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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

December 2, 2004

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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

518TH MEETING

+ + + + +

THURSDAY,

DECEMBER 2, 2004

+ + + + +

The meeting was convened in Room T-2B3 of Two  
White Flint North, 11545 Rockville Pike, Rockville,  
Maryland, at 8:30 a.m., Dr. Graham B. Wallis,  
Chairman, presiding.

MEMBERS PRESENT:

MARIO V. BONACA	Chairman
GRAHAM B. WALLIS	Vice-Chairman
GEORGE E. APOSTOLAKIS	ACRS Member
F. PETER FORD	ACRS Member
THOMAS S. KRESS	ACRS Member
RICHARD S. DENNING	ACRS Member
DANA A. POWERS	ACRS Member
VICTOR H. RANSOM	ACRS Member
STEPHEN L. ROSEN	ACRS Member-at-Large
WILLIAM J. SHACK	ACRS Member
JOHN D. SIEBER	ACRS Member

ACRS STAFF PRESENT:

SAM DURAI SWAMY                      Technical Assistant, ACRS/ACNW,

JOHN T. LARKINS                      Designated Federal Official



## I-N-D-E-X

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

8:31 a.m.

CHAIRMAN BONACA: Good morning. The meeting will now come to order. This is the first day of the 518th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following: Expert Elicitation on Large Break LOCA Frequencies, Proposed Rule for Risk-Informing 10 CFR 50.46, Technical Basis for Potential Revision of the Pressurized Thermal Shock Screening Criteria in the PTS Rule, Preparation of the CRS Reports and Safeguards and Security Matters.

A portion of the meeting will be closed to discuss safeguards and security matters. This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Dr. John Larkins is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements from members of the public regarding today's sessions. A transcript of a portion of the meeting is being kept, and it is requested that the speakers use one of the microphones, identify themselves and speak in

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1 sufficient clarity and volume so that they can be  
2 readily heard.

3 Marvin Sykes will be leaving the ACRS  
4 staff on December 17, 2004 to join the Region 1 staff  
5 as the Branch Chief, Reactor Program, Division of  
6 Reactor Safety. As a Senior Staff Engineer, he as  
7 provided outstanding technical support to the ACRS in  
8 reviewing several important matters, including license  
9 renewal applications, digital instrumentation and  
10 control systems, fire protection issues and electrical  
11 group reliability. We would like to thank him for his  
12 contribution to the Committee and wish him good luck  
13 in his new position. Thank you.

14 (Applause.)

15 When is your last day?

16 MR. SYKES: The 17th.

17 CHAIRMAN BONACA: The 17th. So we'll see  
18 you once again for the MOx fuel meeting. All right.

19 We will begin with some items of current  
20 interest. You have in front of you a package. You  
21 may be interested. Inside there are articles to new  
22 commissioners. There's an article on that, Pages 12  
23 to 16. You may also note, Pages 19 to 22, that the  
24 final 50.69 rule was released. There were some  
25 changes made at the last minute after we reviewed it.

1 You may be interested in looking at those changes.  
2 And I believe that Mike Snodderly put together a brief  
3 memo that we'll distribute later on highlighting those  
4 changes that we have not reviewed.

5 With that, I think we'll move to the items  
6 on the agenda. We have --

7 MR. RANSOM: You left out the most  
8 important.

9 CHAIRMAN BONACA: Oh.

10 MR. RANSOM: Pages 27 to 28.

11 CHAIRMAN BONACA: Pages 27 to 28, let's  
12 see. Oh. There is an article on "New Project  
13 Flawed," published by the Cape Times. That's a very  
14 interesting article. Did you write it?

15 MR. RANSOM: No, no.

16 (Laughter.)

17 CHAIRMAN BONACA: All right. We'll be  
18 looking at it. Okay. We have the whole morning  
19 dedicated to 50.46, first of all to the elicitation  
20 work that has been done and then to the rule. So we  
21 will move right away to that item on the agenda, and  
22 Dr. Shack is going to lead us through that  
23 presentation.

24 MR. SHACK: Let me turn it over to Rob  
25 Tegoning.

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1 MR. TEGONING: Thanks for the introduction  
2 Dr. Shack.

3 This is a little bit of a change with  
4 what's in the agenda. The agenda item is to talk  
5 about or discuss the expert elicitation on large break  
6 LOCA frequencies. When we presented at the  
7 Subcommittee meeting about two weeks ago on regulatory  
8 policies and practices, it was clear indication from  
9 the Committee that they really wanted to see how these  
10 elicitation results were used to select the transition  
11 break size. So we've modified this talk a little bit  
12 and what you're going to see here is a focus on the  
13 elicitation results but only on how the elicitation  
14 results set the table for the actual TBS selection.

15 So I will be giving the first half of this  
16 talk, again, focusing on those portions of the  
17 elicitation that are most relevant for the transition  
18 break size selection, and then I'm going to be turning  
19 it over to Gary Hammer at NRR who's going to say quite  
20 eloquently how they took our information as a starting  
21 point and then finally arrived at the transition break  
22 size. And he's going to lay out the logic and some of  
23 the thinking and the rationale that went into that  
24 selection.

25 So the presentation objectives, I'm going

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1 to be leading the first part, providing an overview of  
2 the elicitation scope. The pertinent results for TBS  
3 selection and some of the uncertainty that arises when  
4 you analyze and process the raw input that we got from  
5 the experts in a variety of different ways. Then as  
6 I mentioned, Gary is going to launch into a  
7 description on the approach for selecting the  
8 transition break size that's being proposed in the  
9 50.46 risk informed alternative. And that approach,  
10 as he's going to describe, used the elicitation  
11 results as a starting point. It made sure it  
12 incorporated uncertainty and variability within these  
13 results, and then it also considered adjustments to  
14 account for LOCA frequency contributions which were  
15 explicitly considered within the expert elicitation  
16 process.

17 So I think it's important -- I've stated  
18 this several times to the Committees, probably three  
19 or four different times, but I think it's important  
20 again to stress this first slide, which is why it's  
21 really up here, to discuss what we did, what were the  
22 specific objectives and scope of the elicitation. So  
23 which piece of the LOCA frequencies were we really  
24 trying to get at with the elicitation?

25 Again, the primary goal was to develop

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1 generic BWR and PWR piping and non-piping passive  
2 system LOCA frequency distributions as a function of  
3 the pipe break size or the break size or the opening  
4 break size and the operating time.

5 MR. APOSTOLAKIS: Rob?

6 MR. TEGONING: Yes.

7 MR. APOSTOLAKIS: What is a generic  
8 distribution?

9 MR. TEGONING: Generic distribution, we  
10 meant to -- essentially, fleet average is another way  
11 to consider that.

12 MR. APOSTOLAKIS: What does that mean? I  
13 mean if it's a fleet average, is it a number, a single  
14 number? I mean if you have a distribution -- in the  
15 reactor safety study when they talked about generic  
16 distributions for failure rates, they emphasized that  
17 it was the plant-to-plant variability that was a major  
18 contributor to those distributions. But I think you  
19 had told us that plant-to-plant variability was not a  
20 major factor in your case. In fact, if you look at  
21 the discussion on safety culture, you say, well, maybe  
22 in some plants we may have a higher frequency but we  
23 don't really care about -- or we're not concerned with  
24 plant-to-plant variability. So I'm wondering how you  
25 define and whether actually the experts understood

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1 what you meant by generic.

2 MR. TEGONING: Yes, and we've discussed  
3 this previously. I mean by generic we were looking at  
4 broad industry averages. We did instruct the experts  
5 to consider broad differences in plants, differences  
6 due to different design types, but not to delve into  
7 differences that might exist at one particular plant.

8 MR. APOSTOLAKIS: Why not?

9 MR. TEGONING: Because the way we've  
10 developed and used LOCA frequencies in the past has  
11 always been on a generic basis. And when we were  
12 setting the regulation for 50.46 it made most sense to  
13 develop a basis for that based on a generic average,  
14 not -- we didn't want this regulation to be driven by  
15 frequencies that might be representative of only one  
16 plant.

17 MR. APOSTOLAKIS: So the plant-to-plant  
18 variability then will be covered by the selection of  
19 the TBS, which presumably will be higher than your  
20 estimate. Because somebody has to worry about it, it  
21 seems to me.

22 MR. TEGONING: Well, there's some aspect  
23 in the selection of the TBS that covers that, but,  
24 again, there's other -- and I think somebody from NRR  
25 may want to speak about this, but there's other

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1 procedures and practices that we use to try to  
2 minimize plant variability, especially in the area of  
3 LOCA frequency. And the understanding is that those  
4 procedures and practices are going to continue to be  
5 in place and continue to be enforced. So I don't know  
6 if Rich or --

7 MR. BARRETT: This is Richard Barrett.  
8 I'm with the NRR staff. The selection of the TBS at  
9 this point is also a generic consideration. I think  
10 the one place where plant-specific LOCA frequencies  
11 might come into play is in the risk-informed aspect of  
12 this, which you heard about in some detail in the last  
13 ACRS meeting. At the point when licensees want to  
14 apply this rule, they will have to bring their PRAs in  
15 and apply them to plant-specific licensing actions,  
16 for instance. At that point, PRA practice, as you  
17 know, as you well know, can sometimes use generic or,  
18 as appropriate, use more plant-specific information  
19 regarding LOCA frequencies. And a licensee may be  
20 able to make the case that they deviate from the  
21 generic results based on specific operational  
22 experience with regard to inspections of the reactor  
23 coolant pressure boundary, and I would be speculating  
24 at this point about that. But so far everything we've  
25 done, up to the point of choosing the transition break

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1 size, has been based on generic BWR, generic PWR  
2 considerations.

3 MR. APOSTOLAKIS: Thank you.

4 MR. TEGONING: Okay.

5 MR. POWERS: Rich, let me just follow up  
6 on that. Suppose a guy comes in with his PRA and he  
7 has a peculiarly susceptible piping system. How do  
8 you detect that?

9 MR. BARRETT: Well, I think the correct  
10 answer to that question is right now I don't know.  
11 You know, that would -- we are in the process over the  
12 past three or four years of gaining a great deal more  
13 experience with our knowledge of the degradation  
14 mechanisms and operational experience with  
15 inspections, visual inspections, non-destructive  
16 examination of various parts of the reactor coolant  
17 pressure boundary, more than we've ever had before, I  
18 think.

19 And so at the time when this rule is  
20 implemented, if a licensee comes in and we know of  
21 some very adverse operational experience, I think it  
22 would be incumbent upon us, our PRA staff working with  
23 our materials engineering staff, to challenge a  
24 licensee about that operational experience.

25 MR. POWERS: I guess what I'm fishing for

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1 is how do you know? I mean is there some activity  
2 that says, "Okay, yes, we did not consider plant-to-  
3 plant variability in developing these frequencies, but  
4 we know that if a plant has such and such a condition,  
5 that it might deviate outside of this or  
6 up/down/sideways. These things are consequential."  
7 I mean is there such a base of information someplace,  
8 is there somebody I can go ask about that? Or do I  
9 have to reconstitute this panel of experts in order to  
10 -- and then ask them that question, how does plant-to-  
11 plant variability affect these?

12 MR. BARRETT: I think what's more likely  
13 to happen is that licensees will take actions to bring  
14 themselves into the norm; that is to say I think we  
15 would -- rather than challenging a licensee to use a  
16 higher frequency number because they've had  
17 unfavorable inspection results or unfavorable  
18 operational history, I think we would challenge the  
19 licensee to take more corrective action to bring  
20 themselves more into the norm. And that would be in  
21 compliance with bulletins that we have out there,  
22 orders that we have out, technical specifications in  
23 some cases, voluntary industry inspection programs in  
24 other cases, and as time goes along, we are going to  
25 be evolving into a more -- into a different regime as

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1 to how we inspect and manage the flaws in the reactor  
2 coolant pressure boundary. So I think it's going to  
3 be more in terms of trying to -- seeing that licensees  
4 are more in conformance rather than trying to figure  
5 out probablistically how --

6 MR. POWERS: I think I agree with your  
7 comment there. I guess when we look at the materials  
8 science, either research program or the capabilities  
9 in the line organizations, we need to look  
10 specifically in these areas is what you're saying,  
11 because -- I mean you in your position are reliant on  
12 them of telling you look specifically at this part of  
13 the application.

14 MR. BARRETT: Right. And you've been  
15 briefed on the pert process that the Office of  
16 Research is going through, and it's a very systematic  
17 process. The industry is doing something similar, and  
18 we're on a pretty steep learning curve right now, but  
19 I think we're heading very much in the right  
20 direction.

21 MR. SHACK: I mean you do some of that in  
22 the risk-informed inspection where you actually look  
23 at the degradation mechanisms on a piping system-by-  
24 piping system basis. You're looking at the number of  
25 welds in piping systems. And so you do end up with a

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1 variability. I mean not all plants will have the same  
2 results, even though you're using sort of generic  
3 results on a per weld basis.

4 MR. TEGONING: And one of the necessary  
5 baseline things that you do for risk-informed ISIs,  
6 you do what's called a baseline study of your plant to  
7 evaluate precursor events and identify those that may  
8 be different than industry average and trends. And,  
9 again, I think what we're envisioning whenever we see  
10 an issue that pops up the first question in our mind  
11 is is this a plant-specific or a generic issue? I  
12 think if you look at CRDM cracking, that's sort of a  
13 classic example where we have been working to identify  
14 cause as root causes and differences and identifying  
15 those plants which may have bigger problems than  
16 others. So I would anticipate that that sort of model  
17 would be what we would apply and utilize in this case  
18 as well.

