MR. MAYFIELD: Then you've got the soils structures piece, which is how the building moves given that the earth moved, and then the internal structures inside.

CHAIRMAN POWERS: And there are literally jillions of people working on that. It's a major growth industry in California, as well. What is it that you're going to do that's so unique?

DR. BAHADUR: I may add a few things here. The cooperative programs that we have with a number of countries are focused on a number of things. We are working on the seismic response of the nuclear piping. We are doing that with Battelle Columbus Laboratory.

CHAIRMAN POWERS: Is there something unique about the nuclear piping that's not covered by all the other work in piping?

DR. BAHADUR: It may not be unique in the sense of the structural integrity of piping, but when you start looking at the literature, there aren't that many people who have concentrated on looking at the response of piping to the seismic loading.

You will see that there are a lot of industrial buildings that have been researched to see as how would they behave due to seismic loading, but when you look at the containment design, then you see that it would be difficult for you to extrapolate that information onto the containment design.

CHAIRMAN POWERS: I guess what I'm really struggling with is you guys come back and you say you've got a couple of rules. Say, the plant's got to survive the safe shutdown earthquake and a design basis earthquake. Okay. You, licensee, show me that you can do this.

Is there anything they're going to show you that you don't know so much about that you can't say yeah, they proved it to me well enough? Can you not evaluate seismic analyses that licensees submit to you now?

DR. BAHADUR: You approach this from a different angle. Approach it from an angle when the licensee is coming to you with an application where the structures aren't pristine and it's not new, and now you have to evaluate its fragility and you have to determine as to how much of a credit you're going to give to the licensee.

Our research right now in this area is, for example, the model that we are testing at Sandia, is not only testing the seismic behavior of the structure under seismic loading. What we have done is in a round-robin test, we have had a pre-test analysis, whereby 14 different countries came up with a different failure mechanism that would take place under this loading.

DR. APOSTOLAKIS: Let me play the devil's advocate here. If I look at the results of PRAs, the uncertainty in the frequency of the seismic contribution is huge, but it comes form the seismically, in part, and the ground motion. The models for propagating the ground motion, not from the structures.

And for those two, I don't know what you can do about them. First of all, it's a much bigger issue than just for nuclear facilities, and then if I look at it that way, why am I spending money on the structures when my uncertainties will be large anyway because of that other part I can do nothing about.

MR. MAYFIELD: You've got an uncertainty in how the earth moves, but you also have the uncertainty in how the structure is going to react, and there is a piece of the work that looks at precisely that.

Then Dana's questions about, well, the piping, everybody analyzes piping, well, the industrial piping codes differ substantially from nuclear piping design codes, at least once you get into the primary and secondary systems. You get out into balance of plant, it starts looking a bit different.

MR. THADANI: George, I think maybe using the same points you made, I come to a different conclusion, that you said, and I agree with you, by the way, that seismic is for many studies is a pretty significant contributor.

And an important element in that is the uncertainty in the hazard part. Now, it makes it even more important, in my mind, to try and make sure that we, at least to the extent we can, better understand the conditional probability of the response and how well -- you know, I can --

DR. APOSTOLAKIS: I understand that point, Ashok.

MR. THADANI: But what I think we didn't really address, I don't think -- I think we need to address is the issue of participation in USGS. The dialogue that I have heard so far does not answer the question that Dana has asked, and we need to respond to that.

DR. APOSTOLAKIS: If you're only spending $2,000 --

DR. BAHADUR: It's not 2,000, it's 200,000.

DR. BONACA: That's why I said at the beginning I could see $200 million for this program and it deserves it. And I'm not saying that seismic -- all these plans are no worthwhile. I was talking about prioritizing. And I can see the first category, where you are looking at issues even of seismicity with the Japan collaboration effort and you are addressing the performance of degraded equipment, equipment that is aging.

That is so current, that is a very important question, because all the seismicity studies were made and the effects on plants have been assuming the plant was new and capable to the design capability.

And now we would like to understand, in fact, how that is affected by seismicity. So that portion of seismic studies being done is very important for that, and I can see priority one for me, not in the middle. I would see it there.

But when I see just simply getting a better understanding, for example, collaborating with NUPEC on seismic structure engineering, that's more like, it's very important, I think, but maybe in a restricted budget, it would not come to make the cut. And, again, for me, it's a much rougher judgment than you are bringing in. I don't have all the other programs.

DR. APOSTOLAKIS: From my experience with PRAs, you don't see anything happening unless you go significantly higher than the SSC, is that true? I mean, I saw design and --

MR. THADANI: I think that is true. I think that is true.

DR. APOSTOLAKIS: Significantly higher.

MR. THADANI: You have to go significantly above. I can also tell you that if it weren't for the work that was done, we would have had extremely tough time on Maine Yankee. You might recall, we used the seismic design margins approach to solve what was a really difficult issue of the design base for Maine Yankee, seismic design base, and ability to deal with --

DR. APOSTOLAKIS: My point was that you are talking about really rare earthquakes when you go to that level.

MR. THADANI: That's true.

DR. APOSTOLAKIS: And another thing that I know, you don't want to worry about it, but you're not going to have anybody around to get killed by the nuclear accident by that time, but anyway, that's not your responsibility, because you're the Nuclear Regulatory Commission.

