

1                   And in the power updates, it is also  
2 where people put numbers there, you know, and some  
3 of us objected, but I wonder whether it is worth  
4 pursuing this anymore. If we manage to get an upper  
5 bound, that is good enough. Maybe an expert opinion  
6 elicitation is the answer.

7                   MR. CUNNINGHAM: It may be, and I guess  
8 I am not quite sure where you are going.

9                   MEMBER APOSTOLAKIS: Where I am going is  
10 that we don't have a model, but yet people are  
11 coming in here for important issues and nobody says  
12 I cannot do this because there is no model.  
13 Everybody does something and people seem to say  
14 okay, that is reasonable.

15                   MR. CUNNINGHAM: Well, we do have  
16 models, and part of what we are doing now is trying  
17 to be -- as Alan was talking about, in terms of the  
18 quantification process, I am not sure you would say  
19 that we have a model there.

20                   But we are trying to take something and  
21 make it more systematic if you will, and so you can  
22 in a sense call it a model.

23                   MEMBER ROSEN: I don't know if it is  
24 called a model really. It is a method.

25                   MR. CUNNINGHAM: It is a method.

1 MEMBER ROSEN: And Alan described it in  
2 some detail for the subcommittee.

3 MEMBER APOSTOLAKIS: But basically the  
4 way that I understand it is that people are happy  
5 that they have a description of the context, and  
6 then you have a number of experts, and they tell you  
7 what the number is.

8 MEMBER ROSEN: It is more complicated  
9 than that, but yes.

10 MEMBER APOSTOLAKIS: It is always more  
11 complicated.

12 MR. SIU: If I may, you know, clearly in  
13 this project we tried to exercise with the tools  
14 that we had, and we have some belief that the  
15 results that we are getting are reasonable and  
16 useful for the decision at hand.

17 It is not to say that improvements in  
18 these tools won't lead to better decisions later on.  
19 We just don't have such better tools at this point.  
20 So I guess I would argue that we are not necessarily  
21 at a state where we should be freezing development  
22 on these methods and tools.

23 We always learn, and the project that  
24 you see in front of you now, where HRA is just a  
25 part, we have done a lot of work on fracture

1 mechanics, and we have done work on thermal-  
2 hydraulics, and have done work on PRA and a  
3 culmination of all of that is for example, this  
4 particular -- this is one product of such an  
5 integrated process.

6 If we had said back in the '80s, well,  
7 we can make decisions, and you have seen the tools  
8 that we have now, and that is the current rule. So  
9 now we are in a position to better that.

10 MEMBER APOSTOLAKIS: Well, it is hard to  
11 generalize. A lot of things were done  
12 conservatively and so on, but it is a real issue,  
13 and a major intellectual challenge to develop a  
14 model that will give you the probability of time-  
15 dependent human actions. So let's recognize that.

16 MR. SIU: Yes.

17 MEMBER APOSTOLAKIS: I mean, ATHEANA  
18 tried, and it really didn't lead anywhere. I mean,  
19 it did a lot of qualitative work, but not the  
20 quantitative. And then at the same time we see the  
21 staff coming here, and both of them do research at  
22 NRR, and they seem to find reasonable things like  
23 asking experts, and looking at upper-bounds, and so  
24 on.

25 So it really makes you wonder whether it

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1 is worth pursuing an HRA effort now. Maybe 10 years  
2 from now, after again we find that a lot of things  
3 were wrong and very conservative, because I don't  
4 know whether if we lead anywhere, and people do  
5 things, but don't make them unhappy.

6 They don't make them happy, but they  
7 don't make them unhappy.

8 MR. CUNNINGHAM: If we could go back to  
9 the HRA program that we have got planned over the  
10 next couple of years. I think we have talked to the  
11 committee that one element of the expert elicitation  
12 process is what kind of experimental information  
13 could you provide on human performance insert  
14 context.

15 And I think that is a big element of  
16 what the staff is proposing, in terms of research,  
17 and getting back to trying to collect more, if you  
18 will, empirical evidence or experimental evidence,  
19 to support an expert elicitation process.

20 MEMBER SHACK: We are sort of a quarter  
21 of the way through, and so I think we had better  
22 move on.

23 MR. HACKETT: I think I will just add  
24 one final comment specific to this project in HRA.  
25 One of the slides that we will come to is showing

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1 that a lot of the risk is dominated by LOCA and then  
2 the HRA is not a huge contributor in that regard.  
3 We can get into that further.

4 MEMBER APOSTOLAKIS: Which LOCA is that?

5 MR. HACKETT: LOCAs in general.

6 MEMBER APOSTOLAKIS: Really.

7 MR. HACKETT: We have got a slide on  
8 that. Another motivation was the fact that to  
9 quantify some plants are predicted to be close to  
10 the screening criteria at EOL, and so sort of this  
11 red band that Mark Kirk had here on the slide.

12 And, you know, starting out towards the  
13 end of this decade that you are starting to see some  
14 plants that are beginning to impact this criterion.  
15 And so their interest level -- and our industry  
16 colleagues are not here today by and large, but that  
17 gets their interest level up pretty quickly when  
18 they are starting to look at making cases for  
19 license renewal man, many years in advance.

20 So that is another major motivator, and  
21 also another major motivator --

22 MEMBER APOSTOLAKIS: Let me understand.  
23 Some plants close to the screening criterion?

24 MR. HACKETT: Right.

25 MEMBER APOSTOLAKIS: And which ones are

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1 these?

2 MR. HACKETT: Arbitrarily, what Mark did  
3 on this slide is that he is showing a band that is  
4 within about 50 degrees of, say, the 270 or the 300  
5 criterion.

6 And then basically what you are getting  
7 towards are --

8 MEMBER APOSTOLAKIS: Oh, this is from --

9 MR. HACKETT: Right, exactly. Exactly.  
10 So the bottom line is that we are trying to show the  
11 interest level, and I think we skipped over one.  
12 No, not yet.

13 MEMBER POWERS: The more I think about  
14 this, I didn't understand it at all. Could you  
15 focus us here on at least that first one?

16 MR. HACKETT: Sure.

17 MEMBER APOSTOLAKIS: The previous one  
18 you mean?

19 MEMBER POWERS: Yes.

20 MEMBER WALLIS: That is the simplest  
21 slide he has got I think, is that one.

22 MR. HACKETT: Yes, really this is just  
23 in simplicity, these are the number of degrees that  
24 you are from the screening, and it should say  
25 criterion. But from the 270 or the 300, and so it

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1 is just showing you that there is a grouping of  
2 plants here, especially when you are getting out  
3 towards where folks are considering license renewal,  
4 where we are starting to get into increasing  
5 numbers.

6 And not that anybody is in any  
7 particular difficulty when they are 50 degrees away  
8 from the limit. But it certainly is going to make -  
9 -

10 MEMBER POWERS: But a lot of them are at  
11 zero.

12 MEMBER WALLIS: Not at the end of the  
13 license period or that time.

14 MR. HACKETT: At the end of the license.  
15 There actually should be two.

16 MEMBER APOSTOLAKIS: What is the point  
17 of showing the years there?

18 MEMBER WALLIS: That's when they get  
19 there.

20 MR. HACKETT: That's just when they get  
21 there. That is when they are predicted to get  
22 there. This in particular would be Palisades, and I  
23 believe that would likely to be Beaver Valley. I  
24 can't say for sure, but this one is certainly  
25 Palisades. They hit their criterion in 2011.

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1 MEMBER POWERS: Who is the guy at 2035?

2 Is that --

3 MR. CUNNINGHAM: At 2012, they would be  
4 at -- they could not operate beyond --

5 MEMBER POWERS: He is in a world of  
6 hurt.

7 MR. CUNNINGHAM: They could not operate  
8 beyond 2012 because of the embrittlement of the  
9 vessel under the current rules.

10 MR. HACKETT: That was another primary  
11 motivation. And in terms of the scope of the  
12 analysis --

13 MEMBER APOSTOLAKIS: That sounds kind of  
14 funny to me, but why are you doing the work and not  
15 them?

16 MR. HACKETT: Well, in the next slide,  
17 we will come to that. They are indeed doing a lot  
18 of work, and working with us on this. In terms of  
19 the scope of the analysis, we have analyzed three  
20 plans which would be Palisades, Beaver Valley, and  
21 Oconee.

22 Two of those are among the most  
23 embrittled at EOL, which would be Palisades and  
24 Beaver Valley, and they are both in about a degree  
25 of the screening limit at EOL.

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1                   We have all the PWR manufacturers  
2 represented in two plants from the original study,  
3 and which would be Oconee and Beaver Valley, or  
4 Oconee and Calvert Cliffs. I'm sorry.

5                   And two plants close to the screening  
6 criterion which I mentioned, and caveat this, you  
7 know, as Mark has done before, and we said -- these  
8 are all that we are aware of, when all significant  
9 and potential initiating event sequences are  
10 considered.

11                   That is not to imply that there aren't  
12 some that could be out there that we missed.

13                   MEMBER ROSEN: We have spent a lot of  
14 time talking about model uncertainty yesterday.

15                   MR. HACKETT: Yes.

16                   MEMBER APOSTOLAKIS: And you will again.

17                   MR. HACKETT: This is just to get to  
18 Professor Apostolakis' point. The conduct of the  
19 project has --

20                   MEMBER APOSTOLAKIS: And you will gather  
21 facts and conclusions to report to the full  
22 committee?

23                   MEMBER WALLIS: We gathered estimates  
24 and --

25                   MEMBER POWERS: And idle speculation.

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1 MEMBER APOSTOLAKIS: It seems to me that  
2 if you want to form a peer review group, you are  
3 going to have a hell of a problem.

4 MR. HACKETT: We are working on that. I  
5 agree, and we are working on that right now. That  
6 is one of the slides that you will see that we will  
7 get to, in terms of things that still need to be  
8 done.

9 MEMBER POWERS: Let me assure the  
10 committee that I have no idea what Sandia is doing  
11 on this.

12 MEMBER APOSTOLAKIS: Yes, I mean, you  
13 are creating --

14 MEMBER POWERS: I have no idea what they  
15 are doing.

16 MEMBER SHACK: I mean, who is the  
17 cognizant Federal employee here?

18 DR. LARKINS: I guess I am.

19 CHAIRMAN BONACA: Yes, John Larkins is  
20 the Cognizant Federal Employee.

21 MEMBER APOSTOLAKIS: Well, maybe I  
22 should -- can I talk to you?

23 DR. LARKINS: Sure.

24 MEMBER APOSTOLAKIS: Not on the  
25 transcript.

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1 CHAIRMAN BONACA: Can we proceed.

2 MR. HACKETT: In addition, I will  
3 mention that this also does not indicate public  
4 participation, but we have had some significant  
5 participation from the public. At least not a lot  
6 lately, but definitely some since then.

7 In terms of how the analysis is  
8 conducted, there are two main components. There is  
9 the estimation of the plant, which TWC stands for is  
10 through wall cracking.

11 And then you compare that to an  
12 acceptable frequency of through wall cracking, which  
13 is what we spent one of the previous slides talking  
14 about.

15 And this is how you get there, going through the  
16 three major disciplines, from PRA event sequence  
17 analysis, to combinations of those running through  
18 the thermal hydraulics, and getting the inputs from  
19 thermal hydraulics feeding into a probabilistic  
20 fraction mechanics assessment.

21 And that addresses the materials aspects  
22 and things like flaw distribution. And what you get  
23 coming out of all of this is a conditional  
24 probability or yearly frequency of through wall  
25 cracking. And that then you are going to compare

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1 with the limit.

2 MEMBER APOSTOLAKIS: And when you  
3 quantify uncertainties, don't you address them? I  
4 mean, can you quantify uncertainties without  
5 addressing them? Why do you say address, then  
6 quantify?

7 MR. HACKETT: Okay. Address, then  
8 quantify. No, in fact, maybe it should be written  
9 that in a lot of cases that you can't get there.  
10 The acceptance criterion, bottom line, is that we  
11 feel, or at least the team feels, that we are  
12 consistent with the Commission's safety goal policy  
13 statement, the SRM that was issued after Yankee  
14 Rowe, and in general the principles of Reg Guide  
15 1.174.

16 And then the way that this thing pans  
17 out for you is --

18 MEMBER WALLIS: Excuse me, but when you  
19 say through wall cracking and vessel failure, that  
20 means the same thing?

21 MR. HACKETT: That means the same thing,  
22 reactor vessel failure frequency, or frequency of  
23 through wall cracking, and that is going to get you  
24 to the establishment of a limit and the comparison  
25 with the curve for the material behavior.

1 MEMBER APOSTOLAKIS: Without adding  
2 anything to it?

3 MR. HACKETT: Without adding anything  
4 in. This part at least is just schematic, and so we  
5 are not even going to get into whether degrees F, or  
6 C, or RTNDT.

7 MEMBER WALLIS: But you are going to  
8 define it in your report?

9 MR. HACKETT: It is defined in the  
10 report, and obviously I think that is an area where  
11 we are going to need to have some clarify.

12 MEMBER APOSTOLAKIS: When you say in  
13 your report that your results indicate that you may  
14 increase the screening limit by 80 --

15 MR. HACKETT: By 80 to 110 degrees.

16 MEMBER APOSTOLAKIS: You are referring  
17 to the 270?

18 MR. HACKETT: That's right.

19 MEMBER APOSTOLAKIS: So that becomes  
20 350?

21 MR. HACKETT: 350 to 380 or so.

22 MEMBER APOSTOLAKIS: And calculated the  
23 way the regulatory guide says?

24 MEMBER WALLIS: I don't think that is  
25 true. No, that is not true.

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1 MEMBER APOSTOLAKIS: So you have a new  
2 method for the screening criterion, but the old  
3 method for developing your --

4 MR. HACKETT: Let me see if I can take a  
5 crack at that, and we may be back in the same place  
6 we were for --

7 MEMBER APOSTOLAKIS: It not a simple  
8 deal.

9 MEMBER SHACK: Sure it is.

10 MR. HACKETT: All we are doing there is  
11 that you will see a new metric for RTNDT, which we  
12 will call an RTNDT star, and I will try to explain  
13 that a little bit later how that compares with the  
14 current criterion.

15 And so we are trying to compare apples  
16 to apples and you are exactly right. We should try  
17 80 to 110 degrees fahrenheit, and you are adding  
18 that on to the screening criterion. So what was 270  
19 becomes nominally 350 to 380.

20 MEMBER APOSTOLAKIS: Okay. That is one  
21 issue. But the other issue is that you are using a  
22 more sophisticated methodology now to come up with a  
23 screening criterion. Yet the licensee would be  
24 using the old approach to come up with the RTNDT?

25 MR. HACKETT: i see your point.

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1 MEMBER APOSTOLAKIS: And compared to the  
2 new screening criterion?

3 MR. HACKETT: That was one of the things  
4 that we addressed. The answer to that is really no.  
5 They will be using an RTNDT based approach, and the  
6 only thing they will have to adjust for is basically  
7 going to be the weighting of this RTNDT for weld  
8 type, and weld length, and fluence.

9 I will try and explain that a little bit  
10 better. In practice, they won't have to do  
11 anything. If we set the criterion out, all they  
12 need to demonstrate is that they are that far back  
13 from it, and there won't be any need for any plant  
14 specific analysis.

15 MEMBER APOSTOLAKIS: Yes, but the  
16 question is how do you demonstrate?

17 MR. HACKETT: Well, the only change in -  
18 -

19 MEMBER APOSTOLAKIS: Is it from the old  
20 approach?

21 MR. HACKETT: The only change in  
22 regulatory space that they would need -- for  
23 instance, here are a few things that they would need  
24 to know. They would need to know details of the  
25 fluence analysis for their vessel, and they will

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1 need to know weld type and length that are limiting,  
2 and they have that information now.

3 So we are not imposing anything new in  
4 regulatory space.

5 MEMBER ROSEN: They won't have to worry  
6 about it until they are running out about 200 years  
7 anyways.

8 MEMBER WALLIS: Well, that assumes that  
9 all the statistical stuff that you are doing is  
10 typical of all plants.

11 MR. HACKETT: Right. It is assuming a  
12 generalization. That's right.

13 MEMBER APOSTOLAKIS: But the earlier  
14 argument that it doesn't really matter that we honor  
15 the 60 degrees, because there is a compensating  
16 addition on the calculational side.

17 Now you are changing the screening  
18 criteria and making it more realistic.

19 MR. HACKETT: No.

20 MEMBER APOSTOLAKIS: Aren't you going to  
21 touch the other one?

22 MEMBER SHACK: The screening limit  
23 before and we will now make it 290, and we added 60  
24 degrees to the 210 to get 270, and we will add 60  
25 degrees to the 290 to get 350.

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1                   So you do the two exactly the same way,  
2 just so you don't change anything that the licensee  
3 does. He will compute the number and exact --

4                   MEMBER APOSTOLAKIS: So we are doing a  
5 good analysis here, and then we will make it bad  
6 based on the calculations?

