UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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MEETING WITH THE ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

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PUBLIC MEETING

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Nuclear Regulatory Commission

One White Flint North

Rockville, Maryland

WEDNESDAY

JUNE 2, 2004

The Commission met in open session, pursuant to notice, Chairman Nils J. Diaz, presiding.

COMMISSIONERS PRESENT:

NILS J. DIAZ, Chairman of the Commission
EDWARD MCGAFFIGAN, Member of the Commission
JEFFREY MERRIFIELD, Member of the Commission

STAFF AND PRESENTERS SEATED AT OR NEAR THE COMMISSION TABLE:

MARIO V. BONACA, ACRS CHAIRMAN
GEORGE E. APOSTOLAKIS
THOMAS KRESS
DANA A. POWERS
WILLIAM J. SHACK
JOHN D. SIEBER
GRAHAM B. WALLIS

(This transcript is produced from electronic caption media and audio video media provided by the Nuclear Regulatory Commission.)

P R O C E E D I N G S

CHAIRMAN DIAZ: Good afternoon, gentlemen. Pleasure to see you all on that side of the table. The Commission is being briefed by the Advisory Committee on Reactor Safeguards. We are relying on the ACRS to provide us an independent technical perspective on the challenges that the agency face, and there are many of them, as you well know. Your advice is valuable to the Commission, and it really aids in our decision-making process.

Now, at the last meeting in October, we discussed some of the challenges that were facing the agency, including the continuing risk forming of our regulations and how we are going to handle some of the issues of the quality of the PRAs. We discussed power rates and advanced reactors. I think we continue to make progress in these areas, and we continue to streamline some of our processes. You help us in looking at our Reg Guides of technical contained research and so many other issues.

We are very interested in your views, especially some of your views that look at the long term on the research issues, also. We all realize we have a few specific technical challenges this year, including the PWR sump and the Davis-Besse lessons learned, and other various asunderies, which I am sure you are putting a significant amount of time to make our life easier, which is what you're here for, to make our life easier.

I turn my meeting over to you, to my fellow commissioners. Any comments?

COMMISSIONER MERRIFIELD: No, Thank you Mr. Chairman.

CHAIRMAN DIAZ: If not, Dr. Bonaca.

DR. BONACA: Yes, good afternoon. It is a pleasure to be here for our periodic update and meeting with the Commission. Today we have, as you know, six

technical presentations: PWR sump performance, PRA quality for decision-making, risk informing 10 CFR 50.46, 2004 safety research program, ESBWR pre-application review, and then the interim review of AP1000. So we have a full agenda.

I will just proceed with a very brief review of current activities and future activities of the ACRS that we are planning.

I'll start with license renewal. We have streamlined the ACRS review of license renewal applications, although I believe that we cover the ground that we have to cover for proper reviews. We have reviewed three applications since October 2003 and plan to review three more between until now and the end of CY 2004.

Next page.

We will review six applications in CY 2005. Also, we plan to review in the fall, I believe, whatever, the available -- the updates for the Generic License Renewal Guidance documents, the SRP, GALL, and the Regulatory Guide. I think they are good documents but there are improvements that are being made, and we are looking forward to working with the staff on this important task, which is the one of still improving the process.

Next.

On 10 CFR 50.69, we held a subcommittee meeting in February 2004 to discuss the resolution of public and ACRS comments on the proposed 10 CFR 50.69 and also to review the NEI Implementation Guidance Document, Revision D.

We are in the process during this meeting of the ACRS to review the draft final 10 CFR 50.69 and will provide comments to you at the end of this meeting, which is this Friday.

Next.

We are quite involved with advanced design. As you know, two of the

presentations today will be specific on AP1000 and ESBWR.

On the ACR-700 design, we held a subcommittee meeting with the AECL representatives and staff in January 2004 to discuss the ACR-700 design. We plan to review the staff's Safety Assessment Report later this year, and we also plan to tour the Chalk River facility in the September-October time frame. We're arranging the meeting. That's the facility where the design is being, well where the plant is being designed and the tests are being performed. So we'll travel up to Canada to do that, a subcommittee of the ACRS.

Next.

We have been involved in early site permit applications. We plan to review the staff's SERs on the ESP applications, and we anticipate the review of one SER in late CY 2004, maybe a Dominion application.

Moving on to the next slide.

I have three actually that lists future activities. It's a summary of activities under the first four headings, risk-informed and performance-based regulation, materials and metallurgy, advanced reactor designs, the resolution of GSIs. Actually, there are many tasks that we have planned, and we have revisions to the SRP, high burn-up fuel issues.

Next slide.

We just commented on the use of MOX fuel in commercial reactors, and we are going to be involved in dealing with safety and security and safeguard matters, assessment to research quality, and so on. I mean, there are only several additional items that I've listed here. They are self-explanatory. That gives you a sense of our involvement in a broad range of activities that are listed here.

That pretty much completes my presentation. I would like to move to the next

item on the agenda, which is the PWR sump performance. Mr. Sieber will make this presentation.

MR. SIEBER: Thank you, and good afternoon. During this session, I plan to discuss ACRS's assessment of the staff's progress in resolving PWR sump performance issues and the related issuance of Rev. 3 to Regulatory Guide 1.82.

As you know, the issue of containment sump screen clogging has been around in one form or another for the last 25 years. A similar issue for VWRs was addressed eight years ago. Now, the staff and the industry are taking action related to containment sump screen blockage in PWRs.

This issue is important because in PWRs, the containment sump is the source of water for re-circulation cooling of the reactor core following an LOCA event and is also used to cool and maintain the integrity of the reactor containment following a design basis or severe accident event.

In considering PWR sump blockage, there are lessons to be learned from past operating experience where containment sump strainer clogging has occurred. After the accident at TMI, there was some information that was reported, which is important to our consideration of the sump blockage issue today.

While the TMI accident was not an energetic LOCA event from the standpoint of jet impingement, causing dislodging and transportation of debris. It did produce accumulations of the debris in the containment sump when the pressure relief tank ruptured disc opened and containment flooding began to occur. Of course, this happened because the PRV was open for a fairly long period of time, and the PRT tank went over pressure and flooded. Eventually, they put about 350,000 gallons of water on the floor of the containment.

When licensee personnel entered the containment two years after the accident, they observed some debris located in the sump area. More importantly they discovered a gelatinous substance on the sump screen that was probably deposited by chemical reactions between hot borated reactor coolant and paint and other substances inside containment. This gelatinous substance would certainly trap fibers and particulate debris and increase the likelihood of sump flow blockage.

We believe that this chemical phenomenon is important when considering sump performance in PWRs. In the events of Perry, 1992 and 1993 and at Limerick in 1995, we learned that latent or fugitive particulate and fibrous debris is likely to be present inside the containments or in piping systems of even the most meticulously maintained plants.

While indications of sump clogging at Perry were initially discounted because of a lack of understanding that some of the debris generated could have come from fugitive particles and fibers, similar instances again at Perry and at Limerick indicate that fugitive particles and fibers are indeed present in the suppression pools of BWRs and are available throughout the containment to contribute to sump blockage.

All four events at Perry and Limerick were caused by safety relief valve operations, and sump blockage resulted from agitation of the suppression pool water by the safety relief valve discharges. In other words, these events did not cause a wash-down of fugitive particles and fibers inside containment but only from within the suppression pool.

The similar situation that a PWR would be more severe than these events since the safety valve discharge of a large, dry containment would involve more area, containment area, and potentially more debris than the BWR situations that I have just described.

At the Barseback Nuclear Plant, the Swedish BWR located on the Baltic Sea, a safety relief valve accuation occurred in the dry well, and that is somewhat similar to -- or analogous to a PWR discharge. The effect of the Barseback safety valve accuation inside the drywell indicated that the size and energy of the jet impingement zone of influence from a pipe break is important.

This event also indicates that in case of a discharge directly to the containment atmosphere rather than to the suppression pool, a larger quantity of debris can be disrupted, transported to the sump, and contribute to sump clogging. We also learned that canned insulation, depending on the type, does not offer too much protection from generating fibers and particles during an energetic event. Canned calcium silicate and fiberglass insulation are used in about 40 percent of PWRs. In fact, the size of the effect of the particulate fiborous material, metal fragments generated by destruction of the canning materials add to the sump screen blockage effect.

Now, when considering the amount of debris generation, the size, the orientation, and location of the break are important factors in determining the zone of influence where jet impingement will cause debris to become dislodged and available for transport to the sump. Even using the zone of influence concept, one must not underestimate the extent of latent or fugitive particles and fibers that are available for transport. In addition, if containment spray actuates in a PWR, additional quantities of debris are made available for transport to the sump screens.

Much analytical and test work has been performed to characterize the generation and transport of debris. Important factors are the fluid velocity, obstructing obstacles, and debris buoyancy and other physical characteristics of the entrained debris. Moreover, screen areas, screen mass size, and what I call the thin layer effect are

important considerations in determining the degree of sump screen blockage.

Incidents at Perry and Limerick and test data show that the head loss effect of fibers on sump screens is both nonlinear and non-monotonic. For debris that is not buoyant, there is value in engineered features, such as shields, curbs, and wears. These devices can intercept debris provided the velocity is low enough and stop most non-buoyant debris from traveling to the sump, while still allowing fluid flow to the sump. These features have been incorporated into the designs of some advanced reactors and could be installed in the current fleet of reactors.

