UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
- - -
MEETING WITH ADVISORY COMMITTEE
ON REACTOR SAFEGUARDS (ACRS)
- - -
PUBLIC MEETING
- - -

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland
Friday, December 6, 1996

The Commission met in open session, pursuant to notice, at 9:35 a.m., Shirley A. Jackson, Chairman, presiding.

COMMISSIONERS PRESENT:
SHIRLEY A. JACKSON, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
GRETA J. DICUS, Commissioner
NILS J. DIAZ, Commissioner
EDWARD McGAFFIGAN, JR., Commissioner

STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:
JOHN C. HOYLE, Secretary of the Commission
THOMAS KRESS, Chairman
ROBERT SEALE, Vice Chairman
GEORGE APOSTOLAKIS, Member
IVAN CATTON, Member
DON MILLER, Member
DANA POWERS, Member
WILLIAM SHACK, Member

P R O C E E D I N G S

CHAIRMAN JACKSON: Good morning, ladies and gentlemen. It is a pleasure to meet once again with Dr. Kress and the members of the NRC's Advisory Committee on Reactor Safeguards, who plan to discuss a number of topics of interest with the Commission at today's session.

However, since this is the last Commission meeting for ACRS member Dr. Ivan Catton, I want to pause for just a moment to express the Commission's appreciation for your eight years of dedicated service to the ACRS and to the Commission. In fact, I would like to present to you this letter expressing our sincere appreciation, signed by all members of the Commission, thanking you on behalf of each and all the Commissioners. Thank you very much.

MR. CATTON: Thank you very much.

[Applause.]

CHAIRMAN JACKSON: I also have a plaque.

MR. CATTON: Thank you very much.

[Applause.]

CHAIRMAN JACKSON: Over the years the ACRS has provided valuable and timely advice to the Commission on the safety aspects of proposed as well as existing nuclear facilities. I know you are considering a number of topics that are of critical importance to the Commission today. So we are fortunate to be able to draw on your expertise and

the views of you who are a selected group of technical experts as we try to solve and resolve various issues in licensing and regulation.

During today's briefing we will cover a number of

topics and I will just detail them for the record.

Digital instrumentation and control systems.

The plan developed by the Office of Research for upgrading thermal-hydraulic codes.

Risk-informed, performance-based regulation and related matters.

The potential use of IPE and IPEEE results to compare the risk of the current population of plants with the safety goals.

Use of the Commission's safety goals on a plant-specific basis.

The use of RuleNet in the regulatory process.

Dr. Kress and members of the Committee, my fellow Commissioners and I welcome you to this meeting and anticipate another candid and informative session with the Committee.

I understand that copies of the briefing material are available at the entrances to the room.

If my colleagues don't have any opening comments, Dr. Kress, why don't you proceed.

MR. KRESS: Thank you once again. It is a

pleasure to meet with the full Commission in a way of communicating and exchanging the views and maybe clarifying some of our views for you.

I don't have much else to add other than that. So I think we ought to jump right into the agenda. The first item is the digital I&C. That, of course, is under the cognizance of Dr. Miller.

MR. MILLER: Thank you, Tom.

I'm pleased to report that a regulatory framework for digital I&C systems has been issued, and that has been issued for public comment in the form of a Standard Review Plan Chapter 7 update, various regulatory guides, a large group of branch technical positions, and an SER on EMI/RFI.

The ACRS met in three different meetings, in March, May and August, to discuss these documents with the members of the staff. I might say that dialogue has been very constructive on both sides. We issued reports to the Commission in June and October following those meetings.

We do expect final review of the overall regulatory framework sometime in either April or May, depending on various schedules, public comments and the National Academy study. The Committee also expects recommendations made by the Academy study will be factored into the regulatory framework at that time in addition to public comments and an SER on commercial, off-the-shelf

software.

CHAIRMAN JACKSON: When do you expect the National Academy Phase 2 report to be available?

MR. MILLER: The current date that I understand is the middle of December. So just in a few weeks. We will, of course, have that very quickly, and I'll be reviewing it, as well as other members, during the month of January.

COMMISSIONER DICUS: That report was clearly overdue. There is a little bit of information, I think in part, at least, because of some of the complexities involved. Is there something else why this is running behind schedule? I had heard perhaps it was going to be into next year before it was available.

MR. MILLER: Members of the ACRS have really not been too involved in their debates. I think only one member attended one meeting, as I recall.

CHAIRMAN JACKSON: I don't think you can really control that.

MR. MILLER: It's their study.

COMMISSIONER DICUS: I just wondered if you had anything else on it.

MR. MILLER: There are difficult issues. I know some members of that study panel and I know their views, and there are very diverse views on several issues. They are trying to reach a consensus, and that's a challenge at

times.

MR. APOSTOLAKIS: I attended the meeting. The differences of opinion were significant. So I can see how the report can be very late. Very significant.

MR. SEALE: I think there is one other point. The Committee was very much involved in the process, working with the staff to initially decide to do the study, that is, to refer the issue to the National Academy, and so on. There was a rather conscious decision that it would be

inappropriate for the ACRS then to try to influence the direction of that study. So we've tried to keep our hands off of it and strictly act as observers to the extent that we did have any involvement at all.

CHAIRMAN JACKSON: Thank you.

MR. MILLER: Thanks for the question. We are anxious to see the report. It will certainly be very important to the regulatory framework.

There have been a number of issues and concerns we've expressed in our letters that I would like to review for you. Members of the Committee will probably make comment.

One is the level of detail provided in the regulatory guides.

The second is the balance and guidance between the review of design process versus assessment or product.

. 8

And then the linkage of the Standard Review Plan Chapter 7 update with other parts of the standard review plan, specifically probably Chapter 18, which is PRA.

A graded approach is based on importance of safety. I might make a comment. As the various parts of the Standard Review Plan PRA, which I know you are all interested in also hearing about, are evolving it is becoming evident that various parts of that might be important to digital I&C systems. So there may be an obvious linkage and obvious supporting situation between those parts.

Finally, we had a review of the I&C research program yesterday, and I'm pleased to say a number of issues there addressing both current research programs and planned research programs are important to I&C systems, particularly digital systems. Specifically, software and design, which are a noted weak link in the process of software development, and environmental stressors, which we have various interest in. Specifically, lightning, smoke and EMI/RFI, all being addressed by a research program.

I always like to close with a comment. As we look at digital I&C systems, particularly as they relate to safety systems, we always need to look back in history. I always like to look back at IEEE 279, which is part of regulation, which very clearly says safety systems in

. 9

nuclear power plants should be and must be maintained very simple. That means digital I&C systems with respect to safety systems have to be simple. In that respect, they should be able to be made safer and very effective in their use in nuclear power plants.

CHAIRMAN JACKSON: Let me ask you this question. I'm aware, and you've just made the point, that the Committee has raised concerns about the level of detail provided in the reg guides. Do the guidance documents contain acceptance criteria for things like software reviews and defense in depth and diversity, and if so, how would you characterize those criteria as they are currently laid out?

MR. MILLER: I think there is even diversity of opinion among the Committee members. First of all, the regulatory guides fundamentally endorse a set of industrial consensus standards, which really represent current software engineering practice.

In that sense, there is some debate about the level of acceptance criteria. I know my colleague Dr. Apostolakis will jump in on that one, because he has a lot of concern about that where the acceptance criteria are correctly specified.

I think in the area of diversity and defense in depth, those issues are more appropriately spoken to in branch technical positions rather than regulatory guides.

. 10

George, I'm certain you want to make comments on that one.

MR. APOSTOLAKIS: I really don't like what I see. I tried to follow the details of the guide. One of the things that strikes you is that you are continually referred to some IEEE standard. By the time you are done you have a whole pile of standards, each one sending you to another and another and another. I am exaggerating a little bit, but you follow all these references to another guide, another guide, another guide, and at the very end the ultimate advice is make sure you do a good job. To me that's not an acceptance criteria. You could have told me up front that I have to make sure I do a good job.

Example. You have to have a plan to review or to

develop the software. That's great. Let's have a plan. So you go a little more deeply to see what does that mean. All it says essentially is the acceptance criteria is "here's my plan." Then you say, okay, you have a plan. To me that means nothing. That means absolutely nothing, just to say here is a plan, thank you very much; you do have a plan; let's go on to the next item.

I don't see any requirements or any criteria as to what constitutes a good plan. The mere existence of the plan seems to be the acceptance criteria. And that's a problem I'm having.

. 11

CHAIRMAN JACKSON: Any other members of the Committee have any comments?

MR. MILLER: I think the counterpoint is that the standards do specify the quality of the plan in various aspects. They do specify requirements for testing throughout the plan. Each step you go through the software development process requires testing.