19 MR. BARRETT: Exactly.

20 MR. SHERON: Dana, if I could -- this is  
21 Brian Sheron from the staff. Just in terms of putting  
22 a perspective on this, keep in mind that, number one,  
23 when we're talking about a transition break size for  
24 a plant we've considered the question of other plant-  
25 to-plant variability, and we just don't have enough

1 information on all 103 operating plants to be able to  
2 sit there and say we can go and pick what the right  
3 number is for each one of those plants.

4 When we went through the process we did  
5 put margin in our thinking. In other words, when you  
6 see how we arrived at a transition break size, which  
7 is basically the largest attached pipe to the primary  
8 system, the thinking was is that the most likely  
9 pipes, in other words the pipes that are going to have  
10 the higher probability of breaking, it's not the main  
11 coolant pipe, you know, the big 30-inch or 25-inch  
12 pipes, whatever and the like, it's probably the  
13 attached piping. And we think we've covered that. In  
14 other words, the highest probability piping, if  
15 there's going to be a failure, is going to be  
16 something that's attached. And so that's why we  
17 picked those pipes, the largest attached pipe.  
18 Because we think that covers plant-to-plant  
19 variability to some extent. A plant that has a 14-  
20 inch surge line will have a bigger break than one that  
21 has, say, a 12-inch and the like.

22 The only other piece I would point out is  
23 that really what -- you've got to remember these  
24 licensees are still required to mitigate up through  
25 the double-ending guillotine rupture. The only thing

1 we're arguing about is what kind of conservatisms they  
2 put in their analysis when they do the calculation.  
3 So I feel -- I mean I personally feel comfortable that  
4 we've got enough margin to account for any plant-to-  
5 plant variability.

6 The one place where we did raise the issue  
7 has to do, for example, with the power uprate, okay,  
8 where they may now be operating the plant at  
9 conditions that were greater than what the expert  
10 elicitation panel considered, in which case a  
11 licensee, I believe, would have to come in and tell us  
12 what that effect is.

13 MR. APOSTOLAKIS: Well, that brings up  
14 another issue, though. I mean are we reviewing this  
15 work in the context of 50.46, in risk-informed, in  
16 50.46, or are we reviewing it as a piece of work on  
17 its own? At the Subcommittee meeting, we were told  
18 that these results may be used in other applications,  
19 so we have to make sure then that they're reasonable  
20 results, but also, you know, it's a NUREG so we have  
21 to review it. If we review it only in the context of  
22 determining the TBS, then a lot of the details that  
23 one can worry about disappear, because if we go with  
24 your choice of the TBS, you have such a margin that  
25 you add, in fact it's significantly higher than the

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1 95th percentile of the most conservative expert. So  
2 what do you want? I mean they just increase it by  
3 four inches above the ten-inch estimate of the expert.  
4 So then you might even wonder why spend all this money  
5 to do this. You could have called up the experts and  
6 say the guy who was most conservative was this, we're  
7 going to go up and that takes care of that.

8 So I have been thinking about it. I mean  
9 it seems to me at least this committee should review  
10 this work in its own right. Does it produce  
11 reasonable results independently of how risk-informing  
12 50.46 will take those results and use them. Okay? So  
13 in the context of 50.46 and what you guys are doing,  
14 maybe everything is okay.

15 MR. SHERON: Yes. The only thing I would  
16 -- I won't say I disagree with you but I don't think  
17 there's -- when you say there's so much more margin in  
18 the TBS that we selected from the most conservative  
19 expert's opinion, we recognize that the expert  
20 elicitation didn't consider a lot of -- or not all of  
21 the various failure modes. There were some other  
22 uncertainties. I think even the Committee raised the  
23 question of safety culture and how does that impact --

24 MR. APOSTOLAKIS: No, I agree. I mean you  
25 did a good job listing those.



1 MR. SHERON: Yes. So I mean there's  
2 margin there, but I can't tell you that it's that far  
3 above. It's just accounting for things we don't know  
4 how to quantify.

5 MR. APOSTOLAKIS: But my main point,  
6 though, is still valid, that since they didn't  
7 consider other things, say, four inches or something,  
8 then a lot of the details that went into this analysis  
9 are not very relevant any more unless this analysis is  
10 used somewhere else.

11 MR. BARRETT: Doctor, I think I'd say that  
12 a little differently. I think that the details and  
13 the technical analysis and having a systematic  
14 elicitation available as a starting point was very,  
15 very useful for us at NRR in choosing this TBS because  
16 it gave us a place -- you know, we know that we're not  
17 at the ten to the minus five mean 50 percent  
18 confidence level; we know that. We know that we've  
19 placed -- we've gone to a more conservative position.  
20 But by having this systematic analysis available and  
21 having it available at this point in time, that's  
22 very, very useful for us to know where we are. So  
23 this is one of those happy cases where a very good  
24 research product has come along at exactly the right  
25 time.

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1 But I would agree with you that there is  
2 a separate question as to making sure that the ACRS  
3 fully understands this because it is a piece of work  
4 that may be applied in many, many cases in the future.

5 MR. BISHOP: Dr. Apostolakis, Bruce Bishop  
6 from Westinghouse. On the first agenda item this  
7 afternoon, we're going to be talking about pressurized  
8 thermal shock, and in fact the limiting transients do  
9 turn out to be the LOCAs, and we did use -- the staff  
10 did use preliminary estimates that came out from the  
11 panel, not the final ones. But one of the action  
12 items that came out of the joint subcommittee meetings  
13 the last couple days was to reverify that the  
14 frequencies are consistent for the small and large and  
15 medium break LOCAs. So it is being used in different  
16 places.

17 MR. APOSTOLAKIS: Thank you.

18 CHAIRMAN BONACA: The only thing I wanted  
19 to mention, I totally agree that they're different  
20 things, and we discussed during the Subcommittee this  
21 issue of the bridge from the elicitation to the actual  
22 choice of the break and I expressed my interest  
23 particularly in those factors such as the bottom  
24 bullet here, no significant changes will occur in  
25 plant operating profiles.

1                   There was another statement that says that  
2                   the assumption was that mitigating strategies on  
3                   piping will be as good as the one used in the past.  
4                   Now, the question I have at that point is, well, the  
5                   rule would in fact cause possibly power uprates, which  
6                   are significant changes in plant operating profiles.  
7                   The rule may also cause mitigation strategies which  
8                   are lesser than we have in the past for design basis  
9                   of transition breaks. And I have an expectation that  
10                  the bridge going from elicitation process to the  
11                  choice of a break size will address those issues. Did  
12                  you talk about those?

13                  MR. APOSTOLAKIS: Yes. Okay.

14                  MR. TEGONING: Okay. Let me continue  
15                  quickly then with this since I think we've already  
16                  discussed most of this slide. So, again, we're  
17                  dealing with unisolable LOCAs, LOCAs related to  
18                  passive component aging. We looked at a variety of  
19                  different break sizes, from the classical small,  
20                  medium and large break up to a double-ended guillotine  
21                  type of LOCA, which is much bigger than the historical  
22                  definition for a large break LOCA, and we looked at  
23                  three different timeframes. Again, the primary focus,  
24                  the last two bullets, we were looking at frequencies  
25                  associated with normal operating loads and transients

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1 that are expected over the extended lifetime of the  
2 plant. So we weren't dealing with rare event loading  
3 like you can get for a more significant seismic event.  
4 And Dr. Bonaca just talked about the last bullet.

5 So I wanted to list here next some --

6 MR. POWERS: Let me ask you on the last  
7 bullet it's remarkable and it's like a head-in-the-  
8 sand approach. Do you have any evidence that power  
9 uprate changes the frequency substantially?

10 MR. TEGONING: No. The only thing we have  
11 is preliminary information. I mean we've seen it in  
12 BWRs that --

13 MR. POWERS: That preliminary information  
14 is information.

15 MR. TEGONING: Yes. Well, we've seen in  
16 some instances with boiling water reactors when they  
17 have gone through uprates we have seen increased  
18 frequency of damage due to internal steam dryer  
19 components. So that is evidence that we certainly do  
20 have -- there's no other evidence that I'm aware of  
21 beyond that. And that's an important cautionary note,  
22 and that's one of the reasons that that note was  
23 struck so heavily in the NUREG. The experts were  
24 provided with the operating experience. The operating  
25 experience is valid over the conditions, parameters

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1 that represent the way plants have been run over the  
2 last 25, 30 years. So that precursor information is  
3 important, and it's just an understanding that if we  
4 do things that significantly alter I'll say the  
5 appearance or the information that's provided in that  
6 precursor database, then that would potentially result  
7 in a change in LOCA frequencies.

8 And this caveat is in there just to make  
9 sure that we maintain vigilance. When we do things  
10 like this, when we make changes, we need to  
11 continually monitor precursor events to see if those  
12 changes have any end result. I think the steam dryer  
13 is an excellent case because we did some power  
14 uprates, we were evaluating what happened to the plant  
15 after we made those uprates and we realized that,  
16 okay, there were some unintended consequences that  
17 occurred because of those uprates. And now we've got  
18 a fairly -- and I can't speak about this but there's  
19 others in the room that can -- but now we have a  
20 fairly extensive strategy to go in and modify and fix  
21 those issues so that it brings us back down to  
22 precursor events which are consistent with our  
23 historical operating experience.

24 CHAIRMAN BONACA: Well, the words in the  
25 elicitation document specifically indicate they could

1 be significant increases, and that's what is  
2 troublesome about -- one is left with a judgment  
3 without information. Significant may be in the eye of  
4 the beholder, I mean what does it mean? So, anyway.

5 MR. TEGONING: Yes.

6 MR. POWERS: Yes. That's kind of the  
7 situation you're stuck in, isn't it, that -- I mean  
8 most of these assumptions -- what you'd like the  
9 assumptions to know is there's a continuous evolution  
10 of things here and now you're left with this may be a  
11 clip here and what not and there's no evidence offered  
12 and apparently none exists.

13 CHAIRMAN BONACA: But, again, since the  
14 whole process is an elicitation, so it's an  
15 engineering judgment being provided by experts. You  
16 have to take it in that context as well as the same  
17 way you believe in certain estimations of numbers you  
18 believe in the word, "significance," and you know how  
19 to place it in the context of a estimation of  
20 transition break of an Appendix A criteria. I'm  
21 talking about this bridge going from one to the other.  
22 I mean it's a difficulty I'm having when I read that  
23 report.

24 MR. TEGONING: Well, again, I think that  
25 caveat's necessary because you couldn't go into the

1 elicitation and postulate all possible changes that  
2 could occur. We know what we know, we know what our  
3 history tells. We had to make certain assumptions to  
4 try to project that history forward.

5 CHAIRMAN BONACA: I'm just troubled by  
6 those which are circular in nature, which is once  
7 applied to a rule, the rule may cause certain changes  
8 in the plant which may result in undermining the  
9 estimations that we have. And there were two that I  
10 saw. One was a potential for less capable mitigating  
11 strategies tied to the fact that there will be less  
12 focus on beyond transition break components, and this  
13 other one was this, but I think there may be  
14 additional ones when I read the report.

15 MR. TEGONING: Well, again, that's why  
16 those caveats are in there. And it's not -- we're not  
17 developing these results through elicitation and  
18 throwing them on the table and walking away from them.  
19 Part of the plan is to continually evaluate these  
20 things, and if we see changes, that's when the  
21 action's necessary.

22 CHAIRMAN BONACA: Yes.

23 MR. TEGONING: So there are a number of  
24 other LOCA risk contributors that we didn't explicitly  
25 consider within the elicitation. And I've listed a

1 few of the more -- I think more prominently discussed  
2 contributors. We didn't specifically consider active  
3 system LOCAs, stuck open valves, pump seal LOCAs,  
4 those types of scenarios. We did not explicitly  
5 consider seismically induced LOCAs.

6 MR. APOSTOLAKIS: Excuse me, regarding  
7 your second bullet, if you were to define an  
8 equivalent diameter for a stuck open valve or a pump  
9 seal LOCA, what would that be?

10 MR. TEGONING: These are usually small  
11 LOCAs at best.

12 MR. APOSTOLAKIS: Small LOCAs.

13 MR. TEGONING: At best.

14 MR. APOSTOLAKIS: So in terms of the  
15 choice of the TBS, the fact that you left those out  
16 probably doesn't matter that much.

17 MR. TEGONING: That would be what I would  
18 argue, certainly, yes.

19 MR. BISHOP: Dr. Apostolakis, this is  
20 Bruce Bishop again from Westinghouse. We specifically  
21 looked at that question. The biggest valve in the  
22 Westinghouse plants would be the safety relief valves,  
23 and their flow rate would correspond to a break of  
24 between a two- and four-inch pipe.

25 MR. APOSTOLAKIS: Two and four inches.



1 Thank you.

2 MR. BISHOP: Yes.

3 MR. TEGONING: Then as I mentioned,  
4 seismically induced LOCAs and other LOCAs associated  
5 with what we're calling or terming rare event loading,  
6 this would include a rare water hammer, rare major  
7 water hammer and a heavy load drop from some causal  
8 factor like an overhead crane releasing its load. And  
9 Gary is going to discuss these points later in the  
10 talk, so he's going to expound on these much more  
11 fully. I'm just setting the table right here.