Now, screen mesh size must be small enough to prevent blockage of coolant inlet passages in the bottom of the fuel assemblies and also in the containment spray nozzels. Further, depending on the pump design, there may be limitations on the particle size that a pump can tolerate in its working period throughout its mission time.

Another important factor, which was learned from the Perry and Limerick incidents, is that much of the sludge and fibers found on sump screens were likely latent or fugitive debris, not likely to show up on plant drawings or inventories of material.

Lastly, the chemical affects observed at TMI, which could cause gelatinous layer to form on the sump screen is important and research is not fully developed to describe this effect. Last summer, Los Alamos personnel conducted tests to study the chemical reactions between hot borated reactor coolant and coating materials, including zinc and aluminum.

These tests show that the chemical reactions do occur and precipitates form that do contribute to sump screen blockage. In addition, some preliminary experiments at Los Alamos, indicate that several other precipitates may be formed, some of which have a gel-like or sticky consistency that could exacerbate sump screen blockage. In addition,

hydrogen will be generated from zinc hydroxide that is formed in the hot borated sump water, which has been intentionally dosed to produce a high PH in the sump area.

The generation of hydrogen will alter the buoyancy of particulate matter in the sump and effect its transport. Certainly more research is needed to fully understand the effect of chemical reactions on debris transport and screen clogging.

Now, the ACRS has recently written two letters on this subject. The most definitive of our letters is dated September 30th and included in your books, and it's entitled "Draft Final Revision 3 to Regulatory Guide 1.82, Water Sources for Long-Term Re-circulation Cooling Following the Lose of Coolant Accident."

Earlier, we described our review of NUREG CR-6808, the Knowledge Base Report. Our judgment is that this is a good report of the research efforts and observations that have been done so far. However, this report is just what it purports to be, a compendium of scientific and operational knowledge base so far.

We concluded that this document does not represent a finished product from which design or evaluation guidance could be reasonably based. Overall, we have described some of the technical errors and technical challenges and inconsistencies in the knowledge based document. We were particularly concerned about apparent errors and inconsistencies in calculating the zone of influence of an impinging jet spray. We concluded that the report is not mature and can be confusing and cannot be used directly as guidance for the analysis of sump blockage.

We also noted that the knowledge base document contains a wealth of information about the test, experiments, and analyses that have been conducted so far. Unfortunately, not all of the work that contributes to this knowledge base applies directly to the problem or is either inconsistent or overly simplified. Further, when comparing the

predictions, which result from the use of the Knowledge Base Report with the actual results from the Barseback event, the resulting analysis under-predicts the Barseback experience in debris generation, debris transport, and sump blockage.

The Knowledge Base Report does not present consistent bases and adequate methods to properly predict whether debris clogging of containment sump screens will impair re-circulation pump performance.

We believe that the technical challenges inherent in the analysis of containment sump screen blockage are greater than the current technical guidance suggests.

We believe that additional research is necessary to resolve the inconsistencies and other technical problems inherent in the current guidance document.

We further believe that the additional research is necessary to understand the physical and chemical effects that are believed to take place inside containment under these harsh conditions and to factor this additional knowledge into the overall analytical methods. However, we have urged the staff to issue Regulatory Guide 1.82, Revision 3, to facilitate licensee response in the resolution of these technical issues.

The Nuclear Energy Institute is developing and implementing a guidance document based partly on NUREG CR-6808, which is intended to provide guidance to licensees in performing the necessary analysis. But this NEI document is not yet issued in final form and has not yet been presented to us for formal review. We continue to encourage the staff to carefully review this document.

Particularly important in the staff's review would be the accounting for the sources of debris in consideration of fugitive debris, the technical analysis of the effect of jet impingement, and the analysis of debris transport, and the correct treatment of the

nonlinear and non-monotonic nature of sump screen head loss due to deposited debris.

We suggested that the staff should investigate a risk-informed approach to sump screen blockage. However, we did not describe what the basis of a risk-informed approach might be since any risk-based approach would have elements of a policy decision, necessarily involving a determination of adequate protection, as well as a technical decision.

In our September 30th letter, we indicated in the case that the calculational uncertainties are large or that sump screen blockage is likely. Alternative solutions might be appropriate in resolving this issue. These alternative solutions might involve changing the types of insulation within containment, or providing additional sources of injection water to extend the injection phase, or developing diverse means of providing long-term re-circulation flow. There is a possibility that active screens or backwash capability might be necessary and appropriate.

In considering the issues of inconsistency, which we found in the current knowledge base, the apparent large uncertainties that appear to exist in some issues where current knowledge is scant, it is clear to us that additional confirmatory research and some additional basic research are still needed to reach a deterministic conclusion as to the adequacy the current or proposed PWR sump screen installations.

Now is the appropriate time to consider which direction the staff and the industry will take to bring satisfactory closure to this issue. The staff's response to our September 30th letter suggested to us that additional dialog with the staff would be appropriate to clarify our concerns. Therefore, we replied to the staff's response to us by our letter, dated March 18, 2004, to request this further dialog on this subject.

Thank you.

CHAIRMAN DIAZ: Thank you. I guess we'll continue. I think Mr. Sieber used half of the time of Dr. Apostolakis. I wonder if he's yielding. You're not yielding I take it.

MR. SIEBER: I apologize.

DR. APOSTOLAKIS: In your SRM of 18th December of last year, you directed the staff to develop an action plan to define a practical strategy for implementing -- what?

CHAIRMAN DIAZ: No. Nothing. Nothing. I was just --

DR. APOSTOLAKIS: Use the right word. You direct --.

CHAIRMAN DIAZ: I just said something right.

(Laughter)

CHAIRMAN DIAZ: I'm sorry. I couldn't help it.

DR. APOSTOLAKIS: To define a practical strategy for implementing the phased approach to PRA quality, which is the Commissioner's policy, we reviewed our Subcommittee on Probabilistic Risk Assessment -- reviewed this plan on March 25th, and we wrote a letter the 27th of April.

So our first conclusion is -- no, slide 18 -- is that the staff has developed a practical strategy that would encourage the development of guidance documents necessary to implement the Commission's phased approach to PRA quality.

Now, the phases are, of course differentiated by the availability of guidance documents, and this means consensus standards, regulatory guides and industry standards and so on. One issue that came up was what would happen if the various organizations that are responsible for developing these standards do not deliver in time because the Commission wants Phase 3 to be completed by the end of December of

2008.

In fact, we also saw a letter from the American Nuclear Society in the American Society of Mechanical Engineers to the EDO, dated last March that stated that the schedule that the Commission has is ambitious. So we thought that the plan should include some provision so that the staff would have time to develop its own guidance in case outside agencies do not deliver in time.

Just as a side remark, perhaps it's time to abandon the word "PRA quality" and talk about PRA adequacy for a particular decision because the quality may vary from decision to decision. And, of course, everything we're talking about here refers to what you called in the policy statement, baseline PRA.

We are now between Phases 1 and 2, and the staff felt that reviews of new approaches to certain issues are very resource intensive. So they proposed these new analyses should be given low priority. The committee felt that these analyses, usually done by very progressive licensees, they usually form the basis for the development of future guidance documents, which are essential to this approach.

So even though they are resource intensive, we felt that they should not be given low priority because this way pro-active licensees would be discouraged from pushing the boundaries of the state of the practice. Again, as usual, we make a distinction between the state of the practice and the state of the art.

In your SRM, you mentioned technical issues, giving three examples: Model uncertainty, very pleased to see that by the way; seismic and other external events; and human reliability. The licensee should be encouraged to address these issues, and we think this is great advice and the staff should give high priorities to the reviews that involve these technical issues.

We have been promised a document that would deal with uncertainty analyses. When we were reviewing Regulatory Guide 1.200, the staff promised that they would give us this document. The current estimate is that this document will be completed in December of this year. We believe, as we say here on Slide 24, that it should be given high priority. Now, December of this year is probably already high priority. It is urgently needed in my view, and even today we saw the need for it when we were reviewing something else.

This is it for me. I made up for lost time I think.

CHAIRMAN DIAZ: Thank you.

DR. SHACK: (inaudible)

DR. APOSTOLAKIS: Your microphone is not on.

DR. SHACK: -- 50.46. Our letter was written to address issues raised by the staff --

DR. BONACA: Your microphone is off.

DR. SHACK: -- in SECY-04-0037. One of the issues that the staff raised is whether the rule should be a narrow scope rule, where the use of a relied maximum break size should be permitted for some uses and not for other users, somewhat similar to what we do today for dynamic affects, where we have leak before a break, but you can't use that maximize break size for the size of the ECCS system.

If you have a broad scope application, you could use it for many applications as long as it can be demonstrated that the change in risk is small and that you are maintaining your defense-in-depth. Our conclusion was that the risk-informed revision 10 CFR 46 should permit this wide range of applications.

With a maximum benefit from focusing on safety -- important things like by

allowing its use for a wide range of things, you have more coherencies in the regulations. Again, you can't use leak before break for dynamic effects -- or you can use it for dynamic effects, but you can't use it for debris generation, and you're left with inconsistencies.