7                   MEMBER SHACK: No. Let's move on.

8                   MEMBER WALLIS: This is all going to be  
9 clear when they rewrite the report so that it is  
10 clear. It all will be clear when they rewrite the  
11 report so that these 6 or 7 RTNDTs are all very  
12 clearly defined, and we know what is going on.

13                   MEMBER APOSTOLAKIS: And also when they  
14 do page numbers. I was so scared on the plane  
15 yesterday.

16                   MR. CUNNINGHAM: If I can go back just a  
17 second.

18                   MEMBER APOSTOLAKIS: Yes.

19                   MR. CUNNINGHAM: We are proposing a  
20 technical basis for a rule change.

21                   MEMBER APOSTOLAKIS: Yes.

22                   MR. CUNNINGHAM: And the folks at NRR  
23 will be looking at rule, as well as reg guide  
24 changes, possible reg guide changes.

25                   MEMBER APOSTOLAKIS: Okay. All right.

1 That is a better answer.

2 MR. CUNNINGHAM: I don't want to commit  
3 Matt to saying that absolutely he is going to do  
4 this or that, or whatever.

5 MEMBER APOSTOLAKIS: Yes, sir?

6 MR. MITCHELL: Again, Matt Mitchell,  
7 NRR. The only thing I would say is we will ensure  
8 as we go forward with any proposed rule change that  
9 the way that licensees would analyze the actual  
10 material properties or vessel is completely  
11 consistent with the basis upon which the screening  
12 criteria is established.

13 I mean, that is incumbent in the way  
14 that we would modify the rule. So weighted average  
15 used -- and which I Ed is going to get to -- to try  
16 to enumerate a screening criteria, weighted average,  
17 for evaluating the vessel.

18 MR. HACKETT: What we are hoping is that  
19 as a resource that a --

20 MEMBER WALLIS: Wait a minute. I'm  
21 sorry. The present RTNDT is not a weighted average.  
22 It is a bounding curve. So you are changing the  
23 definition if you go to a weighted average. You  
24 won't just be using the --

25 MEMBER SHACK: But that is only

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1 proposed.

2 MR. HACKETT: That is proposed right  
3 now, and it would be changing it in a way that they  
4 would be able --

5 MEMBER WALLIS: And all of this will be  
6 clear when you rewrite it to make it clearer?

7 MR. HACKETT: That would be our goal.

8 MEMBER WALLIS: All right. Thank you.

9 MR. HACKETT: Let's move on to some  
10 results. The bottom line is that over the realistic  
11 operational time frames, and we tried to show that,  
12 and some of this is really extending out too far,  
13 but that is just the way that the mathematics went.

14 But over realistic operational lifetime,  
15 the through wall cracking frequency that we are  
16 finding coming out of the FAVOR code is very small,  
17 and by that we mean somewhere between E minus 8, E  
18 minus 9, range.

19 And you can see that on the slide here,  
20 and at the current screening criteria the yearly  
21 through wall cracking frequency in a generalized  
22 sense is on the order of 1 times 10 to the minus 8.

23 And then it is important to note here  
24 that two of the plants that we use to try and set  
25 this up are among the most embrittled that have been

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1 evaluated. So we feel we are well below.

2 MEMBER APOSTOLAKIS: Well, that is  
3 confusing, and so let's talk about this figure.  
4 When you say the mean of the 95th person, I was  
5 looking for those. Where do I find them?

6 The only difference in the product is  
7 the plants.

8 MEMBER SHACK: They are the same.

9 MR. HACKETT: Those are the same  
10 basically. they are skewed.

11 MR. CUNNINGHAM: The calculation  
12 results, as they are essentially -- the mean is at  
13 the 95th percentile.

14 MEMBER APOSTOLAKIS: And that is  
15 mentioned somewhere in here?

16 MR. CUNNINGHAM: I am sure it is.

17 MEMBER APOSTOLAKIS: It is? Well, I  
18 missed it. Not hear the figure.

19 MEMBER SHACK: In some of the figures  
20 you can almost see a shadow of your --

21 MR. HACKETT: The second major result is  
22 looking at what are the dominant contributors to  
23 risk and what the team has found is that its LOCAs  
24 are the dominant contributor to risk, as opposed to  
25 stuck-open safety valves, which are actually a

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1 contributor as you can see here for Oconee, and for  
2 the B&W type design.

3 But an important feature is that  
4 secondary side breaks in general are not  
5 contributing the way that they were during the  
6 original study. There are a couple of reasons for  
7 that, and a lot of it goes to the severity in  
8 binning, and again the team can correct me if I am  
9 wrong on any of this.

10 But in terms of the binning on the  
11 secondary side previously it used to be that  
12 everything was binned with the severity of the main  
13 steam line break is my understanding.

14 Also, they are just not as severe a  
15 challenge as are the LOCAs, in terms of the thermal  
16 transient, and then of course you have the piece  
17 that we talked about previously, and some credit  
18 applied now for operator action that was not applied  
19 previously, or the three main elements don't affect  
20 the --

21 MEMBER WALLIS: So if we actually took  
22 the importance of the things which are thought to be  
23 important 20 years ago, they seem to be like 1 or 2  
24 percent of the thing now?

25 MR. HACKETT: Very small.

1 MEMBER WALLIS: And so in fact you have  
2 not only gained a factor of 10 to the 4th, you have  
3 gained a factor of 10 to the 6th, because the things  
4 that you thought were important have now decreased  
5 to 1 percent of what matters. This is even more  
6 remarkable.

7 MR. HACKETT: I think it is remarkable.

8 MEMBER ROSEN: And things that you have  
9 ignored.

10 MEMBER WALLIS: The things that you have  
11 ignored have come up to be important, but they went  
12 down. They really were important before because you  
13 had the factor of 10 to the whatever.

14 MR. SIU: Or perhaps even a different  
15 way of looking at it is that the things that we  
16 ignored are still unimportant in an absolute sense.  
17 The numbers are small.

18 MEMBER WALLIS: But for different  
19 reasons.

20 MR. SIU: But they are high in  
21 proportion to what you have got left.

22 MEMBER WALLIS: But if you had not  
23 considered the LOCAs and just used the same basis 20  
24 years ago, you would have been picking up another  
25 factor of 10 squared.

1 MR. HACKETT: And the purpose of the  
2 following slide here is to show that we are trying -  
3 - we tried to, and we think that we have achieved  
4 balance in the project, and in the execution of the  
5 project, and that the contribution of the initiating  
6 event frequency, and the conditional probability of  
7 failure is somewhat balanced.

8 And the analogy here is, you know, the  
9 idea that the initiating event frequency were so, so  
10 low that maybe you could operate a plant with a  
11 glass reactor vessel.

12 MEMBER APOSTOLAKIS: Let me understand.  
13 What is that figure showing?

14 MR. HACKETT: What it is really showing  
15 here, which is the X-factor, which is the initiating  
16 event frequency. The Y-axis is the conditional  
17 probability of failure given that event.

18 MEMBER APOSTOLAKIS: Failure of what,  
19 the vessel?

20 MR. HACKETT: Of the vessel, and that  
21 you would not want to see this laying over too much  
22 either way, and it is especially skewed to me  
23 towards the initiating event frequency side.

24 MEMBER APOSTOLAKIS: Well, is the  
25 initiating event frequency goes to 10 to the minus

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1 2, and the condition probability goes also to 10 to  
2 the minus 2?

3 MEMBER WALLIS: No, no, the other event  
4 doesn't mean anything really.

5 MR. SIU: The question is whether the  
6 small numbers that I showed you on the previous  
7 slide are coming solely from, let's say, small  
8 initiating event frequencies, or solely from the  
9 condition of probability of vessel failure.

10 And what the slide is showing is that by  
11 and large for most important sequences there is a  
12 roughly equal contribution.

13 MR. HACKETT: In terms of the materials  
14 aspects on the slide that you are seeing here, what  
15 we have seen, which is not at all surprising to  
16 those of us who have been associated with this for a  
17 while, axial welds tracks way dominate the through  
18 wall cracking frequency on the order of over 90  
19 percent.

20 And in this case it is the axial weld,  
21 RTNDT, or the adjacent plate RTNDT that is  
22 governing. The circumferential weld cracks play a  
23 minor role, and in a lot of cases we have seen  
24 significantly less than 10 percent.

25 And in that case you are looking at the

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1 circ weld RTNDT, or the plate, or the forging  
2 situation governing. Cracking plates and forgings  
3 by and large are too small to play a role.

4 What you are really seeing -- and Terry  
5 can give you the details on this, but you have to  
6 have cracks that are probably more than a quarter of  
7 an inch or so, or I think what I remember from runs  
8 that I have done in the past were things on the  
9 order of a quarter-of-an-inch to three-quarters-of-  
10 an-inch to really be contributors.

11 And what you see from our flaw density  
12 and distribution that was developed is that you see  
13 a lot of flaws on the weld fusion lines, but they  
14 are a lot on the order of these two millimeter  
15 characteristic flaws. They are very small.

16 So when you hit those with a PTS  
17 transient, by and large they don't participate in  
18 contributing to --

19 MEMBER WALLIS: When you calculate your  
20 RTNDT star, you had a weighting factor for axial  
21 welds.

22 MR. HACKETT: Right.

23 MEMBER WALLIS: Now, I don't really  
24 remember, but I think it was independent of plant,  
25 and it looks as if the weighting factor here should

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1 not be independent of the plant.

2 It is very different for the Palisades  
3 than it is for Oconee.

4 MR. HACKETT: Yes. In fact, if you look  
5 at Beaver Valley, is a plate-dominated plant and so  
6 this actually is probably a pretty good place to  
7 take that kind of question as a lead-in to the  
8 weighted RTNDT.

9 The reason that -- and Mark Kirk  
10 developed that, and again at this point it is a  
11 proposal, as a way that you could proceed to  
12 recognize exactly this piece here.

13 That there is not an equivalence in how  
14 these things are initiating, and so it was a good  
15 idea to try and bring that data scatter today to try  
16 and weight these.

17 MEMBER WALLIS: But that is for  
18 different plants, and that is the thing that I  
19 wasn't sure about.

20 MR. HACKETT: It will be different  
21 depending on the material condition.

22 MEMBER WALLIS: So you calculate your  
23 weighting factor .

24 MR. HACKETT: Correct.

25 MR. SIU: That's right. I think you

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1 could view what he has as a curve fit for the three  
2 plants, and now we are doing Calvert and there will  
3 obviously be a check on that.

4 MEMBER WALLIS: So since you had three  
5 weighting factors at three plants, and that seems to  
6 be --

7 MEMBER SIEBER: Could you tell me why  
8 Beaver Valley is different than the others in that  
9 it is plate dominated?

10 MR. HACKETT: It really comes down to  
11 being as simple as their welds are in good shape.  
12 So they don't have --

13 MEMBER SIEBER: That is a high copper  
14 plant.

15 MR. HACKETT: They don't have high  
16 copper welds. They have a plate in this case that -  
17 - and I may have to turn to Matt for the exact  
18 reason. I don't know the exact answer to your  
19 question.

20 MEMBER FORD: Wasn't one of the reasons  
21 is that the axial welds were not at peak flux  
22 azimuth of the core?

23 MR. HACKETT: Matt, is that the correct  
24 answer?

25 MR. MITCHELL: Yes, what it comes down

1 to is that the plates at Beaver Valley are -- one  
2 might consider them atypically high in copper when  
3 compared to other plates around the industry.

4 And the way that the core management  
5 scheme has been conducted at Beaver Valley has  
6 tended to put the flux peaks on the plates rather  
7 than on the axial welds.

8 MEMBER SIEBER: I did that, too.

9 MEMBER WALLIS: It is not just core  
10 management. It is design. You have got a core  
11 which is square inches, and you have got a round  
12 vessel and where the square points come close to the  
13 vessel is where you have a high fluence, and put  
14 their welds on the flat part.

15 MR. HACKETT: That is also true.

16 MEMBER SIEBER: Well, it was done  
17 intentionally at that plant.

18 MEMBER WALLIS: Well, you don't -- it is  
19 inherent in the design, and you don't manage  
20 anything after that.

21 MR. HACKETT: There would be certain  
22 limitations as to how much you could change it with  
23 the core design versus inherent construction.

24 MEMBER SIEBER: Well, that plant always  
25 had a low-leakage core and the idea wa to keep the

1 fluence to the welds down, and we did that by zoning  
2 fuel. So that is how --

3 MR. HACKETT: Prior -- and that is a  
4 good question, but prior to the conduct of this  
5 project, I think there was a concern that with the  
6 plate being the embrittlement concern, and the  
7 material concern, you now have this very large  
8 surface area, and then if you were to sum up all the  
9 flaws that you might expect over that surface area,  
10 you might back yourself into a problem.

11 Instead, what you find is you find again  
12 that the flaws are focused on the weld fusion line,  
13 and the plates by and large aren't defective.

14 MEMBER SIEBER: Yes, I would suspect  
15 that most of the flaws are initiated in the welds.

16 MR. HACKETT: Right.

17 MEMBER SIEBER: And the density of the  
18 flaw initiators in the plates should be very low by  
19 orders of magnitude.

20 MR. HACKETT: That's exactly what we are  
21 finding.

22 MEMBER SIEBER: Okay.

23 MR. HACKETT: This next slide gets into  
24 basically -- well, it does not get into much. Mark  
25 Kirk is supposed to be here for that, and we had

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1 some -- we even had some audio for that. But the  
2 bottom line of this is looking at the containment as  
3 a system and its performance in terms of PTS and PTS  
4 impact on containment performance, is that the  
5 system energy for these types of situations are  
6 lower at the time of RPV failure, and so you have a  
7 limited mechanical impulse, and you have a limit to  
8 the containment pressurization.

9 And I think we have another graphic  
10 here. There it is. I think that Dave and Nathan  
11 can help me through this if I don't get it quite  
12 right. But I think what David did here was put a  
13 line on showing basically water at 212 degrees as a  
14 base line for energy, and then showing that  
15 particularly in the case of LOCAs, and this is a 16  
16 inch LOCA here.

17 But the LOCAs drop very quickly and then  
18 the energy that you are at is much lower. So the  
19 whole bottom line is that the design bounds this  
20 type of -- the design being basically to take the  
21 double-ended guillotine break from LOCA for  
22 containment performance is something that initially  
23 in this type of scenario should not present any  
24 extra challenge to the containment.

25 And with some dependency if you are

1 looking at containment sprays, and we are looking at  
2 a situation where we have done at least a  
3 qualitative analysis and there is not a missile  
4 threat or other threat that would hopefully in a  
5 dependent way take out containment sprays.

6 Another element would be the fuel  
7 cooling, depending on the reactor cavity design.  
8 Some of the cavities are designed and would be  
9 flooded in the event of a significant LOCA.

10 And then obviously that goes towards  
11 your fuel performance or any core melt  
12 characteristics. This one I know the committee  
13 heard this morning about GSI-191, and there is  
14 obviously some dependence in here with regard to 191  
15 and some strainer blockage.

16 MEMBER POWERS: Are you arguing that if  
17 you flood the cavity that the core won't melt?

18 MR. SIU: We are arguing that the  
19 probability of core damage is significantly less if  
20 the cavity is flooded, yes. We are not saying -- we  
21 just have not carried the analysis all the way  
22 through, but you are in a situation where you have  
23 got lots of cold water.

24 You have dumped the RWST, and in some of  
25 these plants the water level will rise above the top

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1 of the active fuel. In other plants, it won't.

2 MEMBER KRESS: There is a whole there to  
3 get the water into it?

4 MR. SIU: Yes, it is pouring out of the  
5 reactor pressure vessel. This is after the reactor  
6 pressure vessel has failed.

7 MEMBER POWERS: But you are not  
8 circulating it.

9 MR. SIU: It will heat up, but --

10 MEMBER WALLIS: Even if it doesn't  
11 completely cover the core as a pool, you will get  
12 two-way effects from spitting and steam cooling, and  
13 all that kind of thing.

14 MR. SIU: Yes.

15 MR. HACKETT: I guess I hesitate to go  
16 back to this type of slide, but -- well, there is  
17 one more piece here and this is basically Nathan's  
18 point here, is that this is addressed in the  
19 sequence analysis in detail for going through this  
20 type of scenario for the tree.

21 This was the one that I was hesitating  
22 to get back into, because this tries to resummari-  
23 ze sort of everywhere where we have been. But just  
24 going through the bullets, you know, and we have  
25 said this before, but very low predicted through

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1 wall cracking frequency values, and this is our  
2 bottom line, is suggesting that a revision of these  
3 criteria is warranted.

4 Basically this reactor vessel failure  
5 frequency set at 1 times 10 to the minus 6, will  
6 correspond to this weighted RTNDT value of 290  
7 fahrenheit. Now, again we are back into this where  
8 it does not compare directly to the ASME or the  
9 regulatory RTNDT.

10 This is a weighted RTNDT, and it was  
11 described in your report, and unfortunately I don't  
12 have -- we have some backup slides that get into  
13 that with a lot of algebra on i showing that it is  
14 weighted basically by weld type in the case of axial  
15 circumferential weld length. And also the fluence  
16 specifics, and the --

17 MEMBER WALLIS: For the benefit of  
18 Professor Apostolakis, you should point out that it  
19 takes account of the epistemic and aleatory  
20 uncertainties in RTNDT.