There would not be a Chicago or a New York to worry about. But the frequency comes primarily from that part, so I don't know that I need to understand the structural response if I --

MR. MAYFIELD: There is one other aspect of this that goes back to the first piece. In doing the PRAs, you have to go very high in the earthquake loading for virgin structures. As they degrade, you don't have to go quite so high before you start seeing it. But that's part of the issue that --

DR. APOSTOLAKIS: It's an aging --

MR. MAYFIELD: It's an aging phenomenon, but that's --

CHAIRMAN POWERS: If it's bad enough to make that a significant thing, we've got a problem in Part 54.

MR. MAYFIELD: That's right. Ed Jordan was recounting the story of when he had gone in and was walking down a plant and found hangers with the bolts missing.

CHAIRMAN POWERS: Then that's a Part 54 problem.

MR. MAYFIELD: That's a different issue, but it's the real world, and so we want to start looking at some of these things.

The other thing we discovered when they did the seismic tests in the HDR is that piping supports don't work exactly like the designers anticipate them working. They saw a significant historesis in the way the supports moved and, oh, by the way, that affected the analysis.

CHAIRMAN POWERS: Well, you're armed now with some questions that you can really pose to the licensees when they come to you about their seismic issues. But you haven't got anybody lined up to come to you, because you've already approved them.

So now what are you going to do with the results of this research?

MR. MAYFIELD: What you see is people coming in with substantial modifications to the plants and they still have to redo their seismic analysis. If we see some new license applications, then presumably there will be seismic questions associated with the structures.

We see seismic issues associated with siting of non-power reactor facilities, some of the fuel cycle facilities. So this work has application for some of our NMSS customers.

You also have siting issues associated with the dry storage sites.

MR. THADANI: I think it's very important that you not -- I mean, much of these points that Mike is making are -- the work is driven by requests and we -- all of us, including -- I do the same thing. I keep thinking reactors and forget there are many other areas, and I can tell you that there is significant issue in people's minds, particularly in fuel fabrication facilities and so on, and --

DR. APOSTOLAKIS: But the earthquakes are not so rare.

MR. MAYFIELD: The earthquakes are not so rare.

MR. THADANI: That's true, that's true.

DR. APOSTOLAKIS: I think the fundamental problem is that this committee has not been briefed on that. I know there is a real issue with the research report, but I think most of this stuff is new to us and --

MR. MAYFIELD: Again, I think that's a fair point.

MR. THADANI: And really I didn't want to tell discussion on this, it's just an example of what we're all experiencing.

DR. APOSTOLAKIS: I have another one that's similar.

CHAIRMAN POWERS: I will have to say, I come away very uncertain what the research does for us, because it seems to me that either you've got a fairly well established technology you can tap into or you've got no requests.

I just don't see where you get anything.

MR. MAYFIELD: Let me give you one concrete example of where the research contributed. We had the ASME revise its piping design codes to significantly change the allowable seismic stress.

It was the research that said no, that's gone too far. It didn't say no, you can't make a change, it said, no, that change has gone too far.

Now, if we hadn't done the research, we wouldn't have had the independent look at it. We wouldn't have known the questions to be asking.

So when the argument goes, well, why don't you simply pose these things to licensees, and, Dana, I've got to tell you, we hear that in a lot of areas and it's a very legitimate question.

The issue in this area, as in many of those others, is you have to know enough about it to be able to ask the questions.

CHAIRMAN POWERS: That's absolutely true.

MR. MAYFIELD: And that's really where we are with this piece of work, is knowing enough and staying sufficiently involved to be able to ask the questions to challenge --

DR. APOSTOLAKIS: It's a core competency.

MR. MAYFIELD: It's a core competency and that's really what we're talking about. We're not off looking to break new ground, no pun intended. But it is something where we do believe it is a core competency, it is one of those areas where we have to stay smart enough and it's not enough to simply send a couple of guys to conferences periodically. You have to keep your hands in.

DR. SEALE: And wouldn't Mr. Lochbaum have fun if he was able to shoot arrows at the NRC about not being involved in the modern assessment of seismic behavior. He'd make the PRA thing look like duck soup.

MR. MAYFIELD: I've got to tell you, when we rattled the west coast a few years ago, we got a lot more support for and interest in our ability to answer questions about seismic and why it looked different from the traditional earthquake assumptions.

CHAIRMAN POWERS: I'd come back to George's point. If I've got a factor of ten in my seismic return frequency, I can be awful uncertain about everything else.

MR. THADANI: I'm going to disagree with you.

CHAIRMAN POWERS: I know you already --

MR. THADANI: I tell you, I am troubled by this discussion because it is a very fundamental in safety, I think, and we're treating it a little too casually, I think.

I agree with George's suggestion. I mean, I'm the first one to say if we're doing something that's not really yielding value, cut it, but cut it after you understand what it's all about and not because of an opinion.

I feel strongly that I look to you for ideas, suggestions, and I like this collegial discussion, but if you - maybe some of us at the table can answer some questions. I believe we have not answered the question about USGS that you raised.

On the other hand, I disagree strongly if you say just because there's uncertainty in the hazard function of order of magnitude or more, you don't need to worry. I think that's the wrong way to look at safety, in my view.

Recognize that even the Livermore and the EPRI curves have come a lot closer together. We're not talking about ten years ago when there were big differences and it was a big driver then.

It's not as big a driver now. So I think we are maybe over-simplifying the issue a little bit.

But on this issue, I think the best thing is to brief you, perhaps talk to Mario first and then whenever it's convenient for the committee.

But I hope the recommendations that you make about our programs would be based on first making sure there is an understanding of what it is we're doing and why and if that's not good enough, you say disagree, that's fine.