12 So the elicitation results -- so that's  
13 the objective and scope. Now, I want to go right into  
14 the elicitation results, and, again, this is a summary  
15 of information that I think you're well familiar with  
16 at this point. The way the NUREG is laid out we  
17 developed baseline results, and those baseline results  
18 were developed having measures of both individual  
19 uncertainty, so uncertainty that each panelist had,  
20 and then also measures of group variability.

21 With these baseline results, we conducted  
22 sensitivity analyses in a number of areas and they  
23 were specifically five broad areas because we wanted  
24 to look at the effect of assumptions that we made in  
25 processing the baseline results, how changing those

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1 assumptions might affect the results that you could  
2 glean from the elicitation. So there were five broad  
3 areas that we looked at. We looked at the effect of  
4 distribution shape, looked at overconfidence  
5 adjustment, we looked at the effect of assuming  
6 different correlation structures, different methods of  
7 aggregating expert opinion and then also different  
8 ways of capturing panel diversity.

9 And I've bolded two here, the  
10 overconfidence adjustment and the aggregation of  
11 expert opinion. These are the two that we thought  
12 were most applicable to the TBS selection. So this  
13 was information that very early on the results of  
14 these sensitivity studies were communicated to NRR.  
15 And the baseline results, as modified by the  
16 overconfidence adjustment, is what they were using and  
17 what they were basing their TBS selection on. And  
18 then we gave them various results with various  
19 aggregation schemes so they could take into account or  
20 understand the uncertainty that arises when you  
21 process the results in different ways. So these were  
22 the two components to the baseline results that were  
23 added and included in the NRR selection.

24 MR. APOSTOLAKIS: Well, did the experts  
25 see any of this? Did the experts see the sensitivity

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1 analysis, did they see your final results, did they  
2 express any views?

3 MR. TEGONING: The experts had reviewed  
4 the NUREG at two different phases. We had a  
5 teleconference in July with the first draft of the  
6 NUREG and we had all the sensitivity analyses  
7 conducted in four out of five of these areas. The  
8 only thing that we hadn't finished at the time was the  
9 effect of distribution shape on the mean. And the  
10 other thing that we didn't show them at that point is  
11 we didn't have the mixture distributions developed.  
12 But they did see the difference between arithmetic  
13 mean aggregated and geometric mean aggregated. Now,  
14 since we've completed these additional sensitivity  
15 analyses, we've sent the NUREG back out for final  
16 review. So they've certainly seen all of these. We  
17 haven't had another video teleconference or another  
18 gathering of the experts, again, to comment again, but  
19 we did have relatively rather extensive comments at  
20 the July meeting.

21 I think just to summarize some of the most  
22 -- there was generally good agreement on most areas of  
23 the NUREG. I will say there was some probably some  
24 violent disagreement when we got into the different  
25 ways of aggregating. And there were --

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1 MR. APOSTOLAKIS: Which we will probably  
2 have here as well.

3 MR. TEGONING: Yes. Yes. This is a  
4 common theme here. When we get into aggregation  
5 there's violent disagreement amongst individuals. And  
6 I would think, and this is probably not surprising,  
7 most of the disagreement was against using an  
8 aggregation scheme like an arithmetic mean type  
9 approach or a mixture distribution approach because,  
10 again, I think the thinking was it didn't accurately  
11 represent the group as a whole.

12 MR. APOSTOLAKIS: But, you see, that's my  
13 question, really. Were the experts as a group ever  
14 given an opportunity to say, "Yes, what you guys are  
15 putting in the executive summary represents our group  
16 and maybe by extension the state of the art." Or a  
17 guy's sitting in his office in California, he gets the  
18 NUREG, reviews it, reads its, now, again, it depends  
19 on the point of view he takes, says, "They represented  
20 me well? Yes. Then they did all these analyses.  
21 They sound reasonable to me. It's okay." But he  
22 never really asks himself do I agree that this final  
23 distribution of the staff report reflects my views as  
24 well. So the whole thing is you should give a chance  
25 to the experts after you do the sensitivity analysis

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1 and everything to revise their views and maybe try to  
2 come up with a consensus curve. And I'm asking  
3 whether they actually had that opportunity or they  
4 just individually reviewed the NUREG to make sure  
5 there was nothing unreasonable?

6 MR. TEGONING: Yes. And you get into  
7 different strategies. That would have been one  
8 strategy that we could have taken with the  
9 elicitation. We specifically did not want to develop  
10 consensus curves because we did want to have a measure  
11 of what the differences in opinion would be.

12 MR. APOSTOLAKIS: Right. I mean remember  
13 now you're --

14 MR. TEGONING: And, again, the sensitivity  
15 analysis and getting input from the panelists were  
16 important; however, it's recognized that while these  
17 are experts in materials and fracture predictions and  
18 the technical subject matter of the elicitation,  
19 they're not experts in aggregating group opinion or  
20 applying these results to a 50.46 rule. So there's  
21 only certain -- their comments are very valuable and  
22 they formed a necessary basis for this entire  
23 document; however, there are aspects of the document  
24 that quite frankly I don't feel that the experts --  
25 they're certainly welcome to comment on them, but I

1 don't think they're necessarily qualified to.

2 MR. APOSTOLAKIS: But you're not asking  
3 them -- well, they're certainly more qualified than  
4 talking about safety culture, okay? And you have them  
5 talk about safety culture and speculating that safety  
6 culture will improve in the future. I mean they're  
7 absolutely not qualified to say things like that.

8 MR. TEGONING: They are with respect to  
9 LOCAs; sure, they are.

10 MR. APOSTOLAKIS: I don't think so. I  
11 think anybody can say things about safety culture. I  
12 mean here you have experts on probablistic fracture  
13 mechanics passing judgment on safety culture. I mean  
14 --

15 MR. TEGONING: Only as it relates to  
16 passive system failure. That's a very small aspect of  
17 safety culture.

18 MR. APOSTOLAKIS: They can say something  
19 useful as to the impact of a given culture on the  
20 failure of a passive system but they cannot say  
21 anything useful to me regarding what safety culture  
22 we'll have in the future. That's an entirely  
23 different ball game, whether people will do things  
24 like Davis-Besse and so on. But, anyway, that's a  
25 separate issue.

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1           The point is, though, that the experts  
2       would probably have benefitted a lot by seeing the  
3       sensitivity analysis. Because, you know, once you  
4       pass judgment and seeing them and having an  
5       opportunity to change their judgments possibly --

6           MR. TEGONING: But they did see them.  
7       They did see them.

8           MR. BISHOP: Dr. Apostolakis, Bruce Bishop  
9       again. I was a member of the --

10          MR. APOSTOLAKIS: Bruce Bishop, did you  
11       have a role in this?

12          MR. BISHOP: Yes. I was a member of the  
13       Expert Panel, and I did make some comments about --

14          MR. APOSTOLAKIS: So you are one of the  
15       experts.

16          MR. BISHOP: Right. And I did make some  
17       comments about --

18          MR. APOSTOLAKIS: So you think the safety  
19       culture --

20          MR. BISHOP: -- the safety culture, but I  
21       don't want to talk about that. What I want to talk  
22       about is that at the next to last meeting when we were  
23       provided a draft of the NUREG there was some violent  
24       disagreement on the overconfidence adjustment among  
25       the experts, and Rob and Lee provoked -- proposed --

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1 MR. APOSTOLAKIS: Provoked too.

2 (Laughter.)

3 MR. BISHOP: -- some resolution of those  
4 comments. And those were discussed. And the basic  
5 agreement was of the Panel that that appeared  
6 acceptable to all of us. So there were opportunities  
7 to do that. At the second meeting where we were  
8 presented preliminary results I do know that Panel  
9 Members did make adjustments to their individual  
10 contributions because the results after that changed,  
11 in particular the small, like the four-inch diameter  
12 PWRs were increased significantly for the PWSCC  
13 concerns that the Panel -- most of the Panel did not  
14 believe that we had that under control yet, and I mean  
15 at the time for the 25-year elicitation results. So  
16 there was that feedback.

17 But the latest results we've been shown,  
18 and what Rob did is sort of he gave, "Well, here's the  
19 ratio of the numbers you had at the last meeting, and  
20 here's the ratio of the new numbers." So we could see  
21 very clearly what was changing. And I would  
22 characterize most of the changes that have been made  
23 recently have been relatively small. I mean we have  
24 not seen big orders of magnitude changes or things  
25 like that. We've seen adjustment factors, typically

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1 a factor of two or less or something in the last  
2 adjustments. And so I think most of the Expert  
3 Panelists would agree that that's probably within the  
4 scope of our estimates. So I just wanted to set that  
5 straight.

6 MR. DENNING: I'd like to make a comment  
7 because my concern is exact opposite of George's and  
8 that is I think that there is danger in driving to  
9 approve consensus, and it goes along with some of the  
10 things that you just responded back to George.  
11 Because I think there is substantial uncertainty here,  
12 and I think that the value of the group getting  
13 together is to understand what the other people are  
14 saying and sometimes they get additional insights.  
15 But their danger is that you'll drive them towards  
16 minimizing what's a real uncertainty. So my concern  
17 in the aggregations and those group elements of this  
18 is that we're making the uncertainty appear much  
19 narrower than the reality is.

20 MR. APOSTOLAKIS: Well, again, it depends  
21 on what the experts are doing. The experts, in my  
22 view, should see the sensitivity analysis, because  
23 experience has shown that the results of this analysis  
24 provide very useful insights to them, and they may  
25 want to change the thing. But we'll talk about the

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1 form of the results later.

2 One question that I have, because that  
3 really confused me when I looked at the whole thing,  
4 shouldn't your final results be in the executive  
5 summary?

6 MR. TEGONING: The final baseline results  
7 are in the executive summary.

8 MR. APOSTOLAKIS: I'm sorry, not baseline.  
9 Your final word should be in the executive summary.  
10 And I'm confused now. At the Subcommittee meeting,  
11 you told us, I think, that the results with the  
12 overconfidence adjustment are your results, period.  
13 Is that correct?

14 MR. TEGONING: The statement that we make  
15 in the executive summary is that we provide baseline  
16 results and then we have a statement in there that  
17 says, "The particular results that you use for a given  
18 application will be dependent on the intents and  
19 purposes of those applications."

20 MR. APOSTOLAKIS: I understand that, but  
21 in --

22 MR. TEGONING: And that's why here I'm  
23 highlighting what results and what adjustments due to  
24 the sensitivity analysis are most appropriate for the  
25 50.46 transition break size selection.

1 MR. APOSTOLAKIS: In Chapter H of your  
2 report, there is a series of results. If I read the  
3 executive summary, it seems to me that's the purpose  
4 of the executive summary, I should be able to see what  
5 your final conclusion, your final results are, and you  
6 may have a -- you know, "We also did a lot of  
7 sensitivity analysis, go to H."

8 So at the Subcommittee meeting, I got the  
9 impression that your results included overconfidence  
10 adjustment, but the executive summary has only the  
11 baseline results without the overconfidence  
12 adjustment. So now I'm confused. Which one's would  
13 you advocate, the ones with overconfidence adjustment  
14 or not?

15 MR. TEGONING: For 50.46 TBS selection, we  
16 are advocating use of the overconfidence adjustment  
17 results. Again, the NUREG's meant to stand alone and  
18 deal with other applications. There may be other  
19 applications for whatever reason you don't want to use  
20 the overconfidence adjusted results.

21 MR. APOSTOLAKIS: But the overconfidence  
22 adjustment has to do really with the experts  
23 themselves, so I can't see an operation where the  
24 experts cease to be overconfidence.

25 MR. TEGONING: Do you want to --

1 MR. ABRAMSON: This is Lee Abramson of the  
2 staff. The whole idea of overconfidence adjustment is  
3 somewhat controversial. We used it because there's a  
4 lot of evidence in the literature that people, experts  
5 in particular, people in general, tend to be  
6 overconfident in their judgments. Of course, our  
7 whole elicitation process was designed to try to  
8 minimize this with training of the experts and so on  
9 and so forth.

10 So we don't know, certainly, in this case  
11 to what extent they may or may not have been  
12 overconfident. However, there's some indication  
13 internally from the results that we got, namely the  
14 very wide disparity between the experts, that some  
15 would seem to be certainly far less uncertain than  
16 others and so on. So we felt that we had to explore  
17 this and we did this through a sensitivity study.

18 So I would think it would depend on a  
19 combination of to what extent you are concerned about  
20 this possibility of their being overconfidence -- that  
21 is as somebody who's going to apply these results. If  
22 you're particularly concerned that perhaps the experts  
23 might have been overconfident, you can't be sure, then  
24 you may say we need to use an overconfidence  
25 adjustment. In other words, you want to conservative

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1 in your results because of the kind of application  
2 you're using.

3 So it's a combination of both your  
4 assessment of whether they might have been  
5 overconfident or not and the risk you're taking in  
6 using the results with or without adjusting for it.  
7 It really depends a lot on the application and on your  
8 approach to the whole problem.

9 MR. APOSTOLAKIS: I'm not sure that the  
10 application is so significant here, and it's really --  
11 the problem -- well, I have a few comments on this.  
12 First of all, having seen the statement of the  
13 considerations, I went back to the report and I tried  
14 to figure out where they got the range of six to ten  
15 inches for PWRs. I thought it was going to be a  
16 straightforward thing, and it wasn't. I had to  
17 speculate a lot. Maybe they used this figure, maybe  
18 they used that figure, maybe they used a mean here and  
19 median there and so on, and that question will come up  
20 again.