21 MEMBER APOSTOLAKIS: Yes, we will come  
22 to that.

23 MEMBER WALLIS: Oh, you will come to  
24 that, but this RTNDT star is supposed to take  
25 account of that or not.

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1 MR. HACKETT: We feel that it does.

2 MEMBER WALLIS: Well, maybe not. It  
3 doesn't. I'm sorry, I'm wrong. It is in evaluating  
4 the mean of the TWCF that you take account of that.

5 MR. HACKETT: Yes, that is correct. In  
6 this case, we --

7 MEMBER APOSTOLAKIS: This is weighted  
8 over what again?

9 MR. HACKETT: This is basically to try  
10 and do like the layman's view of this thing. This  
11 is taking the RTNDT and going back to that slide  
12 that I had showed you that breaks down where the --  
13 I think like Marsh liked to put it yesterday, where  
14 do you assign the blame.

15 And where you assign the blame for  
16 failure of these things is failure of axial welds  
17 for the most part. So it is trying to weight it  
18 where the meat is. So largely weighted towards  
19 axial welds, but it will be weighted both in terms  
20 of the type of weld, axial versus circumferential,  
21 and the weld length.

22 MR. CUNNINGHAM: So it is the weld  
23 length.

24 MR. HACKETT: And the way the fluence is  
25 delineated. So it is a function of those things.

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1 MEMBER APOSTOLAKIS: There was an  
2 argument made, which I can't find now, is on page X,  
3 and that if a particular utility does not  
4 necessarily know what kinds of axial rods it has, a  
5 nd that is what it says here, and that is why you  
6 are taking the weighted average.

7 And you have a generic average of 10  
8 percent of them, and what is that called, heating,  
9 or heat something?

10 MR. HACKETT: A heat analysis?

11 MEMBER APOSTOLAKIS: Yes.

12 MR. HACKETT: There are obvious  
13 different heats of weld material.

14 MEMBER APOSTOLAKIS: Yes, and they don't  
15 know, right?

16 MR. HACKETT: Actually, they have  
17 everything, and this gets back to the discussion  
18 that we had earlier. They would have everything.  
19 If you were to get into the plant specifics, they  
20 have everything that they need to address the  
21 weighted value also.

22 MEMBER APOSTOLAKIS: So if they haver  
23 everything, they will not need to use a weighted  
24 value, and that is where I am going. Why would they  
25 need a weighted value?

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1 MEMBER WALLIS: No, no, a weighted value  
2 takes account of the composition.

3 MR. CUNNINGHAM: The variability of  
4 materials and welds within a given plant. The  
5 weighting is all for one plant.

6 MEMBER APOSTOLAKIS: Within a plant.

7 MR. CUNNINGHAM: Within a plant.

8 MR. HACKETT: Now, if you were to get to  
9 -- and Professor Apostolakis may be going beyond to  
10 -- if you were to get to a plant specific analysis,  
11 and if your question is can they make this case, and  
12 can they calculate this parameter, again it is just  
13 a proposal at this point, but yes, they could,  
14 because they know the weld types that are limiting,  
15 and they know the weld lengths, and the geometry.

16 And they have the detailed fluence map  
17 of their vessel. So they could argue on that basis  
18 if they needed to. And the chances are that if this  
19 project is successful, they won't need to.  
20 Hopefully you won't ever need to.

21 But that is there if it had to come out.  
22 The last point really goes to this issue here, this  
23 RTNDT star that we have been talking about, and we  
24 have RTPTS,, which is RTNDT, but that is the way  
25 that it is calculated currently.

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1           There is a difference of on the order of  
2       80 to 110 degrees F. to compare apples to apples.  
3       So like what we were talking about before, what this  
4       means in the end is that a 290 F. screening limit on  
5       RTNDT star corresponds to the current regulatory  
6       limit moving out to 350 or more, depending on  
7       exactly where we end up.

8           And then that then has the effect of  
9       pushing out the operation for -- and I think that is  
10      my next slide in fact.

11           MEMBER APOSTOLAKIS: Yes.

12           MR. HACKETT: Well, maybe not, but the  
13      bottom line is that the plants are grouped here and  
14      it takes them for even coming close to impacting  
15      this revised screening criteria for many years.

16           At least it looks like for the license  
17      renewal period, and probably beyond, and Mark has  
18      the graphic down here saying 60 to 80 years  
19      potentially.

20           It may be getting to the point of eliminating this  
21      as a real regulatory concern.

22           MEMBER WALLIS: Mark also pointed out  
23      that the highest value you have for Beaver was  
24      something like a thousand years or something like  
25      that.

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1 MR. HACKETT: They ran the analysis out  
2 pretty far I think.

3 MEMBER WALLIS: So for 60 to 80 in the  
4 yellow region, but if you start and kind of go up to  
5 the 10 to the minus 6, you have got to go out for  
6 hundreds or thousands of years.

7 MR. HACKETT: We did get into some  
8 discussion yesterday, and again --

9 MEMBER POWERS: We will never get out of  
10 the license renewal business.

11 MEMBER SIEBER: By then it will have  
12 corroded through.

13 MR. HACKETT: So I think our conclusions  
14 we have pretty much been through most of that. I  
15 think we have covered most of this. There is a  
16 question that Mark Cunningham raised about the reg  
17 guide.

18 Certainly we feel that we have a tech  
19 basis to go forward with the rule revision. Whether  
20 or not we engage in revision of the reg guide is  
21 probably going to be a resource issue largely.  
22 Nathan mentioned and talked about the reactor vessel  
23 failure frequency.

24 And the metric that we are talking about  
25 that is proposed here is that that is equivalent to

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1 the through all cracking frequency, and other  
2 options were evaluated.

3 And that that failure frequency would be  
4 set at 1 times 10 to the minus 6 per reactor year,  
5 and we think that is consistent with the guidance  
6 that we received from the committee, and previous  
7 foundation for the PTS rule, and also the  
8 quantitative health objectives.

9 The analysis supports this revised  
10 screening limit, and in this case the 290 on the  
11 weighted basis, which is equivalent to this 350 plus  
12 number. in terms of what we are used to thinking  
13 about.

14 MEMBER WALLIS: Well, I am just  
15 wondering about you screening them, which is such  
16 that they will never reach it. So there ought to be  
17 some regulatory check on what is going on with  
18 embrittlement.

19 MR. HACKETT: Before then.

20 MEMBER WALLIS: Before that, and how are  
21 you going to do that?

22 MR. HACKETT: A couple of things that I  
23 could comment on, and I am glad that you brought  
24 that up because we have gone through this so fast  
25 that we didn't bring up some of the other issues.

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1                   One effect that this will have is that  
2 we have to now go back and look at the companion in  
3 Appendix G for the operational limits. I know that  
4 we talked about that yesterday, but we should get  
5 into that here, too.

6                   So we have an activity that is looking  
7 into the effects on Appendix G for heat up and cool  
8 down curves, and that is probably more likely to be  
9 where we will shift some of the limiting concerns  
10 here.

11                   MEMBER WALLIS: But maybe this should  
12 also be an ongoing effort to evaluate some of the  
13 key assumptions that got you to this wonderful  
14 immortal vessel as you go along.

15                   So that you say, oh, well, yeah, we made  
16 these big changes in what was assumed about flaws on  
17 the basis of the knowledge that we gained. And as  
18 we gain more knowledge, do we have to go back on  
19 that because of the extra knowledge that we are  
20 getting, and say maybe we were too optimistic about  
21 flaws or something.

22                   MR. HACKETT: Yes, absolutely. That one  
23 is a key one that Dr. Ford mentioned yesterday. The  
24 potential or at least we have looked at for fairly  
25 near term, and any possibility for any active

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1 advancement of these fabrication flaws.

2 We think the answer is no, and we have  
3 data that says that it should be no, but that is not  
4 to say that is true for all time.

5 MEMBER WALLIS: And how about this noble  
6 chem thing? Suppose they come up with some new kind  
7 of chemical treatment for the water, and is this  
8 going to do anything about the surface flaws and all  
9 of that? Are we going to have to revisit this?

10 MR. HACKETT: We are going to have to  
11 continue to monitor those types of developments, and  
12 then maybe we will finish up and take any other  
13 questions with where we are going.

14 MEMBER APOSTOLAKIS: Oh, I thought you  
15 were finished.

16 MR. HACKETT: As I said, maybe to  
17 revisit where Mark started us off, and we feel that  
18 we have this interim product that we have shared  
19 here with the committee that has been forwarded to  
20 the NRR for detailed comments.

21 And that describes a lot of activities  
22 in the Office of Research from all three of the  
23 divisions. There is also that NRR has been involved  
24 while we have been doing this.

25 But in terms of the things that we still

1 need to do, the Calvert Cliffs analysis, or the  
2 analysis of the Calvert Cliffs plan is not complete,  
3 and we should complete that in 2003, and that is a  
4 big aid in helping us with number two, in terms of  
5 the generalization of what we have done here to  
6 other plants, and to all plants.

7 We do have some sensitivity studies to  
8 work on, and one of them involves the flaw density  
9 and distribution. We have been challenged with some  
10 what if's there.

11 We feel that we have a pretty solid  
12 basis for that, but you can always second-guess what  
13 we have done so far, because there is a limited  
14 amount of data there like in a lot of cases.

15 There is verification and validation of  
16 the FAVOR code, which has been ongoing, and a lot of  
17 which has been completed. A lot of interaction with  
18 the industry on that.

19 Professor Apostolakis mentioned the peer  
20 review, and it is a challenge to get people, and it  
21 is almost like an O.J. Simpson jury. You know, you  
22 are looking at trying to find people who have not  
23 been involved in this thing in the United States,  
24 and it is not easy.

25 So we do have that as a take away, and

1 that we have got an external peer review, and I  
2 think in Mr. Mr. Thadani's letter, he had indicated  
3 that the ACRS was sort of subbing for -- and I don't  
4 know if that is the right word, but there was some  
5 discussion yesterday about ACRS substituting for an  
6 external peer review, and that is not the case.

7 As always, we have gotten many useful  
8 comments from the committee, and we think that we  
9 have addressed a lot of them. We have more to  
10 detail with, but it is not substituting for an  
11 external peer review, and so we will have that  
12 going.

13 The implications of the operational  
14 limits, we talked just briefly about that here.  
15 That is something that we still need to address. We  
16 have a user request from NRR to get into that area,  
17 and we are budgeted to do work in that area in 2004,  
18 I believe.

19 And Matt can get into any other details  
20 on the NRR activities, but just briefly here this  
21 was sent on -- we actually made a New Year's Eve  
22 deadline, which is maybe the first time in my career  
23 that we actually did that.

24 But Shipp (phonetic) was here, and he  
25 signed it out, and it went over to NRR on New Year's

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1 Eve. We have to have our comments back by the end  
2 of March, and then looking at decision to proceed  
3 with rule making, which is -- we talked a lot about  
4 that yesterday, too.

5 We feel that it is warranted technically  
6 and there are obviously a lot of other concerns at  
7 NRR that we will have to consider with regard to  
8 engaging rule making activities. So that will be  
9 their decision.

10 Preliminary indications from discussions  
11 with the EDO and NRR are that they feel pretty  
12 strongly about this, and so that is likely to go  
13 forward hopefully in the near term here.

14 And that is pretty much the end of our  
15 prepared remarks, and we are happy to take any  
16 questions.

17 MEMBER APOSTOLAKIS: Okay. I have a few  
18 questions on the uncertainly analysis that is  
19 described in Chapter 2 of this report. In Section  
20 2.1.6.1, it says that -- it describes how aleatory  
21 uncertainties are handled, and I understand the  
22 aleatory problem.

23 But then much to my surprise, it says  
24 that model uncertainties are aleatory, and also  
25 uncertainties due to incompleteness are also

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1 aleatory. So 2.1.6.1.

2 And I have always believed or thought  
3 that model uncertainties were part of the epistemic  
4 uncertainties. Now, you might say all you have to  
5 do is take these two paragraphs and move them to the  
6 other section that talks about epistemic  
7 uncertainties.

8 But actually there is more to it than  
9 that, because somewhere else it says that in 2.26, I  
10 believe, it says that parameter uncertainties which  
11 are classified as epistemic the only epistemic  
12 uncertainty in the report is the parameter  
13 uncertainties.

14 Now, propagated using Monte Carlo and  
15 Latin Hypercubes. The other, the aleatory, are  
16 handled by considering a best estimate, lower and  
17 upper bound, and you put some subjective  
18 probabilities.

19 And then there is Table 2.3 that lists  
20 some of these aleatory uncertainties. For example,  
21 the break location. We don't know what it is. The  
22 season. It says there is one-quarter probability of  
23 it being winter, and .5 being spring or fall; and .2  
24 5 being the summer, which I think I know where it  
25 comes from.

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1                   So these are aleatory and they are  
2 random, and you can't do anything about them. But  
3 the same table is the RELAP-5 code model uncertainty  
4 is an aleatory uncertainty.

5                   So that tells me now that if I run the  
6 code a thousand times I will get random results  
7 because it is a random code, and then if I go to  
8 what Nathan wrote in Appendix B, which was written  
9 some time ago, the interpretation that Nathan used  
10 for aleatory and epistemic, which I agree with, is  
11 inconsistent with this, because I can't believe that  
12 the code is --

13                  MR. SIU: George, if I made, I will give  
14 my interpretation of what I see written here. And  
15 then, James, I don't know if you want to add  
16 anything to that.

17                  I think they were referring to model  
18 uncertainty in a very limited sense, and in models  
19 in a very limited sense. They were talking about  
20 the input parameters, such as the valve area.

21                  And when you say the valve has failed,  
22 what does that mean? So you look at different  
23 openings. That is an aleatory --

24                  MEMBER APOSTOLAKIS: So it is the event  
25 that is --

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1 MR. SIU: It is a boundary condition.  
2 So you could say that is part of the model.

3 MEMBER APOSTOLAKIS: But that's not  
4 aleatory. I mean, that is not model uncertainty.

5 MR. SIU: Well, that is what I am  
6 saying, is how I was reading that particular model  
7 uncertainty, as opposed to saying RELAP is off by --  
8 you know, let's pick an arbitrary number, which may  
9 not be real at all, and let's say 10 degrees, plus  
10 or minus, standard deviation. That is differently  
11 than what this is trying to reflect.

12 MEMBER APOSTOLAKIS:

13 MEMBER APOSTOLAKIS: What is says, for  
14 example -- are you there, Vic? Table 2.3. I need  
15 you guys to look at it. For 2.3, there is no page.

16 MEMBER RANSOM: It must be missing.

17 MEMBER APOSTOLAKIS: If it is messed up,  
18 you will never fix it. Does anyone on the table  
19 have 2.3? Okay. So that I can understand the valve  
20 state, now where it says component heat transfer  
21 rate, can that be an aleatory variable?

22 I mean, the heat transfer rate, what  
23 does that mean, the heat transfer coefficient? Yes,  
24 sir, what is it?

25 DR. CHANG: This is James Chang from the

1 University of Maryland. When we modeled this, we  
2 considered that there is the uncertainty in the  
3 measurement of the heat transfer rate. So in our --

4 MEMBER APOSTOLAKIS: What heat transfer  
5 rate is that? Where?

6 DR. CHANG: It is the heat transfer --  
7 well --

8 MEMBER ROSEN: From the fluid to the  
9 wall.

10 MEMBER APOSTOLAKIS: Okay.

11 DR. CHANG: Yes, but in doing so, we are  
12 not able to change the unified equation. Instead,  
13 we changed the heat transfer area by --

14 MEMBER APOSTOLAKIS: And what equation  
15 is that? You said that you cannot change the  
16 equation. What equation is that? Is it the heat  
17 equation in the code?

18 DR. CHANG: Yes.

19 MEMBER APOSTOLAKIS: Okay. So that will  
20 give you the nominal value, right?

21 DR. CHANG: Yes.

22 MEMBER APOSTOLAKIS: And you say that I  
23 believe that equation that the code uses only .9  
24 percent of the time, but 10 percent or .8 percent of  
25 the time. And 10 percent of the time, I believe it

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1 is 30 percent less, and 10 percent of the time I  
2 believe it is 30 percent more. That is what the  
3 table says.

4 So there are two questions now. The  
5 first is what is the basis for these assessments,  
6 and second is that aleatory. In other words, for  
7 the same sequence and for the phenomena, 10 percent  
8 of the time it would be underestimated, and 10  
9 percent of the time it would be overestimated? That  
10 doesn't make sense.

11 It is always the same value, but you  
12 just don't know what it is. So it is a mistake. It  
13 shouldn't be the same table as the others, and again  
14 if it is a matter of removing it from the table, I  
15 wouldn't mind that much, but you used it in your  
16 calculations.

17 You combined it with an aleatory, and  
18 now I don't know what happened to all of this.

19 MEMBER WALLIS: This concerned me, too,  
20 and when you do this, and when you make a  
21 calculation with RELAP, you get the temperature  
22 going down like this on a curve.