DR. BAHADUR: I would like to add one more thing about USGS. The USGS actually annual collects the data and it processes that data to a frequency which is applicable to similar structures. What our dollars do, when we take the dollars and join the program, is that then it gets the range extended so that it can be applicable and handed to our facilities.

So it's the millions of dollars of program that

USGS maintains, but they are maintaining mostly in a bandwidth which is applicable to the similar structures only.

DR. APOSTOLAKIS: I think there is another area -- are we done with earthquakes?

MR. MAYFIELD: Can I ask one question?

DR. APOSTOLAKIS: Sure.

MR. MAYFIELD: Tell us, if not now, in the near future, what we can do to support you and what additional information we can give you.

DR. BONACA: It's more understanding how you prioritize this and clearly I was using my judgment and saying this is number one and this is -- where does it fit. That was more my question there regarding -- and because the prioritization process is not transparent in identification of these issues, of course.

DR. APOSTOLAKIS: There is another major program, at least the little summaries I've seen, that deals with improved PRA methods and tools and just human reliability, fire risk analysis, digital system risk analysis, and that's all I know.

It seems to me that that is a major undertaking. On the basis of the --

MR. THADANI: I hope it includes aging effects, also. You didn't read that.

DR. APOSTOLAKIS: It doesn't. What I have doesn't say that. I can check again. But here is -- I don't know. We have reviewed parts of the program, fire research and so on, in different contexts, but I don't know the details of this and -- well.

I don't know what to say about it, but it's heavily funded.

CHAIRMAN POWERS: What is it? I guess that's what you're asking, what's in it.

DR. APOSTOLAKIS: Yes.

MR. KING: And you want some more information on what are we doing, what's the schedule --

DR. APOSTOLAKIS: Yes.

MR. KING: Okay. We can get you that.

DR. APOSTOLAKIS: I have a number of other questions. Can I go through them? Not detailed. Real-time decision-making using PRAs. You know, with the monitors now, people are beginning to use them more and more. In fact, I think there is a situation where -- I forget now -- when they go up to power, where they are asking that they be allowed to go to other -- that's a minor use really. But do you think that's something that you ought to worry about?

The original PRAs were not developed for real-time applications. They're sort of averaging a lot of things over time. But in a real situation, of course, you know that this pump doesn't work. I mean, you're not going to work with the unavailability of the pump.

So do you think that's something you may want to start maybe at a low level at this point, but to be ready? I bet you San Onofre is going to come here in a couple of years and say now we want to use this, because they are very proud of their --

MR. THADANI: They are. And this is probably what the future is going to look like beyond.

DR. APOSTOLAKIS: So you agree that maybe you ought to think about it.

MR. THADANI: Something we need to.

DR. APOSTOLAKIS: Low power shutdown. Let's see. Mario has already preempted this. I think I have one or two more.

DR. BONACA: You and I have lost some hair on it.

DR. SEALE: His is more evident than yours.

DR. APOSTOLAKIS: Thank you very much, Bob.

CHAIRMAN POWERS: I guess as long as we're asking questions. One of the things that I noticed about the program plans with respect to probabilistic risk assessment, the first thing I noticed was indeed there was, over the period from 1999 to the projections for 2003, an evolution, more and more of the programs became connected with probabilistic risk assessment.

It was very clear in the way things evolved. One of the things that surprised me was that research work on fire protection or fire risk assessment as opposed to fire protection seemed to come to an abrupt conclusion as though you would have solved the problem.

Is that the intention? Is that the belief, that you would have solved all of our fire risk analysis problems by --

MR. KING: No, that's a wrong impression. We had put together a fire risk research plan a year or so ago that carried us through the end of this fiscal year and at that point in time, we had hoped to have a lot of the modeling issues resolved and then we were going to decide where to go from here.

Now, Nathan Siu was working on where do we go from here based upon today's knowledge and, in fact, we're increasing the funding starting in 2002 in the fire area to get into not just risk assessment, but maybe some true fire protection research kinds of issues.

CHAIRMAN POWERS: One of the things that Nathan mentioned to us in the -- he came down and talked to us a little bit about his research program at the Fire Protection Subcommittee meeting and I guess they had been going through and hand-analyzing circuits, but they come to whatever conclusions they come to.

And he allowed -- he said it was tremendously manpower intensive to do that, and we asked him are they computerizable, and he said he thought so.

It struck me -- one of the industry guys came up and presented a hand analysis that he had done on looking at hot shorts and things like that and circuits and it was very clever what he had done, and so we asked him, is that computerizable, and he said, oh, yeah, you can do this, and you can imagine being one of these graphical user interface kinds of computer programs, where you draw out the circuit and then you can go in and say, okay, if the short occurs here, what does it affect and things like that.

That seemed like a very good idea to me.

MR. KING: That's the kind of thing we'll have to think about. Do we want to spend some money to computerize the methods that Nathan has developed in circuit analysis.

CHAIRMAN POWERS: It just struck me as to why was he doing inspections of plants with respect to circuit analysis, and I know we don't inspect on circuit analysis right now, but maybe we'll get back to it.

MR. SIEBER: Wait till you read my letter.

CHAIRMAN POWERS: But having that kind of a tool would be a tremendous asset.

MR. KING: Another thing Nathan is thinking about is should we take a plant that's done a fire PRA in the past and rebaseline it using the upgraded methods, circuit analysis, whatever the current understanding is and see what difference does it make, where are the big differences, where is --

CHAIRMAN POWERS: You and Jack may want to work together a little bit so that we -- right now, to us, fire protection comes to an end at 2001.