COMMISSIONER MERRIFIELD: Is your orange button on?

DR. SHACK: Yes.

COMMISSIONER MERRIFIELD: You may want to just pull back your mic a little closer. They are kind of sensitive that way.

DR. SHACK: Another issue that staff raised was the appropriate guidance for evaluating the acceptability to changes under the proposed rule. They have been arguing that for most cases, we had been using Reg Guide 1.174 and that perhaps you needed new, different criteria for something as fundamental as 50.46.

We feel the 1.174 guidance is appropriate. Risk is risk and evaluating it. Reg Giuide 1.174 has an extensive discussion of defense in-depth. We do think that in terms of 50.46, which is largely a defense-in-depth issue, that perhaps some more explicit criterion would be helpful. One of the things that we saw was to provide assurance of adequate defense in-depth. We wanted an explicit criterion for late containment failure that should be considered. The staff has already proposed such a criterion in their framework document, the conditional probability of large, late release. Again, some criteria like that is a possibility.

Next.

The Commission also directed the staff not to permit changes in ECCS flow rates for containment capabilities, again, to ensure that we had maintained sufficient defense-in-depth. We agree with the Commission's guidance in this thing but feel that we should have explicit criteria for mitigative capability should be development in order to assure that sufficient defense-in-depth is maintained as plant changes are made.

That is, we know we have sufficient defense-in-depth now, but again we expected a large number of changes could be possible and be made in response to a change in 50.46 with the revised break size. We want to insure that that defense-in-depth capability is maintained. Again, we need to ensure that the poolability is maintained. The important thing is though is to get this out of the design basis. We could use essentially realistic assessments of core damage rather than the Appendix K kind of conservatism.

Because of the low frequency of such events, we feel that these realistic PRA-type analyses will give sufficient adequacy of the defense-in-depth to give them a low frequency of the events.

Next.

Again, there is a question of how you pick a metric to define the new design basis maximum break size. We believe that that should be the direct LOCA initiating event frequency. This is consistent with sort of a rationalist approach that you really design for things that you expect to happen. You have a structuralistic defense-in-depth approach that says, “Okay, I do maintain some defense-in-depth even for things that are very unlikely to happen.”

We did not attempt to reach consensus on what this frequency should be for the new maximum break size. I would point out that in the framework document, the staff has considered a rare frequency initiating goal of ten to the minus five per year, but they suggested that for initiators a specific type, you can have ten to the minus six per year. Again, we haven't reached consensus or really discussed this in depth, but the numbers are on that order of magnitude. Since we are maintaining a defense-in-depth capability, it gives you a little different perspective. But as I said, we really have not reached a consensus on that.

The choice of the frequency is really independent of plant type. That, I think, comes to what you think is a reasonable design basis and how much defense-in-depth you want to do. The resulting break size, of course, comes from your analysis of what frequency the breaks are for different plant sizes. We think we can make generic definitions of the maximum break size if applicable to categories of plants. We think that it's sensible to make decisions in terms of a BWR or PWR split but not necessarily for each individual plant to have its own maximum break size.

The number and kind of plant changes allowable with a revised break size will really depend on the scope and technical detail of the licensee's PRA. Again, this comes back to the notion that the true measure of PRA quality is that it’s got to be adequate for the decision to be made. With a higher quality PRA, you can make different kinds of decisions than you can with a PRA of less technical scope and depth.

In all cases, we need a convincing demonstration that the resulting changes in risks are small enough. Again, if a limited scope PRA is used, we really do have to be able to estimate and convincingly bound the contributions to the total risks and change in risks for the emitted portions of the PRA.

The other important ingredient here, of course, is what the frequency of LOCA events are. Staff is conducting an expert opinion elicitation for these frequencies. Those results are not yet final. The results need to be peer reviewed.

We have done our own initial review of this process, and we feel that the process is well structured. The expert panel has an appropriate range of expertise, and we think that the results will be very helpful in providing a technical basis for the selection of a new maximum break size. We will be reviewing the draft final NUREG on the expert elicitation this summer, and we'll have our final review of that topic at that time.

DR. BONACA: Okay. This completes his presentation. The next presentation is on the ACRS 2004 report on NRC's Safety Research Program. Dr. Powers will present this material.

DR. POWERS: Hi. We recently submitted a report on the NRC's Reactor Safety Research Program. The scope of this report was restricted to a comprehensive examination of those research programs associated with existing light water reactors. Within that grouping of existing light water reactors, we did include those advanced reactors AP1000 and ESBWR where there is research supporting the certification program. We did not include the more adventurous or speculative designs, such as the GEN-4 designs. We had recently reported to you earlier on the planning for that research.

Just haven't had enough time for them to really progress far on that research. There were open questions about how GEN-4 plans are going to progress within the Department of Energy. We also did not include the work the ACR-700 reactor. It's not a particularly novel design, but it’s new to the NRC and work had just gotten started on that.

Of course, we leave to the Advisory Committee on Nuclear Waste to report on the waste research, and we will report to you under separate cover on safeguards research.

The considerations we had in looking at this program was to look at both programmatic justifications, as well as the technical work and the progress of the work. We were particularly interested in this particular review and trying to identify programs that had achieved their regulatory mission, and were reaching the point of diminishing returns as far as the need within the regulatory agency.

General observations on the research program, well, you have got a very well focused, well planned research program. It is trying to cover the waterfront of your needs for research support to the regulatory process. It is very heavily focused on support of

what I would call immediate term needs of the regulatory line organizations. There is less capability within the research program to do what I would say explore the regulatory process in search of perhaps longer term undertakings that could make major changes in the way we conduct regulations of nuclear power.

There are some efforts that we did highlight in our report that we thought were exceptional and noteworthy. I would bring to your attention, especially the high burn-up fuel research for reactivity initiated reactor accidents. This has to be a premiere example of a confirmatory research program, well conceived in its undertaking and well executed, yielding a product of direct use to the regulatory process.

Also, take note of the work being done in the PRA research supporting Reactor Oversight Program. It is actually quite amazing to me they've been able to accomplish as much given the demands on PRA and other aspects of the regulatory process. This is obviously a very highly productive organization.

We have seen some stay substantial rejuvenation in the work in human factors research. They are generating products of direct use to the regulatory process. We still think that there is need to develop an overall foundation for the objectives of human factors research within the agency, but the work they are doing is definitely proving to be quite frankly exciting and of use to the regulatory process.

Also, call attention to the severe accident research. They are attempting to bring greater realism in the analysis of severe accidents. But I think the point that's most interesting is their extensive use and commitment to international cooperation in severe accident research. It may well serve as an example of how to do cooperative research within the international community. In so many of these areas, we are finding no single country can really afford to solve the whole problem; and if we are going to attack these

problems to get realistic assessments, you are going to have to do collaborative and not competitive research.

We did identify some projects that we think have achieved some success. One of those is the really outstanding program that was undertaken to get a realistic assessment of the structural capability of existing reactor containments under accident conditions. This too was a collaborative international program, involving both experiments and the development of models. The experiments were used to validate those models. We think we have reached the point where those models can now be transferred to the line organization for use in the regulatory process.

Similarly, we think that seismic engineering has for existing reactors reached the point that it can be turned over largely to the line regulatory organizations.

COMMISSIONER MCGAFFIGAN: So, just as a clarification. Projects that have achieved success means they're over?

DR. POWERS: Well, I think our point was they had reached the point of diminishing returns. I am sure that any self-respecting researcher can always identify additional issues and additional things to do. But -- in this I --

COMMISSIONER MCGAFFIGAN: But you chose not to label this "some projects that have reached the point of diminishing returns".

DR. POWERS: Well, I try to be a nice guy.

(Laughter)

DR. POWERS: But I think it's an accurate statement there because they've achieved their success.

COMMISSIONER MERRIFIELD: Well, we have in fairness to ACRS, and I have been one of the objectionable parties, we have lectured them in their use of language

at various points during the course of the last few years. So, I am actually encouraged to see they are more selective in that.

DR. POWERS: Your research program also has the obligation to maintain expertise in those areas where it would be difficult for the agency to go out and get that expertise from the private sector and still have that expertise sufficiently independent of the licensees that would yield an acceptable product. I've listed here four areas that are of that nature, you just will not find a great deal of expertise in a community that is not working to support your licensees. So, you have to maintain your own expertise. Your research program is doing this and doing this fairly well.

There are some areas where additional efforts would be needed. We think that there needs to be an ongoing program of independently analyzing and evaluation of operational data independent of specific line needs. We believe the staff has also come to this conclusion and has an initiative in this area.

Fire safety research is an interesting area because we find that it's relatively risk significant. It has not received attention commensurate with its risk significance and in fact many of our computational tools are getting very geriatric in this field. In fact, one of the important codes for fire progression analysis I'm told there is at least at one national laboratory no machine capable running the code anymore because of its age. So, we have suggested a rejuvenation of the fire safety research in light of its risk significance.

Mr. Sieber has discussed with you the issue of PWR sump blockage. Another area though is the TRACE code for thermal hydraulics. The staff believes they now have the TRACE at the level of development that it is second to none in the thermal hydraulics field. It's now important to begin integrating that into the regulatory process and displacing the older codes that have been used in the regulations.