23 If you use the aleatory, it jumps around  
24 as it comes down the curve and that changes the  
25 thermal testing. Well, it doesn't jump around as it

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1 comes down.

2 MEMBER SHACK: Well, no, it predicts a  
3 heat transfer coefficient which you are going to use  
4 in favor.

5 MEMBER WALLIS: And then do you stick to  
6 that, or as it randomly changes as --

7 MEMBER SHACK: No, in some codes or in  
8 some cases they use the predicted value, and they  
9 say there is some uncertainty in that value, and so  
10 sometimes they use a higher value, and sometimes  
11 they use a lower value.

12 MEMBER WALLIS: But they use it  
13 throughout all the time, this correction?

14 MEMBER SHACK: No, but --

15 MEMBER WALLIS: Oh, you don't change it  
16 from time to time?

17 MR. BESSETTE: No, and so let's say we  
18 have a heat transfer coefficient for a convection  
19 model and so we put a multiplier on that of 1.3 or  
20 .7.

21 MEMBER WALLIS: So it is always off in  
22 the same direction? The thing that we are looking  
23 for --

24 MEMBER APOSTOLAKIS: No, no, and if you  
25 go to Appendix B, Nathan has a very nice figure of

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1 how aleatory uncertainties is handled. It is inside  
2 in a loop, and then the epistemic are on top.

3 This cannot be part of the loop, period.  
4 It is epistemic.

5 MR. BESSETTE: This particular table is  
6 everything that we varied, and so it is not intended  
7 to be an aleatory table.

8 MEMBER APOSTOLAKIS: It is not in terms  
9 of what?

10 MEMBER SHACK: Separate the table in two  
11 if it makes you happier, George.

12 MEMBER APOSTOLAKIS: Yes, but the  
13 calculation --

14 MEMBER SHACK: Split the table.

15 MEMBER APOSTOLAKIS: No, because the  
16 text says that all of these are aleatory and they  
17 are treated as such, because the epistemic are  
18 treated via the Monte Carlo. It is not just a  
19 table. The text says this is what we do.

20 MR. BESSETTE: Yes, and so none of these  
21 things are treated in a Monte Carlo sense. These  
22 are all treated as --

23 MEMBER APOSTOLAKIS: It is random, and  
24 we are taking -- right? What else?

25 MEMBER RANSOM: I think they made

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1 sensitivity studies, and so they made parametric  
2 studies, although I don't understand why 9/10ths of  
3 the time that --

4 MEMBER APOSTOLAKIS: Well, that is  
5 another issue, but the other issue is the process  
6 issue. I mean, to put in a table things like I  
7 don't know what season of the year it will be,  
8 right, and so it is that one-quarter of it is  
9 winter. I understand that.

10 And then to say that the coefficient  
11 will be treated the same way, that just does not  
12 make sense to me.

13 MEMBER WALLIS: Well, there is a bigger  
14 question than that, is that if you are going to make  
15 this correction to the heat transfer coefficient  
16 throughout the whole transient, then you simply  
17 displace everything.

18 But in reality RELAP could be critically  
19 too high a heat transfer coefficient at the  
20 beginning, and to low a coefficient at the end. And  
21 that is where you get a transient with a steeper  
22 time variation of temperature.

23 MEMBER APOSTOLAKIS: Right.

24 MR. BESSETTE: Well, you know, we deal  
25 with this single -- let's say convective model. I

1 mean, so RELAP can be wrong in the sense that it is  
2 calculating the wrong fluid velocity, which gives  
3 you -- maybe you say how can RELAP be wrong in  
4 different directions at different times in a  
5 different transient, and it is.

6 MEMBER WALLIS: It is wrong.

7 MR. BESSETTE: The way that you would  
8 obtain that in practice is somehow if RELAP is  
9 sometimes toggling too high a fluid velocity, and  
10 sometimes too low.

11 MEMBER WALLIS: Well, what I was looking  
12 for is that you said you drew these curves for RELAP  
13 predictions versus the data, which is fine. And  
14 then you have to say intellectually how am I going  
15 to represent this difference between the two.

16 How am I going to do that given that it  
17 has certain features, and some of it is above and  
18 some of it is below, and with time the deviation  
19 goes plus or minus. How am I going to represent  
20 that?

21 How do I go from that to whether it is  
22 epistemic or aleatory, and how do I treat it? And  
23 all that logic could somehow come out in the report.

24 MEMBER APOSTOLAKIS: And aren't you  
25 actually -- well, admittedly you are doing

1 sensitivity analyses?

2 MR. BESSETTE: Yes.

3 MEMBER APOSTOLAKIS: How do you do that?

4 Do you do it one parameter at a time? How do you

5 conclude that the LOCA between 1-1/2 inch and 4

6 inches is a dominant scenario?

7 I mean, you have some something, and all  
8 you are saying in the report is that for each key  
9 PTS contributing parameter, typically three  
10 representative values are presented lower, nominal,  
11 and upper bound with corresponding predetermined  
12 probabilities are used for the assessment of their  
13 (inaudible) sensitivity indicator.

14 But it does not tell me how. So are you  
15 taking all the possible combinations of this table  
16 and run the code and see what happens, or are you  
17 doing one parameter at a time?

18 DR. CHANG: We do think one parameter at  
19 a time. So we fix -- at first we fix the break size  
20 and we select 1.5 inches, and 2 inches, and 2.8  
21 inches, and 4 inches, and 5.7 inches, and 8 inches.

22 So for each break size, I varied the  
23 parameter, and at that time we changed a few other  
24 EOC water temperature, from the spring time  
25 temperature to the winter time, and then see the

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1 difference.

2 MEMBER APOSTOLAKIS: So when you change  
3 the component heat transfer rate, you assume that  
4 there is perennial summer, because you don't change  
5 that. If you are unlucky to have a different heat  
6 transfer rate, and it happens in the winter, then  
7 you are in trouble, because you are using nominal  
8 values for the other parameters, which really goes  
9 against this aleatory business.

10 Aleatory means that things are random  
11 and all sort of combinations.

12 MEMBER WALLIS: And you need 59  
13 combinations.

14 MEMBER APOSTOLAKIS: Well, whatever it  
15 is, yes. We were all very happy when we saw what is  
16 now Appendix B that Nathan wrote 3 years ago, or 4  
17 years ago, because that was logical, and explained  
18 how things were going to happen. But now they  
19 didn't happen that way.

20 MR. CUNNINGHAM: It is clear, Dr.  
21 Apostolakis, that we need to go back and look at  
22 this, and either clarify --

23 MEMBER APOSTOLAKIS: I thought you said  
24 Appendix B was clear, yes.

25 MR. CUNNINGHAM: If Appendix B was

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1 clear, yes.

2 MEMBER APOSTOLAKIS: I was completely  
3 confused by this discussion here, and I thought  
4 again, thinking of my colleagues' shock, that maybe  
5 I was overreacting and that this was academic, and  
6 that you actually did things like that. So it  
7 matters this time.

8 MEMBER SHACK: They have the main  
9 sequence, and at least as I understand it, the  
10 thermal-hydraulics, they have been in the PRA, and  
11 that is how they get those sequences that they  
12 considered.

13 Then they want to consider the  
14 uncertainty associated with each of those main  
15 sequences. So they take the one-inch break, and --

16 MEMBER APOSTOLAKIS: No, that is not  
17 what it says. They want to characterize the  
18 variables.

19 MEMBER SHACK: But you do that because  
20 you are representing this whole set of scenarios by  
21 a thermal hydraulic sequence, but that one thermal-  
22 hydraulic sequence doesn't account for all the  
23 uncertainty that you have in it.

24 So you account for that uncertainty by  
25 considering the range of variables over which that

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1 scenario really covers for you representing 15,000  
2 thermal-hydraulic sequences by one, but that really  
3 corresponds to a range of variables.

4 There is the aleatory representation  
5 that you have, because the break could occur  
6 anywhere. It could occur in winter and in the  
7 summer, and there is also the epistemic problem that  
8 RELAP may not be calculating the heat transfer  
9 coefficient properly.

10 MEMBER APOSTOLAKIS: Right.

11 MEMBER SHACK: So you include an  
12 uncertainty for that. In that sense that you have  
13 included when you do the hydraulics for that bin,  
14 you have included the thermal-hydraulic  
15 uncertainties covering the fact that you are  
16 representing 15,000 sequences by one thermal-  
17 hydraulic sequence.

18 And that there are things that you don't  
19 know about the -- and even if you had all 15,000  
20 sequences, there is still things that you don't know  
21 about the sequence, like when it is going to happen  
22 in the year. And the fact that RELAP could be  
23 wrong.

24 MEMBER APOSTOLAKIS: I understand all of  
25 this. The question is what do you do about it? And

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1 that is not what is --

2 MEMBER SHACK: Well, today you have to  
3 look that it favors --

4 MEMBER APOSTOLAKIS: No, no, no. I am  
5 looking at 2.6.

6 MEMBER SHACK: Well, it is a question of  
7 how he does it in the calculation.

8 MEMBER APOSTOLAKIS: Yes.

9 MEMBER SHACK: Is he picking it randomly  
10 within -- I mean, what Monte Carlo loop is he  
11 within, and I believe that he does it so that he  
12 treats the RELAP uncertainties as epistemic, and the  
13 other uncertainties as Aleatory.

14 MEMBER APOSTOLAKIS: All the indications  
15 --

16 MEMBER SHACK: But he is probably the  
17 best --

18 MEMBER APOSTOLAKIS: Why do you believe  
19 that when the author says that they treat them as  
20 aleatory? I mean, why do you believe that?

21 MEMBER SHACK: Well, personally I don't  
22 believe when I read that report the figure of 1.1.

23 MEMBER WALLIS: But, George, there is  
24 another point that needs clarification. Is that  
25 when the thermal hydraulics result goes to the next

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1 step, it is treated as being a deterministic result,  
2 and it is one curve. It is not a curve, plus  
3 uncertainties.

4 So I am not quite sure then how the  
5 thermal hydraulic uncertainties propagate through to  
6 influence the final answer.

7 MEMBER APOSTOLAKIS: Okay. So there are  
8 several issues here. One is the issue of how did  
9 you come up with the 30 percent more or 30 percent  
10 less with the probability of .1.

11 MEMBER SHACK: Well, that is a judgment.

12 MEMBER APOSTOLAKIS: Right, but it can  
13 be questioned by experts in that field. Secondly,  
14 why do mix aleatory and epistemic; and why do you do  
15 a sensitivity analysis one variable at a time?

16 MEMBER POWERS: Because you are an  
17 idiot. It is the wrong way to do it. No, it is  
18 easy to do.

19 MEMBER APOSTOLAKIS: It is easy to do.

20 MEMBER SHACK: Sure. It is easier to do  
21 it at multi-variables at a time than it is one  
22 variable at a time.

23 MEMBER APOSTOLAKIS: So they chose the  
24 hard way?

25 MEMBER SHACK: I bet that they did.

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1 DR. CHANG: Well, I say it is the Table  
2 2.3 here where we changed one variable at a time, a  
3 nd then we used the first 10,000 seconds, the  
4 downcomer average as a sensitivity indicator, and  
5 from here we used a single probe to mix all of them.

6 MEMBER APOSTOLAKIS: You mixed them?  
7 When? I thought you said you do it one at a time.

8 DR. CHANG: Yes, one at a time, and that  
9 is the first set, doing the sensitivity of one  
10 parameter uncertainty, and how it could affect the  
11 PTS, yes.

12 And then the second step is that now we  
13 have the sensitivity of one parameter, and then all  
14 the associate probabilities, and that probability is  
15 assigned here.

16 And then through the all the parameters  
17 combined --

18 MEMBER APOSTOLAKIS: So you are going by  
19 the probability?

20 DR. CHANG: Yes.

21 MEMBER APOSTOLAKIS: But then that  
22 assumes that the dependence of the 30 models in the  
23 code is linear, because if it is not linear, then  
24 you can't do that.

25 DR. CHANG: Yes.

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1 MEMBER APOSTOLAKIS: Are they linear?

2 DR. CHANG: Because the sensitivity  
3 would be indicated, we choose for the first and  
4 second parameter checks an average of --

5 MEMBER APOSTOLAKIS: Well, there again  
6 you have a problem again because you are saying now  
7 that I will take the weighted average.

8 So I will take 70 percent of the nominal  
9 heat transfer coefficient with a probability of .1,  
10 and multiply that by .1, and take the results for  
11 winter and multiply them by five and add the two.  
12 Well, winter is aleatory, and it is really --

13 MEMBER WALLIS: It is average behavior  
14 through the year.

15 MEMBER APOSTOLAKIS: Average is  
16 everything. Anyway, I think Mark is right.

17 MR. CUNNINGHAM: We need to go back and  
18 look at this, and look at it further.

19 MR. ROSENTHAL: This is Jack Rosenthal,  
20 Safety Systems Analysis Branch. I agree with Mark  
21 that we have to go back and regroup on this issue.  
22 Nevertheless, in preparation for this, I asked Dave  
23 please help me as we continue on.

24 And he pointed out to me that if you  
25 take the water from the refueling water storage

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1 tank, and you pump it through the system, and you  
2 throw it against the wall. And in the winter it is  
3 40 F., and in the summer it is 80 F.

4 So that delta-40 ends up with almost the  
5 delta 40 on the wall. So we take these values, and  
6 the delta 40 F. is long compared to at least on an  
7 RMS basis how we did between RELAP and the  
8 developmental assessment calcs, and we run it  
9 through FAVOR.

10 And what you get is a low number in  
11 favor either way. So I acknowledge that there is  
12 some real methodology things that we have to  
13 straighten out with the report, and I think we can  
14 do it right, but my basic understanding is that we  
15 have done enough variation of parameters, and done  
16 enough FAVOR runs that the basic conclusion that we  
17 have that the PTS risk is small is robust.

18 MEMBER WALLIS: Jack, that's why we need  
19 some numbers of these green and red arrows, and my  
20 impression is that the effect of this thermal-  
21 hydraulics is probably a 10 or 20 percent effect.

22 And the effect of what you assume about  
23 the flaws is a factor of 20 to 70, and so one  
24 overwhelms the other completely. If we make that  
25 clearer, we might have more perspective on what we

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1 ought to concentrate on.

2 MR. ROSENTHAL: Fair enough.

3 CHAIRMAN BONACA: I think so.

4 MR. ROSENTHAL: I figured that the  
5 probablistic fracture mechanics is maybe three, or  
6 what is the magnitude on the thermal-hydraulics, and  
7 yes, we will acknowledge that we need to go back and  
8 rewrite the document better.

9 MEMBER WALLIS: You really need this  
10 overview document which puts the whole thing in  
11 perspective, all these things in perspective.

12 CHAIRMAN BONACA: I wanted to ask  
13 another question. Just because it is a rather  
14 significant contributor that has been eliminated,  
15 and we discussed this before, but I did not attend  
16 the whole meeting yesterday.

17 You concluded secondary side breaks are  
18 not important. So now I remember one of the  
19 dominant breaks assumed for a B&W plant in the  
20 previous analysis, and that was a steamline break,  
21 and we had run out of feedwater, and tried to  
22 isolate the primary system pressure drops.

23 And you had this ECCS injection, and  
24 further cooldown, and repressurization, and now you  
25 have this very severe condition. Now, I grant that

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1 there is no operator actions being assumed there,  
2 and failure of the (inaudible) isolation, and so  
3 that is understandable in that scenario, for  
4 example.

5 But how do you eliminate that being any  
6 contributor? Just because of operator actions in  
7 the procedures? Yesterday, you pointed out that it  
8 was not only operator actions.

9 MR. KOLACZKOWSKI: There are three  
10 reasons which Ed mentioned, and we will go over that  
11 again, I guess. Hopefully it will be clearer. As  
12 we pointed out in the early work, and of course the  
13 Oconee analysis that was done in '81 or '82, or  
14 whenever it was, the early '80s, that was the one  
15 that really showed the main steamline break was  
16 important.

17 If you go in and look at that analysis,  
18 you find that because we are dealing today in doing  
19 a 150 thermal-hydraulic bins, or as back then it was  
20 more like about a dozen, as Ed pointed out, that if  
21 you go look at the analysis, you find that  
22 essentially they took all the frequencies of things  
23 like main steamline break, and maybe a couple of  
24 multiples, a nd stuck-open turbine bypass valves, and  
25 small steamline break, a nd treated all of those

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1 events as if it was a main steamline break.

2 MEMBER APOSTOLAKIS: Okay.

3 MR. KOLACZKOWSKI: So from a thermal-  
4 hydraulics standpoint, we get this very rapid  
5 cooldown, so on and so forth, and they are dumping  
6 all these frequencies into that bin, and then  
7 obviously applying a very high, or relatively high,  
8 CPF.

9 That is, a conditional probability of  
10 vessel failure, because they were treating it like  
11 it was all a main steamline break. So first of all,  
12 we come along and we say we are not going to treat  
13 it that way. We are going to take a main steamline  
14 break, and we are going to put it in its bin, and  
15 have its frequency.

16 And that will still give us a high, or  
17 relatively high, CPF, but the frequency if we had  
18 not dumped in all these other things as if they are  
19 all main steamline breaks.