In the end the staff has to audit whether the plan is carried out or not. Maybe Professor Apostolakis is worried about how do you audit it and verify the plan has been carried out in a high quality manner. It does require you to carry out a plan.

MR. APOSTOLAKIS: Obviously there is a disagreement here.

MR. MILLER: One of the strengths of this Committee is there is not always total agreement.

MR. APOSTOLAKIS: Trying to understand how these documents work, what is a regulatory guide, what is this, an SLP and so on, I went back and I found some other regulatory guides for other issues that dealt with more, let's say, technical issues, like thermal-hydraulics and so on. And I found acceptance criteria that are acceptance criteria: You should make sure that the humidity is below this value. To me that's an acceptance criteria. To say "make sure you have a plan" is not an acceptance criteria in my book.

. 12

On the other hand, Professor Miller has argued that there is a certain culture among software developers. To them this kind of advice means a lot, which perhaps means that we are at the mercy of the reviewer. If the reviewer is very good, perhaps you will get a good review. If the reviewer is mediocre, you will get a mediocre review, because certainly the documents will not force him to do a good job.

It's probably an extreme position, but it was also very frustrating, frankly.

MR. KRESS: I think part of the problem here is you're trying to put together a process to assure a very reliable set of software, software that does what you want it to do. An ideal acceptance criteria would be that it has a certain reliability and it has a certain fidelity. It's just impossible, I think, at this stage of the state of the art of evaluating software to come up with such definitive criteria. I think one has to back off to controlling and defining the process in developing the software, which is what the standards and the reg guides do.

I just don't think there was any choice other than to write the review plan and the reg guides in a way that you focused on process and not the final fidelity and reliability of the product. This has been a debate among the Committee itself, process versus product, for quite a

. 13

while.

MR. MILLER: Each stage of development does test the product in the sense of that stage. What is missing and what is frustrating to some members is a final test of the final product to give you a number which says this product will perform with this amount of reliability. That's difficult. That's not able to be done with current software engineering practice.

MR. APOSTOLAKIS: That's a different issue, though. I was arguing about the quality of the process itself. The issue of process versus product is another issue. There I tend to agree with you that in this particular case it's very hard to test the product itself. So you have to control the process. What does controlling the process mean? Give me a plan? To me that is not controlling the process.

By the way, hardware also we have a problem when it comes to design errors, because that is essentially what we are talking about.

CHAIRMAN JACKSON: Is your difference of opinion due to what you think the IEEE standards that are endorsed in these reg guides actually accomplish, or you just don't like the kind of structural layout of the reg guide?

MR. APOSTOLAKIS: I would say both, but especially the former. I don't know what the standards actually

. 14

accomplish. In fact, Dr. Powers raised a very interesting question as to who actually puts together these standards, but maybe he can tell us about that.

Dana, I put you on the spot here.

MR. POWERS: It strikes me it's not the best example to raise on this issue of how you use expert opinion. In an area where you don't have a vast amount of experimental data to calibrate that expert opinion, you are really asking experts to prognosticate the future. We have a fair history that experts do a very poor job in prognosticating the future.

MR. KRESS: Present company excepted.

[Laughter.]

MR. POWERS: I've got several little skeletons in the closet that I've not told you about.

The NRC is frequently in the position where it has to prognosticate the future in its probabilistic risk assessments because it can't develop an experimental database on everything that we want to know about reactor accidents, and they have set a standard for how you use expert opinion in those circumstances. It's a fairly detailed, prescriptive approach.

The question I posed is, when we set these standards like this where we don't have a lot of experimental data, ought we not use this fairly detailed

. 15

approach that the NRC has set for using expert opinion?

Instead of saying to the community, in the case of software engineers, I'm going to write a standard and you are invited to comment on this, you say, no, I want to be sure I get comments from the width and the breadth and depth of that community. I want comments not from those people that attend the meetings and those people that are active in the community alone, but I want the comments from those people that are the Lone Rangers, the wild thinkers, the non-joiners as well, because they may actually have the insight that I need to prognostic the future here.

In fact, a study on expert opinion as it has been used in Great Britain when they frequently formulate royal commissions to look into various things like -- I believe one of the more famous ones is whether heavier than air aircraft could exist or not, and more recently, on utility of pressurized water reactors in nuclear power. When people went back and looked at the history of these committees, they found that if you were to bet on the most outlandish view as opposed to the majority view, you would be more right than wrong.

I think that is why you want a breadth of opinion on these areas where you just don't have experimental data to calibrate experts. The consensus standard approach that is used I think confines you to getting the much more

. 16

conformist view, because you tend to get members of the societies; you get the members who are employed by companies that are large enough that they can afford to have people devote time to this; and you don't get as extensive participation of those people in the startup organizations that are struggling to make a living but who may have the real insights for the future. The wilder opinion.

The question I posed is, is this consensus process correct for those circumstances where there is not a wealth of experimental data, or would it be better to use the process that in fact the NRC has developed and is now being academically researched? It has always been a great amazement to me that there are actually experts and expert opinion in the world. I'm very interested in the kinds of things that they are trying to do, because we do have to use expert opinion a lot.

This is one of those areas where I'm simply raising the question. Is the consensus process adequate for the NRC's needs here?

CHAIRMAN JACKSON: Let me make sure I understand one point coming out of all that you have said. Are you essentially positing that it is impossible to have a balance between the design process or the quality of the design process and the assessment of the final digital product in

the end, the software?
. 17
MR. KRESS: No, of course not. There has to be a connection between those two. The quantification of the final product is a difficult problem.
CHAIRMAN JACKSON: Is that a particular problem in this specific context, or is it one that is throughout many industries?
MR. KRESS: I think it is in the specific context of software reliability.
MR. MILLER: But that still applies to every industry.
MR. KRESS: Yes.
MR. SEALE: It's generic in the software in the I&C sense, not in the regulatory sense.
CHAIRMAN JACKSON: In the nuclear sense.
MR. APOSTOLAKIS: It may be in fact simpler for us in some respects, because according to the experts we are not really using systems that are too complex. All the horror stories about software that are in the literature come from very complex systems, like a shuttle, and so on. We don't have those. We don't have those. So for simpler systems probably you can do a better job. There is no question that the answer to your question is, yes, we can have a nice balance.
COMMISSIONER ROGERS: You say do a better job. Do a better job on what, the process?
. 18
MR. APOSTOLAKIS: The product.
COMMISSIONER ROGERS: I seem to hear you saying you could focus more on the product for simpler systems rather than the process.
MR. APOSTOLAKIS: Yes.
CHAIRMAN JACKSON: Or equally.
MR. APOSTOLAKIS: Or equally, yes.
COMMISSIONER ROGERS: Or some combination.
MR. APOSTOLAKIS: Yes. You can test it. If it's simple, you can test it. You can apply simple methods for analyzing it. If you have a huge system that is controlling a shuttle, that's a different story.
COMMISSIONER DIAZ: Is it possible to really make a very specific QA program for the process and the product, so specific that it will actually give you guidance of acceptability of both?
MR. APOSTOLAKIS: By specific, you mean for the specific product?
COMMISSIONER DIAZ: Right. Sometimes we tend to take QA programs as very broad things. Can we really be more specific and actually apply it to the process and the product with some common points that enables you to conduct the process?
MR. APOSTOLAKIS: I believe that would help a lot. That would help a lot. If you look now at the guides, they
. 19
really don't address, as far as I can tell, the specific systems we are using or are about to use.
Again, when I visited the Academy committee, it was the same thing. You say something and you are hit with three weird incidents someplace in a very complex system. Then you scratch yourself: Does that apply to me?
I think the fact that our systems are not very complex has to play a very central role here.
MR. MILLER: The standards themselves are developed for the software industry, not specifically for our particular type system.
MR. APOSTOLAKIS: That's correct.
MR. MILLER: As a consequence, they were developed generically for complicated systems like you find in the space shuttles and airplanes, and so forth. As long as we keep focusing on the fact that nuclear power plant safety systems should be simple, then agreeably we should be able to maybe do better than we are doing with these standards. But what we are endorsing is these standards which are current software practice, and we just need to keep looking for better ways to do it.
CHAIRMAN JACKSON: I think, though, that there are two things that one could ask, one of which Commissioner Diaz has already asked, and that is, can an appropriately focused QA program or effort as part of the design process
. 20
itself track to certain comfort about the quality of the product?
The second issue is, if you are already saying

that the existing standards are for more complex systems than one typically is focused on in a nuclear plant, that these are the accepted standards, but therefore a more complex universe, but we are somehow saying that our universe is more simple, then it strikes me that should not embedded in those be the ability to try to develop something like what Commissioner Diaz is talking about, and why can there not be focus in that particular area?