21 And then I thought that maybe in the  
22 executive summary there should be sufficient  
23 information for me to figure out very quickly how NRR  
24 selected that range. And by reporting only the  
25 baseline results and then maybe using something else,

1 that doesn't help. And I think, Less, coming to your  
2 point about you have to use your judgment for this and  
3 that, I think you are putting an awfully large burden  
4 on the user here. You are asking the user to decide  
5 on which sensitivity analysis is appropriate, you are  
6 asking him to go back and read the literature to  
7 understand what overconfidence means.

8 I mean one would expect that the project  
9 of this nature where experts in these things got  
10 together and produced a report that these guys would  
11 resolve these issues for people like Brian, for  
12 example, so he wouldn't have to go back and say, "Gee,  
13 what do they mean by this. Should I do this, should  
14 I go with the median." No.

15 As far as I'm concerned, one should read  
16 the executive summary and that should say, "This is  
17 our final word on this with all the uncertainties, if  
18 you will, and so on," and right now all it says is the  
19 study does not recommend whether the frequency  
20 estimates corresponding to the baseline or in  
21 particular sensitivity analysis should be used in  
22 applications, which means, "Mr. User, you have to read  
23 all this NUREG, hire your own consultants and make  
24 your own judgments." I just couldn't figure out this  
25 six to ten inches where it came from.

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1 MR. ABRAMSON: Well, you're right, we do  
2 put a burden on whoever's going to apply us, and I  
3 think that's an appropriate burden to place because  
4 you're talking about decision making under  
5 uncertainty. That's what's being done here,  
6 regulatory decision making for something like that.  
7 And we're providing them a tool to do this. But the  
8 purpose of this was not to provide them with the  
9 criteria that they were going to use; we don't know  
10 that. That's why we emphasize the importance of the  
11 application, the criteria, the risks they're willing  
12 to take of all sorts and so on. So we cannot do that.  
13 Now, that's another effort perhaps that we could  
14 explore, but that was not the purpose of this NUREG.

15 MR. APOSTOLAKIS: But if Rob is telling us  
16 that the overconfidence adjustment is really something  
17 that you guys like, let's put it that way, why aren't  
18 you reporting these results in the executive summary  
19 and you're reporting only the baseline?

20 MR. TEGONING: Because I'm a particular  
21 advocate or not an advocate of a particular set of  
22 results, we wanted to make the NUREG a stand-alone  
23 document, essentially, without consideration of any  
24 application, although we realize 50.46 was the first  
25 application that was going to most extensively utilize

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1 these results. And, quite frankly, as Lee mentioned,  
2 overconfidence correction is fairly controversial.  
3 There is no standardized way to do that. We explored  
4 a number of different ways to do that, and just  
5 because Lee and I preferred a particular way and we  
6 think we have some basis for that, I mean we could  
7 make that recommendation, and I understand your point,  
8 but we just chose not to at this point in time  
9 because, again, there's no standardized way to do  
10 this.

11 MR. APOSTOLAKIS: You know what's going to  
12 happen. I mean people are going to go to the  
13 executive summary and lift numbers from there, period.  
14 Maybe NRR won't because this is a big deal, I mean  
15 risk-informing 50.46, and they will call you and ask  
16 you and all that. But once this NUREG is released,  
17 people are going to be using your baseline results in  
18 the executive summary, especially when you say that  
19 the sensitivity analysis didn't affect it much except  
20 for the application.

21 MR. TEGONING: Well, it sounds like you're  
22 advocating maybe instead of having a particular set of  
23 results in the executive summary having no results in  
24 the executive summary.

25 MR. APOSTOLAKIS: Well --



1 (Laughter.)

2 MR. APOSTOLAKIS: -- actually, the  
3 opposite should be results. No, I just don't think  
4 it's fair to the reader to have results in the  
5 executive summary but when we talk to you you say,  
6 "No, these are not what we're really recommending.  
7 It's something in Section H."

8 MR. TEGONING: No, I totally understand  
9 your point.

10 MR. APOSTOLAKIS: All right.

11 MR. TEGONING: Okay. So the next slide is  
12 going to get at the results that George has been  
13 looking for. So this shows the results that were  
14 provided to NRR. Of course, they were given  
15 preliminary results; these are final. I think we gave  
16 a set of earlier results to NRR end of May-June  
17 timeframe. We've been tweaking things, as Bruce had  
18 mentioned, in the interim, but there hasn't been  
19 significant changes in the results since what NRR was  
20 provided with in May and June.

21 So these show the BWR results and we just  
22 have -- all of these results are adjusted using our  
23 error factor adjusted correction.

24 MR. APOSTOLAKIS: It's obvious your heart  
25 is there, Rob. I mean you really like the adjusted

1 results. All you need -- you really want people to  
2 spend hours trying to figure how the six to ten inches  
3 were produced. It's obvious to me that you really  
4 like this, and I have no objection, actually. I mean  
5 this is your professional judgment, I know the issue.  
6 Fine.

7 MR. TEGONING: This is why I don't play  
8 poker, obviously, George.

9 MR. WALLIS: Rob, I have a question here.  
10 In reaching these numbers, you're treating these as if  
11 they were continuous curves, it seems to me.

12 MR. TEGONING: No. We say that in the  
13 report.

14 MR. WALLIS: This is appropriate to join  
15 them up. Don't you have different classes of piping  
16 that certain types of pipe are going to break in  
17 certain ways. So there really isn't a continuous  
18 curve. When you've changed from one kind of a pipe to  
19 another one, it's a different story. Maybe we should  
20 have a step function between sizes or something.

21 MR. TEGONING: That's right. And we  
22 indicate --

23 MR. WALLIS: That makes a big difference  
24 when you start to say you've got some place where  
25 you've got ten to the minus five.

1 MR. TEGONING: And that's a valid point.  
2 We state in the NUREG that these lines between the  
3 points -- we asked the experts for discrete points,  
4 and those are the dots you see in the figure. The  
5 lines are just there for trending.

6 MR. WALLIS: These numbers at the bottom,  
7 though, they seem to correspond to intersections  
8 between the continuous lines in some curve.

9 MR. TEGONING: The numbers --

10 MR. WALLIS: That's what I interpolate.

11 MR. TEGONING: The numbers at the bottom  
12 are interpolated numbers based on --

13 MR. WALLIS: No pipe size at that size at  
14 all.

15 MR. TEGONING: And that's why when you see  
16 the rest of this talk that's why these numbers are  
17 just a starting point. You bring in those  
18 considerations later on when you look at interpreting  
19 and applying these numbers in a regulatory sense. So  
20 that's an excellent point, and that's the point that  
21 I would --

22 MR. WALLIS: This goes again to George's  
23 point. Someone's going to say, "Aha, we've now got  
24 this magical number 19, and that's the answer."

25 MR. SHACK: But you could also have a leak

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1 that's not a break.

2 MR. TEGONING: Yes.

3 MR. APOSTOLAKIS: True.

4 MR. SHACK: So if you have a 32-inch pipe,  
5 you can have a break size in that 32-inch pipe  
6 anywhere from a leak size --

7 MR. WALLIS: A 20-inch size break in a 30-  
8 inch pipe is probably a completely different animal in  
9 terms of probability from a 20-inch pipe which itself  
10 breaks. It's a different problem.

11 MR. TEGONING: Maybe not that different.

12 MR. WALLIS: Not that different?

13 MR. TEGONING: You're talking about a  
14 major -- we would classify that as a major failure of  
15 that pipe in any instance.

16 MR. SHACK: No, but the question is what  
17 is the likelihood.

18 MR. WALLIS: It's quite a different thing.

19 MR. SHACK: It's quite different.

20 MR. TEGONING: Yes. And I don't know that  
21 I would make that assertion.

22 MR. WALLIS: But this is another thing  
23 that the intelligent interpreter should take into  
24 consideration. As they have, I think.

25 MR. APOSTOLAKIS: This last row, mixture

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1 of distribution, is that in the NUREG?

2 MR. TEGONING: Yes.

3 MR. APOSTOLAKIS: Where?

4 MR. TEGONING: Well, it --

5 MR. APOSTOLAKIS: I've been looking for  
6 it.

7 MR. TEGONING: Yes. The version of the --  
8 let me be clear, the version of the NUREG -- the NUREG  
9 has been in continual preparation. There was a  
10 section added after the version we gave you for  
11 review.

12 MR. APOSTOLAKIS: So which NUREG are we  
13 reviewing today?

14 MR. TEGONING: You're essentially  
15 reviewing a preliminary version that will be available  
16 for public comment. So we've added -- this is the  
17 only section that's been added.

18 MR. APOSTOLAKIS: Can we have that section  
19 today?

20 MR. TEGONING: Yes.

21 MR. APOSTOLAKIS: How long is it?

22 MR. TEGONING: Less than a page.

23 MR. APOSTOLAKIS: Oh.

24 MR. TEGONING: A page or so.

25 MR. APOSTOLAKIS: So just for purposes of

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1 clarification, geometric mean means that you take,  
2 say, the medians of the experts, multiply and take the  
3 end root.

4 MR. TEGONING: Yes.

5 MR. APOSTOLAKIS: Okay. Arithmetic mean  
6 means you take the median of the experts -- or the  
7 means of the experts, add them up and divide by N.

8 MR. TEGONING: Yes. Of the various  
9 parameters of the distribution, either the fifth, the  
10 median, the 95th or the mean.

11 MR. APOSTOLAKIS: Yes.

12 MR. TEGONING: Because we've got estimates  
13 for each of those.

14 MR. APOSTOLAKIS: Some characteristic  
15 value.

16 MR. TEGONING: Right. Right.

17 MR. APOSTOLAKIS: Yes. And then you find  
18 some distribution for the expert value fitting a curve  
19 or something. And mixture distribution means that  
20 from what the expert gives you, each expert, you  
21 produce a distribution and then for each diameter you  
22 add up the probabilities and divide by N. This is the  
23 NUREG 1150 approach.

24 MR. TEGONING: Yes. Yes.

25 MR. APOSTOLAKIS: Very good.

1 MR. TEGONING: Yes. Yes. And, again --

2 MR. APOSTOLAKIS: I really want to see  
3 that section.

4 MR. TEGONING: And we'll provide that.  
5 Again, I apologize. Due to the schedule and --

6 MR. APOSTOLAKIS: No, that's fine.

7 MR. TEGONING: -- due to the scheduling of  
8 these meetings, we've been trying to give you the most  
9 up to date version.

10 MR. APOSTOLAKIS: You know, I spent hours  
11 trying to figure out why you guys didn't do that when  
12 NUREG 1150 did it, when the seismic study did it. The  
13 seismic study says in fact that working with the  
14 percentile ties is wrong. You didn't want to help me,  
15 though. Okay, now I understand, and it's important to  
16 see that the mixture distribution is at least a higher  
17 percentile than the geometric mean, higher numbers in  
18 general, because the mixture distribution contains  
19 expert-to-expert variability and uncertainties of the  
20 experts. And I remember when we were reviewing 1150  
21 we had long discussions about these things, what it  
22 contains and Steve Horac gave us a long spiel there.  
23 And then the seismic study confirmed that. So that's  
24 very important to bear in mind.

25 MR. TEGONING: But the interesting thing

1 and part of the results that we've been looking at  
2 from the beginning is not only the mean values but  
3 evaluation of the confidence bounds. And what's  
4 interesting there is the mixture distributions, if you  
5 compare with the geometric mean when you consider the  
6 95 percent confidence bounds, you get a pretty good  
7 correlation there.

8 MR. WALLIS: Well, despite all this, some  
9 naive person like me looks at the numbers down at the  
10 bottom there and says, "These are pretty big pipes."

11 MR. TEGONING: Yes.

12 MR. WALLIS: What rationale you're going  
13 to use, those are pretty big pipes you've got down at  
14 the bottom.

15 MR. TEGONING: Yes.

16 MR. APOSTOLAKIS: Yes. That's why the  
17 choice is, what, 20?

18 MR. WALLIS: Well, they're pretty -- 24.  
19 Numbers above 20 look pretty hairy to me.

20 MR. FORD: Rob, could you just satisfy me  
21 on one thing?

22 MR. TEGONING: Sure.

23 MR. FORD: Looking through your  
24 presentation you don't talk about future performance,  
25 the end of six years. Tell me again, for instance,



1 flow assist occurs in the carbon steel piping in BWRs?

2 MR. TEGONING: Yes.

3 MR. FORD: May well increase in  
4 probability, they go to power uprates. How is that  
5 fed into this sort of rationale? Is a plant-specific  
6 analysis that is done at a later date?

7 MR. TEGONING: Well, again, when we did  
8 the elicitation, we looked at different time periods,  
9 and those sort of longer-term trends that you would  
10 get from predicting either probabilistic fracture or  
11 other types of predictions, were included in those  
12 trends. I don't summarize in here just because for  
13 the most part there were no strong time dependencies  
14 that were predicted by the experts.

15 MR. FORD: I saw nothing in any detail on  
16 FAC in the station report. This is why I bring it up.

17 MR. TEGONING: Yes. No, FAC was -- and I  
18 don't -- maybe you can clarify in terms of what sort  
19 of detail you're looking for, because FAC was  
20 definitely a prominent mechanism that was discussed  
21 for -- again, it's a small subsection of piping. It's  
22 really only the feedwater piping and steam piping in  
23 BWRs that are really susceptible to FAC in the primary  
24 side system. But that was certainly an important  
25 consideration. And we discussed as a Panel quite at

1 length the relative merits between IGSCC likelihood of  
2 failure versus FAC likelihood of failure.