20 And then we have a multiple turbine  
21 bypass valve bin, and we say, okay, we are going to  
22 get its frequency, but you know what? That is a  
23 much smaller break, and so even though the frequency  
24 is higher, the CPF is a lot lower because we don't  
25 get much cooldown.

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1                   So first of all the binning, and the  
2 fact that we are not using as gross bins, everything  
3 else equal, you have already lowered it a lot  
4 because we are not treating all these frequencies  
5 like they are all a main steamline

6                   MEMBER APOSTOLAKIS: I understand.

7                   MR. KOLACZKOWSKI: And so that is reason  
8 number one.

9                   MEMBER ROSEN: You're not treating all  
10 of them with the steamline breaks degree of  
11 overcooling?

12                  MR. KOLACZKOWSKI: That's right.

13                  MEMBER APOSTOLAKIS: So the frequency of  
14 that particular event is much lower now because of -  
15 -

16                  MR. KOLACZKOWSKI: Yes, that is reason  
17 number one. The binning itself, and the process  
18 itself, changed the numbers.

19                  The second thing is if you just look at  
20 -- and now with all the changes that have occurred  
21 in FAVOR code and so on, and so forth, removing all  
22 these conservatisms, et cetera, if you were to take  
23 the same main steamline break back in 1980 with  
24 today's code, and now do the analysis with today's  
25 code, what you would find is that the CPFs were

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1 grossly over-estimated because of the old -- well,  
2 whatever was the precursor to the current FAVOR  
3 code.

4 In other words the CPF that was being  
5 predicted back in 1984 for a main steamline break,  
6 are higher than the CPF we would predict today with  
7 today's version of the FAVOR code, just because of  
8 the fact that we have removed a lot of those  
9 conservatisms in the fracture mechanics part of the  
10 analysis.

11 So that has lowered the main steamline  
12 break. And then finally the third thing is as you  
13 have already pointed out, Dr. Bonaca, is that the  
14 early analysis gave little to no credit for  
15 isolating, let's say, a faulty steam generator  
16 because they didn't want this to rely on necessarily  
17 human action or whatever.

18 And we said, okay, but we are trying to  
19 do a best estimate with uncertainty bounds on  
20 things. So as a result, we want to acknowledge that  
21 operators just aren't going to watch a steam  
22 generator blowdown and continue to feed for 30  
23 minutes and not do anything about it.

24 And so we said, okay, let's give --  
25 well, whatever we felt was the appropriate credit,

1 and it went through the systematic process, ATHEANA,  
2 and expert elicitation, to try to put some, we hope,  
3 realistic values on what is the chance that  
4 operators would not isolate a steam generator by 30  
5 minutes into this event.

6 And we all believe that probability of  
7 failure is not 1.0 based on the simulations that we  
8 have seen, and based on EOPS today, based on where  
9 EOPs were back in 1970, late, when those early  
10 analyses were done. and based on current training  
11 today, et cetera.

12 And that there are real reasons to  
13 provide some credit for operator error.

14 MEMBER ROSEN: The big change is in  
15 systematic procedures, right?

16 MR. KOLACZKOWSKI: Sure.

17 MEMBER ROSEN: Since 1970.

18 MR. KOLACZKOWSKI: Clearly. I mean, the  
19 systematic procedures, and so on and so forth of the  
20 higher sensitivity to PTS that we have today than we  
21 had back in 1981 when this was first all coming up,  
22 et cetera.

23 MEMBER ROSEN: The operators don't have  
24 to diagnose what it is. They just look at symptoms.

25 CHAIRMAN BONACA: And I thank you very

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1 much for bringing that out.

2 MR. KOLACZKOWSKI: And I don't want to  
3 over-emphasize the --

4 CHAIRMAN BONACA: No, no, let me just  
5 say that for the purpose or the point that Dr.  
6 Wallis was making before, these are pluses and  
7 minuses contributors. This was a very important  
8 presentation to me, because it tells me that we are  
9 not just relying on operator action judgments, and  
10 there are other factors.

11 And again in the context of a report, it  
12 would be valuable to understand roughly what kind of  
13 contribution we had from these considerations. And  
14 that would take the issue off the table and  
15 convincing say, yes, let's just forget about the  
16 secondary side and cooldown, because even if what  
17 was said about human reliability is wrong, still it  
18 is a small contributor, or a smaller contributor  
19 than we thought.

20 MEMBER APOSTOLAKIS: I think in that  
21 context, you know, I think we were promised more  
22 than a year ago a walk through calculation. I don't  
23 think we ever saw that or I ever saw that.

24 So I have two comments here. One is  
25 that Mark Cunningham said earlier that this is a

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1 summary report, and so there will be a bigger report  
2 somewhere else?

3 MR. CUNNINGHAM: There will be  
4 supporting reports behind this, yes.

5 MEMBER APOSTOLAKIS: But still though I  
6 think it would be useful for the summary report to  
7 be a little more explicit.

8 MR. CUNNINGHAM: Yes.

9 MEMBER APOSTOLAKIS: Now, in addition to  
10 what I said earlier, in 2.3, it just says that we  
11 formed a team, a party, a working party, that was  
12 able to distinguish between aleatory and epistemic,  
13 period. Thank you very much.

14 Well, give me something, you know. And  
15 also the emphasis is too heavy on the process. We  
16 formed the party and the party did this or the party  
17 did that. I don't care what the party did. What is  
18 the method.

19 Second, I really would like to see a  
20 chapter or a presentation on how figure B.4 in  
21 Nathan's appendix was actually used. If you do  
22 that, I think it would go a long way towards  
23 explaining everything that was done. B.4.

24 MEMBER WALLIS: Well, George, there has  
25 to be a much more extensive summary of what were the

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1 procedures, and how it all hangs together, and what  
2 thermal shock is, and the fact that you have to  
3 calculate wall temperatures and so on.

4 And a lot of the stuff which is very  
5 good, you don't get until you get to the appendix.  
6 It has got to be right up front, and this is how we  
7 did it.

8 MEMBER APOSTOLAKIS: I think that figure  
9 is great. It tells how we did this, and how we did  
10 that. Let's make a sequence or something, whatever  
11 is convenient, and demonstrate how that figure was  
12 implemented, and then show the susceptibility  
13 results and the whole works.

14 Don't just tell me that the working  
15 party went and ate dinner last night. I mean, that  
16 is what it says in Chapter 3. Not dinner, but we  
17 formed a party to understand the physics, because  
18 this is important.

19 Well, you know, I never knew that the  
20 physics was important. But this is full of that.

21 MR. CUNNINGHAM: Between yesterday and  
22 today, we have gotten a lot of constructive comments  
23 on ways to improve the report, and we appreciate  
24 that, and we will take it to heart.

25 MEMBER POWERS: Let me ask a question.

1 I hope that I don't get over-interpreted, as it is  
2 not intended as a criticism. It is curiosity on my  
3 part. At constructing this undertaking, you did a  
4 lot of calculations on binned interim results, and  
5 then you did subsequent calculations. Why did you  
6 bin interim results?

7 MR. KOLACZKOWSKI: Resources. Learning  
8 as we go, and recognition that if it was pretty  
9 clear to us that some things were going to be not  
10 important at one stage, then we could begin to  
11 screen out certain portions of things that we had to  
12 model in more detail.

13 And/or perhaps we learned that the  
14 binning was too crude in some places, and more than  
15 what we needed in other places, and so therefore we  
16 could redo or reshuffle some of the binning, et  
17 cetera.

18 But clearly at the beginning, Oconee had  
19 181,000 over-cooling sequences in the PRA model

20 MEMBER POWERS: Right.

21 MR. KOLACZKOWSKI: We could not do  
22 181,000 thermal-hydraulic calculations and avoid  
23 binning.

24 MEMBER POWERS: Why couldn't you do  
25 181,000 thermal-hydraulic calculations?

1 MR. ROSENTHAL: I think surely you can,  
2 and I just got new linux clusters up today, and so  
3 we can or must pull the rip cord and let it run.  
4 But would it be meaningful?

5 You know, I am starting out with a --  
6 well, I don't know what, maybe 530 or 550 F. And I  
7 am not bringing it in any lower than 212 F, and so  
8 about 300 degrees, and I am doing this over a period  
9 of two hours or so.

10 And by the time that I have calculated a  
11 hundred ways of going from stake point A to stake  
12 point B, and I don't know if it is winter or  
13 summertime anyway outside, I would say this would be  
14 overkill on just running RELAP.

15 MEMBER POWERS: I said don't over-  
16 interpret my question.

17 MEMBER WALLIS: But there must be a  
18 systematic way of calculating 180,000 sequences to  
19 find out the reasons where --

20 MR. ROSENTHAL: Right.

21 DR. KORSAH: And to find out a grid.

22 MR. ROSENTHAL: Right. And I will stop  
23 after this, but in fact we did that. And the  
24 reality was that we guessed some sequences, and we  
25 were off building decks and writing models.

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1                   Then we had some PRA input, and then  
2 based on that we ran some more cases, and then as a  
3 function of time, we started getting fracture  
4 mechanics results back.

5                   And then we had already done a fair  
6 amount of arithmetic, and we then had an integral  
7 finally closed system, and this was a function of  
8 time.

9                   And at that point the PRA guys started  
10 refining their models, because now they had the  
11 fracture mechanics, and the end answer, and asking  
12 us to do more thermal-hydraulics. And that is what  
13 happened with --

14                   MR. BESSETTE: Our first consideration  
15 at Oconee, for example, we had 20 bins, 20 RELAP  
16 bins, and this process of refinement and deciding  
17 how many we needed, we went from 20 to ultimately to  
18 about 200.

19                   MEMBER WALLIS: Do these bins take care  
20 of the uncertainties in RELAP?

21                   MR. BESSETTE: Well --

22                   MEMBER WALLIS: Do the bins somehow take  
23 account of the uncertainties? The next step is a  
24 deterministic calculation.

25                   MR. KOLACZKOWSKI: The bins really

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1 representing the uncertainty in the event, because  
2 there is randomness in the event, and we don't know  
3 if the break is really going to be 1.8 inches or 1.9  
4 inches.

5 MEMBER WALLIS: I know that, but there  
6 is a whole chapter in this report which claims that  
7 you have taken account of the RELAP uncertainties.

8 MEMBER APOSTOLAKIS: And that should be  
9 on top of these uncertainties, and what Alan is  
10 talking about is the aleatory, and you don't know  
11 the size and you don't know the place.

12 MR. KOLACZKOWSKI: Yes.

13 MR. BESSETTE: So we had all these bins,  
14 and what we did is that we picked the let dominant  
15 bins in which to do further uncertainty analysis  
16 with RELAP,

17 MEMBER POWERS: Let me just ask another  
18 question again. This is not a criticism of this  
19 particular study, but you did a lot of calculations  
20 for Oconee, and that means that you had to set up an  
21 Oconee deck. If I asked you to do a lot of  
22 calculations on Commanche Peak, how long does it  
23 take to set up the deck?

24 MR. BESSETTE: Well, to set up a deck,  
25 or to set up a new deck from scratch is about -- I

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1 would say two man years of work.

2 MEMBER POWERS: Two man years of work?

3 MR. BESSETTE: Yes.

4 MEMBER WALLIS: Doesn't the Commanche  
5 people already have a RELAP deck?

6 MR. BESSETTE: No.

7 MEMBER WALLIS: But they have a deck of  
8 some sort.

9 MR. BESSETTE: We don't, no. They don't  
10 have a deck.

11 MEMBER WALLIS: They don't have it?

12 MR. BESSETTE: No.

13 MEMBER SHACK: So even after you get  
14 TRAC-M, you still have to wait years to point out  
15 decks to --

16 MR. BESSETTE: Well, we don't come  
17 anywhere close to having a deck for each plant. We  
18 have decks for perhaps 10 plants or so.

19 MEMBER SIEBER: Even that is a lot.

20 MR. KOLACZKOWSKI: Let me make a comment  
21 about this and why we make the statement that the T-  
22 H uncertainties are covered, and I agree that we  
23 have not probably proved the point.

24 But let me just say that I think we  
25 believe that the uncertainties in RELAP and its

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1 ability to really match experiments, we believe that  
2 uncertainty is small, and I grant you that we  
3 absolutely have not proved that point sufficiently.

4 But we believe it is small compared to  
5 these things like is the break really 2 inches or 4  
6 inches. That is going to so swamp we believe the  
7 uncertainties of the T-H calculation of what a 2  
8 inch response should be, or what a 4 inch response  
9 should be, that from that sense, that is why we are  
10 qualitatively saying in the report that we believe  
11 that the T-H uncertainties have already been  
12 enveloped by the ones that we have looked at,  
13 because we believe those are larger, and have a  
14 greater effect.

15 MEMBER WALLIS: It is just a question of  
16 shielding?

17 MR. KOLACZKOWSKI: I understand that,  
18 and that's why I am saying that I think that we have  
19 not proved the point, but I think that is why the  
20 statement is there, is that we believe that the T-H  
21 uncertainties, in terms of the code uncertainties,  
22 are small relative to this randomness of is the peak  
23 really going to be six inches or three inches.

24 MEMBER APOSTOLAKIS: Does this apply  
25 also to the probablistic fracture mechanics

1       uncertainties? Are there any uncertainties there?  
2       I mean, I appreciate the Marshall distribution, the  
3       flaw distribution, but are there any model  
4       uncertainties?

5                   MEMBER WALLIS: If you look at the RELAP  
6       clause, and any other data --

7                   MEMBER APOSTOLAKIS: What kind of model  
8       of uncertainties would you have?

9                   MR. HACKETT: I would take a crack at  
10      that. The model uncertainty there is several  
11      sources, One, of course, is the one that has been  
12      referred to most often here today, would be the flaw  
13      density and distribution, and we do have a model  
14      there that does explicitly address uncertainties.

15                   And as well as we could do it weighted  
16      on the data that we had, as opposed to  
17      extrapolations with expert codes, or expect  
18      elicitation. That is one. The other model is of  
19      course the one that we have spent a lot of time  
20      debating here today, and that is on the toughness  
21      model and that we did not get into that today, as  
22      opposed to what is the measure of truth in this  
23      situation.

24                   And the bottom line there is that we did  
25      go into this in a fair bit of detail yesterday and

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1 you are trying to get an estimate of the fractured  
2 toughness of this material, for which RTNDT is but a  
3 -- I have to admit is a bad surrogate for that here.

4 It is what you are stuck with by the  
5 historical way this thing played out. So you are  
6 trying to get to fracture toughness with this RTNDT,  
7 and the imperfections that lie therein.

8 And there is a model that goes with  
9 that, which ultimately traces back to the  
10 development of the master curve approach for  
11 fracture toughness. And we could spend a lot of  
12 time on that,

13 but there is a model there, and  
14 epistemic and aleatory uncertainties that go along  
15 with that. The last major piece would be --

16 MEMBER APOSTOLAKIS: And these are  
17 represented somewhere?

18 MR. HACKETT: Yes, they are in Appendix  
19 A.

20 MEMBER APOSTOLAKIS: Appendix A?

21 MR. HACKETT: That's right. The last  
22 major piece I will just mention is the embrittlement  
23 model. which we have spent more time than anything  
24 else on between us and the industry.

25 And in terms of how do you get from

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1 throwing neutrons at a vessel of certain composition  
2 and how embrittled it ends up and we have that  
3 covered in there, too.

4 MEMBER SHACK: However, they do believe  
5 that fracture mechanics is written in stone. That  
6 when  $K_{material}$  equals  $K_{applied}$ , things break.

7 MR. HACKETT: Correct.

8 MEMBER APOSTOLAKIS: And these  
9 uncertainties are evaluated?

10 MEMBER SHACK: When you look at the  
11 uncertainties in the embrittlement model, and the  
12 uncertainties in the material toughness model, you  
13 can make Alan's argument that they ought to swamp  
14 any other model.

15 MEMBER WALLIS: Just look at some of the  
16 parts, George. I mean, you have a curve and you  
17 have the data, and just take a look at those.

18 MEMBER APOSTOLAKIS: Yes, but I thought  
19 that what Alan and others were saying was that the  
20 aleatory uncertainties are overwhelming here. But  
21 there is epistemic and aleatory?

22 MEMBER SHACK: There is aleatory and  
23 epistemic.

24 MEMBER APOSTOLAKIS: But the epistemic I  
25 would suspect would be more significant there.

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1 MEMBER POWERS: To be precise, there are  
2 aleatory uncertainties in the material properties,  
3 and there are epistemic uncertainties in fracture  
4 mechanics models.

5 MEMBER APOSTOLAKIS: yes, yes.

6 MEMBER WALLIS: And most of the RTNDTs  
7 are a very weak surrogate for toughness, but it is  
8 the thing that is being used.

9 MEMBER APOSTOLAKIS: Yes, but what I am  
10 asking is the argument that was made that the  
11 thermal-hydraulic uncertainties are overwhelmed by  
12 the uncertainties in the LOCA size and so on, right?