MR. APOSTOLAKIS: Do you want an answer?

CHAIRMAN JACKSON: A short one.

MR. APOSTOLAKIS: I think what you said can be done. I think the next round it would really be useful if the staff summarized or took what they felt was important from these IEEE standards and not keep referring to one standard after the other, after the other. It can be done in a simple document.

CHAIRMAN JACKSON: In fact, then, it would be fair, as you call it, in the next round, however that is defined, to ask the staff to do that and to think about how that can be used in the context of Commissioner Diaz' focus and then to have you gentlemen come back and comment again.

Let me see if any of the other Commissioners have

any questions. Commissioner Dicus.

COMMISSIONER DICUS: No.

CHAIRMAN JACKSON: Commissioner McGaffigan.

COMMISSIONER McGAFFIGAN: No.

CHAIRMAN JACKSON: Commissioner Rogers, do you have any further questions?

COMMISSIONER ROGERS: No.

CHAIRMAN JACKSON: Commissioner Diaz.

COMMISSIONER DIAZ: No.

CHAIRMAN JACKSON: Let's move on.

MR. KRESS: Very good. Let's move to the next item, which is the research plans for upgrading the thermal-hydraulic codes.

Ivan, you're on.

MR. CATTON: I believe the path that was initiated by RES is a good one and the ACRS supports it. I basically agree with the views expressed in the letter but would like to balance the initial euphoria with a few of my own views.

In the past, the ACRS has recommended that further development of codes like TRAC and RELAP5 be curtailed and that some resources be focused on a fast running code for a PWR and like the BNL code for BWRs. At this time the BNL code has disappeared and a fast running code for PWR has never appeared.

There are a number of reasons why I still lean

towards this view.

First, the two-fluid modeling that is the basis for both TRAC and RELAP5 is one of the more challenging problems in heat transfer and fluid mechanics. Because of its complex closure relations, a great deal of detailed experimental data is needed, and for the most part it does not exist. As a result, there are many ad hoc relations that are tuned to macroscopic data in these codes.

Some examples are simple things. Like a droplet in a decelerating flow versus an accelerating flow. What happens to it? A good example is, if you have fog in a room and the velocity goes to zero, these codes will predict the water falls on the floor.

There are others. Dynamic flow regimes. How do these things change as the conditions of the problem change?

Unfortunately, in the past, agency support for producing the needed data and understanding has not been forthcoming. And I don't see it now. Without it, two-fluid modeling has evolved about as far as it is going to.

The three facilities, an AP600 at Oregon State, an SBWR at Purdue, and a B&W plant at the University of Maryland, along with the relationship with the French will yield a great deal of what is called integral system data. This is the macroscopic data. And because they are very well instrumented, in fact they are far better than anything

we've had in the past, some of the detail type information needed for support of codes like TRAC and RELAP may be forthcoming. Without special emphasis, however, I think it will fall short.

This doesn't mean that codes like TRAC are not valuable. They are, and they have been terribly neglected and for the most part the user has been ignored, leaving their use to the dedicated code jock. I can define that if

you want.

The plan to revitalize TRAC by updating the FORTRAN and development of graphical interface and input along with consolidation of all that is good is long overdue and should be encouraged. You have several people in RES who are highly qualified to do so. Further, the involvement of users from NRR and AEOD will add another dimension to the process. I believe this is essential.

In the past, the problem has been that once the code process started, it was somewhere else and the user came later. As a result, these codes were not very user friendly, and I think if you want to make good use of the computational capabilities within the agency, they damn well better be user friendly. They have to be other things too, but that's important.

What else should you do?

Codes like TRAC have a history of not performing

. 24

well when presented with new problems. This is not surprising when you realize that the code was developed for a large-break LOCA, which is a fast transient. That makes many facets of the two-phase flow and heat transfer relatively unimportant. And that there was sufficient data to tune the codes. We have a great deal of large-break LOCA data. It essentially became the biggest empirical fit you've ever seen.

There is nothing wrong with this, and much of the complexity in the code was needed in order to get it done. A simpler tool, however, would also have done the job. There are lots of examples of this where a much simpler tool can accomplish the same thing as the big code. It requires skilled people to make the judgments as to when you can do what.

The problem was we were carried away with the view that given the right set of equations we could solve any problem, and it took a long time for that euphoria to wear off. This started in the early 1970s. It was a very heavy-duty committee that was put together to help start this thing off and running, and when all those equations were up on the board, we all got excited.

There are many difficulties with the codes. For example, one cannot do time and space conversion. The basic part of the code is quite weak. This is one of the reasons

. 25

you have to tune them. You can't do the conversion studies. A lot of what is done with them is just because that's the way it was done before; we've interpreted data to fit the way we've done it. This is a problem.

Yet the code did meet its target mission, and much more. I think these codes are very good for problems where we know how to use them, and they will continue to be useful, but how far you can push it is another question.

During the past 20 years we have seen a number of issues arise and found our computational tools to be defective. The problem was they were too inflexible and rigid to allow changes needed to focus more on a particular phenomena. I can name a few of these if you wish.

The new plan includes a task that will supposedly deal with this, and it is to make the code modular so that a separate model can be incorporated. For example, if you are treating the pressurized thermal shock, you can have a CFD code that could be inserted somewhere to deal with it.

There are a lot of things you have to think about before you do that. If you are going to start interfacing different kinds of tools, you damn well better make sure that whatever the structure is can accommodate this. If it's successful, it will go a long way towards dealing with my concerns. A demonstration that this can be done supposedly is underway. I've not heard about it. I don't

. 26

know when the results will be put on the table.

Another aspect is computational time. I think you need to have codes that you can get answers quick and you can look at a lot of parameter variations. If you don't have that, you don't properly evaluate the problem you have at hand.

Again, the large-break LOCA was a fast transient and required a particular kind of time advancement algorithm. It was also forgiving. So one could be numerically careless and not worry too much about things like numerical dissipation. If you want to treat reactor instabilities of some kind or another, you don't want something built into your code that damps disturbances. You

just don't want that. And you have to go to special lengths to make sure it doesn't happen.

With the AP600 and the small-break LOCA on the table, we are now faced with long duration transients. AP600 long-term cooling is an example. And as Westinghouse is finding out, they can't afford to do the calculations. So they have to play all sorts of games to pick up pieces of it as it moves along.

A problem like this is a quasi-steady problem. Why the hell are you using a transient code? I don't understand, but some aspects of this business are beyond me.

To summarize, I believe the cleanup,

. 27

standardization and consolidation plans are essential. Right now you have a tool that is difficult to use, inflexible, and it costs you probably more money in trying to use it than it will cost you to fix it.

Before further development, however, I think RES should take a serious look at future needs of the agency and assure you that the bases and resources are available. There must be sufficient reason and resources coupled with a commitment to pursue the basic understanding needed to support the underlying two-fluid modeling concept before marking on a new two-fluid code program.

The needs have been delineated repeatedly for the past ten years. Almost every meeting you go to. You were at the CSNI meeting, and I bet somebody could show you a viewgraph from that meeting that doesn't look very much different than one we would have put up ten years ago. There are just difficult problems, and nobody has come forth with the resources to eliminate them.

Flexibility and modularity are another aspect. If they cannot be accomplished, I think the effort should be downscaled and consideration should be given to different codes for different problems.

Sort of as a final note, the computer code should not be more detailed than your understanding and data will allow. Don't make the same mistake we did in 1974.

. 28

CHAIRMAN JACKSON: Let me ask you a couple of quick questions. When you talk about the need to deal with issues having to do with computational time with an ability to have variation of parameters, are you saying that it's an issue having to do with modeling, the kind of algorithms used, or the platforms, or all of the above?

MR. CATTON: All of the above. I think that Wolfgang Wolf did that at BNL. He set out to put together what he called a plant analyzer, but he set out to put together a program that was based on data as he had it to analyze the BWR. His ground rules were fast, reasonably accurate, and an ability to address a wide range of types of problems. When the LaSalle instability incident occurred, it was really good that the agency had that capability, because GE said it's not a problem.

Wolfgang, because of the kind of program he had, was modeling the entire plant. The TRAC-GE really hadn't done that because it was too expensive. The result was people who lean more towards the PRA view took a bunch of sequences, said these are possible things that can happen, and calculated the end point. He did 60-plus calculations in a very short period of time and clearly demonstrated where the problem was. Whereas the TRAC-B, which was the agency's program, they never got it running. They couldn't solve the problem. They couldn't make it work.

. 29

Eventually that code wound up at Penn State and some students managed to make it work, but that's a separate issue.