3 If you look at Appendix L, I believe,  
4 which has the detailed results, there's a lot more  
5 system type discussion that's provided in that  
6 appendix.

7 MR. FORD: This definition of the TBS will  
8 be very much plant specific.

9 MR. TEGONING: No.

10 MR. FORD: Well, this is what puzzles me,  
11 because it's got to be, it should. I mean if you've  
12 got a plant that's on hydrogen water chemistry --  
13 we're talking about BWRs -- those curves are going to  
14 shift dramatically as to whether a specific plant is  
15 on -- all the plants are on hydrogen water chemistry  
16 now but --

17 MR. TEGONING: Yes, but we considered the  
18 effects.

19 MR. FORD: And your past performance has  
20 been based on normal water chemistry.

21 MR. TEGONING: But we have performance  
22 based on both, and that was another explicit point in  
23 the elicitation is we looked at the difference in  
24 operating experience as a function of the various  
25 mitigation steps that had been done over the years to

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1 account for IGSCC cracking and the effectiveness of  
2 those mitigation strategies.

3 So, no, that was a very -- we had very  
4 lengthy discussions about that as well. We looked at  
5 data, both pre and post sort of early '80s timeframe,  
6 looked at different trending, looked at what plants  
7 were generally doing out there to mitigate for IGSCC  
8 and, again, the explicit instruction that was given to  
9 the experts was when you consider IGSCC, you consider  
10 IGSCC as it exists now, not as it existed back in  
11 1980. So there was one instance where we had to be  
12 very careful because the operating experience is  
13 clouded by a lot of data based on pre-mitigation  
14 IGSCC.

15 And that's where the experts really earn  
16 their money. Of course, some of them weren't paid,  
17 but that's where they were really important because  
18 they had to distinguish between what part of the  
19 operating experience was most important and what was  
20 most relevant to current-day estimates.

21 MR. WALLIS: Well, I'm wondering -- you've  
22 had your time, according to the schedule. You seem to  
23 be about a third of the way through it.

24 CHAIRMAN BONACA: And let me just make a  
25 correction to the record before I turn to Dr. Shack --

1 or it's actually Dr. Apostolakis is the one that is  
2 leaving this session here. So now the record is  
3 corrected.

4 MR. APOSTOLAKIS: So now that we're  
5 running out of time --

6 CHAIRMAN BONACA: We're running out of  
7 time because --

8 MR. APOSTOLAKIS: -- you turn it over to  
9 me so I will be going.

10 CHAIRMAN BONACA: We're running out of  
11 time because we heard your presentation rather than  
12 their presentation.

13 MR. ROSEN: So that you will lead us out  
14 of the problem.

15 CHAIRMAN BONACA: That's the reason why  
16 we're running out of time.

17 MR. WALLIS: Well, it seems to me these  
18 are important conclusions here. Are you giving us  
19 conclusions in this page or are we still discussing  
20 all about the methods you employed?

21 MR. TEGONING: I'm giving you results that  
22 were used as a starting point by NRR for selecting the  
23 transition break size, not conclusions.

24 MR. APOSTOLAKIS: Maybe I missed it, what  
25 do you mean by mean with 95 percent confidence?

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1 MR. TEGONING: Well, when we did the  
2 geometric mean aggregation, we also --

3 MR. APOSTOLAKIS: Can you point to the  
4 figure and show us which one would that be?

5 MR. TEGONING: These bars represent  
6 confidence bounds. So this value represents  
7 essentially where this bar would intersect, ten to the  
8 minus fifth.

9 MR. APOSTOLAKIS: So you would go to the  
10 curve labeled mean?

11 MR. TEGONING: Yes, with 95 percent  
12 confidence.

13 MR. APOSTOLAKIS: Show me the 16? Where  
14 is --

15 MR. TEGONING: It's between here and here.

16 MR. WALLIS: It's the red bar there.

17 MR. SHACK: You go to the mean curve and  
18 you go to the arrow bar on the mean curve, go to the  
19 top of it.

20 MR. TEGONING: This represents the upper  
21 confidence boundary.

22 MR. SHACK: And then you can draw  
23 interpolations between those points.

24 MR. APOSTOLAKIS: So at the point where  
25 the straight line intersects with the ten to the minus

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1 five? Okay.

2 MR. TEGONING: Yes, essentially. Let me  
3 move on. I don't think we need to talk about means.  
4 These show essentially the same thing, but they're the  
5 PWR results. And, again, I've chosen to show here  
6 just the adjusted geometric mean and the adjusted  
7 arithmetic mean results. The mixture distribution  
8 results, if I plotted them, look very similar to the  
9 adjusted arithmetic mean results.

10 MR. APOSTOLAKIS: Now, the mixture  
11 distribution will have a mean value but it will also  
12 have a 95th percentile.

13 MR. TEGONING: Yes.

14 MR. APOSTOLAKIS: And where is that? Oh,  
15 it's over there, ten.

16 MR. TEGONING: That's it. We didn't  
17 develop confidence intervals for the mixture.

18 MR. APOSTOLAKIS: No. For the mixture, it  
19 doesn't make sense to do that.

20 MR. TEGONING: We could, but we didn't.  
21 We could use boot-strapping or something to do that.  
22 We just didn't.

23 MR. APOSTOLAKIS: No, this is good enough.  
24 So, essentially, the mixture distribution defines the  
25 six to ten range.

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1 MR. ABRAMSON: Just a point of  
2 clarification. The mean of the mixture distribution  
3 is always equal to the arithmetic mean.

4 MR. APOSTOLAKIS: Yes.

5 MR. ABRAMSON: However the 95th  
6 percentiles will differ.

7 MR. WALLIS: Well, I note that one of the  
8 numbers is 31, so if you wanted to be ultra-super risk  
9 averse, you might pick the biggest pipe in the system.

10 MR. TEGONING: Yes. And that number is  
11 essentially a threshold. If you look at the  
12 arithmetic mean, you start to get -- I mean the shape  
13 characteristics you get much more of a plateau with  
14 the larger break size.

15 MR. WALLIS: It's interesting that you can  
16 come up with a number 31.

17 MR. APOSTOLAKIS: And these results are  
18 adjusted. Now, in my view, if I were writing this, I  
19 would report a mixture distribution, and I would say,  
20 "These are adjusted because this is our professional  
21 opinion. Thank you very much. If you want to see  
22 variations, go to H." That's what I would do.

23 MR. WALLIS: He's telling us this is what  
24 was given to NRR. I think that's significant. This  
25 is what he gave --

1 MR. APOSTOLAKIS: No. The NRR has a whole  
2 NUREG, I hope, right?

3 MR. TEGONING: NRR has a preliminary --

4 MR. BARRETT: NRR had the whole NUREG and  
5 Rob was attached to it.

6 MR. APOSTOLAKIS: He was Appendix A.

7 (Laughter.)

8 MR. TEGONING: Appendix R.

9 MR. KRESS: With respect to Graham's  
10 comment, if I wanted a bigger number, I could use 97-  
11 97 or 99-99.

12 MR. APOSTOLAKIS: I know but 95 is sort of  
13 the one that's used traditionally.

14 MR. KRESS: Yes, for no apparent reason.

15 MR. APOSTOLAKIS: Thirty is kind of  
16 curious. Thirty-two is the biggest pipe you  
17 considered, is it?

18 MR. TEGONING: Well, the 31 is in there.  
19 It's just meant to essentially be you get no reduction  
20 if you use the 95th. With the 95th percentile, you're  
21 essentially at a double-ended guillotine break at the  
22 largest pipe in the plant. So that number's a bit of  
23 a misnomer.

24 MR. APOSTOLAKIS: It seems to me what  
25 makes sense is to report a mixture distribution graph.



1 Because if we go that way, as I said earlier, you  
2 might say, "Well, gee, I want to be conservative.  
3 Tell me what the highest number any one of the experts  
4 reported and I'll go with that." I mean supposedly  
5 we're putting some rational thinking into this, and in  
6 my view, that's in the mixture distribution.

7 MR. ABRAMSON: This is a comment about  
8 that. As I said, it's controversial about whether you  
9 want to use the mixture distribution or the geometric  
10 mean, and we talk about that in detail in the report.  
11 What I feel in the report is that it makes sense with  
12 the kind of data we have and the kind of situation  
13 that the geometric mean makes a lot much more sense  
14 than the mixture distribution.

15 As far as conservatism is concerned, I  
16 think what you should do is use the best most  
17 appropriate methodology you have for aggregation, and  
18 then if you want to be conservative, put the  
19 conservative on top of that. And you can do that in  
20 several ways. One, for example, you could use the  
21 95th percentile instead of the mean or you could use  
22 a confidence bounds or some other measure of  
23 variability. I think it's a mistake to use as an  
24 argument for the mixture distribution that it gives  
25 you larger results, namely more conservative ones.

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1 MR. APOSTOLAKIS: That's not the argument.

2 MR. ABRAMSON: Well, that sounds like what  
3 the argument is that you're making. I think if you're  
4 going to use the mixture distribution, you should use  
5 it because in your best professional judgment it's the  
6 best way to aggregate. But you should not use it --  
7 the fact that it is --

8 MR. APOSTOLAKIS: It doesn't give me --

9 MR. ABRAMSON: The fact that it gives you  
10 more conservative results is a benefit, but that  
11 should not be your main reason for using it.

12 MR. APOSTOLAKIS: It doesn't even do that.  
13 The geometric mean of 95-95 is 14, so that's not my  
14 reason.

15 MR. WALLIS: The message I'm getting,  
16 George, is that there's an argument about which number  
17 should be used; therefore, I've got to be careful how  
18 I use any of the numbers.

19 MR. APOSTOLAKIS: Okay. The mixture  
20 distribution, in my view, reflects uncertainties due  
21 to expert variability and individual expert  
22 uncertainty. It was used in the NUREG 1150 routinely,  
23 it was used in the seismic studies and so on.

24 MR. POWERS: George, one of the things  
25 that you can agonize over is number manipulation,

1 which is not the word I would use if I weren't on the  
2 record, but it seems to me that's not what the  
3 conclusion that NRR came to. They came to a rather  
4 interesting conclusion that says very interesting all  
5 this stuff on your pipe break frequency. What I'm  
6 going to do is say the largest pipe attached to the  
7 main coolant pipe is my break frequency. And  
8 interesting conclusion because it does not exactly  
9 follow from any of this expert elicitation that I'm  
10 aware of. Did the experts in the course of doing this  
11 come to the conclusion that it's really this attached  
12 piping that's the most vulnerable? I mean did they  
13 drive this conclusion or is this creativity -- a  
14 creative interpretation, and I mean that in the very  
15 best sense, by the way, on the part of NRR?

16 MR. TEGONING: Well, no. Frankly, I'll  
17 just say flatly, no. I think it's well known, and it  
18 was documented and stated in the elicitation as well  
19 that it's very well agreed upon in the community that  
20 the largest pipes, the coolant piping is robust  
21 piping. There are a number -- and the fact that it is  
22 large, relatively thick-walled, more likely to exhibit  
23 leak before break, there's a number of reasons why  
24 that piping is robust, as well as it's proven over its  
25 lifetime to be robust.

1 MR. POWERS: So all this agonizing over  
2 numbers means nothing. The fundamental physical  
3 phenomenon here, the fundamental physical insight is  
4 that the main piping is robust and it's the attached  
5 piping that's vulnerable.

6 MR. ROSEN: Is that what you just said?

7 MR. TEGONING: No. I'm not saying it's  
8 vulnerable. I'm just saying compared to the largest  
9 piping --

10 MR. APOSTOLAKIS: Yes, it's less likely.  
11 It's more likely.

12 MR. TEGONING: -- it's more likely.

13 MR. APOSTOLAKIS: Now, if you look at the  
14 argument, though, the NRR gives in their statement of  
15 considerations, I think it's an excellent application  
16 of defense-in-depth in fact, both rationalists and  
17 structures. The stopping point is the result here,  
18 six to ten inches. Then they have a list of all the  
19 assumptions and what's left out, which Rob also showed  
20 us on his second slide, I think. Then they said based  
21 on all these things that are missing and based on the  
22 fact that the expert elicitation came up with six to  
23 ten, we have to do something bigger -- choose  
24 something bigger, and then the issue of the largest  
25 attached piping came in and they said, "Well, gee,

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1 that's great. Fourteen inches for PWRs makes eminent  
2 sense to us." So this was their reasoning. It's not  
3 that they ignored everything that was done here. I  
4 mean they started but these guys did a good job, I  
5 mean Rob and Lee and their colleagues, in listing what  
6 is missing and various sensitivity studies and so on.

7 MR. WALLIS: Well, they may have done a  
8 good job but it seems to me that that idea that these  
9 numbers that you're agonizing over are the starting  
10 point is not correct. It is supporting information to  
11 the decision that was made that's really based on a  
12 very phenomenal logical kind of point of view.

13 MR. APOSTOLAKIS: I don't know, Dana. If  
14 those guys had come up with a range of ten to 18  
15 inches, I don't think those guys would say, "No, we'll  
16 go back to 14 because --

17 MR. WALLIS: Well, I think instead of  
18 speculating about why NRR made the decision, why don't  
19 we let them tell us why they made the decision.

20 (Laughter.)