Some areas where we thought additional planning was needed. There is an interest in examining the utility of the NRC undertaking a pro-active materials degradation initiative. Of course, materials degradation is primarily a licensee's response. Staff is going to look to see if it can make a major contribution in this area, and we're certainly supportive of that planning effort.

Staff also needs to look at the continued study of reactor pressure vessel embrittlement. There is a substantial database that has been developed there, and there may be a utility and continuing to look at that to develop probabilistic fracture mechanic. And, staff needs to make an assessment there.

We are embarked on undertaking another initiative in connection with the research program. Research is required to have an independent evaluation of the quality of its research program, a quantitative evaluation. Research has approached the ACRS to ask if we would do this. We have agreed to try, and we will undertake the quality evaluation -- this is technical quality, independent of programmatic justification with the technical quality of the work. We've agreed to undertake the evaluation of two programs in this current fiscal year and four others in the next fiscal year to see if we can, in fact, meet RES's needs in this area. With that, I will conclude.

DR. BONACA: The last two presentations in the agenda are on advanced nuclear reactor designs, and Dr. Kress will provide both presentations.

DR. KRESS: Thank you. As you know, ACRS has been actively participating in the re-certification and certification of ESBWR, AP1000, and recently ACR-700. Our reviews are in various stages for those reactors. They're certainly not complete. They are ongoing. So this presentation is of the nature of another status report.

I'll give you the bottom line first. We will accommodate the staff's schedules

for these. Second areas, as yet, although our review and not complete, we have not what I would call a real show stopper. With respect to the ESBWR, our participation so far has consisted of only two meetings.

In the first, we familiarized ourselves with the design safety features and with the safety philosophy that they are using. In the second meeting, we had an early focus on GE's analytical tools for assessing design basis accidents.

We limited this at this time to the large break LOCA and the corresponding containment response. GE relies on their TRACG code for this, which is the same derivative as our TRACE code, and we have reviewed it in the past with respect to ESBWR. So both the staff and the ACRS are somewhat familiar with this code.

I think GE is in pretty good shape here because in the qualification in this code they have followed the CSAU process, which is something we always look for, and they have had extensive integral testing and separate testing, mostly related to the SBWR work. But they have done a scaling to show in a convincing way that that work is mostly applicable to the ESBWR also.

Our early conclusions about the TRACG application for large break LOCA is that yes it is applicable, and it has been qualified with these -- and can be used for that purpose. That's a limited approval because they plan to use it for a whole spectrum of design-based accidents, and we haven't reviewed it with that respect yet.

With respect to the LOCAs, the core is predicted never to uncover. So, there are large margins to the figures of merit for LOCAs. In assessing that the core doesn't uncovered, although it was a realistic calculation as opposed to Appendix K, they used a number of conservatisms in there in places where they couldn't be very realistic. In order to meet the 9595 criteria, they put the uncertain parameters to their two sigma values, and

still the core didn't uncover. So we think it's a robust conclusion that the core is pretty well protected under the LOCA events.

Some of our further review items that we have on our plate for ESBWR, this is not a complete list, but it's the ones that we have identified that we want to look at pretty soon. I mentioned that we gave conditional approval to TRACG for large break LOCA and other LOCAs, but we want to review their analytical methods for the full spectrum of design basis accidents and the results that they get from those.

I also mentioned to satisfy the 9595, they used the two sigma values on their uncertain parameters. That's probably okay. But it leaves us wondering just exactly what degree of conservatism is there. We'd prefer to see a real uncertainty analysis that gives us the distribution of these things and that way we can find the degree of conservatism and where the sources of margins are and what they are. So, we suggested to GE that that would be a nice thing for us to have. I don't know if the staff has accepted that or not yet.

They did a very good scaling analysis, but the staff described a somewhat unique scaling approach that they are having developed at the University of Maryland. We haven't reviewed that yet. It looked interesting -- sounded interesting, and we look forward to reviewing that.

The vacuum breaker issue. They have a new design for their vacuum breaker. It's a somewhat bigger than the ones they used in current BWRs. In assessing the design basis consequences they assumed a leak rate that is much smaller than what the experience has been with the current. We merely asked to see the technical basis for this assumption. We have yet to see that, but we'll get it in continuing reviews, of course.

We're fairly well along in our review of the AP1000 design. We have completed our part of the Phase 2, pre-application review. It was not very exciting because

we basically agreed with practically every position the staff had on the Phase 2 issues. We also agreed with Westinghouse's proposal for what they would like to put in that.

We did write a letter recently on March the 17th. It was an interim letter, our latest one on AP1000, and in it we identified seven technical issues that we basically needed additional information on. You could view these like an ACRS RAI. We have already covered several of those. You could probably see the list of these in the letter.

We are holding meetings with the Westinghouse and the staff during this week's ACRS to discuss the rest of these and see how they deal with the issues and what additional information they can bring.

We expect to have an FSER and review it in the July meeting, assuming that we are satisfied with what we hear about the seven issues that we identified in our last letter, and we will probably wrap up our review. I will probably write a finally letter following that. I don't think the seven issues that we identified -- I can't see them as show stoppers. They are not that serious from the standpoint of risk I don't think.

I note in passing on this particular slide, our reviews have not addressed security matters at all. We're leaving that up to the staff. We think if they satisfy the current regulatory requirements and the additional security matters that have been put in place that they will be at least as good as the current reactors, which we deem to be pretty good from this standpoint.

But the question has come before us in our discussions: Is there anything more we should do for new reactions in this respect? We have not discussed that, but it's an issue that we might want to have some guidance from you folks. But it's a question.

With that, I'll quit and turn it back to you, Mario.

DR. BONACA: This completes our presentation. I think we have recovered

some of the time.

CHAIRMAN DIAZ: I'll take it. You did well. You must have practice.

Well, I certainly appreciate the committee bringing the issues in a succinct manner, and I certainly appreciate also, I'm sure my fellow Commissioners did too, having the support information timely so we can review before we get to this meeting sometimes. It is important that we have a little bit of time, and this time we were well served.

Commissioner McGaffigan is supposed to go ahead. But because I have to leave for downtown in a few minutes, he's graciously agreed that I should start.

So let me start with one of my favorite subjects and that's deltas. In this case, deltas of safety. Mr. Sieber, you talk about the PWR sump and the need to do much more additional work in a series of areas. That's the way it sounded to me. You said there are significant uncertainties both in the debris size and the chemical reactions, etc.

My problem is I think this is an issue that we need to reduce to practice sooner rather than later. So can you give me a ballpark, you know, figure, estimation, in safety space, where are we from your perspective from being able to make a regulatory decision that is satisfactory, not perfect, that is sufficient to go forward with what we need to do now, although we realize we might have to do more later?

I think we are faced -- the Commission is faced with the fact that this issue has some significant safety importance to the point that it needs to be resolved. And we have been pressing the staff towards resolution of this issue.

Now, uncertainty is something that we all deal with in every day life. When the uncertainty reaches a certain point, something is triggered. My question is, is the issues that you are seeing triggered -- relayed, I would say, slow down, resolve this, this, and this issue before you go forth or are they at the point where you can go over with

regulatory decisions and then continue to narrow down the uncertainty?

MR. SIEBER: Well, is that's a multi-part question, and there are many ways to look at this. One way is to consider for example what the staff and we are doing with regard to the 50.46 rulemaking. That gives you some idea of what the likelihood of having a large break LOCA is, you know, pipe breaks that would be energetic, that would dislodge a lot of material, is probably in the range of ten to the minus fifth, which is pretty unlikely.

On the other hand, there is some uncertainty associated not only with that particular kind of number, but also whether all the safety systems will perform or not. So when you look at the issue of sump screen performance, you can go one of two ways.

One of them is to research and analyze forever until you come to a satisfactory policy decision as to what is safe enough and then make modifications to the plant. Or, you could be more aggressive in the kinds of modifications that one makes by saying I'm going to dramatically increase the sump screen size. I may put in back-wash capability. I may put in an active strainer in there, which has its downside, which is the power requirements to make that work, or I could add a new refueling water storage tank and, you know, just keep on pumping water in there and never get to the re-circulation mode.

So there is a variety of things and the trade-off to me seems to be how much time and money do you want to spend on the research to come up with a pretty definitive answer that minimizes the amount of physical changes to the plant versus accepting a larger degree of uncertainty and perhaps taking these alternative solutions that are more aggressive, much larger screens, active screens. So that would be the balance that I would see. So it depends on how fast you want to move.

CHAIRMAN DIAZ: Well, we have been wanting to move relatively fast. On

the other hand, I don't think that I've seen anything that says we need to go as drastic as active screens and as additional refueling tanks.

MR. SIEBER: Well, I'm taking the extreme.

CHAIRMAN DIAZ: Yeah, you are taking -- and that's precisely what I think the issue is. You know, has ACRS been able to narrow down the potential deltas in safety that will result from additional analysis to the point that the staff should be able to complete this in the time period that the Commissioner is trying to get this done? You know, we're talking a year. We're not talking years.