So I think it is sort of all of the above. You really need to focus on what you want. If what you want is a fast running, highly reliable code, you know when you start you are going to give up something. You need to try to figure out what it is you are going to give up. Maybe you want to give up being able to solve the large-break LOCA, because it's a relatively low risk thing anyway.

You want to address other kinds of problems: What kind of transients do people like Caruso deal with for NRR? Maybe compile a list and then ask yourself, what do I need? Most of the time you don't need very much of the horsepower in these big codes.

CHAIRMAN JACKSON: Let me ask you this.

MR. CATTON: I think I answered more than you asked.

CHAIRMAN JACKSON: That's right. It's like the algorithm that has more than the data.

[Laughter.]

CHAIRMAN JACKSON: I take that back.

I noted that you had indicated that you felt that financial constraints forced NRC to allow the codes that would be predictive of fuel behavior to kind of wither on

the vine. Do you think that was because of an undue focus on severe accidents, and issues related to, say, high burnup fuel hadn't been identified?

The real question I have is, the codes that we have and that are not state of the art, the ones that have to do with prediction of fuel behavior, are you saying that they can't adequately predict fuel and clad behavior at the burnups now being used by licensees?

MR. CATTON: One thing I very deliberately did was avoid discussing the fuel codes. I'm starting at the clad working out.

I really don't know, but maybe Dana could help, because Dana has been paying a little more attention to the fuels problems.

To me, as far as the thermal-hydraulics is concerned, if you change the burnup, you change some of the conditions that the code has got to operate under.

MR. POWERS: The agency will admit that indeed its codes aren't capable of treating fuels at the very high burnups right now, that they have been allowed to atrophy. The research program is trying to amend that problem.

I don't think we have reviewed the length and the breadth of their attempts to amend that, but certainly it is my impression that we do not now have a program that carries our understanding of the way fuels behave, especially when

you go to burnup sufficient to develop a rim effect; that we have a physical understanding of all that goes on in the fuel.

Perhaps of more importance is we don't have a good understanding of all the degradation that occurs in the clad as we go to very high burnups. A lot of the concerns about high burnup fuel have been prompted by some experiments dealing with reactivity insertion accidents.

Those are interesting, but I don't think that is where the big difficulties are going to arise with very high burnup fuel. I think it is really the degradation of the cladding and other kinds of operational accidents where that clad failure is going to pose difficulties to you.

I don't think we have a good understanding of all the metallurgical processes that take place at this high burnup, and they are going to be very stochastic type of processes. Much of the difficulties that arise with the cladding occur because you get high hydride precipitation at local fluctuations in the temperature in the clad. Those are caused by discontinuities in clad thickness, discontinuities in the fuel clad gap. Small perturbations in the manufacturing process lead to localized deposition of large hydrides that make the clad brittle.

You can understand that brittle clad now affects everything else that you are going to do with this fuel.

It's going to affect accident situations. It's even going to affect handling and storage subsequently.

I don't think we have predictive tools in this area right now. I think the staff has now embarked on a research program that they are fairly enthusiastic about. We have not as a committee or as a subcommittee reviewed that research program, though our intention is to do that when they are ready to come forward.

The research program is interesting because it is not the NRC going it alone; it is the NRC joining with the world in this area, because all reactors are interested in using fuel to longer and longer burnups. It contributes enormously to the economics of nuclear power. So the research program is a consortium of efforts between NRC, France and Japan in particular, and it may be a broader community than that. I'm uncertain.

CHAIRMAN JACKSON: How close are we to the edge relative to the current burnups?

MR. POWERS: Our codes were developed for predicting fuel behavior under things like reactivity insertion and were prepared and validated against a database that extended no higher than 33,000 megawatt days per ton. We now approve fuels going up to, I believe, 55,000 megawatt

days per ton. So it's not a case of being close to the edge. We are now beyond our validation limits.

. 33

That probably is not terribly important. You can probably extrapolate the behavior that we saw up to 33,000 megawatt days per ton up to around 50,000 or 55,000 megawatt days. When you go over that and you start developing rim effects and hydride precipitation is when you get into the problem. I believe right now that licensees need to make a very special and elaborate case to go beyond that. I don't know of anybody that has tried to go beyond that.

So our codes aren't validated into this regime, but it's the next step to go beyond the 55,000, where I think that would be an unacceptable situation.

CHAIRMAN JACKSON: Commissioner Rogers.

COMMISSIONER ROGERS: Coming back to the thermal-hydraulic questions, I know in your letter, your comments, Dr. Catton, you said that you thought a broader approach is needed where different modeling schemes would be tied together. I take it this relates to your comments about modularity and flexibility. Is that correct?

MR. CATTON: That's correct, and that's not going to be an easy task.

COMMISSIONER ROGERS: But you also go on to say that a skilled code user who is also knowledgeable in the field of thermal-hydraulics is needed to decide what is important and how do we implement it in a code. Where do you see us standing with that in-house capability now or our

. 34

ability to tap that?

MR. CATTON: In the past few years there has been a significant change. I don't remember when one of the Commissioners decided that it might be nice if your own people could run your codes, but I think it has happened. You have people like Caruso in NRR, who is really very good at using the code. You have people like Joe Kelly in Research, who is really very good.

There was a very nice paper by Mr. Caruso where he talks about three kinds of users. One is the guy who understands all of these things and knows how to run the code; the second is just a good engineer; and the third is a systems kind of guy.

I think you should develop some sort of administrative controls on how you do business so that if it's a run of the mill kind of problem the systems engineer is welcome to do whatever he wants to do. If the problem is a new one, you need to get your category 1 person involved and maybe develop some sort of a sign-off system.

Too many times people get too complacent about the results of the code. If that printer, or whatever, the screen, runs the numbers up and they are like you've seen them before, you tend to believe it. If it's new and you're not experienced with actually touching some of the data, you don't recognize good from bad, and usually you can generate

. 35

all kinds of arguments as to why it's good: the code did it; and this code compared with that code. That can lead you into troubles.

The category 1 type, there are not very many of them in the agency, and I think you have got to maintain them somehow, and you need to establish a procedure so that anytime they move into new problems, like boron mixing or whatever, the category 1 person is involved with the process at least in a review capacity.

CHAIRMAN JACKSON: Commissioner Dicus.

COMMISSIONER DICUS: Let me follow up on that. Not so much in terms of the capabilities of the individuals, but you seem to be implying -- and correct me if this is a wrong implication -- that perhaps three people is adequate for staffing for what we need to accomplish here. Or would you suggest we need additional staffing?

MR. CATTON: I really haven't seen a plan showing what all the tasks are. That aspect of our interaction was somewhat superficial. I don't know all that they are going to do. I think the three people in Research are very good. What kind of workload they are going to pick up relative to what they send out the gate, I don't know. So I really can't address that question.

I think within NRR you have a very good team, and as near as I can tell it's adequate, but you probably have

. 36

to ask them if they are overworked.

CHAIRMAN JACKSON: Commissioner Diaz.

COMMISSIONER DIAZ: Long time no see.

MR. CATTON: About ten years, I guess.

COMMISSIONER DIAZ: First, a generic comment. I've been looking at the past history. I realize that ACRS really in a very consistent way has emphasized the use of systematic, practical, auditable, flexible and traceable methods to integrate the experiments with the codes and develop the capabilities. I believe that is a very, very worthwhile sense of direction that we need, and I hope we keep doing that. I have a small interest in the area from past experiences.

I think that some of the smaller issues that always keep coming up, those we need to determine that we have the staff to solve them. I do agree with Dr. Catton that there is a time in which flexibility is important and there is a time in which we need to assess our capabilities to develop codes or change them and to use them properly.

I believe that we have the capability to use them properly, and if we are going to really take this five year plan, which I guess everybody agrees is basically and fundamentally a good plan, we need to really focus on what capabilities you have to have, code developers inside, people that can interact with the community on a one-to-one

basis and not be lost when Dr. Catton comes out with a new project, which he is quite capable of doing very quickly, as I well know.

I have a question in this area which may be addressed to the Committee. I have done some experiments. I always like to see that we have some experimental verification of thermal-hydraulic codes. We know that codes are one-dimensional or are dynamic, and going into static or vice versa might have some problems.

Are there financial constraints that NRC has in the international arena, in this experimental base that we are trying to get that are really affecting our ability to guide the experimental programs to the things that we need?

MR. CATTON: We need to first separate the kinds of experimental programs and their purpose. The large facilities are integral facilities. You don't get the detailed physics that you need to address the issues about the internals of the code. So what do you do?

You're a person who has been tasked with creating this computer program. You just make sure it gets the right answer that you measured. But you have a lower level. You have droplet sizes. Are they ligaments? What's their shape? You have all sorts of constitutive relations. Nobody really agrees on what they all are. But once you pick a set of equations, then you tune them. This is very

true in two-phase flow. Even in porous media where the bed is fixed there are lots of disagreements on what the equations should be.