21 CHAIRMAN BONACA: Well, there's a section  
22 on transition break size --

23 MR. APOSTOLAKIS: But the other point,  
24 though, is I think Dana is raising a very important  
25 point, which I tried to raise earlier. The other

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1 thing is let's not forget that the SRM says pick the  
2 mean frequency of the distribution. So if one were to  
3 go with the SRM, then the stuff that these guys did  
4 acquires tremendous significance because now you go  
5 with the curve they have. I don't know how you could  
6 do that when they also tell you, "We left a lot of  
7 things out." So that creates a problem there.

8 CHAIRMAN BONACA: The following slides  
9 talk about what has been left out. I think they're  
10 important. We may have to move --

11 MR. APOSTOLAKIS: No, but this is the real  
12 issue. Are we reviewing this work in the context of  
13 50.46 or in its own right?

14 MR. TEGONING: And I would argue that  
15 you're doing both. You really need to do both.

16 MR. APOSTOLAKIS: You're probably right.

17 MR. WALLIS: But it should certainly stand  
18 in its own right.

19 MR. APOSTOLAKIS: It should. It should  
20 stand.

21 MR. WALLIS: It shouldn't be warped by  
22 some consideration of 50.46.

23 MR. APOSTOLAKIS: So what do we do next?  
24 So, okay, now --

25 CHAIRMAN BONACA: We're moving ahead,

1 George. You're ten minutes past the time and you have  
2 to manage this next seven or eight --

3 MR. WALLIS: Minus so many minutes.

4 MR. TEGONING: I'm going to turn it over  
5 to Gary Hammer now of NRR and he's going to --  
6 although I think George sort of outlined the rationale  
7 to get us back on time pretty eloquently.

8 MR. APOSTOLAKIS: Would you please when  
9 you give numbers tell us exactly from which figure or  
10 table you got them from?

11 MR. HAMMER: Yes, I will attempt to do  
12 that.

13 MR. APOSTOLAKIS: Thank you very much.

14 MR. HAMMER: Yes. Thank you, Rob. And,  
15 yes, I'm Gary Hammer with the Office of NRR and the  
16 Division of Engineering. As Rob said, we wanted to  
17 use the expert elicitation results as a starting point  
18 to give us some idea about what it is we're looking at  
19 in terms of some of these frequencies, pipe sizes.  
20 And what you see, as he said, is that there are a  
21 range of pipe sizes which correlate to the frequency  
22 that we're trying to target, which is ten to the minus  
23 fifth per calendar year.

24 And as he indicated, there's a lot of  
25 uncertainties, both in the process of the elicitation

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1 and in variability and some of the things that have  
2 been discussed here already. And those are some of  
3 the things that we indeed have also been thinking. I  
4 heard a lot of things being said that sounded very  
5 familiar to some of our own internal discussions.

6 And we felt like the selection should  
7 accommodate some of these various considerations. And  
8 there are considerations, as Rob mentioned, which do,  
9 ultimately, we think, impact the selection, at least  
10 potentially. Because they weren't specifically  
11 considered in the elicitation process, and those would  
12 be categories of active LOCAs and low-generated LOCAs.  
13 And then, finally, we think that we need to consider  
14 the actual configuration of the plant, anything we  
15 know about specific operating experience that could be  
16 brought to bear on the final selection.

17 Regarding the other considerations not  
18 addressed by the Expert Elicitation Panel, Rob hit on  
19 these briefly, if I could go into just a little more  
20 detail. You have the topic of active LOCAs. As it  
21 was mentioned a little earlier, we think those are  
22 generally small-break LOCAs from stuck open valves,  
23 failure of seals and gaskets. Those valves and seals  
24 and gaskets don't end up being that large. I think we  
25 had a question just the other day, "Well, what about

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1 the loop isolation valves?" Those are the biggest  
2 valves we can think of. They're actually in the main  
3 coolant lines. If you failed the seal on those,  
4 however, that wouldn't even be as big as the TBS that  
5 we're looking at because you're looking at a valve  
6 that's basically backseated in its normal  
7 configuration, and if you had the seal blowout, it  
8 wouldn't be that big.

9 They are a higher frequency than pipe-  
10 break LOCAs. It is something that --

11 MR. WALLIS: Don't those big valves,  
12 excuse me, have some bolts in them in the way they're  
13 put together? So they could -- if there was some  
14 overtorquing of the bolts or something, that would be  
15 a cause for --

16 MR. HAMMER: Yes, but --

17 MR. TEGONING: We covered those in the  
18 elicitation. Those types of failures were considered  
19 in the elicitation.

20 MR. WALLIS: I know, but those valves  
21 actually if they popped would give you a break which  
22 is comparable with the break of the major pipe.

23 MR. TEGONING: To the pipe size that it  
24 was attached to, right.

25 MR. WALLIS: Okay. So I was hoping that

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1 your --

2 CHAIRMAN BONACA: Are we talking about  
3 loop installation valves?

4 MR. TEGONING: If the whole casing failed,  
5 you would get that.

6 CHAIRMAN BONACA: The loop installation  
7 valve, some plants have them, most plants don't.

8 MR. HAMMER: Right.

9 CHAIRMAN BONACA: Okay. But that's  
10 consistent with the thought process that they will be  
11 plant-specific, and that may cause the consideration  
12 of different break size because you have a certain  
13 component there.

14 MR. ROSEN: Did you cover reactor coolant  
15 pump bolting, the bolts that hold the halves of the  
16 reactor coolant pump together?

17 MR. TEGONING: Yes. That was all covered  
18 in the elicitation. The only thing that wasn't  
19 covered was, again, mechanical operation of the  
20 valves.

21 MR. ROSEN: When you say it's covered,  
22 what do you mean? I think I know what you mean but  
23 I'm --

24 MR. TEGONING: It means that we discussed  
25 piping and non-piping contributions to the LOCA

1 frequencies. We developed failure scenarios for each  
2 of those components. They were discussed --  
3 identified, discussed and then evaluated by the  
4 experts. So that's what I mean by considered.

5 MR. ROSEN: So in that discussion someone  
6 talked about, for instance, boric acid corrosion of  
7 the bolts that holds the coolant pump together.

8 MR. TEGONING: Yes.

9 MR. ROSEN: And that has the operating  
10 experience of corrosion of those particular bolts.

11 MR. TEGONING: And we provided operating  
12 experience of especially in primary systems bolts that  
13 had failed. And there was a realization that any bolt  
14 failure would need to be a common cause type of  
15 mechanism, and we discussed various common cause  
16 mechanisms, from boric acid corrosion to systematic  
17 overtightening to some maintenance error. And we  
18 developed these failure scenarios that we then  
19 provided back to the experts and asked them to assess.

20 MR. ROSEN: I asked you a very specific  
21 question about the reactor coolant bolts, you answered  
22 it. Can you apply that same answer to the manway  
23 bolts?

24 MR. TEGONING: Yes. Yes.

25 MR. ROSEN: Because those are very large

1 breaks if the bolts unzip.

2 MR. TEGONING: That's right.

3 MR. ROSEN: In other words, one fails or  
4 two fail and then the rest start to fail.

5 MR. TEGONING: That's right. And when you  
6 get up to the Category 5 we call them in the  
7 elicitation results Category 5 and 6 type LOCAs,  
8 they're large-break LOCAs, manway failures becomes a  
9 contributor to those break sizes. It's still not as  
10 big a contributor as a piping failure, but, yes, it  
11 factors into the final numbers.

12 MR. SHACK: In a sense, are you saying  
13 it's less likely or it's an 18-inch hole?

14 MR. TEGONING: It's less likely.

15 MR. SHACK: Oh, you still think it's less  
16 likely.

17 MR. TEGONING: I don't think so. That's  
18 what --

19 (Laughter.)

20 MR. TEGONING: That's what the elicitation  
21 results --

22 MR. ROSEN: That's what the experts think.

23 MR. TEGONING: That's what the experts  
24 think.

25 MR. ROSEN: Now, it would be wrong, would

1 it not, for me to say that I can buy what the staff  
2 has done by taking a bigger break than the elicitation  
3 because I'm worried about the kind of breaks we just  
4 discussed? That would be double counting it, wouldn't  
5 it, from your point of view? You say you've already  
6 taken into account, and if I were then to say, "Well,  
7 you need more margin because of those kinds of regs,"  
8 that's double counting.

9 MR. TEGONING: Yes. It depends on how you  
10 look at it. If this were -- if we were going to do a  
11 risk-based rule that was primarily going to be based  
12 on development from the elicitation results, you could  
13 argue that it is double counting. However, when you  
14 factor in other considerations, and, again, like Bill  
15 had said, if you don't necessarily believe that the  
16 elicitation may have accurately considered those  
17 things and you want to allow yourself some increased  
18 margin, then it's not necessarily double counting. I  
19 don't want to get into how the staff had used these  
20 because I don't believe they double counted the  
21 results in any way.

22 MR. APOSTOLAKIS: When in doubt, you  
23 should double count.

24 (Laughter.)

25 MR. ROSEN: When in doubt, double count.

1 MR. APOSTOLAKIS: We are regulators.  
2 Defense-in-depth. Would you please proceed.

3 MR. HAMMER: Okay. So, in genera, we  
4 found that they're limited in size at least by the  
5 size of the associated pipe. And they're certainly  
6 not larger, at least we couldn't find anything that  
7 would be larger than the largest attached pipe, which  
8 we'll discuss a little later on, and that becomes a  
9 consideration.

10 There's another type of load, heavy drop  
11 loads that Rob mentioned a little earlier. There has  
12 been some work done on that, and I've got there in the  
13 first bullet there were a couple of studies done back  
14 in the '80s and then more recently with the generic  
15 safety issue. Therein you'll find estimates of  
16 various type of accidents due to load lifts,  
17 frequencies of those types of things that can occur.  
18 And from that they estimate the probability of  
19 occurrence of damage to various safety equipment  
20 that's based on an estimated average number of lifts  
21 that are made at the plants.

22 However, when you look into that, though,  
23 you find that a lot of those lifts are made during  
24 shutdown conditions, so they wouldn't specifically be  
25 of interest to us for this so much. Very few lifts

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1 are made during power operations, and they tend to be  
2 a little lighter. You're not lifting things like  
3 their reactor vessel head and these kinds of things.  
4 So you're not getting into something that looks like  
5 it would be very significant in terms of the  
6 contribution to LOCA, at least at the ten to the minus  
7 five level.

8 Then the other thing that we've spent some  
9 effort on, and Rob can help me here if we want to go  
10 into some great detail about it, because they have  
11 been sponsoring a study on seismically induced LOCAs  
12 over the past few months, and so it is something that  
13 we considered. It wasn't specifically addressed in  
14 the expert elicitation. As you're probably aware, a  
15 seismic event at the ten to the minus fifth per year  
16 frequency is a fairly large magnitude earthquake. It  
17 would vary from plant to plant. Some plants have a  
18 quite a bit higher than the SSE, some a little less.  
19 Less so, I think all of them are probably at least in  
20 the SSE area.

21 And what we found in general is that we  
22 would expect that some plants -- and this is based on  
23 sort of a generic study with some conservative  
24 modeling -- we would expect that some plants might  
25 have a higher failure frequency, especially if they

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1 havE degraded piping. However, what we found was  
2 that, generally, for undegraded piping, we're not  
3 expected to have a significant effect in this  
4 frequency range. And if you have small flaws, it's  
5 essentially equivalent to the undegraded condition.  
6 You're just not affecting the response of the system  
7 or the failure mode for a small flaw. However, for  
8 some larger flaws, and certainly for the worse flaws  
9 that are possible, we would see an unacceptable  
10 increase in failure probabilities.

11 MR. POWERS: This sequence of comments --

12 MR. HAMMER: Now, this is, like I said --

13 MR. POWERS: This sequence of comments  
14 makes -- I mean I'm not -- I'm very confused by it.  
15 It says if I have very tiny flaws, it doesn't affect  
16 the probability, and if I have very big flaws, it does  
17 in a dramatic fashion. There must be then some  
18 intermediate flaw that does affect the distribution.

19 MR. HAMMER: It is actually a multifarious  
20 effect, obviously, and there's a continuum. You could  
21 have varying load levels and various flaw levels, and  
22 it would be, like I said, a multivaried effect. And  
23 it was this area where you could have this spectrum  
24 that we were actually worried about.

25 MR. TEGONING: We explicitly looked at

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1 that. I'm going to just say and then you can jump in,  
2 Bruce, we did a case study, we looked at -- by flaw  
3 sizes here, you specifically mean flaws that you would  
4 leave in due to current Section 11 procedures that you  
5 wouldn't have to repair. So for those types of flaws,  
6 given the nature of the piping, essentially you see no  
7 increase in failure probabilities to those level of  
8 degradation.

9 For worst-case flaws here, what we did is  
10 we actually looked at the Dwayne Arnold safe and  
11 cracking, which is about the worst thing that we've  
12 ever seen in service. Now, obviously, if you evaluate  
13 that extreme, you are going to see big increases in  
14 failure probabilities at that type of -- if that pipe  
15 would have been hit by an earthquake at that time, it  
16 likely -- much greater increase likelihood of rupture.

17 We did do a third thing here that Gary  
18 hasn't captured is we looked at distributions of  
19 damage that are more representative, and where we got  
20 that information is there's quite a bit of information  
21 for IGSCC cracking about the sizes and flaws, types of  
22 flaws that they found when they've gone in and done  
23 these augmented inspections and then they reported  
24 these and then gone ahead and repaired them. So we  
25 looked at those distributions which you would argue,

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1 if anything, are slightly conservative, because these  
2 are flaws that they found and then repaired. And when  
3 you compare undegraded versus degrading for those  
4 types of distributions, you can get up to maybe  
5 quarter of magnitude increase in failure probability.  
6 So still significant but not as significant as you  
7 would get if you looked at these worse-case flaws from  
8 something like a Dwayne Arnold.