13 MR. KOLACZKOWSKI: And perhaps other  
14 things in the fracture mechanics.

15 MEMBER APOSTOLAKIS: So the fracture  
16 mechanics are up there? Okay.

17 MR. HACKETT: In that case the modeling  
18 for the flaw density and distribution, and the  
19 toughness, I think overwhelm that, too. And we do -  
20 - and Dr. Shack raises a good point, in terms of in  
21 the fracture mechanics, you are assuming that the  
22 fracture mechanics truth in this thing is still a  
23 Kapplied versus a Klc type of thing, which takes you  
24 back 20 or 30 years in fracture mechanics  
25 technology.

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1                   And Professor Apostolakis asked a good  
2 question there, too, that in terms of -- well, does  
3 that work pretty well for this case, and we feel  
4 that it does, because you have got a big thick  
5 vessel that is about the best way of coming at that  
6 type of fracture mechanics that you are going to  
7 get, a big thick vessel with a thermal shock.

8                   And that is not to say that you couldn't  
9 apply elastic plastic fracture mechanics as a  
10 refinement to this thing. And we do in fact do that  
11 when we look at low upper shelf welds, for instance.

12                   And that is a whole different problem,  
13 but when you are looking at cleavage fracture in a  
14 big thick steel component, that is probably still  
15 pretty good.

16                   MEMBER POWERS: When are we going to be  
17 able to do elastic plastic fracture mechanics  
18 routinely?

19                   MR. HACKETT: We do it now. I think we  
20 are back to the same kind of point that Jack was  
21 making on the binning. It is really a resources  
22 issue more than anything.

23                   And Terry Dickson is at the microphone,  
24 and I think I can say that by adding elastic plastic  
25 fracture mechanics into FAVOR would -- and I will

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1 let Terry comment, but it would greatly complicate  
2 the computational aspects of the analysis. Terry,  
3 did you have some comments?

4 MR. DICKSON: Yes, but to my knowledge  
5 that is on the agenda to do. That is where we kind  
6 of go from here. Everything that has been discussed  
7 here is based on a linear elastic plastic fracture  
8 mechanics model.

9 And I was going to address the question  
10 by Dr. Apostolakis --

11 MEMBER POWERS: Before you go on to  
12 that, do you have some sort of -- is there somewhere  
13 a strategy written down on how to evolve our  
14 fracture mechanics?

15 MR. DICKSON: We are working on that  
16 right now. But the expectation is that by including  
17 the higher constraint plasticity models is that that  
18 will be a removal of conservatisms, and that these  
19 numbers will go down. That is the expectation going  
20 in.

21 MR. HACKETT: Let me come to a little  
22 bit more background on that, because the elastic  
23 plastic fracture mechanics has also been around for  
24 20 plus years at least, and there are some major  
25 analyses that the NRC and the industry have done in

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1 terms of qualifying low upper shelf welds for  
2 operational performance that is governed by 10 CFR  
3 50, Appendix G, that are indeed based on elastic  
4 plastic fracture mechanics.

5 And with this case there just was not a  
6 need to go there as Terry is indicating, but that is  
7 future work.

8 MEMBER POWERS: That's fine. What I am  
9 really asking about is what is the Agency's plan to  
10 develop its fracture mechanics technology, and  
11 whether or not it is applicable to this problem.

12 MR. HACKETT: Correct. Yes.

13 MR. DICKSON: I can't speak for the NRC,  
14 as I work at Oak Ridge National Laboratories, and we  
15 are a contractor, but I know that our plan, and I  
16 believe it has been coordinated with the NRC, is  
17 that we will be developing a version of FAVOR that  
18 includes elastic plastic fracture.

19 MEMBER POWERS: If there is some sort of  
20 a plan on this, it would just be interesting for me  
21 to see.

22 MR. HACKETT: We will make note of that  
23 and we will -- Mark Kirk in fact has the lead for  
24 developing that right now, and we will make sure  
25 that we bring that forward.

1 MEMBER POWERS: I mean, it is one of  
2 those areas that if we are to be supportive, it  
3 would be nice to know what the plan is. And it may  
4 not be this year, or next year, or five years, but  
5 if we have a plan, then we can do things that are  
6 supported.

7 MEMBER WALLIS: Plastic is fine, but  
8 then you will get down to the business of what is a  
9 flaw, and you said you were using the worst flaw,  
10 which is this sort of a razor-like atomic sized flaw  
11 that cuts its way through in the worst possible way.

12 MR. HACKETT: That's correct.

13 MEMBER WALLIS: And that must be a very  
14 conservative assumption.

15 MR. HACKETT: It is certainly a  
16 conservative assumption. Even elastic plastic  
17 fracture mechanics does not address that. You are  
18 still assuming these atomistically sharp flaws. So  
19 that is probably there for the foreseeable future.

20 MEMBER WALLIS: But that is a  
21 conservative assumption?

22 MR. HACKETT: Yes.

23 MEMBER WALLIS: George seems to be  
24 satisfied, and I would only add to your statement,  
25 George, that you need to be shown the thermal-

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1 hydraulic uncertainties are swamped by these other  
2 ones. But it has to be shown though. It can't just  
3 be stated. There has to be a rationale.

4 MEMBER APOSTOLAKIS: I would like to see  
5 though a sequence of calculations all the way  
6 through the beginning to the end.

7 MR. HACKETT: And just as a comment, I  
8 have the same recollection as Dr. Apostolakis, and I  
9 have been off on another rotation loop here at the  
10 NRC, and I have been out of the loop in this project  
11 for a while, but I do recall a commitment that we  
12 had to do that with the Committee.

13 And I don't believe for some variety of  
14 reasons that never happened.

15 MEMBER APOSTOLAKIS: It never happened.  
16 I am not chairing.

17 MEMBER WALLIS: How far along are we in  
18 this presentation?>

19 MR. CUNNINGHAM: I guess we are -- I  
20 guess if I could wrap up again. We talked earlier  
21 that we were interested in a letter from the  
22 committee, and we are at the point where we think we  
23 have a reasonable technical basis to recommend to  
24 NRR that they proceed to rule making to make some  
25 changes to the pressurized thermal shock rule to

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1 reflect over what we have learned over the last X  
2 years in terms of the frequencies of PTS types of  
3 events.

4 So we would be interested in a letter  
5 from the committee either endorsing this research  
6 idea, and that it is a good idea to proceed to rule  
7 making, or some such thing. And again any other  
8 comments that you have in that regard, we would be  
9 happy to get them.

10 I am sure that we will be back talking  
11 to you, and perhaps Matt and the NRR folks will be  
12 the lead the next time we are here.

13 MEMBER WALLIS: Well, when we were  
14 waiting for the train last night, we said what you  
15 really need is sort of an external writing  
16 committee, which is not so tied up with the work,  
17 and just see the details of what you have been  
18 doing, and they can present the whole thing in a way  
19 that is sort of a half-inch report that tells the  
20 whole story.

21 MR. CUNNINGHAM: Okay. We will look  
22 into it.

23 MEMBER WALLIS: And if you want to know  
24 the details, you look somewhere else.

25 MR. CUNNINGHAM: Okay. We are going to

1 look into that.

2 MEMBER POWERS: Mark, one of the  
3 hallmarks of this PTS work has been bringing  
4 together experts in PRA fracture mechanics, human  
5 factors, thermal-hydraulics, people that ordinarily  
6 don't speak even similar languages, and producing a  
7 product.

8 And I guess I have been unabashed in my  
9 admiration about the way that that was done. Have  
10 you had a chance, or will you take the time to go  
11 back and assess how easy that is, and what would  
12 facilitate those things, and the multidisciplinary  
13 activities?

14 I think you have done this one  
15 extraordinarily well, and it sets a high standard  
16 for subsequent people coming along, and it might  
17 well be useful to set down for people who  
18 subsequently try to organize these efforts things  
19 that make this an attractable approach

20 MR. CUNNINGHAM: I think that is a great  
21 idea. I think we obviously -- or maybe you didn't  
22 see it, but there was some rocky times in this  
23 project trying to interweave different disciplines.  
24 Many people speaking many languages if you will, and  
25 I think we can learn from that.

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1 MEMBER POWERS: I think it is one of the  
2 few instances where I have seen matrixing actually  
3 work, and that comes from a laboratory that prides  
4 itself on doing that, and I don't think we did it as  
5 well as you guys did for this particular study.

6 MEMBER WALLIS: Well, I take a bit of  
7 issue with you. Almost all engineering is  
8 interdisciplinary in some degree, and you can over-  
9 estimate or over-state this division between  
10 disciplines, and the different languages.

11 And in fact it is possible for someone  
12 knowing a PRA to have some idea on what is going on  
13 in thermal-hydraulics and so on. There are lots of  
14 common approaches in all engineering.

15 MEMBER POWERS: Well, as I said, I spent  
16 most of my working career at a laboratory where we  
17 try to do a lot of that, and I am always stunned at  
18 how difficult it seems to be to do these  
19 multidisciplinary things, and I think this team has  
20 really done an outstanding job on this.

21 I attribute it a lot to the  
22 personalities involved, and Ashok, I think you are  
23 to be congratulated for a heck of a good undertaking  
24 here.

25 MR. THADANI: Thank you.

1 MEMBER POWERS: Thank you.

2 MR. HACKETT: I think a comment that I  
3 would add, because I see that Dr. Powers' comment is  
4 going towards sort of a managerial issue, too, and  
5 this in my opinion has been one of the better  
6 efforts, if not the best effort that I have seen  
7 managed from within the Office of Research.

8 And in that regard a lot of credit does  
9 go to Ashok Thadani's management team, in terms of  
10 providing the resources and lining things up so that  
11 other things got out of the way when it came time --

12 MEMBER POWERS: We would never say  
13 something like that. It would go to their head, and  
14 they would be insufferable.

15 MEMBER WALLIS: I am astonished by you  
16 are saying that this is one of the difficult  
17 interdisciplinary projects, and that it is managed  
18 better than one of the purely disciplinary ones. I  
19 don't think you mean that.

20 MEMBER APOSTOLAKIS: Say thank you very  
21 much.

22 MR. HACKETT: I will say thank you.

23 MEMBER SHACK: We are ready to wrap it  
24 up.

25 MEMBER ROSEN: Are we going to have a

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1 committee discussion?

2 MEMBER SHACK: We will have it later on  
3 today as we get ready to consider the letter, and we  
4 will have a discussion.

5 CHAIRMAN BONACA: So at this time we  
6 will just recess for 15 minutes until 3:15.

7 (Whereupon, at 2:59 p.m., the meeting  
8 was recessed and resumed at 3:17 p.m.)

9 CHAIRMAN BONACA: Okay. The meeting  
10 will come back to order. And we have now a review  
11 of the draft final version of Regulatory Guide DG-  
12 1077, Guidelines for Environmental Qualification of  
13 Microprocessor-Based Equipment Important to Safety  
14 in Nuclear Power Plants, and I believe that John  
15 Sieber is going to walk us through.

16 MEMBER SIEBER: Okay. Thank you, Mr.  
17 Chairman. As Mario said, we are going to consider  
18 draft Regulatory Guides DG-1077, and the title is,  
19 "Guidelines for Environmental Qualification of  
20 Microprocessor-Based Equipment Important to Safety  
21 in Nuclear Power Plants.

22 This draft reg guide builds on the  
23 environmental qualification guidelines and the rule  
24 to which it all refers is 10 CFR 50.49, and Reg  
25 Guides 1.89, and 1.180, and IEEE Standard 323-1983,

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1 and the International Electrotechnical Commission  
2 Standard 60780, all apply.

3 And the foundation work is contained in  
4 two Oak Ridge studies, NEUREG CR 6741, and 6479.  
5 The staff provided the ACRS a copy of the draft  
6 regulatory guide on June 8th, 2001 prior to  
7 publishing for public comments.

8 At that time the ACRS declined to review  
9 it, deciding instead to wait until the comments were  
10 received and incorporated. And so now we have come  
11 to that point in time.

12 So the ACRS, other than through mailings  
13 has really not had a chance to review the draft  
14 regulatory guide that is the basis of these  
15 documents except for what we will have this  
16 afternoon.

17 There actually were a significant number  
18 of comments received by the staff from 11  
19 commenters, and there is a staff analysis which is  
20 proprietary and therefore not a public document,  
21 which includes the technical analysis of the  
22 comments, and a description of changes that were  
23 made to the draft reg guide to bring it to its final  
24 form as it is today.

25 Among those 11 commenters, one that had

1 a particular large number was Winston & Strawn,  
2 which is a Washington law firm that represents the  
3 Nuclear Utility Group on Environmental  
4 Qualification.

5 And there were a number of comments  
6 which the staff's resolution and technical analysis  
7 took about 29 single-spaced typed pages. And so  
8 those are listed there.

9 Winston & Strawn has asked for time to  
10 make a statement during this meeting, and I think I  
11 will call upon them right now to make that  
12 statement.

13 MR. HORIN: Good afternoon. I  
14 appreciate the opportunity to provide a brief  
15 statement with respect to our comments on this draft  
16 guide. As mentioned, Winston & Strawn represents  
17 the Nuclear Utility Group on Equipment  
18 Qualification.

19 We are a group of utilities that are  
20 comprised of over 90 of the operating power reactors  
21 in the United States.

22 We are supported by a technical  
23 consultant who has been involved in environmental  
24 qualification of electrical equipment for over  
25 decades, and is the author of a number of papers,

1 the EQ Reference Manual, published by EPRI.

2 We submitted comments as mentioned, and  
3 we have not had the opportunity to see the  
4 resolution of those comments. So I want to keep my  
5 statement brief here, and hopefully we will have an  
6 opportunity to look at the resolution of the  
7 comments prior to any finalization of this draft reg  
8 guide.

9 Unfortunately, our technical consultant  
10 is out of the country and cannot be here, and so I  
11 am standing in as a lawyer, and so I will limit my  
12 brief comments to a couple of regulatory points.

13 We have provided copies of our comments  
14 to the committee, and as mentioned, they were rather  
15 extensive and dealt with a number of technical  
16 issues, and a number of regulatory questions.

17 I wanted to make a couple of key points,  
18 and then I will sit back and listen to see where the  
19 reg guide has gone in a revised state. I think most  
20 fundamental to our comments is a concern that there  
21 has been an approach taken in the draft guide which  
22 would confuse the overall regulatory scheme with  
23 respect to the environmental qualification of  
24 electrical equipment under 10 CFR 50.49.

25 And again I am referring to the draft

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1 guide that was issued for public comment.  
2 Principally among those concerns have to do with the  
3 confusion of the applicability of 50.49 to equipment  
4 that is in mild environments, versus equipment that  
5 is in harsh environments.

6 50.49 applies to electrical equipment  
7 that is in harsh environments, which is specifically  
8 defined in that guide regulation as environments  
9 which are significantly more severe following a  
10 design basis event than during normal operation of,  
11 and we are not talking about environments or  
12 conditions which are slightly different, or not any  
13 different at all.

14 They are -- 50.49 is geared towards the  
15 harsh environment qualification. Secondly, with  
16 respect to mild environment qualification, there is  
17 guidance, and there is a clear direction within the  
18 current regulatory scheme with respect to mild  
19 environment qualification.

20 That guidance is contained in the  
21 Standard Review Plan, and that guidance is part and  
22 parcel of an overall scheme that would apply to  
23 quality assurance criteria, design control criteria  
24 under Appendix B, coupled with design analyses for  
25 particular applications that are already within the

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1 regulatory scheme.

2           So we had some fundamental problems with  
3 the way that the draft guide characterized certain  
4 effects as being either aging effects, or effects  
5 that would be seen that would create a harsh  
6 environment, because they are effects which are not  
7 necessarily more severe following a design basis  
8 event.

9           So those type of clarifications are  
10 important, because we think that if they are not  
11 clarified, and if there is not a clear distinction  
12 maintained between harsh and mild equipment, this  
13 draft guide, again as we saw it, would be wholly  
14 inconsistent with 50.49.

15           And to the extent that there was an  
16 attempt to proceed along those lines would direct or  
17 practically necessitate that there would be a whole  
18 rule change under 50.49.

19           So we don't see that as drafted that  
20 this was consistent with the existing regulatory  
21 scheme. We have some comments with respect to  
22 backfit issues, and we will make sure that those are  
23 addressed in the context of CRGR, and fundamentally  
24 our recommendation here was that certainly as  
25 drafted this guide should be withdrawn as a reg

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1 guide.

2 It just simply did not provide a clarity  
3 of direction or consistency with the existing  
4 regulatory scheme necessary to on its own address  
5 these issues.

6 Alternatives may be whether it is issued  
7 as a separate NEUREG document, or perhaps an RIS to  
8 address some of these questions, but nonetheless, we  
9 felt that this was not an appropriate mechanism to  
10 apply these particular considerations.

11 And we also -- and I don't want to go  
12 through all of it this afternoon, but there is an  
13 extensive number of comments that sounds as though  
14 there has been an extensive resolution, or at least  
15 an effort to address those, but again we have not  
16 seen that.

17 So we don't know whether it ends us.  
18 But I appreciate the opportunity just to point this  
19 out to the committee. Hopefully we will have an  
20 opportunity to take a look at how these comments  
21 have been addressed in the past. Thank you very  
22 much.