Under these kind of circumstances you need to do the necessary work to understand the basic physics or else back off on your expectations from the code. I think it's a mistake to build a model that requires data input at a level that you don't have it unless you plan to go get it.

If you go back through the history of the ACRS' views, when the program first started this was a complaint, that you get a major group like the people at Los Alamos, Frank Harlow and those guys, who are just super at developing codes, but unless you feed them the bottom physics, they are not going to get it done right. But they're going to make it work.

So now you have this on the table. What do you do with it? As long as you are working within the macroscopic data you have at hand, you know. In Japan they had the SCTF. I forget what SCTF stands for, but it was a reflood facility. The first thing they found is that if you got the friction factor right, the interfacial friction factor, the heat transfer was wrong. If you got the heat transfer right, something was wrong with the other. What it was is a basic inconsistency, but the code had been tuned to deal with it.

Some of these things have been taken out, but you still have, for example, the heat transfer packages. Most data is taken by measuring a heat flux from a boundary into this mix. You don't know whether the heat goes to the vapor, then the droplet, or the droplet to the vapor, or wherever. Now the code person has to do something with this. So they somewhat arbitrarily split them. Sometimes

good, sometimes bad. A guy with a lot of insight might even get it right.

But you're never really sure until you try to measure these things. If you don't want to measure these things, then rewrite the way you work your code so it deals with this thing that you measured. What this allows you to do is to have good traceability. You can make a good statement about uncertainty in the results.

I don't know if I answered your question.

COMMISSIONER DIAZ: I don't think so, but that's okay.

[Laughter.]

CHAIRMAN JACKSON: Commissioner McGaffigan.

COMMISSIONER McGAFFIGAN: I'd like to ask about the balance of what the appropriate role is of the different actors that we can call on, the staff, the three people you talked about in Research, the labs. I know there has been some history of problems in dealing with at least one of the

labs. The universities and the university community, which you have built into the plan, and the private sector. How do you get the sort of continuity, the data so that the codes don't get more complex than the basic physics? What is the role of the different entities as you see it, and are there dangers?

My original concern was we might be trying to do too much in house. What is the appropriate role of the different institutions?

MR. CATTON: Let me try. I think, first, you have to have some kind of an in-house effort going on. If you don't, you won't have that category 1 person -- you just won't -- who is interested in these things enough, that understand them well enough to help you. That's number one. You need some people. They need to be somewhat unencumbered with all of the bureaucratic management stuff that is a necessary part of federal government. I was going to use some other words, which I did not do.

CHAIRMAN JACKSON: We are not bureaucrats. I don't know what you are talking about.

[Laughter.]

MR. CATTON: And I think at present the management within RES seems to have done that. These three people are pretty unfettered.

What kind of support do they need? In the past

they have just gone to the national labs, and I think there there has been an uncoupling, because they don't manage the labs. I don't know whether this is a characteristic of government or what, but the programs just have not been managed well at any of the labs in the sense that there is a clear definition of what you want and a clear statement of when you got it.

I think the labs can play a role. I think places like Los Alamos have the people who could take some of these things and put it into good programming. They certainly could do that. But when it comes to trying to understand the basic science of two-phase flow and heat transfer and these kind of things, you are not going to get it from the labs. The labs are professional people who have a job to do from eight to five. Somehow you need that graduate student who can't get out unless he understands it.

There is a problem with getting that set up. If you just do a grant, the professor and a student can go off on a different tangent, spend your money, and thank you very much. I think what you need is an institute, because the institute then is staffed by some full-time professional people, and they can lean on the professor or cut him off if whatever it is is headed in the wrong direction, and you also have somebody that you can reach out and touch. If you set this up properly, it can be the focal point.

I was very impressed with the French and the way they do business. In France, typically the lab, or whatever, is directly attached to the university. A French professor usually has a managerial role in that, and he's got his interest in what the students do. The French felt that if we do this in the thermal-hydraulics area, which is Grenoble, we're going to maintain the capability that we need; new people are going to come into it because, let's face it, the professor is going to hammer students wherever he is.

I think the process works. Not necessarily as direct grants, although there is a way you can deal with

that. Other agencies do it through workshops, and the professors who go to them are not stupid. They know if they want your money, they had better propose something within that spectrum.

COMMISSIONER McGAFFIGAN: This institute or center, would it involve potentially a consortium of universities? It wouldn't necessarily be tied to a single one? Or would you see it as a consortium that had an institute at one but the ability to tap universities nationwide if it was needed?

MR. CATTON: If I were doing it, that's the way I would do it. I think there is a nice example of what was done in the thermal spray area at Stony Brook. They sort of

sit in the lead position. However, there it's an NSF center. I wouldn't do that. It would have to be an institute so that I could get some assurance that whatever the path is I'm trying to follow will be followed.

They have a whole range. I think Sandia and Idaho both have very good thermal deposition, spray deposition kind of laboratories. They're involved with them. So they sit at the top, and you have the national labs associated with them.

There is another thing that I have been bothered by too.

CHAIRMAN JACKSON: I think we are going to have to move along.

MR. CATTON: Sure.

CHAIRMAN JACKSON: Finish your sentence.

MR. CATTON: I was just going to say that other government agencies seem to be able to control the labs. I don't know why NRC cannot.

CHAIRMAN JACKSON: Okay.

MR. KRESS: I resist the temptation to try to defend the labs.

CHAIRMAN JACKSON: Why don't we move on to the next topic.

MR. KRESS: Let's move on to a subject that is of much interest and one which we have paid a great deal of

attention to recently, and that's the risk-informed, performance based regulation and related matters.

Dr. Apostolakis.

MR. APOSTOLAKIS: We have been meeting with the staff on a fairly regular basis. The PRA subcommittee had two meetings last summer. The full Committee heard from the staff in August.

I thought we were proceeding well and according to schedule. There were some differences on specific guidance, but the discussions were technical, and so on, until we found yesterday that things are now up in the air, that there are some questions that have been raised at the high levels regarding allowed risk increases and whether they should be allowed at all.

The original schedule now is not valid anymore. We have tentatively scheduled a supplemental meeting with the staff for, I think, the third week of February to review the documents that will be delivered to us by the first week of February. This will be the final review, and we will write a letter to you during the March meeting the first week of March. That seems to wrap it up.

Do you have any questions?

CHAIRMAN JACKSON: What progress is the staff making in addressing the issue of uncertainty in the use of PRA results?

MR. APOSTOLAKIS: You mean in the regulatory guides, how they are dealing with uncertainty?

CHAIRMAN JACKSON: Correct.

MR. APOSTOLAKIS: That is one of many issues. There is a disagreement there. I think the staff wants to give prescriptive guidance as to what kind of PRA one should have, depending on the application and the change in risk.

For example, a rough point estimate calculation would be acceptable if the change was very, very, very small, like ten to the minus six or something, without external events, and so on. And there is some point to that.

But I've always felt that we are trying to overdo it and be too prescriptive. It seems to me the guidance should be that we should be using the models and analyses that are appropriate to the situation. People feel that that is too general, that we have to be more specific.

The thing that is missing is how do you handle uncertainties that have not been quantified. In fact, we had an interesting discussion at the last meeting as to whether the ten to the minus four core damage frequency subsidiary goal was set as an absolute goal or was set with respect to what can be quantified. In other words, I can go as close to the ten to the minus four goal as I can if I can prove with my calculations and analytical tools that I have

done a good job.

If, on the other hand, that subsidiary goal is an absolute goal for the core damage frequency period, then I should not be allowed to go very close to it because I know that there are certain things that are not in the PRA that contain the risk to the frequency of core damage. We were told that the original intent was to exclude these.

I'm not sure the things that have not been quantified have attracted the attention they deserve. On the other hand, I don't think that that is because people feel that these are not important. The staff has had its hands full trying to develop all these regulatory guides in the last several months. But these are certainly things that both sides are aware of.

CHAIRMAN JACKSON: I'm not sure how happy I am with your answer.

What are your views on the plant-specific application of PRA results?

MR. APOSTOLAKIS: First of all, you are not happy with my view or with the way things are?

CHAIRMAN JACKSON: I'll make it explicit. I asked the question of what progress you feel the staff is making in addressing the issue of uncertainty in the use of PRA results, and you said that is one of many issues. Then you talked about uncertainty that had not been quantified.

I think what is missing here is, if there really are some issues of points of vulnerability, et cetera, in terms of what the staff is doing, what would be needed to be able to give comfort to make use of PRA and how it's handled in these guidance documents without being what you consider to be too prescriptive, it would be useful for the Commission to get a listing of that.