9 MR. BISHOP: The point I wanted to make --  
10 this is Bruce Bishop again -- and, again, it's on Page  
11 4 of SECY 04-060, that we did in fact, like Rob said,  
12 we did in fact discuss the rare events like the  
13 seismic events, water hammers and various events like  
14 that. It isn't that we didn't discuss them, it's just  
15 the conclusion was that based on our experience, even  
16 if you have flawed piping, typically, like Rob said,  
17 the failure probabilities can increase by as much as  
18 a factor of ten but not less than a factor of 100 is  
19 what we've seen in all the PFM calculations we've  
20 done, even with degraded piping that has flaws and you  
21 somehow miss those flaws and they continue to grow.

22 The consideration you always have to  
23 remember, though, is what's the probability of that  
24 event occurring during a given year and when you  
25 factor that into it, the only event that really

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1 appears to be significant is the water hammer event  
2 because we do have experience with water hammers  
3 occurring, so the frequency is not 1E to the minus  
4 fifth. It's maybe like 1E to the minus two, in that  
5 range. And when you factor that into it, the net  
6 effect is maybe to double the frequency of the  
7 undegraded piping due to water hammer.

8 So there is an effect there. I know in  
9 the Risk-Informed ISI Program we have in fact run into  
10 situations where that's been the controlling  
11 mechanisms for doing an inspection. So we do take  
12 that into account, but, again, it's not a factor of  
13 ten or 100; it's a factor of two, typically, which we  
14 believe is within the scatter of the estimates to  
15 begin with.

16 MR. APOSTOLAKIS: Well, what is your  
17 bottom line conclusion?

18 MR. POWERS: Nothing that's been said has  
19 helped me at all on these two bullets. It seems to me  
20 that you've got something that must truly have to do  
21 with your probability of detection of flaws. Are the  
22 two bullets telling me you just didn't worry about  
23 that?

24 MR. SHACK: Well, no. You need a  
25 probability of occurrence of flaws too. I mean, you

1 know, the --

2 MR. APOSTOLAKIS: What is the bottom line?

3 MR. SHACK: The probability of occurrence  
4 of flaws in stainless steel PWR piping is pretty low.  
5 So unless the conditional probability of failure is --

6 MR. POWERS: It's adequately done with a  
7 probability of detection, because if it ain't there,  
8 I'm not going to detect it.

9 MR. APOSTOLAKIS: Is your bottom line  
10 conclusion that seismically induced LOCAs will not  
11 change the frequencies?

12 MR. HAMMER: I think the bottom line that  
13 we've kind of come upon right now is that since it's  
14 a flaw sensitivity problem and it becomes an issue of  
15 being able to detect and monitor and take adequate  
16 corrective action for the flaws, as necessary, so what  
17 we're going to do is complete our confirmatory studies  
18 and we'll publish the work that research is currently  
19 got ongoing, and then we'll ultimately issue guidance  
20 on what has to be done for the licensees to ensure --

21 MR. APOSTOLAKIS: I find the last bullet  
22 very strange: Licensees need to ensure inspection.  
23 Well, yes, licensees need to comply with the  
24 regulations, they need to be good guys. I don't know  
25 what it means in the context of revising the rule.

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1 They need to ensure inspection plans are adequate. Is  
2 there any possibility that they don't need to ensure  
3 that?

4 MR. HAMMER: This isn't really in the  
5 context of existing regulations so much. There might  
6 be necessary improvements to the inspection plans in  
7 order to ensure that you don't have a break larger  
8 than --

9 MR. APOSTOLAKIS: I don't understand this.

10 MR. WALLIS: How did this consideration  
11 affect your choice of pipe size?

12 MR. APOSTOLAKIS: Right, exactly. That's  
13 the question.

14 MR. HAMMER: Well, what we would argue is  
15 that specifically for the seismic consideration we  
16 really wouldn't have a specific consideration on the  
17 TBS because of the way this has fallen out. And I  
18 think, see, if you have undegraded piping, then you  
19 don't have a significant effect. It's really these  
20 levels of degradation that we're worried about, and we  
21 want to be able to detect them and then that sort of  
22 eliminates it as a large consideration.

23 MR. WALLIS: Well, certainly, the experts  
24 when they did their work looked at the probability of  
25 flaws in pipes?

1 MR. APOSTOLAKIS: No, because they didn't  
2 consider seismic --

3 MR. WALLIS: Not with seismic but when  
4 they did their other --

5 MR. APOSTOLAKIS: Oh, the other stuff,  
6 yes.

7 MR. WALLIS: So you should be doing the  
8 same sort of thing.

9 MR. TEGONING: I think the point we're  
10 trying to make here is if you have a TBS of like 14  
11 inches or 20 inches, seismic considerations are not  
12 expected to be significant with that transition break  
13 size. However, if we would have used the elicitation  
14 results as they stood, six inch, ten inch, then  
15 seismic would have had likely a much more significant  
16 -- would have had a more significant risk  
17 contribution.

18 MR. POWERS: And it seems to me they're  
19 going on and saying, "We're coming to this conclusion  
20 and we're not going to consider degradation of that  
21 piping in coming to that conclusion because it's the  
22 small sizes that don't affect it and the big ones  
23 we're going to detect and fix."

24 MR. APOSTOLAKIS: That's right.

25 MR. POWERS: Ergo the bottom line.

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1 MR. APOSTOLAKIS: That's right.

2 MR. TEGONING: That's right.

3 MR. POWERS: It seems to me it would have  
4 been easier to say on the slide than --

5 MR. WALLIS: Is that what that says?

6 MR. POWERS: Yes. That's what that says.  
7 We're going to blow off piping degradation and we're  
8 going to cover it on our In-Service Inspection  
9 Program.

10 MR. APOSTOLAKIS: We're not going to cover  
11 seismic events.

12 MR. POWERS: I think that's what it says.

13 MR. APOSTOLAKIS: This confirms again that  
14 you can't separate all this stuff from the final  
15 decision, and the final decision is define the TBS,  
16 what does that do to you, what does it do to the plant  
17 and so on? Because I mean in the deterministic world,  
18 you assume the biggest pipe breaks, you cover  
19 everything, small flaws, large flaws, whatever. Now  
20 that you want to be risk-informed, you have to agonize  
21 over all these things.

22 MR. HARRISON: Dr. Apostolakis?

23 MR. APOSTOLAKIS: Yes.

24 MR. HARRISON: My name is Wayne Harrison.  
25 I'm going to speak for the rest of my group later on

1 today but I want to put on my South Texas project  
2 licensee hat and speak to that last bullet. I think  
3 from the comment, the licensees would tell you that  
4 inspection plans and in-service inspections and so  
5 forth are designed such that we expect to find flaws  
6 such that we have no breaks. And we don't say no  
7 breaks larger than the transition break size. We're  
8 looking for any flaws and it's not dependent upon the  
9 size.

10 MR. APOSTOLAKIS: The whole point of the  
11 DBAs was to give you -- it was really an  
12 implementation of defense-in-depth, right? So, yes,  
13 we'll do the best we can not to have flaws and this  
14 and that, but in case the largest pipe breaks, here's  
15 what you have to do. Now you go to this conformed  
16 world and all of a sudden things change.

17 CHAIRMAN BONACA: What about this summer?  
18 This summer had the crack right through, I mean we  
19 didn't see it. I mean they didn't see it. I wasn't  
20 there.

21 MR. RANSOM: You'd have seen it.

22 MR. SHACK: Well, I think it does impact  
23 the notion of a risk-informed inspection because in a  
24 risk-informed inspection the largest diameter pipe  
25 always falls out of the inspection plan because it

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1 doesn't contribute to risk. The inspections of the  
2 largest pipes are always defense-in-depth inspections.

3 MR. APOSTOLAKIS: Right.

4 MR. SHACK: And you're saying that you  
5 need those defense-in-depth inspections essentially to  
6 maintain your confidence in your assumptions here. So  
7 you do want to watch the argument that when you go  
8 through your risk-informed inspection plan you put  
9 some floor on it that covers your defense-in-depth  
10 considerations for this large-diameter pipe.

11 CHAIRMAN BONACA: That's right. And those  
12 are provisions that -- why don't we move to the water  
13 hammer? We just heard that that's a much more likely  
14 event.

15 MR. HAMMER: All right. Yes, on water  
16 hammer we --

17 MR. APOSTOLAKIS: Well, Mr. Chairman, what  
18 do you want to do? I mean we're behind here.

19 CHAIRMAN BONACA: Well, I think we have to  
20 hear this. I think --

21 MR. APOSTOLAKIS: No, we'll hear it but do  
22 you want to continue until we're done or stop?

23 CHAIRMAN BONACA: I think so. Let's try  
24 to see if we can do it by 10:30, around 20 minutes.

25 MR. HAMMER: Okay. On water hammer, it's

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1 another consideration that we wanted to take, and  
2 we're talking only about the primary system and the  
3 breaks that could occur there. So while there have  
4 been a lot of water hammers in other systems, you  
5 don't expect water hammers to occur during normal  
6 operation because the system is filled with water.  
7 There aren't voids, things of that nature that can  
8 normally occur. However, during a small-break LOCA  
9 accident, there is a scenario that we were considering  
10 that would involve condensation-induced water hammer  
11 involving a situation where during the small-break  
12 LOCA the water level drops below the top of the hot  
13 coal legs and gives you a squatter steam interface.  
14 Then due to the cold injection water, you would form  
15 a slug which would then trap a void and a classical  
16 condensation induced water hammer scenario.

17 It's possible that you could get very  
18 large pressures from such an event which might rupture  
19 a pipe, which could create a bigger LOCA, so this was  
20 of particular interest to us in that regard. This was  
21 reported in the NUREG CR 3895. Professor Griffith  
22 from MIT did some scale model testing and showed that  
23 the effect was possible.

24 In operating plants, we think it's  
25 actually in a narrow range of small-break LOCAs. It's

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1 plant-specific somewhat in that regard, and, like I  
2 said, it requires a level drop amp in combination with  
3 having a high enough pressure to drive the slug with  
4 some large velocity.

5 So what we would like to do on this is  
6 develop some screening criteria that we would provide  
7 to the licensees in a reg guide, and this would allow  
8 licensees, hopefully, to demonstrate that they're not  
9 susceptible to this type of event.

10 MR. WALLIS: What I heard from an expert  
11 behind me was that this could double the frequency of  
12 pipe breaks? It seems to me -- I'm surprised that  
13 you're not focusing on that. You seem to be focusing  
14 on what licensees need to do. That doesn't sort of  
15 affect the choice of transition break size, does it?  
16 The water hammer doubles the frequency. Maybe that  
17 affects my choice of transition break size.

18 MR. BISHOP: That information came from  
19 work that was done for the pipes. My contribution to  
20 the Expert Panel was to take the results that were  
21 based on seven plants that had done risk-informed ISI  
22 studies and in several plants where there might be a  
23 possibility of a water hammer and some degradation  
24 going on simultaneously, that increased the frequency  
25 by about a factor of two and that would be high

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1 enough, okay, that we would go out and do an  
2 inspection to make sure that there is either no  
3 degradation going on or we would make corrections  
4 consistent with what you were saying, okay, to  
5 eliminate the water hammer or reduce the probability  
6 of having a water hammer.

7 MR. WALLIS: So what you're saying is if  
8 the licensees do certain things, then we don't need to  
9 worry about certain increases in this frequency. Is  
10 that what we're learning here?

11 MR. APOSTOLAKIS: I guess now I don't  
12 understand what the DBA means anymore. I really  
13 don't. We're defining a frequency. We said anything  
14 below that, I mean a diameter corresponding to a  
15 frequency, will be treated as a DBA, traditional or  
16 Appendix K analysis. But since we're not sure about  
17 the frequency, we will also establish some programs  
18 and so on to make sure that flaws don't exist and all  
19 that. What's the idea of a DBA then? I mean what is  
20 the idea of doing all this conservative analysis for  
21 diameters smaller than that? Now the program becomes  
22 an essential part of the regulation, and Regulatory  
23 Guide 1.174 says that defense-in-depth means no  
24 excessive reliance on programmatic activities, right?  
25 That's one of the first bullets.

1 MR. BARRETT: George, this is Rich Barrett  
2 again.

3 MR. APOSTOLAKIS: Yes.

4 MR. BARRETT: I think that I don't believe  
5 it would be considered excessive reliance on  
6 programmatic activities if you were to take into  
7 account programs that are part of the licensing basis  
8 of these plants and programs that are in fact being  
9 implemented every day in the plants. I mean we do,  
10 whether tacitly or explicitly, we do rely in all of  
11 our regulations on in-service inspection, in-service  
12 testing as a way of assuring that the licensing basis  
13 is maintained throughout the life of the plant.

14 I think what we're doing here, and I think  
15 this is a very important point that we probably  
16 haven't made, and that is that this whole rulemaking  
17 is a set of incremental steps. When we enact this  
18 rule it's an enabling rule, and that has certain  
19 implications. It will take away certain fetters on  
20 the licensees in terms of what they can propose to the  
21 staff, in terms of changes to the design and operation  
22 of the plant, but it will not in and of itself make  
23 any changes to the design and operation of the plant.  
24 So the question is do we have a sufficient -- and this  
25 is a legal question -- do we have a sufficient

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1 technical basis to justify the action that we are  
2 taking in publishing this as a proposed rule?