So, I think that is where I would call, you know, looking at the different issues, integrating them into a series of recommendations that would allow us to say, "This is sufficient. We have reasonable assurance of adequate protection provided by this and this." Of course, I think it's important that we try to stay within bounds of what can be achieved in a reasonable period of time without sacrificing safety. That's what I'm trying, trying to narrow these things down.

DR. BONACA: Well, to some degree we are elaborating on a comment we put on paper, a recommendation in the first letter we wrote. That was based on a review of work, which has been done to date that in some ways it's focusing purely on a deterministic fix. In that context, we have noted that, for example, this chemical effects that seems to be so important at the -- have not been considered.

So we have commented on what we have seen. It is not a complete basis to make those kinds of decisions. We have suggested, however, in a letter, for example, a risk-informed approach. Now, we did not specify how to go about it, but some of the thoughts have been presented here. That would lead certainly to a different path that may in fact provided a solution, but it's not right now the one being be presented to us. I mean,

we didn't see any thought in that direction and that may be in fact the approach that we have to take.

CHAIRMAN DIAZ: You mean an approach we will have to take if we need to move with whatever the decision-making is within a reasonable period of time.

MR. BONOCA: Correct.

CHAIRMAN DIAZ: Because what I haven't seen is what is the independent contribution to all of these factored chemicals, sizes and so forth. Once you change the screen size, you are introducing, you know --

MR. BONOCA: Right, my own --

CHAIRMAN DIAZ: So there is answer trade-off in here. You pay for something, and you gain something. The issue is what we want to do is to have a realistic approach that will gain us additional margin as needed. We don't need to have margins increased beyond the bounds of what the design basis is. You know, we need to make sure we are with that design basis, and my question goes to precisely at how this delta is placed within a manner that eventually the Commissioner can make a decision that maintains those safety margins according to a design basis.

MR. SIEBER: Well, to give you that short answer, which I'm sure we're striving to do, is the ACRS has not done that kind of calculations and analysis to be able to tell the staff where it is they ought to be. I don't see from the information we have received so far that we have enough data to do that.

On the other hand, I think that is a good approach as to how to arrive at an optimum decision in a reasonable amount of time. I think that we ought to pursue your suggestion to see if we can get to that point.

CHAIRMAN DIAZ: Okay. Sir?

DR. BONACA: Yes, but the point they're making is if we had to design traditionally, determinalistic, write a spec for this larger screen or whatever, the point we're making is I don't think there is sufficient information yet to do that. So we have to think out of the box as to some other approach maybe.

CHAIRMAN DIAZ: Maybe a hybrid to the proper approach. Maybe we need to have a consideration -- This is such a key issue the Commissioners have been working on and maybe our fellow commissioners want to jump in.

COMMISSIONER MCGAFFIGAN: You have to leave in five minutes. I don't want to eat into your time, but I do intend to bring it up later.

CHAIRMAN DIAZ: Well, let me go into the adequacy. Is that what it is?

DR. APOSTOLAKIS: Yes.

CHAIRMAN DIAZ: See, I can change vocabularies very good, especially when somebody speaks to me in Greek.

(Laughter)

COMMISSIONER MERRIFIELD: You are learning and learned Chairman. Is that what you're trying to tell us?

CHAIRMAN DIAZ: That is exactly right. So the technical adequacy, you know, versus quality I understand perfectly. It's a very good point. The things that we are looking at is I think the Commission is pretty serious about trying to subsume this into a practical set of guidelines by either year 2008 to bring us to Phase 3. And of course we got this problem with developing standards in which everybody wants to dot every "i" and make sure that it will stand the test of time. And I understand that. I've been there and done that, you know, and glad I'm not doing it anymore. It takes too much time.

But in between should we then ask the staff to develop guidance that in case the standards are being delayed that we should be able to move forward with the

approach?

DR. APOSTOLAKIS: Well, there has to be some kind of context where we decide to that. We can't just say stop, go, or have them develop standards for everything or guidance.

CHAIRMAN DIAZ: No, no, no. I'm not talking about a specific issue.

DR. APOSTOLAKIS: There are certain areas where we have seen a reluctance on the part of the industry to really go in and develop some guidance, the issue of model uncertainty, for example. In this case, we know enough and maybe the staff should do it. In fact, we are told they are already doing it. So the NUREG will be available at the end of the year, and there may be other places too. All we're asking in the letter is that since all ready two major societies expressed concern about the schedule that when the plan is finalized there should be some provision for the staff to intervene and do something.

CHAIRMAN DIAZ: So we should be prepared.

DR. APOSTOLAKIS: Prepared.

CHAIRMAN DIAZ: Conduct in parallel an approach that will assure, just in case there is a delay, that we would be able to implement what we want to.

DR. APOSTOLAKIS: And I hope it is not going to take as much time as the ASME standard, but that was the first one.

CHAIRMAN DIAZ: Yeah, yeah, but you never know.

DR. APOSTOLAKIS: You never know.

CHAIRMAN DIAZ: So, your recommendation will be that we continue to work with the standards, but at the same time develop a parallel path that will go through the Commission that we will be to move forward.

DR. APOSTOLAKIS: Yes.

CHAIRMAN DIAZ: Fine. I understand. Let's see. On the 50.46, the issue is, you know, trying to do the broad approach, and you recommended that. You know, that's a little bit of work to do in that area. But, do you think we need to do anything different for new reactors, the AP1000, or do you think the way that the rule is proposed right now or at least the guidelines, will it meet the test of time of the next 25 years? I don't intend to be here. So to make sure that the next 25 years are covered.

(Laughter)

DR. SHACK: I believe it will. It seem to me I don't see any impediments to its application for that next generation of reactors.

CHAIRMAN DIAZ: Okay. So you think that it will be good enough. Any technical issues that came out of your review on the 50.46? I know you were going, you know, searching on the key issues? Anything that jumped at you that the Commission should be aware of as a potential issue that will come out later on that we should already be looking at?

DR. SHACK: In dealing with the maximum break size, I think it's really the problem of pipe breaks due to known degradation modes is an addressable problem. I think the expert elicitation has looked at that. The staff is doing a large break LOCA of probabilistic fractured mechanics code that will give you more insight to that. The question of dealing with large break LOCAs from all other possible sources, including security concerns, is a much more difficult one to address.

I think that's one of the reasons we feel it is important to have the explicit requirement to maintain a defense-in-depth capability. But I still believe dealing with that in a realistic basis provides that defense-in-depth that you don't need to have a design basis

requirement.

So I don't believe there is a fundamental, technical issue there. Now, again, there will be many technical issues that arrive in the application of 50.46, as you try to address different issues. But I think in terms of the fundamental redefinition of the large break LOCA and the enabling position. I, and again, this is not something that we have addressed as an ACRS position, but I don't see a fundamental technical problem there.

CHAIRMAN DIAZ: Okay. Let me now, I have very little time, but we'll do a little bit of integration in here, the PWRs sump issues, the 50.46 and the LOCA, and the already experienced TMI, Limerick, and so forth. Isn't it a reality that the probability of having a problem with the valve appears to be much larger than the probability of having a break in a pipe? Isn't the issue of impingement on surfaces much more, you know, restricted to really in probably space to valves that are opened and discharged and to any of the other issues that we have looked at?

MR. SIEBER: Well, in PWRs I think an mal operation of the valve is far more likely than a pipe break. In addition to that though, you know, the discharges of PWR values are --

CHAIRMAN DIAZ: More energetic.

MR. SIEBER: Well, but it's captured. It's captures in, the discharge pipe goes to a blow off tank or glass tank of some sort, which takes the kinetic energy out of the stream. So as long as you are restricted to valve mis-operations and not pipe breaks, I think the concern related to jet impingement is far reduced. And really what you were talking about at that point in time is this fugitive and latent material that you are washing off the surfaces and --

CHAIRMAN DIAZ: Well that was my point. It is more captured or entrained

than the probability is less

MR. SIEBER: That's right.

CHAIRMAN DIAZ: So we are dealing with issues in here that I am trying to make sure they are put in the proper perspective in the matrix. The ones that we experience with BWRs were the valve discharging -- and creating the problems and so forth. And in the PWRs, we have the values that are entrained, then we are now looking at a reduced set rather than a larger set.

MR. SIEBER: That's right.

CHAIRMAN DIAZ: So I'm talking about reducing the set of potential issues so that we don't try to cover, you know, every possible discharge into the containment because then we will be out of the proper space.

MR. SIEBER: That's right. On the other hand, when I first wrote my talk, I put in all these kinds of risk arguments and was informed that not every member agreed.

[Laughter]

MR. SIEBER: It's much more general now.

CHAIRMAN DIAZ: That I can --

MR. SIEBER: And I agree with you.

CHAIRMAN DIAZ: All right. Well, that I can believe. And with that, I am sorry, but I'm going to have to leave. I might have a couple of questions that I might have to submit later.

Commissioner McGaffigan, will you please take over the meeting. Thank you.

COMMISSIONER MCGAFFIGAN: Thank you Mr. Chairman. Let me start with the sump screen issue where Chairman Diaz began and ended. I am not an expert in this area by any means, but we started working on this issue formally in 1996 and we

commissioned Los Alamos to do some work. We got the initial work in 2001. There is a September 2001 Research memo to NRR that I recall reading some time ago. And gelatinous material never raises its head during the first seven years of trying to resolve this issue.