As long as we kind of talk out in space, it's very hard to pin down just where the problem or problems seem to be. Perhaps that is what you will be addressing in your letter to the Commission once you have reviewed these documents in February.

I like PRA and I know on a rudimentary basis how to do PRA calculations, but that's not my job. However, in order for me to do my job and the Commission to do its job, we need to have more understanding and specificity about where you think the problems really are, because that forms the basis of giving guidance back to the staff in terms of what needs to happen. That's really what I was trying to talk about.

MR. APOSTOLAKIS: My answer to that would be, yes, they are making good progress. There are some disagreements but the disagreements are not fundamental. In particular, they are trying to be more prescriptive than I would like.

CHAIRMAN JACKSON: Are there any advantages or

benefits to our assembling a group of specialists to review the PRA guidance documents beyond the review that ACRS is itself providing?

MR. APOSTOLAKIS: The documents that will be produced in February?

CHAIRMAN JACKSON: Right.

MR. APOSTOLAKIS: I would say no. You will be getting general comments that you already have.

CHAIRMAN JACKSON: Commissioner Rogers.

COMMISSIONER ROGERS: Nothing else.

COMMISSIONER DICUS: Nothing else.

CHAIRMAN JACKSON: Commissioner Diaz.

COMMISSIONER DIAZ: You just brought up the issue a while ago of allowing small increases in risk under certain conditions. Would you elaborate why that is a problem to you?

MR. APOSTOLAKIS: It is problem in the following sense, in my mind. If we declare in advance that we would have a risk-informed and performance-based system that will not allow increases in risk, then we might as well forget about trying. Why are we doing it?

You have to be able to allow increases, because in

essence you are saying, well, keep it the way it is, or play games and package changes in such a way that the net increase appears to be zero.

. 49

It seems to me that when the Commission states quantitative health objectives and you are well below the objectives in the subsidiary goals, you should be allowed to increase a little bit. How fast, whether we should allow all the units around the country to come just close to the goal, these are questions that certainly deserve consideration.

But to say that no increases are allowed when in fact we are doing this every day without quantifying risk -- the staff told us that we have about 1,000 requests for changes in the licensing basis every year that are not done using risk assessment. So when we look at the risk number, we say, no, we don't want it to go up. But when we don't have a risk number, it's okay?

COMMISSIONER DIAZ: I do agree with you that we need to visit that area very carefully.

CHAIRMAN JACKSON: Isn't it a question of the context within which you talk about increase in risk?

MR. APOSTOLAKIS: Sure.

CHAIRMAN JACKSON: And the question is, what is the goal and what margin has one relative to that goal? When you then talk about risk increase, you are talking about risk increase relative to something.

MR. APOSTOLAKIS: Sure.

CHAIRMAN JACKSON: I think that is where some

. 50

clarification is needed in terms of that you just can't talk about it in a vacuum. It strikes me that that is where there has to be some convergence of the discussion here.

MR. APOSTOLAKIS: And the assumption is, of course, that the quantitative health objectives and the subsidiary goals have already been met. We're talking about increases without constraint. If you are safe above ten to the minus four in core damage frequency, the question doesn't even come up, because you have violated the law.

CHAIRMAN JACKSON: That's the point. One has to put the discussion in the proper context.

MR. APOSTOLAKIS: Sure.

COMMISSIONER DIAZ: I have one minor question. The current set of pilots that you are running to try to check the applications, the ISI, the ISD, the graded QA, are those providing you with sufficient feedback to address the adequacy of the program?

MR. APOSTOLAKIS: We know what is going on. So far, at least my personal opinion is that I haven't seen anything that has helped me understand things better.

COMMISSIONER DIAZ: Okay.

MR. APOSTOLAKIS: But that may be coming. I don't know.

COMMISSIONER DIAZ: There might be a little bias.

MR. SEALE: I would say, though, that my

. 51

impression is that the pilots have provided me with a considerable confidence that the people in the utilities are rapidly learning how to use PRAs in what they feel is a very constructive way. So it's not a tool that is going to be thrust into the hands of neophytes or anything like that.

The other point is that the review that you will get from those people on the SRP when it goes out for public comment will be a very competent review from their point of view. You should expect to get comments from them which are very practical, very focused on the issues that may remain due to perhaps difficulties in articulating the review plan, or whatever. But they're applying PRA methodology and doing a pretty good job of it.

MR. APOSTOLAKIS: One last comment. I think the interesting thing to see in this whole process is how difficult it is for people who are used to doing things in a highly prescriptive way, how difficult it is for them to free themselves from that and move more towards a performance-based system.

There are phrases in the guides that in the hands of someone clever who wants to undermine the process are killers. For example, one of the principles is "maintain adequate defense in depth." Give that to me and I would not approve any change, because you will never meet adequate defense in depth, in my mind, if I want to act that way.

. 52

What is the alternative? We all seem to like

defense in depth even though that is a concept that is up in the air. I don't think anybody has ever defined it. You do have to have defense in depth. What is adequate defense in depth? That kind of fuzziness has to be there, but I must say it makes me very uncomfortable, because we have also other principles of that kind.

I appreciate the fact that you cannot just drop everything and say make sure the core damage frequency is below the goal. That's the other extreme. But this is, I think, the primary difficulty in writing a good guide right now.

CHAIRMAN JACKSON: In some sense that's why it's a longer window than the end of this year and in fact it's the end of next year that presumably there is going to be iteration and re-normalization when there is review on the outside not only by those who look at these things from an intellectual perspective, but those who actually are trying to make practical application of them.

Part of the reason I asked the question about assembling a group of specialists is that many times if we study our own navels that's as much as we see. That's true in terms of how soon we propagate things to the outside, to let the world take a look, but also in letting the world take a look that there are other industries that use risk

assessment methodologies and PRA, and presumably they could share some of their wisdom. It may not be directly specific in terms of application to nuclear plants, but there are some fairly sophisticated uses of it at other places. I don't know if you have any reaction to that, but it's a bias that I have.

MR. APOSTOLAKIS: I don't think we will get much help from other industries. I think we are at the forefront. They may be using it or they may say they are using it, but I don't think anybody is using PRA to make decisions in other industries. Look how long it took in our industry. The reactor safety study was published in 1974, 22 years ago. Now we are talking about risk-informed regulation, not even risk-based, 22 years later.

CHAIRMAN JACKSON: Better late than never.

Commissioner McGaffigan.

COMMISSIONER McGAFFIGAN: I'm going to pass.

CHAIRMAN JACKSON: Dr. Kress.

MR. KRESS: The next item on our agenda is the potential use of IPE/IPEEE results to compare the risk status of the current population of plants with respect to the safety goals. It was my initial thought that this was something that should be done, and it sounded like a very good idea at the time I brought it up.

We then took a closer look at the IPEs and the

IPEEEs to see how this might actually be implementing. As it turns out, in our view, these as PRAs are just too uneven and incomplete. In order to compare with the QHOs, for example, you really do have to have some form of a full-scope level 3 PRA or some surrogate that approximates it or bounds it.

Most of the IPE/IPEEEs cannot be characterized that way, as full scope. None of them did shutdown risk. They did a margins analysis for the seismic. Most of them did a FIVE analysis. Many of them didn't go to level 2 even, especially with the fission product transport and the source term part of it.

After looking at those and actually doing a great deal of work of trying to figure out how to bound the missing parts, for example, how to bound the consequences that would come out of level 3 on a site-specific basis and how to bound the missing parts in the level 1 and 2, we thought that the results you would get by such bounding analyses would just be too uncertain and too questionable for the purpose, and that it really wasn't worth the effort that it would take just for the purpose of seeing what the status is with respect to safety goals.

The feeling is, looking at full-scope PRAs that do exist, that we do meet the safety goals by considerable margin. That's not a definitive answer because of the

limitations in these studies, but that feeling is there.

We really think it ought to wait until sometime in the future when better, more complete full-scope level 3s are available, and then one can make a definitive statement. We just didn't think it was worth the resources and the expenditure to try to do that now.

CHAIRMAN JACKSON: Let me ask you these two questions which kind of relate to that. Do you know what percentage of the IPEs would meet the PRA review guidance criteria being developed in the guidance document and the Standard Review Plan?

MR. KRESS: The answer is no, I don't know. We may have some other opinions.

MR. APOSTOLAKIS: Zero or perhaps one or two.

CHAIRMAN JACKSON: Dr. Powers.

MR. POWERS: Zero.

MR. KRESS: That was my opinion too. We have to remember that the IPEs and IPEEEs weren't intended for that purpose. So it's not a criticism.

CHAIRMAN JACKSON: I know they weren't, but the second question bears on that. Do you have a feel for how much use is currently being made, is trying to be made, or should be made of the IPE results in the regulatory decision-making process? That is, are they being made use of, should they be made use of, and how much are they being

used?