MR. KING: No. No. The budget goes up, actually.

CHAIRMAN POWERS: So we may want to understand and work out what the plans are in the future, if they aren't worked out yet.

DR. APOSTOLAKIS: Speaking of computer tools, SAPHIRE is a major project that has been going on for years, and I have a couple of questions.
First of all, it is claimed somewhere there that a sample of plants from each region have been loaded, the PRAs of these plants have been loaded on the SAPHIRE database.

Why isn't SAPHIRE the central tool that is used and that will be used in the oversight process? Why don't we have all the PRAs there? Why are we developing the significance determination processes if SAPHIRE did not exist?

I mean, either it is a major product of the Office of Research that is going to help us use the PRAs in risk-informed regulation or it isn't. And is there a problem with SAPHIRE?

MR. KING: No, and it's not a major expenditure right now.

DR. APOSTOLAKIS: Right, no, it isn't, but it's been for a number of years.

MR. KING: Development, originally, years ago, was expensive, but now the tools themselves in terms of what you use to develop fault trees and event trees are pretty much in the maintenance boat.

DR. APOSTOLAKIS: Right.

MR. KING: The money that's being spent is to add plant specific PRAs to the database.

DR. APOSTOLAKIS: And why are we happy with a sample of those and not all of them? Why not have all of them? The IPEs, you guys have the authority to request them, don't you? I mean, you are not at the mercy of the licensees.

MR. KING: There is nothing that gives us the right to go out and require those things be submitted. Some licensees have submitted them voluntarily. We have no basis for going out and saying you must submit it.

DR. APOSTOLAKIS: So what is the basis then of the significance determination process? If you don't have access to the plant specific PRA, I don't understand how the inspectors can assess the significance of a finding which was a finding at this plant using some sort of guidance that is not based on the plant's plant specific PRA.

CHAIRMAN POWERS: I know what the mechanics are. The mechanics are that they make -- in phase two, they make an assessment and then they give it to the licensee and ask him to go use his particular tools to see if they agree or disagree and if they disagree --

MR. KING: There is a phase three of the significance determination process, where we will do analysis and we can do the SPAR model analysis or if we have the actual plant PRA, we could put it on SAPHIRE and do that analysis.

DR. APOSTOLAKIS: But wouldn't it be a powerful argument to go to the licensee and say look, if you give us your PRA, we will do a better job when we do this evaluations.

It seems to me that would be a -- it is beyond me how we can have a risk-informed regulatory system without risk models for the licensee facilities. I just don't understand that.

DR. SEALE: Burden reduction ought to cut both ways, too.

DR. APOSTOLAKIS: I just don't understand it.

DR. KRESS: I agree, George.

DR. APOSTOLAKIS: We want the benefits of risk-informed regulation without risk information.

This is a real issue here. Maybe we can bring it up with the Commission. What is this business that we don't have access to the PSAs?

MR. SIEBER: They don't even have to have one. They don't have to have one.

DR. APOSTOLAKIS: But it's a voluntary system, Jack. The whole thing is voluntary.

MR. SIEBER: If you were on the staff and I was back in my job as a licensee, we would have a real interesting discussion about how much I would give you and why. That's the way licensees basically react.

DR. KRESS: You could make it a requirement of them.

MR. SIEBER: You have to have a reason to do that.

DR. APOSTOLAKIS: Jack, in the old days, you didn't have a risk-informed oversight process.

DR. KRESS: That's right.

MR. SIEBER: That's right.

DR. APOSTOLAKIS: Now you probably would have a higher incentive to be more cooperative.

MR. SIEBER: That's right. If we were into an enforcement mode, we certainly would perform whatever it is we had to do to make our case.

MR. KING: WE have SPAR models for every plant in the country. Those were developed by us using some consistent guidelines in terms of the scope and depth and the modeling assumptions that went in, how the data is analyzed.

DR. APOSTOLAKIS: These are for sequence precursor stuff.

MR. KING: Used for ASP, but they're also used for the significance determination process. If a licensee comes in and says no, that inspection finding is low risk and here's my PRA results, we can pull out our SPAR model and say --

DR. APOSTOLAKIS: Okay.

MR. KING: We can say, no, our SPAR model says it's high risk, and then the negotiation starts of why does your model come up with this number and our model comes up with that number and on a case by case basis, you settle which assumptions do you accept and which ones don't you accept.

DR. APOSTOLAKIS: If I were an intervenor, I would love this situation. It gives me so much ammunition to write a report that the NRC doesn't know what it's doing.

MR. KING: It's easy to say, well, let's just get all the licensee PRAs and we use those, but then you've got to go in and ask yourself how good are those PRAs. And that's a lot of work.

MR. SIEBER: It gets even worse because the plant keeps changing and it's keeping it up to date and things like that.

MR. KING: If it's ours, we've got some consistency. We know the basis for how they were developed and we can use them to start asking the right questions.

DR. APOSTOLAKIS: So why then is the significance determination process good enough if it is not based on some sort of reliable information? Is it very conservative? Is it a very conservative process?

MR. KING: The first step when you get the inspection results is there is some qualitative process by which you categorize something high, medium or low, and if that isn't good enough or there is a disagreement, you go into the quantitative and that's where you get into comparing what the licensee calculated versus what we calculated and why is there differences and settle on -

DR. APOSTOLAKIS: So the licensee might tell you I looked at my PRA and this is my number or do you actually want to see the PRA?