23 MEMBER SIEBER: Okay.

24 MEMBER WALLIS: I am wondering if you  
25 planned that this whole thing is unnecessary and

1 unwarranted, it would seem that no change to the  
2 draft would satisfy you.

3 MR. HORIN: We think that the use of  
4 this as a regulatory guide without significant  
5 modifications to make it consistent with the  
6 existing regulatory scheme would make it  
7 unwarranted.

8 MEMBER WALLIS: You see to claim that  
9 the resisting scheme is so good that we don't need  
10 to do anything.

11 MR. HORIN: I think if you read our  
12 comments that there are a few elements that really  
13 establish matters that cannot already be addressed  
14 under the existing design processes for nuclear  
15 power plants.

16 MEMBER SIEBER: I perhaps should not  
17 give advice here, but we are going to give advice  
18 anyway later on, is that it is either come out with  
19 a new guide or modify the existing guides, because  
20 there are some differences.

21 And I think that is pretty well  
22 established through the work, and so what I would  
23 like to do is to introduce our speakers, and after I  
24 give your names, please correct me after I am done,  
25 and except for Mr. Wood, where I think I am on safe

1 ground. But Christina Antonescu; is that correct?

2 MS. ANTONESCU: That's right.

3 MEMBER SIEBER: And you are from NRR.

4 MS. ANTONESCU: No, from Research.

5 MEMBER SIEBER: Okay. And Kori Korsah;  
6 is that correct?

7 DR. KORSAH: Yes.

8 MEMBER SIEBER: I got it right. How  
9 about that, and they will be our speakers this  
10 afternoon. One of the things that I would like to  
11 ask you to do is that the significant part of what  
12 we are about this afternoon will be to address these  
13 comments, and so to the extent that you can do that.

14 And there are too many of them to do  
15 them all, and that you may want to choose some of  
16 the more important points that have been made by the  
17 public to actually explain what it is that you did,  
18 and what the staffs position is on that, and why you  
19 think that we ought to agree with you.

20 So with that, Christina, I would like  
21 for you to begin.

22 MS. ANTONESCU: Before I introduce  
23 myself, I would just like to let you know that the  
24 presentations were organized such that we address  
25 the resolution of the public comments, and the

1 subsequent viewgraph presentations will actually  
2 address most of these questions.

3 And if you will allow us, then we can  
4 proceed with an overview of the reg guide, and most  
5 of your questions will be answered as well.

6 MEMBER SIEBER: I think that would be  
7 helpful

8 MS. ANTONESCU: Good afternoon. My name  
9 is Christina Antonescu, and I am in the Engineering  
10 Research Application Branch in the Division of  
11 Engineering within the Office of Research.

12 My background is in electrical  
13 engineering, and I have worked at NRC as a project  
14 manager in the field of instrumentation and control  
15 for the past 11 years.

16 I am here today to present to you DG-  
17 1077, and DG-1077 describes an acceptable method for  
18 environmental qualification for microprocessor-based  
19 systems.

20 The draft guide was released for public  
21 comments on October 14th, 2001, and we received 11  
22 submissions from the public. After interaction  
23 among the staff, the technical support contractors  
24 at Oak Ridge National Lab, and industry  
25 stakeholders, the draft was revised to reflect

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1 resolution of the public comments.

2 So the purpose here today is to present  
3 to you the guidance contained with this DG-1077,  
4 which describes the need and the benefits of the  
5 guide. And at the end of our presentation, we would  
6 like to request a letter from the Committee  
7 endorsing publication of the final effective guide.

8 Before I proceed, I would like to  
9 introduce other branch members in attendance. Mr.  
10 Steven Arndt, who is the team leader in the I&C  
11 Group, and our branch chief, Mr. Dan Dorman.

12 And our counterparts in NRR I think is  
13 represented by Mr. Paul Loeser today. And again I  
14 would like to briefly introduce our supporting  
15 contractors, Dr. Richard Wood and Dr. Korsah Kofi,  
16 from Oak Ridge National Lab.

17 Dr. Wood is the project manager for the  
18 I&C projects that we sponsor at Oak Ridge. He has a  
19 Ph.D. degree in nuclear engineering from the  
20 University of Tennessee, and has 20 years of  
21 experience with instrumentation and control  
22 technology.

23 Dr. Wood is currently contributing to an  
24 advisory committee of I&C experts that is providing  
25 research recommendations to the Office of Nuclear

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1 Energy in the Department of Energy.

2 And Dr. Korsah is an investigator for  
3 the I&C Qualification Project at Oak Ridge National  
4 Lab. He received his Ph.D. in nuclear engineering  
5 from the University of Missouri, and has 30 years  
6 experience in the I&C Research and Applications.

7 In additional, Dr. Korsah has served as  
8 a member of IEEE working groups on criteria for  
9 computers and safety systems IEEE 7.4.3.2, and for  
10 environmental qualification IEEE 323-1983.

11 Following these remarks, I will present  
12 an overview of the draft reg guide, and Dr. Wood  
13 will describe the technical basis supporting this  
14 guidance.

15 We do appreciate the opportunity to  
16 appear before you today, and we look forward  
17 receiving the benefit of your insight. So if there  
18 are no other questions, I would like to give you a  
19 brief presentation or highlights of DG-1077.

20 The first part of this high level  
21 introduction is the overall of the reg guide and  
22 follow-up by the technical basis for environmental  
23 qualification that Dr. Wood will present. And then  
24 Dr. Korsah will summarize th value of DG-1077 and  
25 its benefits.

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1           Let me give you a high level on what BG  
2 does, and the main scope and what it applies to. It  
3 endorses current consensus of environmental  
4 qualification standards for safety related  
5 microprocessors of these systems.

6           And the main regulatory position in  
7 endorsing the guidance in IEEE 323-1983 for  
8 qualification of safety related microprocessor basic  
9 equipment for service in nuclear power plants that  
10 are subject to conditions and clarification.

11           And it also endorses the guidance of IEC  
12 60780, and so DG-1077 applies to new or modified  
13 safety related systems in existing or future nuclear  
14 power plants that employ microprocessors equipment,  
15 or not already applied to installed equipment.

16           MEMBER WALLIS: Could you explain -- one  
17 of the criticisms of the previous speaker was that  
18 this was unnecessary ,and that you already had  
19 sufficient rules and guidance, and so why is it that  
20 this is necessary in view of what the present system  
21 is, and what are the inadequacies in the present  
22 system?

23           MS. ANTONESCU: If you look at the  
24 subsequent view graph presentations, they will  
25 clarify your question.

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1                   MEMBER WALLIS: You will clarify that  
2 question later on.

3                   MS. ANTONESCU: So if we can proceed,  
4 then we can systematically go.

5                   MEMBER WALLIS: That seems to me to be  
6 the main thing on whether or not it endorses, and  
7 what problem does it solve is the real question.

8                   MS. ANTONESCU: Right, and we are going  
9 to answer all your questions.

10                  MEMBER SIEBER: There is an interesting  
11 aspect to this. Right now in U.S. nuclear power  
12 plants, there is not to my knowledge any safety  
13 related microprocessor based equipment and harsh  
14 environments. Is that correct?

15                  MEMBER WALLIS: That's true.

16                  MEMBER SIEBER: So this really applies  
17 to modifications, upgrades, and totally new  
18 construction of advanced reactors, and I think that  
19 one of the reasons here that you endorsed an IEC  
20 60780, which is a European standard, and I think  
21 based mainly on the fact that suppliers may be of  
22 European heritage.

23                                 And therefore equipment that is built in  
24 Europe to satisfy European requirements can't be  
25 used in the U.S. unless we endorse the standard, or

1 they change their standards.

2 So this is the use of an international  
3 consensus standard as a way to allow for a greater  
4 degree of competition, and choice among licensees.  
5 And lacking that, I think that the only thing that  
6 would apply is 323, which may require some changes  
7 or upgrades in that equipment. Is that correct?

8 MS. ANTONESCU: Well, I just want to  
9 reiterate that if you allow us to go through that  
10 you will understand the reason why we find it  
11 necessary to also present to you for our endorsement  
12 or to provide you the technical basis for  
13 endorsement of IEC 60780.

14 DR. WOOD: I think your comment about  
15 the European suppliers is valid, and that was one of  
16 the motivations as to why we needed to or we felt  
17 the need to also look at the European standards.

18 There is also a move within the entire  
19 U.S. Government to look at more than just national  
20 standards, and I wanted to take this opportunity to  
21 point out that this is not specifically to satisfy  
22 the Code of Federal Regulations 50.49, because the  
23 environmental qualification is not limited to the  
24 rules and regulations within 50.49.

25 So that is why we have this and we will

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1 talk about that later.

2 MEMBER SIEBER: There is a general  
3 design criteria that says that this stuff has to  
4 work during an accident, and so that is really what  
5 the basis is in my view.

6 DR. WOOD: And there is even more than  
7 that, and we will talk about that in the  
8 presentation.

9 MEMBER SIEBER: All right. Go ahead.

10 MS. ANTONESCU: So why do we need to  
11 review DG-1077? We will talk about these things  
12 in more detail in our presentation, but I wanted to  
13 let you know up front what DG-1077 can address. It  
14 is a response to a user need request and --

15 MEMBER WALLIS: But your response could  
16 have been that you don't need a new reg guide.

17 DR. WOOD: had that proven to be the  
18 case, that would have been the response.

19 MS. ANTONESCU: Yes. It addresses  
20 unique characteristics of microprocessor-based  
21 equipment that we think should be addressed, and it  
22 endorses consensus of national and international  
23 standards, and existing reg guides limit the scope  
24 to harsh environments, but we want to include all  
25 environments.

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1                   And also potentially regulatory burden  
2 arises from case by case treatment of qualifications  
3 from the environments. A recent review of topical  
4 reports continue on a case by case qualification  
5 from environments, and vendor qualification programs  
6 were accepted under three separate SERs; from  
7 Tricon, Common Q, and Teleperm.

8                   So instead of having one process, at  
9 this point we are reviewing it case by case. The  
10 resolution of public comments, we had again 11  
11 public comments submitting comments on DG-1077, and  
12 the public comments can be grouped into a group of  
13 categories, and we tried to group them into four  
14 categories.

15                   And these will be addressed in  
16 subsequent slides. The need for guidance, and  
17 whether the existing guidance is sufficient, and the  
18 application of location categories, and how location  
19 categories tend to be applied.

20                   And the scope of qualification, and that  
21 is the full scope of environment conditions, mild  
22 and harsh. And the backfit analysis. The staff's  
23 position is that there are no backfit associated  
24 with this guide, and as described in 10 CFR 50.109,  
25 because there is no change in licensing basis for

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1 existing equipment.

2 And it only applies to new equipment,  
3 and voluntary modifications. And now I would like  
4 to turn the next presentation to Dr. Wood.

5 DR. WOOD: Thank you. I think that the  
6 comment that we received prior to these  
7 presentations highlighted perhaps one of the most  
8 frequent comment that were received in the public  
9 comment and that deals with the need for guidance.

10 So I thought for the technical basis  
11 that we would start with the basis for  
12 qualification, and walk through that, and then  
13 hopefully illustrate why the staff believes that  
14 this guide is both necessary and useful.

15 So to begin with the Code of Federal  
16 Regulations, Title 10, Part 50, requires  
17 environmental qualifications of safety related  
18 systems.

19 Specifically, structures, systems, and  
20 components important to safety must be designed to  
21 accommodate the effects of and be compatible with  
22 the environmental conditions which they will face.

23 And design control measures such as  
24 testing and other quality control activities should  
25 be used to verify the use of that design. The

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1 primary -- I'm sorry, that would make it a little  
2 easier to follow me. The other way. Sorry.

3 In any event the discussion in the  
4 regulatory guide was modified from the version that  
5 was released for public comment to try to more  
6 systematically step through the current regulatory  
7 requirements and the guidance that is given for  
8 those, and then highlight the need for this  
9 particular guide.

10 Part 50.55(a) dealing with protection  
11 systems provides embedded requirements for  
12 environmental qualification of all systems important  
13 to safety, and all protection systems.

14 And in that it by reference includes the  
15 requirements of IEEE 603, which specifically states  
16 that environmental qualifications shall be performed  
17 to confirm the conservative nature of the design and  
18 that it can accommodate the environmental  
19 conditions.

20 Then the specific rule that was  
21 mentioned in the comments prior to these  
22 presentations, Part 50.49, deals with environmental  
23 qualifications of electric equipment important to  
24 safety that are to be implemented in harsh  
25 environments.

1                   And we will talk a little later about  
2 the scope of 50.49, and we are not intending to  
3 expand the scope of 50.49. Our purpose is to  
4 address the full scope of all of the regulations  
5 that are --

6                   MEMBER POWERS: As I understand it,  
7 there are no microprocessor-based systems in harsh  
8 environments now; is that correct?

9                   MEMBER SIEBER: yes, but it is just a  
10 matter of time.

11                   MEMBER POWERS: So that means that  
12 arguments that the current regulatory process is  
13 stable is not applicable here; is that correct?

14                   DR. WOOD: That is I guess part of our  
15 belief.

16                   MEMBER WALLIS: Are these harsh  
17 environments under normal operations or under  
18 accident conditions, or what?

19                   DR. WOOD: Harsh environments that are  
20 addressed under 10 CFR 50.49 are severe environments  
21 that are subject to design basis accidents.

22                   MEMBER WALLIS: So something like a LOCA  
23 break?

24                   DR. WOOD: Yes. Things that are  
25 characterized as mild environments, some of them we

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1 would consider severe environments.

2 MEMBER WALLIS: Temperature and  
3 humidity, and things like that.

4 DR. WOOD: Well, mild covers a big  
5 range, and that is one of the areas that we will  
6 talk about a little later.

7 MEMBER SIEBER: I guess to my mind that  
8 is why you ended up with three different  
9 categorizations.

10 DR. WOOD: Exactly.

11 MEMBER SIEBER: As opposed to two, which  
12 is what, 323.

13 DR. WOOD: That's right, and I will talk  
14 a little later about how the intent of that is to  
15 provide some --

16 MS. ANTONESCU: Relaxation of 323 for  
17 mild environments.

18 DR. WOOD: Exactly.

19 MEMBER POWERS: When I search out to  
20 apply 50.49 and to understand what a harsh  
21 environment is, I should take into account LOCA  
22 kinds of accidents and what not. Do I also take  
23 into account anticipated fires?

24 DR. WOOD: That I would have to defer to  
25 some of our colleagues. It is not specifically

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1 identified, and there is no definition within the  
2 Code of Federal Regulations of a harsh environment.

3 There is a definition of a mild  
4 environment, and fires are mentioned.

5 MEMBER SIEBER: In your report, you  
6 mentioned the effects of smoke.

7 DR. WOOD: Yes.

8 MEMBER SIEBER: On the other hand, you  
9 don't qualify to a fire environment as I read it.

10 MEMBER POWERS: That is what I was going  
11 to get out. Your report is remarkable to me, in  
12 that you come along and say, gee, smoke can affect  
13 these things, and we know that, but we don't know  
14 how to test for that.

15 You know, we don't have a standardized  
16 test for that, and so we are going to ignore the  
17 issue, and have you punted on the most important  
18 issue here?

19 MS. ANTONESCU: We are going to minimize  
20 it and treat it under design, minimize the  
21 susceptibility, and treat it as a design issue.

22 DR. KORSAH: Also, the other thing is  
23 that qualification against fire and so forth, but  
24 fire basis is under Appendix R of the Code. So that  
25 is --

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1 MEMBER POWERS: Appendix R does not  
2 address smoke issues outside the immediate fire  
3 zone. And one of the things that this committee has  
4 kept asking about repeatedly is that if we have a  
5 fire and we disperse smoke beyond the fire zone into  
6 the regions where you have digital electronic  
7 equipment, do you have a long term problem.

8 And do the components of the smoke cause  
9 a long term degradation of these low voltage systems  
10 such that we encounter a difficulty not at the time  
11 of the fire, but 6 months later.

12 DR. WOOD: I think that -- of course, we  
13 address how we had originally intended to deal with  
14 smoke in a position that was subsequently deleted,  
15 because in response to public comments, and that  
16 dealt with multi-tiered protection.

17 Design and implementation approaches  
18 that could be utilized to minimize the potential  
19 susceptibility of equipment to things like smoke.

20 MS. ANTONESCU: The intent was to take  
21 credit for the specific design approaches that can  
22 mitigate the susceptibility to environmental  
23 effects.

24 DR. WOOD: The difficulty that we faced  
25 in taking the research information, the findings,

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1 and converting that into relevant guidance for the  
2 industry is that as you mentioned.

3           There is no means right now to test  
4 whether or not a piece of equipment or in its  
5 installed configuration is or is not susceptible to  
6 smoke, because there is so many variables that can't  
7 be controlled.

8           However, the other difficulty that was  
9 presented is that while the research indicated that  
10 certain implementation techniques would be of  
11 benefit, there hasn't been a full-scale  
12 investigation of all of the possible ramifications  
13 of certain things, such as conformal coding, and  
14 what might that do to temperature susceptibility.