MR. KRESS: Very interesting question. I can't answer the part of it that says how much they are being used. I can address the "should."

CHAIRMAN JACKSON: Are they being used as far you know?

MR. KRESS: I think they are, yes.

CHAIRMAN JACKSON: In spite of what you've just said?

MR. KRESS: Yes. Some of them are quite good on the level 1 in addressing the core damage frequency. That is a fairly appropriate and frequent use of them, I think, in regulatory decision-making. That is being used.

CHAIRMAN JACKSON: What is our metric for determining their acceptability in that context?

George, do you want to address that?

MR. APOSTOLAKIS: It pains me to say this, but you really don't need to do a good uncertainty analysis and a full-scope PRA to get excellent insights about your plan. I used to think that unless you did that you didn't have a good PRA. Of course you don't have a good PRA, but the basic results that are of great use to the licensee and the staff, namely, ranking the accident sequences, identifying important systems, you can get those with very simplistic analysis, point estimates and so on.

When in doubt, if you are a bit conservative, in other words, should I include or exclude this particular sequence, is it important or not, don't play games. Include it. You know your analysis was crude. Keep it. But it turns out that you really get a lot of good information that way. In fact, some of the risk meters, the risk monitors that some of the utilities are using now are using these simple models.

CHAIRMAN JACKSON: I'm trying to make a separation between the use that licensees make of it for their own purposes within the current regulatory context and changes in that regulatory context or regulatory decisions being actually made based on them. There is a difference.

MR. APOSTOLAKIS: Yes.

MR. SEALE: There is a comment on the borderline, though, and that is that a lot of the licensees are using their PRAs as a part of the process of the pilot studies which are input to regulatory decision-making.

I think almost across the board a common feature is that most licensees are finding deficiencies in the IPEs or IPEEEs as they were originally cast and are going back and reexamining certain issues in coming up with the input that they then have to their pilot evaluations.

That sort of demonstrates the other part of the purpose of the IPE program, which was to get the utilities

to assess the showstoppers, and so forth. They are getting used to using them, and when the questions arise, apparently they are prepared to examine the issue in more detail.

As I say, that is an input to the regulatory system, I think.

MR. KRESS: Back to your question of the acceptability for regulatory uses, I think our biggest problem with them is their incompleteness, particularly that they don't deal with the shutdown risk, and their incomplete characterization of the effects of seismic. There are some questionable parts in how they treat common cause failures,

and some of the reliability numbers that come out of different databases don't seem to be consistent.

In terms of acceptability, the biggest problem we have with them is their completeness.

CHAIRMAN JACKSON: How much progress is there in terms of being able to incorporate into PRAs degradation of equipment systems, components and equipment within certain systems?

MR. KRESS: I would defer to George on this one too, but my own personal opinion is it's hardly in the PRAs at all.

CHAIRMAN JACKSON: In a certain sense, if one wants to look at performance and the effect of maintenance and effectiveness of maintenance and examine it within a

risk perspective, one has to be able to incorporate that, and most of the PRAs and level 1 PRAs and the kind of accident sequences that are modeled do not incorporate that. It's a success/failure, a binary approach.

MR. KRESS: Presumably some of the reliability numbers ought to implicitly reflect the status of maintenance and QA and how that affects reliability, but once it's in the PRA it's not changed. There is no time variation; there is no differentiating between a good maintenance program and a bad one.

George, you might want to talk about this. You know a lot more about the PRA.

MR. APOSTOLAKIS: It's true that aging effects are not in the PRA right now, but the real question is whether they would make a difference. The studies that I have seen are very inconclusive. In other words, you cannot conclude that the failure rate really goes up for particular components.

CHAIRMAN JACKSON: I've seen plant-specific data that indicates an ability to discern the effectiveness within a given system, which has a certain reliability or unavailability, the relative importance of certain components within that system, which can change dramatically the risk profile and in certain cases goes against the conventional wisdom of what components or subsystems within

the larger one are affecting that overall system reliability, but it requires a treatment that has to do with a non-binary approach to condition or degradation.

MR. APOSTOLAKIS: Sure.

CHAIRMAN JACKSON: So it's a different dimension in terms of the statistical approach and the kind of statistical modeling that goes into the PRAs, but it is one that, at least based on a couple of examples that were shared with me -- and I'll be happy to talk with you about those --

MR. APOSTOLAKIS: I would like to see those.

CHAIRMAN JACKSON: They have a very dramatic effect. So if you are really talking about efficacy of maintenance, and so forth, it's an issue. If you are talking about real plant-specific applications and understanding how the risk profile changes in a given plant as a consequence of a maintenance program, I think this is relevant.

MR. KRESS: I think it would be a quantum improvement in the PRAs to incorporate that sort of variable probability of failure or variable reliability that is not just binary, yes or no, fail, and relate it to plant specific items. That is a good idea. I hope somebody is approaching that.

CHAIRMAN JACKSON: I've seen some work that is

along that line.

MR. APOSTOLAKIS: It seems to me that before we jump to conclusions we should really look at how that work was done. I have seen some of that work too. I don't know if it's the same work.

CHAIRMAN JACKSON: I don't think the issue is to debate the specifics. I think the issue has to do with an ability to migrate into this framework some capability of really understanding on a plant-specific basis what equipment degradation means in terms of the risk profile of the plant and what that can or cannot say about the efficacy of maintenance and maintenance programs, because that in fact is relevant to us in terms of the implementation of things like the maintenance rule, and particularly if one is going to marry these PRA and risk-informed approaches to real life situations.

MR. APOSTOLAKIS: I agree with you, but I think right now, based on the evidence I have seen -- not the models, the evidence -- I would say that it's inconclusive. The evidence is not telling us that this is an urgent issue. Let me put it that way. I'm getting now awfully close to being conflicted, by the way. We should have that capability, but I don't think it's an urgent issue.

MR. KRESS: It's another good reason to be in favor of the reliability database program.

. 62

CHAIRMAN JACKSON: Why don't we go on. We are running out of time.

MR. KRESS: The next issue we have touched on a little is also mine. It's the use of safety goals on a plant-specific basis.

It's our view that the safety goals were not originally intended for that purpose, but if the desire is to move toward a more risk-informed or risk-based regulatory program, one will have to deal with specific plants, because that's what you are doing with them. They all come in with requests for changes to the licensing basis and a decision will have to made, for example, as to whether it should be granted, and you will want to be risk-informed on that. You will have to have some sort of, I guess we could call them, acceptance criteria as to whether you will grant particularly, say, increases in risk, small increases in risk, or grant a change at all, or whatever.

We felt that it's not necessary that the safety goals be these acceptance criteria but that that would be a good place to start since we do have defined things intended to tell us how safe is safe enough.

We think that it's a good place to start, that you will need to be plant specific in application in a risk-informed, performance-based world, and that in order to do it with the safety goals there is the subsidiary goal of

. 63

ten to the minus fourth, which is the most useful one because it's directly obtainable from PRAs that we now have.

The tough ones to deal with are the QHOs, which are the more important ones. Well, I think they are the more important ones, but ten to the minus fourth is just as important. In order to really deal with that as an acceptance criteria you do have to have some surrogate for a full-scope level 3 PRA with consequences that are site specific.

In our letter we said that that would be the ultimate that you are looking for, but it's going to be some time before each plant, or at least a substantial fraction of them, have such a full-scope capability, and it would be appropriate to back off from that and develop surrogates for the QHO that would be bounding.

We feel very strongly that such surrogates can be developed. They will take the form of a combination of core damage frequency and a large early release, which has to be defined, but we have some ideas on how to define that. Or an even lower tier than that would be a core damage frequency combined with a conditional containment failure probability, which might be different for different classes of plants, BWRs versus PWRs.

We have endorsed the concept of developing these lower tier surrogates that can be used as acceptance

. 64

criteria. We are in the process now of putting together what I guess I would call a white paper that would more fully define what we mean by things like an LERF and a conditional core damage frequency for this use, how they would be derived directly from the QHOs, and how one would derive them in such a way that you're sure they are bounding but yet are still useful tools in such an acceptance criteria.

We are not quite through with that white paper. It's under discussion by the Committee, but I think it would be useful in defining and further clarifying our views on this subject.

CHAIRMAN JACKSON: When do you think you would have that?

MR. KRESS: I expected to have it this ACRS meeting, but it didn't quite get there. It will surely be finished by next week and circulated.

CHAIRMAN JACKSON: So you're talking within weeks.

MR. KRESS: Oh, yes. It's not that far away.

CHAIRMAN JACKSON: Commissioner Rogers.