MR. KING: You actually can ask to see the PRA results that he used to calculate that number.

DR. APOSTOLAKIS: So if you do that maybe 50 times, you get to see the whole PRA.

DR. SEALE: It's what you really call man to man defense.

MR. THADANI: George, what you are saying is efficient way of dealing with issues, go straight to what really may, in the end, be the real good basis for determining how significant whatever the finding may be.

I think we have two issues that I would like to think we can get to where you would like to get to. But we have two issues. Issue number one is to get to a point where we can say yes, these PRAs today, updated PRAs, have a good enough quality and that's number one.

Number two, we have to make sure --

DR. SHACK: Whose PRAs, yours or the licensee's?

MR. THADANI: The licensee's.

DR. SEALE: How do you know, unless you know what's in them?

MR. THADANI: That's clearly -- we will not -- and I think Tom was saying that, that we won't know that they have the right quality until we have an opportunity to look at them, and Tom said that will take a lot of resources, which is true.

However, I think let's leave the issue of resources aside for a moment. We have another challenge which is industry has indicated at the last steering committee meeting that I had with the industry steering committee meeting, they said they would like to make these

PRAs publicly available.

DR. APOSTOLAKIS: That's an issue they are discussing now among themselves.

MR. THADANI: But we're not there yet. Now, if we could get to those two points, number one, we have some confidence in the quality of the PRAs, number two, they would be available for public, whatever decisions we make are scrutable, then I think what you say, to me, makes a lot of sense, why do we beat around the bush in a number of different ways, why don't we go straight to the tool itself, because we agree that the plants in this country are different.

There are lots of plant specific features that play an important part whether something is significant or not.

So I just think that we are now doing about as well as we can given the situation we have. I hope it will change.

DR. APOSTOLAKIS: Okay. Two comments. The first is a question actually. There is a number of licensees who are at the cutting edge of this technology.

MR. THADANI: Yes.

DR. APOSTOLAKIS: Have they volunteered to you their PRAs? South Texas Project, San Onofre, do you have those PRAs? They are very proud of their PRAs.

MR. KING: I think we have South Texas. I'd have to check on San Onofre. I could get you the list of the ones we have.

DR. APOSTOLAKIS: Okay.

MR. SIEBER: Are they on the docket when you get them?

DR. APOSTOLAKIS: No, not the docket. That's an issue that's being discussed, Jack.

MR. SIEBER: So they are not public documents yet. That's where the licensee problem comes from. Once you make them public documents, they take on a life of their own and you're obviously updating them. They're good ammunition for anti-nucs.

DR. BONACA: I think Jack has an important point. I think there is a true paradigm shift in the way you regulate. Before, there was a prescriptive approach or recipe. If you write your SAR, you complete it this way, you design the plant and then you ran it by the tech specs, then you're responsibility for safety. You have to live by these rules.

But then you know how you're running your plant and all you're going to check is that you live by these rules, which is really this boundary of rules of tech specs and so on.

Now, here, once you have a full-blown model of every single component in the plant, assuming that you could have that, which you'll never have anyway, now you're going to say I can make the same -- I can evaluate every decision you make. I can look -- every time you make any decision, I am going to look at it and check it and running the plant with you.

It's a real different -- it's a true paradigm shift in the way that they're running the plants and I don't think it's just an evolution.

DR. APOSTOLAKIS: But we like paradigm shifts. We did it with ATHENA.

DR. BONACA: But I'm not sure that people appreciate that almost at any level. Once you have that, that relationship there was between regulator and regulatee is very much changed.

DR. APOSTOLAKIS: Yes.

DR. BONACA: And there is an exposure, as Jack says, because everything is there in the open and it can be questioned and everything is going to be the basis for dispute.

DR. APOSTOLAKIS: Why are you guys resisting the notion of having SAPHIRE be peer reviewed? Shouldn't it go through the normal peer review? I don't understand that. We raised the issue, what, a year or so ago. There was sort of reluctance to do it. Now we are raising it again and we are told that people are using it, that's peer review.

I mean, would you do the same to a code like MAACS or say, gee, you know, this other laboratory used it once, so it must be pretty good.

CHAIRMAN POWERS: We certainly accepted that justification with open arms in the case of RETRAN, haven't we?

DR. APOSTOLAKIS: Yes. And the third point on the same thing is every time I have a student use SAPHIRE, he finds something wrong with it. Now, wrong not in the sense that, boy, the code is wrong, but certain things are not done the way they should be done.

And, you know, why not subject it to this process and say, well, look, this is what needs to be done and then we have really the best tool in the industry and when we load these PRAs, we really know what we're doing.

MR. KING: I don't know of any reason why we would resist a peer review of it. That's news to me.

DR. APOSTOLAKIS: I think we came out a year ago --

CHAIRMAN POWERS: I think we can pull out the EDO's response to us that essentially said we had the national labs look at it and --

DR. APOSTOLAKIS: Sandia has used it.

CHAIRMAN POWERS: -- a bunch of people used it and they loved it and so that's peer review. Quite frankly, what you guys have done on some of the contractor-developed codes, like SKEDAP and MELCOR, maybe VICTORIA, for peer review, where you get this panel together, they work the hell out of the code, they go through kind of a structured thing that Kevin Boyack set up and whatnot, and then they publish a report with here is all our troubles and then the guy that developed it, here is his response, yeah, we agree with this, these guys are all wet here.