September 30th of last year, you guys helpfully come along and say we got this phenomenon at TMI and Reg Guide 1.82 doesn't properly capture it at the moment. We need some research on that. The frustration -- I mean, I think that's just the history of it. The frustration is why didn't this come up sooner?

Because we are I think somewhat correctly criticized for this thing. The Research memo of September 2001 it's my recollection that they said that we could buy back for perhaps half the PWRs something in the order of ten to the minus four change in core damage frequency on a steady state basis. So, a delta CDF of ten to the minus 4, I should be working on that. I mean, if that's true for half the plants. It ain't ten to the minus two like the New York Times editorial page thought last summer, but ten to the minus four is a significant thing.

Why can't we get our arms around this? Basically, I am repeating the Chairman's question, and just take a swag at solving it? I mean, the French are coming along after us and they may be more willing to back fit and do conservative back fits, but they just ordered EDF do something. And, EDF is going to do something.

MR. SIEBER: Well, I've been here five years and I think this is the first opportunity that we've had to look at the broad scope coverage of the sump screen issue and what's been done, particularly through the knowledge-based document. And so, it was partly because of memory of old folks like myself and others, and reading old LERs.

COMMISSIONER MCGAFFIGAN: You were at TMI after --

MR. SIEBER: I was in the business 20 years at that point.

COMMISSIONER MCGAFFIGAN: Sure, and if we hadn't had you on ACRS, would gelatinous material ever have come up?

MR. SIEBER: Well, I wasn't the first one to remember that. Staff was to their credit. So, this is the first comprehensive look of the knowledge-based document that we have had, and I suggested additional research but it is not a lot of research. Very little basic research needs to be added to this. Some confirmatory research does, but the analytical methods are what need to be worked on, and that's to make them consistent with the actual physics and the kinetics of what water and steam jets do in confined spaces.

The gelatinous material I think is sort of a side show compared to large amounts of latent and fugitive fibers and particles. For example, at Limerick, which I consider to be a pretty clean plant, they have suppression pool discharge that puts 1,400 pounds of material on their screen. And to me that's a lot of material.

COMMISSIONER MCGAFFIGAN: I understand that. So if you were a single administrator, head of regulatory safety agency, and you could order -- I mean, clearly ten to the minus four, delta CDF if it's the right number is a substantial increase in public health and safety. You can order what you want. You can write the rule the way you want it. What would you do? In the next couple of years, what would you do?

MR. SIEBER: I think the best approach would be to resolve some of these outstanding issues that can be easily solved, you know, just correcting the analytical techniques, I think is not a difficult job. From that, you might have a sufficient technical basis to say, "Yes, we do need larger sump screens." I would use risk information including 50.46 types of information. To arrive at some practical solution that doesn't involve building another RWST or something onerous like that.

So, I think you can recover from where we're at right now on the same kind of

path and meet a reasonable timetable, but I don't think we're there yet.

COMMISSIONER MCGAFFIGAN: I hope we can get there because it has just dragged on longer than it should given the potential significance of it.

Dr. Apostolakis, you're my next victim. I read the entire discussion back in mid-April of your discussions about PRA quality or technical adequacy. Dr. Kress was heavily involved in some of those discussions, as were other members of the panel. I just wonder, I was on a panel with you about a year and a half ago at the Regulatory Research Conference, and you pointed out that PRAs have -- existing PRAs have lots of things that are not in them.

One of them you pointed is they don't model holes in heads of reactor vessels, but there is lots of other things that they don't do. The accident sequence precursor program points out that there is a bunch of precursors that are not modeled in any PRAs. PRAs are not routinely updated to take into account real operational data that -- you know, and I hope they are not updated selectively to take into account good operational data, while neglecting back operational data.

But there is just a whole host of -- and obviously PRAs don't attempt, nor should that in my view because we don't know what the initiating events frequencies are to deal with security, initiating events, taking out target sets -- partial target sets and what the likely consequences are.

Given all of those holes, just where are we in risk-informed regulation today? I'll just add one other -- I mean, Dr. Kress in the discussion kept going back and I'm working my way toward Tom Pickford and what some of those guys wrote last week in a GAO report, but you pointed out in these baseline PRAs, we have this famous diagram that GAO puts in their report where if you are ten to the minus four or below, you can make larger changes, larger delta CDSs, larger if it's ten to the minus five or below, larger delta

LERFs, if it's below, you can only make tiny changes.

But we have no clue -- I mean, we had this discussion before, what the total CDF or the total LERF is. So we have no clue where these plants are on this spectrum. Yet I don't know if we actually allow any of these more than trivial delta CDFs or delta LERFs to occur. Enlighten me. Enlighten me as to why I should have much confidence in Reg Guide 1.174, its actual implementation, when I don't have a clue what the total CDF or the total LERF is, given all of these holes in current PRAs.

DR. APOSTOLAKIS: Maybe saying we have no clue is a little of an overstatement.

COMMISSIONER MERRIFIELD: You wouldn't pin it quite so grim? Is that the case?

DR. APOSTOLAKIS: No. We have always known that the PRAs do not model everything, and in fact that's why we have a risk-informed decision-making process rather than risk based. I think the question really should be -- well, first of all, I think the Regulatory Guide by the way that you mentioned, 1.174 is great. It's the implementation that suffers. Everything that you want is there, but how it's implemented, there may be some holes.

COMMISSIONER MCGAFFIGAN: But how do I know -- I mean, I'm looking at it in front of me now to figure out whether I am in zone 2, where I can make bigger changes, or zone 3, where I can't make bigger changes. I have to know where my total CDF, baseline CDF, whatever baseline CDF is doesn't include a lot of stuff. But whatever my baseline CDF is, I have to have it below ten to the minus four. That is not, since it doesn't exist, we are told by everybody that it is not a total CDF that takes into account low power, shut down, fire, seismic, etc.

It's an internal initiating event, CDF, to the extent that it exists at all and apparently that's what we mean. I haven't read the details or footnotes of Reg Guide 1.174, but they must mean with a -- we're open for business and have been for some time and all you have to do is come in here and we're not even at, at Phase 1 in some sense of PRA quality. Come in here and assert you're in the ten to the minus four and below range, and we're open for business for delta CDFs up to ten to the minus 5.

DR. APOSTOLAKIS: Yeah.

COMMISSIONER MCGAFFIGAN: Is that how it works?

DR. APOSTOLAKIS: It's supposed to be the total. For low powering shutdown, the prevailing thinking is that the contribution to CDF is not greater than that from internal events. So if you want to double the CDF you get from internal events, you see where you are. You get some idea.

I think the most important thing is that in the Regulatory Guide, there are other constraints, like defense-in-depth, safety margins, and most importantly the monitoring program.

COMMISSIONER MCGAFFIGAN: I'm going to give all those up in 50.46. I give it up to Dr. Shack in a minute. Well, I'm going give up a lot of margin, right if I take a broad approach to 50.46?

DR. KRESS: Our letter on 50.46 recommended that you keep track of all these margin changes by the 1.174 process so that you keep it within bounds, within the bounds of 1.174.

DR. APOSTOLAKIS: But the monitoring program I think that is required after each change is a very important element of it because you will see what is happening whether things will evolve the way you thought they would evolve. Even if you look at the other elements of the risk-informed approach, is safety culture anywhere in there? I don't

know. That's another important thing.

COMMISSIONER MCGAFFIGAN: Let me just turn to Dr. Shack. On Reg Guide -- on 50.46, you're comfortable as I take it with this expert elicitation process where a bunch of experts are going to get in a room and search their memory banks and say that the number, given I've established what this frequency is, the number is four inches or eight inches. Then, somebody is going to say, "No. I think it's 17 inches", and you're going to sigmas based on expert elicitations, and we're going to end up with the number.

You're comfortable with that process? Does that happen in PRA all the time. Then, I'm suppose to be comfortable with that. That has high technical credibility?

DR. SHACK: It's used quite often in PRA. The process is not quite the way you pictured it with the desk experts in a room.

COMMISSIONER MCGAFFIGAN: They keep them in separate rooms.

DR. SHACK: Well, no. No. Asking an expert for the probability of a pipe break is not a good way to get an answer. You ask experts about the things that they know. What affects the crack growth rate? What affect does having a larger pipe diameter. They start with calculations and models and an experienced database and then try to determine how those are affected by these other parameters. It's a different process, a progress that I think is fairly robust.

COMMISSIONER MCGAFFIGAN: I have had some experience. I only see glimmers of these PRAs occasionally and there was some years back, a couple of years ago, there was a potential serious finding and I had the staff come brief me. The human error probability in this particular calculation that led to a certain color was .3, and I said, "Why .3?" Some expert had once said it was .3 I guess, and there is probably a range of experts.

But I don't know. You get different results depending on whether it's .3 or .2 or .15. It just strikes me that there is a tremendous subjectivity to a lot of this stuff that we

don’t admit.

COMMISSIONER MERRIFIELD: I think it would be helpful to explain it for me at least. You talked a little bit about that expert elicitation process and how those numbers determine. And it's not for purposes of clarifying the record, it's not merely people throwing out a bunch of numbers and picking one out of a hat. That’s not what happens. Can you clarify the record a little bit in that regard?