15           So it is difficult to recommend  
16 implementation guidelines.

17           MEMBER POWERS: I think I am very  
18 sympathetic with the challenge it had there, because  
19 as I look at the experimental database that is  
20 available, it looks at a very acute smoke exposure,  
21 and my reaction to it is fine.

22           You know, I am glad that you found this  
23 stuff out, but when I read Appendix R, I have wiped  
24 that equipment out anyway. It doesn't seem to  
25 address this long term chronic problem where I have

1 smoke constituents degrading contacts, et cetera,  
2 with these materials and what not.

3 And so I think I must appreciate our  
4 argument that says we just have not found the  
5 information that is of the breadth that we need for  
6 this kind of guidance. I think I am much more  
7 sympathetic with that than the apparent wording that  
8 says we are going to punt on this, okay?

9 On the other hand, I say, gee, I have  
10 people from the Navy and people from the Army  
11 telling me that we don't want smoke to affect our  
12 systems, and I see novel designs, especially for  
13 surface naval vessels now, where they are  
14 confronting this issue in novel ways that I won't go  
15 into here on the public record.

16 But I see other people confronting it,  
17 and it might be something that you can put on your  
18 to do list, and not for this regulatory guide, but  
19 maybe for the next one and what not, because it  
20 looks like people are trying to confront this issue.

21 MEMBER SIEBER: Well, maybe I could give  
22 my thought here a little bit. It seems to me that  
23 long term failures due to smoke would be very random  
24 in nature, you know.

25 A piece of the equipment would fail

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1 today and another piece two weeks from now and so  
2 forth, and the single failure criteria would seem to  
3 me to provide a sufficient degree of defense in  
4 depth.

5 DR. WOOD: I can give an example of how  
6 that very point was considered. In the research,  
7 different fire scenarios were investigated to  
8 determine which were the most credible, and then  
9 assessed to determine which would provide the most  
10 harsh smoke environment.

11 And a small in-cabinet fire provided the  
12 most severe conditions.

13 MEMBER SIEBER: That's right.

14 DR. WOOD: And that would be localized.

15 MEMBER POWERS: Ask the people at  
16 Ocone.

17 DR. WOOD: Yes, I know. Exactly.

18 MEMBER SIEBER: The density is --

19 DR. WOOD: Yes, I know, and for reactor  
20 protection systems that would affect one channel,  
21 and the general fires, because of the fire  
22 protection that is engaged, would be detected early.  
23 There would at least be knowledge that they had  
24 occurred, and then maintenance practices could  
25 assess whether or not any of the electronics had

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1       been affected by smoke.

2                   The one where you might not know it had  
3       happened, and it might not detect it until something  
4       failed, would be in the in-cabinet fire, but that  
5       would be in most instances, unless you have an  
6       extreme coincidence, localized to the one cabinet.

7                   MEMBER POWERS:   Yes, but is a localized  
8       one cabinet, and if you produce a lot of smoke and  
9       it gets distributed by the HVAC system either during  
10      the event or in the subsequent recovery, then is it  
11      a more broad issue then?

12                  DR. WOOD:   There you run into the  
13      separation of the air supplies among different  
14      cabinets.  You might affect two cabinets, but not  
15      all four, but certainly we recognize that there are  
16      still a lot of questions that could be asked in  
17      investigations that could be conducted.

18                  MEMBER SIEBER:  It seems to me --

19                  MEMBER WALLIS:  Tell me about the smoke,  
20      and what was referred to as specific components in  
21      the smoke, and presumably there are aerosols that  
22      have water and carbon particles, and so forth.  Will  
23      they cause effects of electrical coactivity on this  
24      rather small space component, and parts of these  
25      components?

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1 Do they penetrate and cause local  
2 corrosion of structural circuits?

3 DR. WOOD: Yes, it is conceivable that  
4 those things could happen. What we found in the  
5 actual physical tests of equipment exposed to smoke  
6 is that high density particles or high density of  
7 particles of where the effects occurred, and very  
8 low density tended -- the equipment tended to be  
9 fairly robust.

10 MEMBER WALLIS: But density you mean the  
11 number of particles per cubic meter in the smoke or  
12 something like that?

13 DR. WOOD: Yes.

14 MEMBER WALLIS: And does size matter?

15 DR. WOOD: I can't say based on my  
16 recollection whether there was any investigation on  
17 the size of the particles themselves. Different  
18 materials were burned and so there were different  
19 sized chemicals and particles released.

20 MEMBER WALLIS: There was a scientific  
21 basis for evaluating these effects then?

22 DR. WOOD: The telecommunications  
23 industry does a lot of research about the  
24 susceptibility of equipment and corrosion effects  
25 that would occur in the long term.

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1 DR. KORSAH: And also typically during  
2 the measurement of doing the scientific measurement  
3 is try to make a second -- you know, leakage  
4 currents and so forth, and so forth and so on. The  
5 other effect is the smoke in conjunction with the  
6 humidity and the environment would form some kind of  
7 acid, and corrode the metal interconnections and so  
8 forth. So that is another effect of the smoke.

9 MEMBER SIEBER: On the other hand, most  
10 of these components -- computer chips, for example,  
11 are coded to avoid contact between the smokey  
12 atmosphere and the metallic portion of the circuit.

13 And they also try it seems to me to make  
14 more low impedance of the circuits than low  
15 impedance circuits so that leakage of currents don't  
16 have the impact that they would if you were involved  
17 in all high resistance circuits.

18 DR. WOOD: And I think that highlights  
19 some of the implementation of things that can be  
20 done, and that was the motivation for that position  
21 that I mentioned that was deleted in this version.

22 MEMBER SIEBER: It would be difficult to  
23 test for, because there are so many variables, and  
24 there are different kinds of smoke, and different  
25 humidity conditions, and different air flows, and so

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1 it would be a complex test.

2 MS. ANTONESCU: Exactly.

3 MEMBER POWERS: All you are telling me  
4 is don't use microprocessor systems.

5 MEMBER SIEBER: Right now they aren't.

6 DR. WOOD: I think what we should  
7 highlight is that we didn't investigate as a purpose  
8 the susceptibility of analog components, but by no  
9 means are we saying that digital or microprocessor-  
10 based components are more susceptible by definition.

11 MEMBER WALLIS: Is there a short  
12 statement that you have about the need for this new  
13 guide?

14 DR. WOOD: A short statement?

15 MEMBER WALLIS: To impress upon us  
16 quickly about the need for this new guide?

17 DR. WOOD: Let's see. I have a tendency  
18 to be long-winded, and so it is very difficult for  
19 me.

20 MEMBER POWERS: I think -- I'm operating  
21 from my recollection, but I think if we look at the  
22 Digital Electronics Research Plan that they had a  
23 nice piffy  
24 paragraph that explained why this work was being  
25 done, and maybe Steve could recall that from memory.

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1 DR. WOOD: I can give you our short  
2 statement here that Ms. Antonescu went over. First  
3 off, we feel that the unique characteristics of  
4 microprocessor-based systems need to be addressed,  
5 and I have a subsequent slide that talks about those  
6 unique characteristics.

7 So one thing that this guide does is  
8 provide that specific guidance in one location.  
9 Some of that guidance is scattered among various  
10 guidance documents.

11 We feel like that leads to a case by  
12 case basis as everybody discovers in each  
13 application what it is that I need to do. Instead  
14 of being able to go to a specific guide. There is  
15 no existing endorsement of the current national or  
16 international consensus standards. That is one  
17 thing that this guide provides.

18 MEMBER WALLIS: And these are specific  
19 standards for microprocessor equipment.

20 DR. WOOD: These are specific standards  
21 for qualification of equipment.

22 MEMBER WALLIS: Microprocessor.

23 DR. WOOD: Of equipment.

24 MR. DORMAN: Just to clarify. This is  
25 Dan Dorman, Research. It is no endorsement of those

1 consensus standards for microprocessor-based  
2 equipment for the range of environments that are  
3 considered in this guide.

4 DR. WOOD: Yes. If you take all of  
5 these together, you get the bigger picture, and I  
6 will show you the bigger picture is a few words as  
7 soon as I finish this discussion.

8 The comprehensive regulatory guide as  
9 Dan mentioned dealing with all environments, there  
10 is that comprehensive guide dealing with harsh  
11 environments, Reg Guide 1.89.

12 But as it was mentioned applications  
13 currently today of microprocessor-based equipment  
14 are in what are called model environments. We  
15 visited Taiwan last fall, and they are working on a  
16 microprocessor-based system for containment  
17 environments.

18 It is not in the far-distant future when  
19 microprocessors will move into containment, and then  
20 the other issue was the case by case basis. But  
21 these last four bullets are the reasons that  
22 motivated the development of this guide.

23 And so rather than going through all of  
24 these in detail, these next two viewgraphs basically  
25 highlight the distribution of guidance among

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1 different documents, and I won't go through this in  
2 detail, but I would like to point out the last  
3 bullet on this slide.

4 The DG-1077 is intended to provide a  
5 road map for existing guidance that is applicable to  
6 microprocessor-based equipment. So you go to one  
7 source, and there it is. You don't have to decide  
8 should I infer from the guidance to the reviewer in  
9 the standard review plan some things that I needed  
10 to do.

11 Do I have to go to the staff position in  
12 NEUREG-0588 and derive some additional information;  
13 and then do I go to IEEE323, and then what do I do  
14 for model environments. Chapter 3 and Chapter 7  
15 have some differences in what they do, because they  
16 apply to different kinds of equipment, and that is  
17 in the standard review plan.

18 CHAIRMAN BONACA: Now, the letter from  
19 (inaudible) does not object to having a regulatory  
20 guide as an umbrella. The next two specific  
21 objections says that new regulatory positions  
22 contained in the draft guide include expanding the  
23 scope of 10 CFR 50.49 to apply to (inaudible) model  
24 environments.

25 And concluding that EMI/RFI is both an

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1 environmental condition and a significant aging  
2 mechanism. Those are two specific objections.

3 DR. WOOD: Those two specific  
4 objections, the objection about the expansion of the  
5 scope of 10 CFR 50.49 resulted from a result of a  
6 lack of clarify in what the guidance that went out  
7 for public comment, and the public comment  
8 highlighted to us the need the make it more  
9 systematic in the presentation of what is the  
10 purpose.

11 CHAIRMAN BONACA: So your intent is one  
12 of expounding it?

13 DR. WOOD: That's right.

14 CHAIRMAN BONACA: So you don't have an  
15 issue there.

16 DR. WOOD: Exactly. And regarding  
17 EMI/RFI, there was no intent to identify EMI/RFI in  
18 general as an aging stressor. But EMI/RFI, and all  
19 the electromagnetic conditions in a plant, are part  
20 of the environment of the plant, and this is a  
21 position that is consistent with the IEC standard,  
22 and it is treated as a condition.

23 It is also a position that is being  
24 adopted by the United States because the revision of  
25 IEEE 323 includes EMI/RFI as a listed service

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1 condition.

2 MEMBER SIEBER: Well, there is a reg  
3 guide for that already.

4 DR. WOOD: That's right.

5 MEMBER SIEBER: 1.180.

6 DR. WOOD: It's inclusion in this reg  
7 guide is to reflect consistency between the IEC and  
8 the IEEE standard, and to remind people not to  
9 forget EMI/RFI, and not to provide full guidance on  
10 EMI/RFI.

11 The position provides a pointer to Reg  
12 Guide 1.180, and also a pointer to EPRI 102323, as  
13 both providing guidance on how to address this  
14 specific issue.

15 CHAIRMAN BONACA: So you don't feel that  
16 even on this issue that you do have a conflict?

17 DR. WOOD: That's true.

18 MEMBER WALLIS: If this is a harsh  
19 environment, it seems to me that harsh is defined,  
20 or a harsh environment is defined by what it does to  
21 a particular thing and in a particular context.

22 And if you simply look at an environment  
23 which has a significant effect on the behavior of a  
24 microprocessor, that by definition is a harsh  
25 environment for a microprocessor.

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1                   It may not be harsh for other things,  
2                   but I don't see why you need to make this  
3                   distinction.  
4                   If it affects the function of that device, then it  
5                   is a harsh environment.

6                   CHAIRMAN BONACA: I think it is more  
7                   than that. It is the practice of how the harsh  
8                   environment is (inaudible) --

9                   DR. WOOD: Yes, there is a lot of  
10                  semantics involved in it, and part of the fuzziness  
11                  of the semantics is the semantics are the reasons  
12                  that we went to the location categories.

13                  MEMBER SIEBER: Right.

14                  DR. WOOD: And I think the public  
15                  comments illustrated that we were not effective in  
16                  conveying that. So hence the revision with  
17                  additional information.

18                  MEMBER SIEBER: Well, you defined  
19                  Category A and Category C, and Category B as  
20                  everything else.

21                  DR. WOOD: Everything in between. Now,  
22                  to be fair to the commenters, there was much more  
23                  conservatism in the boundaries between the  
24                  representative conditions in the version that went  
25                  out, and there was great value in the public

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1 comments and highlighting that we needed to give  
2 consideration to what would make this practical to  
3 implement without adding a burden, rather than  
4 reducing a burden.

5 So we tried to do that. This is an  
6 illustration of environmental qualifications. Some  
7 of the comments, or many of the comments that we  
8 received dealing with the need for guidance  
9 illustrated a great deal of diversity in  
10 understanding what environment qualification is, and  
11 when does it apply. When do you have to do it, and  
12 what do you have to do.

13 These are two views of environmental  
14 qualification. One is looking at the environment in  
15 the plant, and so you have all environments, and the  
16 rule that requires environmental qualification are  
17 given in 10 CFR 50-55(a)(h), and then demonstrating  
18 that you have accomplished the design criterion in  
19 GDC04, General Design Criterion-4, and that you  
20 accommodate the effects of, and are compatible with,  
21 the environment.

22 Normal operation all the way through.  
23 Harsh environments are a subset of that, and as I  
24 said earlier, there is not an explicit definition of  
25 harsh environments in the Code of Federal

1 Regulations. There is a definition of mild  
2 environments.

3 MEMBER WALLIS: Well, you could expand  
4 to fill the whole space available.

5 DR. WOOD: That's right. But 10 CFR  
6 50.49 specifically addresses harsh environments. It  
7 notes that mild environments, qualification for mild  
8 environments are beyond its scope, and it doesn't  
9 say that you have to qualify for mild environments.  
10 It says that it is beyond its scope.

11 So that is the plant environment  
12 viewpoint. Now, where do microprocessors fit into  
13 this right now? They are in that larger bubble  
14 outside the harsh environments, but they are moving  
15 toward the inner-bubble, and part of the vision for  
16 this guide is to anticipate that, and have the  
17 guidance in place, rather than reacting.

18 MEMBER WALLIS: Is there likely to be an  
19 environment that will affect their performance?

20 DR. WOOD: Yes.

21 MEMBER WALLIS: I'm really just playing  
22 with words about whether it is harsh or not.

23 DR. WOOD: That's right.

24 MEMBER WALLIS: As they are not very  
25 important to me.

1 DR. WOOD: The harsh and mild really are  
2 in sort of standard and regulatory space. If it has  
3 an effect, it is a significant environment.

4 MEMBER WALLIS: Right.

5 DR. WOOD: And then looking at it from  
6 the equipment point of view, the Class 1E equipment  
7 point of view, you have got all the electrical  
8 equipment which are within the scope of 10 CFR  
9 50.49, and then you have got microprocessor-based  
10 equipment which are a subset of that.

11 But all electrical equipment -- I'm  
12 sorry, the all electrical equipment expand beyond  
13 the scope of 50.49, because there are Class 1E  
14 electrical equipment that are not implemented in  
15 harsh environments.

16 So the next viewgraph is intended to  
17 sort of illustrate what is the role of DG-1077. You  
18 have the electrical equipment and harsh  
19 environments, which is the regime of Reg Guide  
20 1.189, and you have the microprocessor-based  
21 equipment in all environments, which is the regime  
22 of BG-1077.

23 And then you have got this small overlap  
24 that right now is almost non-existent, but  
25 eventually it will become populated, where you have

1 microprocessor-based equipment in harsh  
2 environments.

3 And then in that case you have DG-1077  
4 and you have the conditions in Reg Guide 1.189. If  
5 you don't have DG-1077, you don't have explicit  
6 guidance about all of the blue part of the small  
7 bubble.

8 And also you don't have added to Reg  
9 Guide 1.189 the specific considerations for  
10 microprocessor-based equipment.

11 MEMBER WALLIS: So Reg Guide 1.189  
12 wouldn't really handle this cross-hatched region is  
13 what you are saying?

14 DR. WOOD: Not absolutely. We think  
15 that there are some considerations that need to be  
16 addressed that are in the various sources of  
17 guidance, but you have to go ferret them out.

18 MEMBER WALLIS: And so it is a question  
19 of difficult to find rather than they aren't there?

20 DR. WOOD: I think that the reviews of  
21 the vendor topical reports on the various systems  
22 indicate that the major vendors know where those  
23 things are, but the concern is there are some  
24 subtleties, and you want to make sure that all  
25 vendors can be aware of what they need to do.

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