I think that is so good, that is so wonderful. I mean, I can look at that and say, okay, read that, and it's better than the code users manual, because now I know what the strengths of the code are, its weaknesses, what to trust, not to trust. It is so nice.

You get no credit for that, by the way, but you get credit for me, because I -- even though I have been on the receiving end of that stuff, I think that's just the slickest best advertising you can do for your codes. The Europeans are just stunned that anybody would do this, but they love it, as well.

And it seems to me that these codes that you use, that the agency uses for its work, the SAPHIRE code and the one you use upstairs for dispersal --

DR. KRESS: Atmospheric transport.

CHAIRMAN POWERS: Atmospheric transport. If you had that sort of thing, it must be the greatest public relations tool in the world to say, yeah, we've had all these experts look at it, here is what they said, here's what we did to what they said, and you can read it yourself and if you don't like the code, you can figure out how you want to modify it.

DR. APOSTOLAKIS: SAPHIRE is playing a unique role here, because as you know, other industries, like NASA, other activities, are getting into this. Also, I teach, at MIT, courses to non-nuclear people on risk benefit and so on.

The moment that you tell you people that you can get a code that does fault tree analysis and all you have to do is log onto the INEL web site and download it for free, they do it overnight.

So all these non-nuclear people now are using a product of this agency. If they start finding things that are not good, I don't think it helps us. This is a unique situation, because other codes are really nuclear code, but this one, because of its wide applicability, really affects the way an important group of stakeholders think about this agency.

MR. THADANI: Frankly, I'm at a loss to know why we say no.

DR. APOSTOLAKIS: Great. So we don't disagree.

CHAIRMAN POWERS: Do we have other comments that people would like to make? Go ahead, Graham.

MR. LEITCH: We sort of left early on the topic of operational experience and how that fits into the budgeting process wasn't really discussed.

I assume there's a base there that handles that kind of work for the analysis of operating data.

DR. SEALE: I have an outline that Steve Mays gave me that outlines the specific topics in that effort and identifies the areas where as yet they have no funding, they're not supported, and I was going to use that to put together --

CHAIRMAN POWERS: That sounds good, because we really need to address this particular issue for the Commission and --

DR. SEALE: Yes, in some detail and that's what I plan to do.

CHAIRMAN POWERS: What we had recommended in our previous report was that the offices be kept separate. They didn't go with our decision. But that was neither here nor there.

The question is are we still getting that kind of data and the stuff we've been presented suggests that that activity is going on still pretty well.

DR. SEALE: Yes, and it's got like what does it turn into in the equilibrium situation where we're touching all the bases, but we're still accumulating more and more experience, so that the overall product gets better and better as time goes on.

MR. THADANI: Graham, you notice the history of when AEOD was created and what was one of the motivating factors behind that, there was a lot of push within Congress to create an independent board to look at the events that are happening at nuclear power plants, independent of the Nuclear Regulatory Commission.

And the Commission argued against creation of yet another independent board and the Commission proposed to create the independent office, called analysis and evaluation of operational data.

Its initial charter was to be independent of the line organizations to look at operational data, to do analysis of the data to make sure there is understanding and learning and what is working well, what may not be working well.

And so when almost two years ago, when the decision was made to eliminate the Office of Analysis and Evaluation of Operational Data, we had a lot of discussions when that function, this particular function was moved to the Office of Research, that it has to be independent, that the staff working on that part has to have direct access to me.

Anytime they have a concern or problem, they should be able to come and not have to get slowed down by the chain, I guess.

The reason I am going into that is to say that I am -- I think what we are doing is very pertinent. We have scaled down what we're doing, particularly in the area that Jack Rosenthal was involved in, until about two years ago, there were additional significant resources devoted to special studies of operational experience, very in-depth studies, like the service water system, air systems and so on.

And it's an issue that's on my mind that we have drastically cut back on and I have asked Jack to come to me and go over what are some areas where we should be doing special studies and we're not doing and how do we go about this delta, given the resources have been reduced.

I don't -- Jack has not yet come to me with that discussion as yet, but it is something that Pat Baranowsky's branch function is smooth. I mean, that is really smooth. It's been that way, it's continuing, and I think that's very good work.

On the other hand, Jack's branch, that also came from -- at least part of his branch that came from AEOD has really shrunk very significantly and it's something that I think I have to pay a little more attention to.

MR. ROSENTHAL: Rosenthal, RES. As the lumpy part, we did do a somewhat feisty report on air operated valves and working with the joint owners group on AOVs this year. We did a report on design basis events that the ACRS was briefed on, longitudinal study of what you saw and you were very complimentary on that report, so I thank you.

We've cranked -- just because of my inclination -- a lot of operating experience into the human performance area by doing all of the accident sequence precursor work at INEL that you heard about earlier.

So there is some synergy. You were briefed on the effectiveness of the blackout rule, which is both an engineering study and also an operational study, because we looked at that aspect. That's been a success. And we just put out for peer review a report on the effectiveness of the ATWS rule, which, again, makes use of operating experience, but within the context of the effectiveness of the ATWS rule.

Would we like to do more? Yes. Would we like to be smoother rather than lumpy? Yes. But we are working, we are doing work and we are putting out reports.

MR. LEITCH: For example, one of the areas that's interesting to me is the number of plants where a reactor trip results in loss of normal heat removal, for example.

Is that an area where you might do a study looking at that?