DR. SHACK: Again, you start with your experienced database. I mean you have a --

COMMISSIONER MCGAFFIGAN: We’re extrapolating way beyond experience here because we don't have a lot of experience with pipe breaks in the larger sizes, right?

DR. SHACK: But we understand from mechanics -- again how diameter -- the impact of a larger diameter has on the likelihood that if you have a crack, how does that affect the likelihood that you're likely to get a failure with that pipe. So we're almost dealing with a first principles kind of extrapolation there, given, you know -- well, we can't do very well for first principles is the initiating event. You know, how often do you initiate cracks? How often do you initiate flaws?

But you can go back to your experienced database and look at that. Then you have essentially additional information to tell you how that initiation leads to failure. You are extrapolating, but you are extrapolating with some physical principles. You have, again, expert judgment on how changes and variables can affect that initiation process they can't give you exact numbers. But they can tell you whether it increases or decreases by -- again, we're much better on deltas than we are on absolute numbers.

COMMISSIONER MCGAFFIGAN: But my judgment is based on absolute

numbers to some degree. We can tell somebody if their absolute number is bigger or smaller. They get more or less flexibility.

DR. SHACK: You can make very useful decisions with highly uncertain information.

COMMISSIONER MCGAFFIGAN: Now, I understand that. We do that all the time on this side of the table.

DR. SHACK: Our uncertainties would be very large in those pipe break frequencies. But what I believe is true is that most of the certainty is on the low end.

COMMISSIONER MCGAFFIGAN: Let me go back to Reg Guide 1.174. I'm just going to use three more minutes. Chairman Diaz used 20, and I think with three more, I'll be at 20.

I don't know if any of you had a chance to look at the GAO report that we got last week and Tom Pickford and his colleagues at the University of Michigan's comments about -- they were brought in by GAO to look at the NRC analysis. I'll just read you -- well, I won't read it to you.

But the heart of it, one piece of it, there are a lot of different pieces, but piece of it came down to trying to figure out what -- you know, these smart guys, all nuclear engineering professors, trying to figure out what Reg Guide 1.174 means when it's applied to something other than a license amendment, as the staff attempting to apply it in the Davis-Besse case They basically said, Well, Reg Guide 1.174 talks about -- has these regions and it talks about core damage frequency. It doesn't talk about core damage -- talk about risk. It's a frequency informed rather than risk-informed.

The staff in doing the Davis-Besse calculation calculated a risk number of probability, frequency times time, and the frequency times time numbers were in the range

that's okay in Reg Guide 1.174 but the frequency number wasn't according to Pickford and company. So, they questioned whether Reg Guide 1.174 is very clear on this matter, whether it doesn't need to be fixed.

I think the staff in practice uses delta -- when we do ask, we do delta core damage probabilities. When we ask people to manage risk under 50.65A4, we ask them to manage risk, not frequency or otherwise in some of the shutdowns situations, they wouldn't do some things. But for very short periods of time, they are in a relatively high risk situation, relatively high frequency situation but frequency time is very small probability.

So which is it? You guys are the experts. You can break a tie between the staff and GAO, or GAO's experts, Pickford and the friends. When you do a calculation for something that isn't a steady state situation, is it fair to multiply by the time period in order to get a risk number or are we supposed to reflectively stay within these regions as if it's a steady stay situation?

DR. APOSTOLAKIS: The way I see it, 1.174 is a frequency based guide. Frequencies.

COMMISSIONER MCGAFFIGAN: It's assuming a steady stay?

DR. APOSTOLAKIS: Yes. Now, one of the derivative Regulatory Guides after 1.174 was published, which I think dealt with temporary situations, puts additional information in there and derives, bounds on the condition of core damage probability now, not frequency.

COMMISSIONER MCGAFFIGAN: Right.

DR. APOSTOLAKIS: They're called incremental. So, as I recall, they needed some additional information. They didn't get it out of just from 1.174. They said, "Well, gee, if we can tolerate for three hours I believe such and such a frequency, that

gives them a pound. So this is the pound." This is only guide as far as I know that deals with incremental probabilities. Not -- steady state.

COMMISSIONER MCGAFFIGAN: So in some sense, the staff was relying on a probability calculation when they -- it took them a fair while after the fact to create this calculation that said we think a risk-informed decision was made. Just in some sense we should have been referring to a different Reg Guide, not to 1.174 because if the numbers are as Pickford and his colleagues suggest, they are in the unacceptable region for frequency. They're not necessarily in the unacceptability region for probability for risk.

DR. APOSTOLAKIS: Now remember, 1.174 deals with changes in the bases.

COMMISSIONER MCGAFFIGAN: I know. Right, and it's meant to be a steady state what happens long term.

DR. KRESS: Well, if I may.

COMMISSIONER MCGAFFIGAN: Yes, sir.

DR. KRESS: You're correct in saying that the real risk is a summation of products of probability times consequences. Now, I have a different view on this frequency thing. It's the frequency per year, and you multiply that by year, you get a probability.

COMMISSIONER MCGAFFIGAN: Right.

DR. KRESS: So you can convert 1.174 to a risk.

COMMISSIONER MCGAFFIGAN: No. I understand that. Embedded in 1.174 is that this risk is constant, steady state, and it doesn't lend itself to the sort circumstance we're dealing with Davis-Besse where we're saying, should we for 46 days of staff presumably in late 2001, should we for 46 days allow the plant to operate in whatever configuration they think they're in.

DR. KRESS: And it's completely appropriate there to use probability. It has the time multiplied by --

COMMISSIONER MCGAFFIGAN: I personally think it's completely appropriate to have used probability in that circumstance as well. Unfortunately 1.174 looks like on its face and you're verifying it as a sort of a frequency-based document and so you can understand Professor Pickford's confusion.

So, at some point we probably need either a pillory document or maybe it already exist, as you say Dr. Apostolakis, with regard to a non-steady state situation because we clearly allow it. In 50.65A4 space we clearly allow for short periods of time, risk significant configurations provided the risk is managed and that's all we ask them is make sure you understand what your risks are, you manage the risks, and the risks shouldn't be in an unacceptable zone. But the frequencies can be quite high for brief periods of time.

That's all. Thank you. Commissioner Merrifield.

COMMISSIONER MERRIFIELD: I'm not going to go over this sump issue anymore.

(Laughter)

DR. SIEBER: Thank you.

COMMISSIONER MERRIFIELD: We have appropriately plumed those particular depths. No pun intended.

Dr. Powers, first of all I do want to commend you. As you know I've had a long-standing interest in the issues associated with reviews that you have conducted on research. I certainly want to give my compliments to you and the other members of the ACRS for the work that went into NUREG 13, that's 16.35, regarding review of the

agency's research activities.

Obviously, I'm interested to see how Office of Research will react to your recommendations. Obviously, we've got some new folks in over there. So, we will be talking to Dr. Paperiello and others about that.

I did note that in your presentation on page 42, you noted that the Office of Research had requested the committee perform quality assessments of individual research projects. You indicated that you had gone ahead and done that. You are free to go ahead --

DR. POWERS: Well, we are undertaking -- it's a trial effort to see if we can meet their needs under the Government Accountability and Regulation. They have to come up with a quantitative score for the quality of their research. That's technical quality they're talking there, and we are going to undertake such an effort for them.

Our primary concern is clearly we'll set up sub-teams to look at individual research programs. How we get a score that's consistent from one research program to the next? We put some various measures in to assure that when we evaluate a human factors research program, it's getting a same consistency of examinations as we do for thermal-hydraulic research program. So, the scores are comparable because what the hope is that RES can use these quantitative numbers to improve the technical quality of its research program over the years. So, they have to be inter-comparable. We have to see if we can do this and achieve that by looking at these episodic in time rather than trying to look at them at once.

COMMISSIONER MERRIFIELD: I'm curious to get some sense as to how this is going to affect the other activities the ACRS undertakes.

DR. POWERS: The chairman sitting next to me will assure you that he too is

curious about this. We think we have come up with a fairly efficient approach to it, but that's clearly one of the things that we are putting in as part of the experiment. If this indeed is an all-consuming thing, we are going to have problems doing that. We may not be able to do this. On the other hand, what we are seeing is one of the biggest initiatives that we have been involved in over the last several years has been the license renewal reviews. And, we are finding a streamlining of that. So, we may in fact be able to find slack that will allow us to pick up this new activity.

COMMISSIONER MERRIFIELD: Given the inter-relationships between the Commission and ACRS, and the need to have you all act as an independent review of the activities of our staff. This wasn't -- I may be corrected on this. This was not one that I believe our Office of Research had cleared with the Commission. If it has a significant impact on the resources of ACRS --

DR. POWERS: About five years ago, I believe there was a -- the Office of Research had a separate committee for reviewing its research programs, and the Commission decided they didn't need it and that the ACRS would pick that activity up. So, we felt pretty much obligated to try to do this for them. It’s very much an experiment.

COMMISSIONER MERRIFIELD: I guess some of this may come to the Office of Research, but given the significant impact -- I mean, it might be a very good thing that you all have agreed to do. But ultimately, I think the Commission needs to make sure it's comfortable with that decision since we weren't involved in that agreement.