COMMISSIONER ROGERS: There are lots of questions

here. How the safety goals relate to an adequate protection standard. What's the relationship between these things? If you want to start using safety goals for regulatory purposes, what does that really mean if we already have an
. 65
adequate protection standard that is being met?

I think one has to try to sort this out. I know it's a very, very difficult question. I certainly have struggled with it in my own mind for years. But if you want to use safety goals, surrogates or not, for regulatory purposes, I think you are going to have to come to grips with how will a regulatory decision based on safety goals, which will be a probabilistic statement of affairs, be related to the adequate protection standard, which is not a probabilistic standard, I don't think.

MR. KRESS: It's not.

COMMISSIONER ROGERS: I'm not even sure what it is. We know it's there, but what is it?

I think we are going to have to come to grips with that if we want to start regulating using safety goals.

MR. KRESS: I think that is a wonderful question.

COMMISSIONER ROGERS: I don't know if it's wonderful, but it's certainly --

MR. KRESS: I've thought about it considerably.

COMMISSIONER ROGERS: I think we need your best thoughts on this, because it seems to me this is where the treacherous territory is going to come.

MR. KRESS: It really is. The real question is, where do the safety goals lie with respect to adequate protection in terms of level of risk? It is my personal
. 66
feeling that adequate protection is a level of risk, if you could translate it into risk, that is below the safety goals.

I say that because what we have now is an adequate protection type of concept, and from all the PRAs I've seen and everything that I can get from the IPEs to see what the status of risk is, we are well below the safety goals, which tells me that adequate protection is a level of safety that is better than the safety goals.

COMMISSIONER ROGERS: I think we could argue that, because if in fact you believe that all the plants meet safety goals, they have gotten there through application of an adequate protection standard.

MR. KRESS: But adequate protection is a different level of safety for each plant; it's plant specific; and it has never really been quantified in terms of what is a risk. If we were to now say we want to move to another criteria, which is safety goals, you are treading on very thin ice, because if it is a level above that, you really have to be careful how you are going to define these acceptance criteria. This is one of the reasons I think, as you saw in one of our letters, that the safety goals are not quite well formulated for this purpose of plant-specific application. That is one of the main reasons that we mentioned, because you are probably putting forth a set that is not as good in
. 67
terms of risk level as adequate protection, and that is a real concern that I think has to be dealt with.

COMMISSIONER ROGERS: I'm sure we are not going to settle it right here, but I do think that it is a very key question in thinking about the use of safety goals for regulatory purposes.

MR. KRESS: It is, definitely.

COMMISSIONER ROGERS: Yes, Dr. Apostolakis.

MR. APOSTOLAKIS: I think there are a couple of thoughts here. First of all, I don't think that what we have now, the deterministic system we have now defines adequate protection. I think the clear statement about adequate protection was the QHOs the Commission approved a number of years ago.

CHAIRMAN JACKSON: Why don't you define for the Commission the QHOs. He knows. We have new Commissioners.

MR. APOSTOLAKIS: I'm sorry. Those were approved in the mid-1980s, I understand.

MR. CATTON: Quantitative health objectives.

MR. APOSTOLAKIS: They are both qualitative and quantitative, and the quantitative part says, I think, in terms of individual risk that the risk from nuclear power plants should not exceed one tenth of one percent of the risks from all other causes, and similar kinds of things for delayed deaths, and so on. It's one tenth of one percent of
. 68

societal risks.

It seems to me that really defined adequate protection. The other one was sort of haphazard: let's do this, let's do that, and then that's adequate protection.

It's interesting to remember, by the way, that when the reactor safety study was published a lot of the old-timers were surprised that the core damage frequency was so high. They didn't think it was going to be close to ten to the minus four and five. They were very surprised. So when you quantify things you see them from a different perspective.

One other thing that maybe is not directly related but I really think I ought to tell you is I'm extremely uncomfortable with this notion that the safety goals, the quantitative health objectives apply on the average. I don't know what that means to the industry, on the average, and the sooner we get out of it the better off we'll all be.

COMMISSIONER ROGERS: It's really just hand waving. It isn't really established when one says that. So I agree with you. I'm not disagreeing.

The other point that I would like to raise, Dr. Kress, is you seem to imply that somehow there would be eventually the development of level 3 PRAs by all plants. I don't understand what would drive anybody to that at this point. Why would you do it?

MR. KRESS: I believe that if we do move into a risk-informed, performance-based or risk-based system, then what that means to the industry is -- one of the things it means is that they can come in now with requests for relief from burdensome regulations that don't add to their safety but really causes them a great deal of problem in terms of resources and time and actually may detract from safety.

If they see the probability or good possibility of getting some relief like this and the acceptance criteria that we have on granting such relief has to do with meeting QHOs, which require a level 3, that would be their incentive to develop. The owners of these level 3s will have to be the plants, not NRC. It will have to be in their hands to come forth with sufficient justification in terms of their position with respect to the QHOs and how a change changes that position. I think the incentive is a relief of burden.

COMMISSIONER ROGERS: Provided that there is some clear regulatory statement from NRC that it would accept something and allow some relief, if you want to call it that. I don't think we have done that.

MR. KRESS: No. I think that is part of what you will see in the Standard Review Plan for implementation of PRA and the reg guides that we are reviewing now. That was one of the concepts that is built into that. It does involve relief and allowing small increases in risk in the

interest of overall improvements in the whole process. I think that's the incentive, and without that, I don't think we will see level 3 PRAs.

COMMISSIONER ROGERS: I think you have to be very explicit in your comments on this.

MR. KRESS: I think we intend to be on that particular one.

COMMISSIONER ROGERS: Thank you.

CHAIRMAN JACKSON: Commissioner Dicus.

COMMISSIONER DICUS: No.

CHAIRMAN JACKSON: Commissioner Diaz.

COMMISSIONER DIAZ: No. I support strongly Commissioner Rogers' question.

MR. KRESS: There is one more item. We probably can finish it very quickly. That's the use of the RuleNet in the regulatory process.

Dr. Shack.

MR. SHACK: Several of our members have looked at the RuleNet site, although none of us managed to register in time for formally participating in the process.

I believe that most of us think that the technology represented by RuleNet does offer a great promise as a way to involve the public, licensees, intervenors, and staff in a more effective interaction in the regulatory process. This improved interaction can lead to greater

confidence in agency decisions and greater public confidence in the way the agency deals with the industry.

The whole process will obviously have growing pains and evolve as we are doing it. It's hardly transparent to use in some ways. There is some concern that

Internet access is kind of still an elitist thing, although I think that is widely becoming much more accessible. From my point of view, even in the current state it still offers the easiest public access to the regulatory process that I can envision.

I have certain biases as a computer jock. I think the give and take of an electronic forum is far superior to sending in a comment or a letter that sort of goes into a black hole and sometime later comes out as a resolution of public comment. There is a real give and take in near real time in electronic forum. And it may even offer greater opportunities for reflection than a public meeting. One just reads the threads in the letters and there is a discussion and you begin to think about it. I think it offers a great deal of promise.

I was a little disappointed in how few people participated in RuleNet, and that may be partly just the uncertainties involved with it. They certainly didn't make it very easy to find. I could never understand why there wasn't a direct link from the NRC home page to RuleNet, and

there is still no direct link from the home page to the LSS Net, which is the sort of successor attempt at this. If you are going to make this publicly accessible, it should be a little more transparent to the public in how to get there.

Again, we have no formal ACRS position on this, but I think those of us who looked at it thought it was a very interesting attempt to increase public involvement.

CHAIRMAN JACKSON: Thank you.

Commissioner Rogers.

COMMISSIONER ROGERS: No thank you.

CHAIRMAN JACKSON: Commissioner Dicus.

COMMISSIONER DICUS: No.

CHAIRMAN JACKSON: I'd like to thank the ACRS very much for another informative briefing and again to thank particularly Dr. Catton.

The topics of today's presentation obviously focused on a number of issues that are critical for maintaining and improving the NRC's ability to regulate effectively. I want to encourage the ACRS to continue to provide the Commission its perspective on issues important to our mission and to be forward looking in bringing developing concerns to the Commission's attention in order to help ensure that we are prepared to meet the future challenges.

Clearly there are a number of follow-up issues

here that we have discussed, several of which have been explicitly discussed here today and are of concern to the Commission. Two examples. Some of our discussion in the digital I&C area and then the later discussion of the relation of the safety goals to the adequate protection standard. I think we all know where we have to go from here.

Unless my fellow Commissioners have any further comments, I'm about to adjourn. In adjourning, I am going to ask that we clear, because we have an affirmation to do, and then we can follow up and have any follow-on discussions that anyone would like to make. Thank you. We're adjourned.

[Whereupon, at 11:29 a.m., the meeting was adjourned.]