MR. ROSENTHAL: Sure, although I'll tell you, Pat's --

MR. LEITCH: And I'm not asking for a commitment. I'm just saying --

MR. ROSENTHAL: That would be the kind of thing --

MR. LEITCH: -- that just organizationally, that's where it would fit.

MR. ROSENTHAL: Right. Now, that, actually, Pat just put out an initiating event study. We might look at where the electrical grid didn't do what it was supposed to do, given that a plant came off-line, because that's more of a new issue created by the changing structure of the electrical utilities.

So Pat tends to be more in the data area and I tend to be more into are there new phenomenological or systems issues in the way we split our work. But, in general, yes.

MR. LEITCH: But I guess my question is really might some of these other research activities draw resources from this former AEOD activity or are those funds, to coin a political phrase, they had a lockbox that this much is devoted to former AEOD activities?

MR. THADANI: We are -- our resources are devoted on the basis of prioritization process.

I can assure you that most, if not all of the operating evaluation experience evaluation we do we think is of high priority.

I am trying to find some resources to respond to criticism, valid criticism, I think, that some of that AEOD function, once it has moved to the Office of Research, is not visible. AEOD used to issue reports, certain reports, which integrated a lot of information at the end of the year and they were very well -- they were very good and the public interest groups were very interested in seeing what they said.

I have been criticized that since the function moved to Research, they don't see that. I made a commitment that we will go back and we will prepare those reports, integrate the operational experience, and make them publicly available and I'm trying to see where I'm going to get the resources.

CHAIRMAN POWERS: And I think I would be really disturbed if the Director of Research was giving responsibility for this former AEOD function, but the money were in a lockbox. I mean, he should be able to prioritize, just like he does everything else. That's what we're paying the big bucks for.

What are we paying the little bucks for? Okay.

MR. THADANI: Thank Congress this year.

CHAIRMAN POWERS: Any other questions that people would like to pose?

DR. APOSTOLAKIS: Yes. There is a project here entitled Root Cause Investigation Improvements, and my information is that there is a substantial increase in funding for fiscal year 2001.

I wonder who is doing this and whether the work that was presented by INEL on latent errors is part of this.

MR. ROSENTHAL: Yes.

DR. APOSTOLAKIS: So yes is --

MR. ROSENTHAL: Let me go on just a little bit, and that is you have the reactor oversight process, as given, and with user needs from NRR, one of the areas that we would like to quantitatively explore is does the reactor oversight process address root cause adequately, what might it miss, what should be included, because the root cause analysis is a cornerstone and what -- the issue was brought up about how could you or should you combine findings and the idea was that it was very clear Commission direction that you shouldn't stack little findings up into a big enforcement action.

That's clear. But technically, are there small greens that you find that when you put together properly become a yellow or a red.

And so we're doing some exploratory work along that line. Now, I also have an activity to look at, at how is human performance picked up in the reactor oversight process, also. To what extent, et cetera.

Both of those projects build on the work on latent failures that we briefed you on that was done at INEL and then these two subsequent efforts. One is actually now another task in INEL and one is a task at Brookhaven.

DR. APOSTOLAKIS: Who is doing this?

MR. ROSENTHAL: Me.

DR. APOSTOLAKIS: It says P.S. and H.A.I. Who is that?

MR. ROSENTHAL: That's still another contract. It's Val Barnes and I will think of what P.S.H. and A.N.I. stand for.

MR. KING: Small outfit out of State College, Pennsylvania.

MR. ROSENTHAL: And we have used her and --

DR. APOSTOLAKIS: I didn't hear you.

MR. KING: It's a small outfit out of State College, Pennsylvania, and P.I. -- I forget what the initials --

MR. ROSENTHAL: And then we've used Bill Vessely as a sub on that work and, again, there, we have gone from, in the reactor oversight process, from a mode in which we look at the root cause analysis that a licensee does, that's what we did in the past, to now a four-course inspection of how well they do their own root cause analysis and this is generating guidelines on how we would do that work.

And, again, the issue of how should you sum up little findings, maybe you don't sum, you multiply, you use a PRA to do it actually, should you accrete small findings is, again, an issue there.

DR. APOSTOLAKIS: All right.

DR. KRESS: I have one other seismic question. Not to belabor it, but I would like to --

CHAIRMAN POWERS: Which we will anyway.

DR. KRESS: There are two sets of seismic hazard curves out there that are still markedly different. NRC has stated that because each of these were developed by an expert elicitation process that made use of appropriate elicitation procedures, that they can't rule one out over the other, because the one is -- they have no valid reason to say one is better than the other.

Therefore, when they go to make a decision that has to do with seismic hazards, it seems to me like they have a condition in which they have an ad hoc bias toward the one that's most conservative, because that's the way you do it.

If you end up with a result where one of them tells you yes and the other one tells you no, you're going to go with the one that tells you no.

So on an ad hoc basis, you have basically said we'll choose one over the other one, even though, in reality, there is no basis for that.

It seems to me like when you have such a situation, that you need a way to consolidate these two curves. There are ways to do that that have been explored, but I don't see this being pursued at all and it seems to me like it's a point that you -- it's a condition you wouldn't want to live with very long. You need to somehow get these two curves together.

I didn't see anything in the research stuff that I looked at that said you had plans to do that.

MR. MAYFIELD: There's a good reason you didn't see anything there. There is a reason you didn't see anything there. It's because we don't have plans to deal with that. I think your comment is something that we'll go back and talk about a bit and when we come to brief the committee, we can come prepared to address that.