COMMISSIONER MCGAFFIGAN: Commissioner Merrifield?

COMMISSIONER MERRIFIELD: Yeah.

COMMISSIONER MCGAFFIGAN: If this is a requirement that this Government Performance and Results Act, alternative to ACRS doing it may well be getting somebody else to do it, where we might also be expending some significant

resources.

COMMISSIONER MERRIFIELD: At the end of the day, I may agree to it. But the point is it's a policy decision about who is going to do it and that's a decision for the Commission.

DR. POWERS: Well, I have to admit that we undertook it based on the decision several years ago. I can't remember exactly when but about five or six years ago to disband what was the NSRRC, which was the Research Review Committee, and turn that function over to the ACRS.

COMMISSIONER MERRIFIELD: Well, I understand. I understand. I mean, it's a response, and I'm not blaming anybody. I'm just saying the review is required as a result of a more recent government requirement.

DR. POWERS: Right.

COMMISSIONER MERRIFIELD: So ACRS together with Research got together and decided that it was appropriate for ACRS to conduct this review given all the history that goes along with it. In retrospect that perhaps making sure we're okay with what may be a major redirect of ACRS's activity.

DR. POWERS: Yeah, I think we will be better able to give you an idea of what its impact is after we have done our first two trials here between now and I think we're obligated to wrap those up in October actually.

COMMISSIONER MERRIFIELD: Dr. Bonaca, I noticed that high burn-up fuel is continuing to show up on your list of items that you want to address more attention to, and I wonder if you can go into a little greater detail of where you think you may be going in that area?

DR. BONACA: Maybe I'm not sure. Go ahead.

DR. POWERS: I should probably respond. Well, it's clear that the Office of Research has addressed one of the important issues of high burn-up fuel and that's the Re-activity Initiated Accident. I think we've got that in good stead. That still leaves open the other areas of how high burn-up fuel behaves under LOCA conditions and presumably under ATWS conditions.

They have work going on to look at how high burn-up fuel behaves under loss of coolant accidents. They are working on a cooperative international agreement to look at how high burn-out fuel behaves under core degradation accidents. It's all under the auspices of a confirmatory research program. They presumably would undertake work on how high burn-up fuel behaves under ATWS conditions. However, we are recommending to them that they probably have enough between what they have done on the reactivity insertion accident and what they are doing in the loss of coolant accident to perhaps address that ATWS condition analytically rather than experimentally between the two of them. That gets you to the current regulatory limit for high burn-up fuel of about 62 gigawatt days per ton burn up.

What we know is that the industry has an interest -- society has an interest, in fact, in going to even high levels of burn-up. And, it appears that we have a clad design that could tolerate those high burn-ups. You need to have your research staff in a position to look at what the industry proposes in going beyond those -- the current regulatory limit. That is presumably up to about 75 gigawatt days per ton, if we restrict enrichments to about 5 percent.

Now, if you go beyond 5 percent enrichment, then you can think about -- we have certainly seen fuel exposed up to 100 gigawatt days per ton. If the clads can take it and the fuels can take it, there's every societal reason to want to go there if there's no

unusual safety development in going to high burn-up.

Clearly, the rem effect and its consequences to develop and going from the mid-30s up to above 50 surprised us. Are there any other surprises between here and 100 gigawatt days per ton. Don't know. You need a regulatory staff that can look at what the industry proposes and anticipate if there are safety surprises in there.

And it's fairly challenging because the industry is very good at coming forward with rich experimental data on how the fuel performs under normal operating experiences. They are less aggressive in looking at how the fuel behaves in off normal circumstances or accident circumstances. You're going to have to have a staff that can look at what they are proposing and say, "No. You do have to have experimental data here," or "No, that's okay. We can physically extrapolate that kind of extrapolation, that there is no new physics emerging."

COMMISSIONER MERRIFIELD: I guess this one probably also goes to you as well. ACRS has been discussing an issue of synergistic effects with power uprates, license renewals, increases in cycle links and the fact that that synergisms needs a bit more attention. Now, my understanding is that the Office of Research is involved internationally in some collaborative programs in that regard. I'm wondering if you can comment at all on that activity and is that another fruitful area of international involvement?

DR. POWERS: It clearly is an international interest because all the countries are going this way, high burn-up fuels, changing the cycle length. Power uprates are not so aggressively pursued in other countries yet, but I think it's just a matter of time.

Can I tell you that there have been identified some significant synergisms there as well. Perhaps we are seeing some in BWR fractioning issues, but I can't say that we have had some real serious smoking guns. But clearly it's one to pursue among all the nations using what I would call western light water reactor designs because it's the same

issue. Collaboration on that is very useful.

We are getting some diversity of information because we see our European reactors getting greater experience using mixed oxide fuels. So, some differences here are going to be very useful to us.

COMMISSIONER MERRIFIELD: Last question, guys, for Dr. Kress. In your February 12th letter to the EDO, Dr. Travers, on the ESBWR pre-application review, you indicated the amount of substantive technical information contained in the SER was limited. This is not the first time this kind of comment has been made regarding the status of SER. Obviously, a communication on the rigor that staff reviews is important to the agency as a whole and certainly SERs would be a natural place in which to make that communication.

So I'm wondering if you can elaborate on that concern a bit more or whether that is underlying a more general concern about products that are provided by our staff.

DR. KRESS: This is a concern we've had for some time about SERs. They don't really reflect the extent of work and effort that the staff puts in, and then the full extent of their considerations when they okay a particular area. We dig that out of them in our reviews, and we discovered that the quality of their reviews generally are very good and extensive.

It's just not reflected in the SER very often. It would make our life a lot better and our reviews if they include much more of the detail of the review in the SER. It is the communication tool that tells the world why, what's the technical basis for our approval of this -- of a particular design or reactor. It's the place in my mind to deposit the staff's judgment. So far, the SERs we have seen just don't reach that level of communication.

So we have hammered on this issue a lot, and the last few SERs we have

seen have been much better than earlier ones. So it is having some effect -- I guess for the ESBWR that was almost relaxing back to the previous one.

COMMISSIONER MERRIFIELD: Well, I'm pleased to see that we've done our homework. We just haven't documented it.

DR. KRESS: That's basically our problem.

COMMISSIONER MERRIFIELD: It could a worse message in that regard. In terms of the engagement, have you ever come upon what you have as a model SER and say, "This is the rock that we're looking for." Have you had that level of engagement with our staff so that there is a degree of clarity about what the expectation is of SERs in that regard?

DR. KRESS: Yes. There was one, and I call on my colleagues to help refresh my memory. Do you guys recall the recent SER that we thought was getting close to what we thought was our standards?

DR. POWERS: Well, it's clear that some of the power uprate SERs have definitely been --

DR. KRESS: Yeah, I was one of the power uprates.

DR. POWERS: What I harken to is that 25 years ago, we put out SERs that were very detailed, very technical, on issues by the staff. They've fallen into a tendency to use shorthand and whatnot that I guess we're trying to reverse.

Have we prepared for them a document that says do this, but don't do this and things like that? No, we haven't done that, and I don't think we want to because the staff has to use a certain amount of judgment in putting these things together. What we would like them to do is to honestly reflect some indication of the technical rigor to which they are doing things, which oftentimes you discover is really quite good.

COMMISSIONER MERRIFIELD: Well, the ability to communicate the

information that you've understood through the results of research and review is important. Now, I harken back to some of the comments that the Chairman makes in terms of adequacy of a product in order for making regulatory decisions, and we need not go to the other end of the extreme of going back to writing "War and Peace," but nonetheless, you know, as a user of your letters and I see these comments frequently, it does raise a concern. But as I said, I'm glad to hear that it's not a problem of our not doing our homework. It's a matter of getting it on paper.

DR. POWERS: Well, sometimes you see particularly technical oriented members of the public taking these piecemeal documents and the elliptical language that might be used, the truncated language, and using that in their own independent analysis, and perhaps arriving at a conclusion that would not be substantiated had they done a more in-depth analysis and had available to them more in-depth information.

So I think you have to -- you owe it to your public to give them enough information so they know what numbers to use and which numbers not, and when not to use those numbers.

COMMISSIONER MCGAFFIGAN: Somebody else want to add something?

On behalf of the Commission, I want to thank you all for your presentations today. We do appreciate your independent look at a whole variety of issues. You touched on some today that we're -- the ones that is we were most interested in, but I can think of a lot of others. I jotted a couple down here. You know, your work on the mitigating systems performance indicators is appreciated. Your work on security is appreciated. We were in much better shape on power uprates today thanks to your urging the staff to come up with the standard review process for the power uprates, which we brag about now when we correspond with the people in Vermont.

You will be part of the Vermont Yankee power uprate review, and we expect you to take an independent hard look at whatever happens there. I know you'll be involved when the staff looks at this cross-flow issues, the staff's design of these new engineering inspections. So we'll have plenty time to talk about the next time you appear before us, and we know you work in all of those areas behind the scene and we appreciate it. And it's not particularly behind the scenes because aside from security and a few proprietary issues, you can go to the web page and get the transcript with mistakes in it of all of your meetings, just as you can get the transcripts with mistakes in it of all of our meetings.

So we appreciate it. I think you provide a great service to the American people. And with that, we're adjourned.