But the reason -- and I don't mean to be flip about it, but the reason you didn't see it there, it wasn't an oversight. We do not have plans today to deal with it. But we will take it back and when we come talk to the committee, we'll -- we may no end up agreeing, but we'll at least come prepared to lay out our rationale.

CHAIRMAN POWERS: Well, I want to thank you guys for coming down and giving us a very thorough understanding of thinking about the future and what your planning is. We have a good understanding of what your ongoing programs are.

I think we will try to maintain the dialogue over the course of the next month, as we try to put together our draft. We'll probably chat with you on this more as things go on.

I will certainly communicate with you if I think there are things that you need to know about as we go along on this and ask that you do the same if you think there are things that we need to know as we prepare this.

We will have some discussion of this going on at the December meeting.

Right now, my intention is to not ask you come give a briefing, but if there are things that you would like to tell us at the December meeting, we will make some time available.

MR. THADANI: Okay. And let me also offer you an opportunity, at any point, if there are any issues you need some information on, I think we'll be pleased to do that.

We have been -- each of the last, I guess, two years, as you well know, I suspect, that there's been a lot of interest in this whole issue of sunsetting and sunsetting could be just totally eliminating doing something versus what we defined in our core capabilities paper as maintenance level, was basically sunsetting a research program.

Now, we've done that in several areas. I have -- and we can provide you whatever information you need for those areas, if you are interested, because I go through that as part of the PBPM process with the Program Review Committee.

I think one area where I feel very inadequate and I would really like your help on, and that is that for so many years, we have been so constrained by planning assumptions that we have allowed ourselves not to think the big picture and we have allowed our staff maybe not to think the big picture, also.

And with the trends that we have in front of us, I believe it is time for us to really focus on those issues. What are the big things that we're not paying attention to that are going to be with us down the road, and that's a challenge that I know the Chairman has given me, to look over the horizon, see what the challenges are, are we prepared for those challenges.

And I tell you, we have become smart thinkers, in a way, and I worry about that and this is a time for us to, I think, speak up, and that's why I'm also making sure that we hear from external stakeholders.

I thought George's point was also a good one. You solicit input from universities and other places as to what they might see what some of the future challenges might be, or maybe small, but nevertheless could be important issues.

And I would really seek your advice in what you think the direction ought to be and where the emphasis should be.

CHAIRMAN POWERS: I think to give you the two areas of feedback that I am almost certain are going to appear in the report is synergisms among the various licensing initiatives that are going on, power up-rates, high burn-up fuel, things like that, the synergisms are things that we need to wrestle with there, rather than looking at each one in isolation.

The other one is tools needed by the line organizations, be they thermal hydraulic or risk assessment tools, and it's really what is the vision for what those guys should have available to them as opposed to coming to you as a service organization to get things like thermal hydraulic analyses and stuff like that.

I think those are the two things I'm almost certain are going to show up in the report as directions for the future.

DR. SEALE: Operating experience data.

CHAIRMAN POWERS: Well, I think we can assure them that we're going to be looking at that and that we feel a need to report directly to the Commission on that particular issue, because they made some management changes and they need -- and they deserve to know if that's working or not working or whatnot.

DR. SEALE: Yes.

CHAIRMAN POWERS: And I get the impression, it's just my personal impression now, that it's sort of working, but there may be things that need to be worked out in it, but it's sort of working.

This issue of the visibility of the product is one that's independent of where it's located. We had the same problem with the AEOD studies in the past and so I'm delighted to hear that you're working it out. We will probably comment on that, that we need to work that issue.

I've often stated that this agency has the most remarkable capability of avoiding any opportunities of gaining any praise for the wonderful things it does and it's one thing that -- it's just a characteristic.

MR. THADANI: And I tell you what, Dana, we're paying the price.

CHAIRMAN POWERS: Yes, you are. Yes, you are. And George brought up to us the other day that there's a seminar being held up at Harvard on innovations in government. What bigger innovation can there possibly than a wholesale change of the regulatory philosophy than what's going on in this agency? I mean, it has to be the biggest change that anybody has ever seen, but it's not going to be represented up there.

DR. APOSTOLAKIS: Ashok, are you familiar with this?

MR. THADANI: I know about it.

DR. APOSTOLAKIS: Is the agency planning to send somebody?

MR. THADANI: I don't know the answer.

CHAIRMAN POWERS: It's a golden opportunity to advertise yourself, because you've really got -- I mean, you could well be -- as I said at the water reactor meeting, you could well be setting the example that public regulation is going to follow in the next 50 years, 100 years.

This could be the way things are done in the future and you deserve credit for those kinds of things.

DR. APOSTOLAKIS: I think you should go there in full force.

MR. KING: There's another one the week of December 4th by the Society of Risk Analysis.

DR. APOSTOLAKIS: No. We're talking about the Kennedy School of Government here.

MR. KING: I understand, but there is another one that NRC is not participating in that has a lot of interesting papers.

CHAIRMAN POWERS: To my mind, what I would do is every opportunity.

DR. APOSTOLAKIS: This other one really is a big level thing.

CHAIRMAN POWERS: You guys pay for not advertising yourself, when I think you're doing some remarkable stuff, truthfully remarkable stuff.

With that, I will bring this session to a close and thank everyone again.

[Whereupon, at 5:51 p.m., the meeting was concluded.]

CERTIFICATE

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

Name of Proceeding: MEETING-SAFETY RESEARCH PROGRAM

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Natalie Perino

Transcriber

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