3 This is a first step to propose and enact  
4 an enabling rule. The second step is for a licensee  
5 to adopt the rule, and then there's a whole set of  
6 third steps which are for that licensee to propose  
7 specific changes in the operation and design of the  
8 plant. And that's what risk-informed licensing  
9 process, by and large, which may or may not involve  
10 generic involvement on the part of owners' groups and  
11 others. So we're talking here about having sufficient  
12 basis to enact an enabling rule.

13 That basis is in the selection of this  
14 transition break size, which, in effect, does define  
15 the limit of the design basis accident, is, first of  
16 all, the elicitation process, which included some  
17 phenomena but not others. And then the consideration  
18 of other phenomena, some of which are sufficiently  
19 well understood but they do not affect transition  
20 break size, others of which, seismic and water hammer,  
21 will involve some statement on the part of the  
22 licensee at the point in which they adopt the rule,  
23 some statement as to whether or not they fall within  
24 the parameters that would make them acceptable.

25 Now, what are those parameters? For water

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1 hammer and for seismic, those parameters are you have  
2 to be -- those screening criteria are yet to be  
3 defined and will be in the reg guide. What we're  
4 doing here is we're simply stating what are the  
5 technical concerns that are still open? Now, the  
6 technical concerns are these larger than some  
7 threshold flaws which could affect the seismic  
8 capability for some plants in high seismic zones.  
9 Those concerns may in fact be resolved by the  
10 conformity research work that continues, but they may  
11 not be.

12 MR. APOSTOLAKIS: But if I take all the  
13 probability of these flaws and fold them into the  
14 analysis, would I come up with a break. The frequency  
15 of ten to the minus five per year would lead to a  
16 larger diameter? Because this is conditional on the  
17 flaws existing, right? If the flaws are large, then  
18 you get this condition. If I take the probability of  
19 the division of the flaw sizes, won't that affect the  
20 choice of the diameter? You say no.

21 MR. BARRETT: Yes.

22 MR. APOSTOLAKIS: Wouldn't that be a  
23 better argument and then say this is our best judgment  
24 now, and on top of it we're going to make sure there  
25 will a program to make sure that the flaw sizes will

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1 remain small rather than say we are relying on the  
2 program?

3 MR. BARRETT: Well, we would --

4 MR. APOSTOLAKIS: The probability is a  
5 risk-informed thing. Because the thing that bothers  
6 me a little bit in the whole logic of the thing is  
7 that I see the current large-break DBA, LOCA DBA as  
8 the ultimate defense-in-depth. If everything else is  
9 wrong, we really don't know what we're doing, and you  
10 have this big break and you have conservatism all over  
11 the place, so now when we become risk-informed, we're  
12 going to say, but now this is not the ultimate  
13 protection. This is now -- if this program is good  
14 and if that program is good, then it's okay. And  
15 there is a philosophical question there with what  
16 defense-in-depth means anymore.

17 MR. BARRETT: Well, I would say it  
18 differently. In the case of the water hammer, we're  
19 asking licensees to describe for us the  
20 characteristics of the plant, and if you wanted to go  
21 into detail, we have someone here who can talk about  
22 the characteristics of a plant such that they would or  
23 would not susceptible to this particular water hammer.

24 And there may be plants that are  
25 susceptible and cannot reference this rule, but we



1 believe that, by and large, plants will be able to  
2 reference this rule and will be able to pass these  
3 screening criteria. In the case of the seismic, I  
4 think our feeling is that when Research, when the  
5 Office of Research continues this that they're doing  
6 and when they begin to do it in a more realistic  
7 fashion, and I hope Rob is shaking his head yes, that  
8 this issue may in fact not be as big an issue as it  
9 appears to be right now. But we don't want to put a  
10 proposed rule out based on that assumption. So at the  
11 moment, we feel that in order to publish a proposed  
12 rule and to be reasonably certain that all of these  
13 issues are covered, we're putting this interface  
14 requirement in there so that a licensee has to address  
15 it.

16 MR. WALLIS: Well, Rich, what you seem to  
17 be saying is if the plant cannot prove that they won't  
18 have a water hammer, then they can't use this  
19 transition break size. That's extraordinarily  
20 difficult because there are all kinds of ways to get  
21 water hammer. This is one way. I don't think that  
22 should be in the rule at all. Water hammers have  
23 already been considered in the elicitation. You can't  
24 now put something on top of that. What it said was if  
25 they can't show that they don't have a water hammer,

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1 they can't use the transition break sizes.

2 MR. LANDRY: Graham, Ralph Landry from the  
3 staff. That's really not what we're saying here. We  
4 have to separate two different water hammer effects.  
5 One is the water hammer that can induce a break, and  
6 what we're talking about here is a water hammer caused  
7 because you've had a break. Now, this is a very  
8 narrow range that we're talking about here. You  
9 already had a small-break LOCA and now you have to  
10 have very specific conditions prevail which will allow  
11 a condensation-induced water hammer to then occur --

12 MR. WALLIS: To make a bigger break?

13 MR. LANDRY: -- to make a bigger break  
14 than what you already have.

15 MR. WALLIS: But then if they can't show  
16 this, they can't use a transition break size?

17 MR. LANDRY: Well, they would have to look  
18 at the screening criteria and determine are they  
19 susceptible to a condensation-induced LOCA.

20 MR. WALLIS: When you put cold water into  
21 a hot system with steam in it, there are all sorts of  
22 ways you might conceivably create a water hammer.

23 MR. LANDRY: But this is looking at the  
24 condensation-induced water hammer in the cold leg.  
25 Now, the screening criteria are going to be very

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1 specific. You have to have a very particular break  
2 size such that you have a water level in the pipe.  
3 You can't have a completely voided pipe, and you  
4 cannot have a water-solid pipe.

5 You also have to have the system pressure  
6 high enough that when you create the water hammer, the  
7 pressure to the water hammer is sufficient to cause  
8 damage. And that is typically going to be at least  
9 ten to 20 atmospheres and above. You're also going to  
10 have to have a very specific velocity range for the  
11 fluid in the pipe and you're also going to have to  
12 have a pipe L over D ratio high enough --

13 MR. WALLIS: I understand what you're  
14 saying if you can show that. I'm just concerned about  
15 this holding up the use of the transition break size  
16 for some licensee.

17 MR. LANDRY: No. We're saying that a  
18 licensee that wants to use the transition break size  
19 can look at the screening criteria and determine do  
20 these screening criteria include their plant or do  
21 they exclude their plant? Now, if they include their  
22 plant, what is the probability of this precise break  
23 size occurring? Now, it's only on a very, very narrow  
24 range of break size. It's not over the whole break  
25 size range.

1 MR. WALLIS: Okay. So your anticipation  
2 is that they'll be able to show that they meet this  
3 criteria.

4 MR. LANDRY: Yes.

5 MR. WALLIS: Okay.

6 MR. APOSTOLAKIS: Okay. So can we move on  
7 now to the actual selection?

8 MR. HAMMER: I'll try to move along as  
9 fast as I can.

10 MR. APOSTOLAKIS: And please don't go line  
11 by line.

12 CHAIRMAN BONACA: We're way beyond time,  
13 so let's get to the selection process.

14 MR. HARRISON: Dr. Apostolakis? I just  
15 want to make real brief in one of the key points that  
16 we're going to make when the Westinghouse Group speaks  
17 -- this is Wayne Harrison again. I just wanted to  
18 address your defense-in-depth and we need to keep in  
19 front of us that we still have to be able to, from a  
20 risk-informed perspective, be able to mitigate the  
21 event all the way up for breaks beyond the transition  
22 break size up to the double-ended. So we need to keep  
23 that in front us too. The defense-in-depth is still  
24 there for us.

25 MR. APOSTOLAKIS: Can you please not go

1 over these line by line. What is the important  
2 message of this slide?

3 MR. HAMMER: All right.

4 MR. APOSTOLAKIS: It's 14 for PWRs, 20 for  
5 BWRs.

6 MR. HAMMER: Let me try to condense it  
7 down. I think the last time we discussed this with  
8 you fellows was back in late October and we had told  
9 you then that we had picked some TBS sizes of 14  
10 inches for PWRs, 20 inches for BWRs, and this includes  
11 necessary adjustments that we felt like were needed  
12 for uncertainties, and it includes the pipes of most  
13 concern, which are the attached pipes. And,  
14 specifically, we wanted to consider the pressurizer  
15 surge lines which have a lot of thermal fatigue and  
16 BWR feedwater lines which have more significant flow  
17 accelerated corrosion. And so we felt like we  
18 captured that by picking those sizes. And the next  
19 larger sizes are the --

20 MR. SHACK: But, again, those were  
21 specifically considered in the elicitation.

22 MR. HAMMER: Yes, they were, Bill, but you  
23 could argue that a 14-inch pipe is not a 14-inch pipe  
24 is not a 14-inch pipe. Indeed a 14-inch pipe might  
25 have more degradation because of some specific

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1 environmental consideration, such as fatigue, than a  
2 size in that range maybe compared to a ten-inch pipe.

3 MR. SHACK: Well, I meant but a  
4 pressurized surge line, they did a system-by-system  
5 analysis, and the surge line didn't come up  
6 particularly high, I suspect because although you're  
7 going to get thermal fatigue, it's hard to rupture a  
8 pipe. You can get cracks, you can get failures, and  
9 they're different.

10 MR. HAMMER: Right. I guess we're  
11 attempting to capture some variation from the average  
12 based on specific piping that we know about.

13 MR. APOSTOLAKIS: But thermal fatigue has  
14 caused piping failures in the past.

15 MR. WALLIS: But not surge lines.

16 MR. APOSTOLAKIS: What kind of failure  
17 occurred there. I don't remember whether the whole  
18 thing broke or whether there was a --

19 CHAIRMAN BONACA: They got a big one.

20 MR. WALLIS: Right.

21 MR. HAMMER: Right. Okay. The next  
22 larger pipe --

23 MR. WALLIS: I don't understand this,  
24 though. This is a preliminary TBS strategy? You're  
25 not going to argue forcefully for a certain value

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1 today or is that coming up in the next presentation?

2 MR. HAMMER: It's coming up.

3 MR. WALLIS: It's coming up in the next  
4 presentation?

5 CHAIRMAN BONACA: We'll see. We'll see.

6 MR. WALLIS: I'm concerned about this  
7 being preliminary.

8 MR. HAMMER: Next slide. We're attempting  
9 to finalize what we're doing. So we're selecting the  
10 TBS as the largest size, large pipe attached to the  
11 main loop. For PWRs, this is fairly easy to define.  
12 It usually comes up as the surge line, and you've got  
13 a well defined hot and cold leg, which are very big  
14 pipes. For BWRs, you have a maze of piping and not a  
15 very well defined loop. The loop essentially goes  
16 outside containment through a steam cycle and back  
17 through the feedwater. You also have a loop of a very  
18 large pipe in the recirculation loop. So it looked  
19 like a logical definition for BWRs would be the  
20 largest of either the RHR or the feedwater pipes  
21 inside containment. And that's around 20 inches.

22 MR. APOSTOLAKIS: What does the last  
23 bullet mean, TBS is actually defined?

24 MR. HAMMER: Okay. Because the  
25 elicitation results that you saw earlier in the curve

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1 are in terms of pipe diameter --

2 MR. APOSTOLAKIS: Yes.

3 MR. HAMMER: -- and the TBS is more a  
4 concept of flow of area as we want to apply it in the  
5 rule. And this --

6 MR. APOSTOLAKIS: Let me follow the logic  
7 here. Six to ten was the original, you picked 14.  
8 Then what is the rule going to say? It's going to  
9 give a flow rate?

10 CHAIRMAN BONACA: Double-ended break of  
11 the 14-inch.

12 MR. HAMMER: It will essentially give you  
13 a flow area based on that size pipe, times two.

14 MR. APOSTOLAKIS: So you take the 14-inch  
15 diameter, you find the equivalent area and then you  
16 double it and do what?

17 MR. SHERON: Now, George, let me -- if I  
18 could explain. The way this works is that you pick --  
19 there's an artificiality still about this. We pick  
20 the largest pipe, let's say it's 12 inches, 14 inches.

21 MR. APOSTOLAKIS: Right.

22 MR. SHERON: When the licensee has to  
23 analyze for that break, they have to postulate that  
24 break occurring around the loop. And so what they  
25 have to assume is they have to find the worst

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1 location. So they have to assume a break in the cold  
2 leg of that size, which is the equivalent of 12  
3 inches. Well, what you get is an offset. You're  
4 assuming that the pipe still has a guillotine rupture  
5 but doesn't completely offset. It offsets such that  
6 the area for discharge, okay, coming out of both ends  
7 of the pipe is the equivalent of 12 inches diameter.  
8 So you have twice that area for discharge.  
9 Understand?

10 MR. WALLIS: Seems to be a strange  
11 rationale? You've already learned that big pipes  
12 don't break and now you're going to assume that they  
13 have a 20-inch hole in them? It's a very strange  
14 rationale. I would think that you'd consider the  
15 small pipes to break and do all that stuff. But then  
16 saying that the big pipes that you've proven are not  
17 going to break are now going to have a 20-inch hole in  
18 them seems a very strange extrapolation.

19 MR. HAMMER: Well, you can get a little  
20 lost in trying to come up with the mechanistic  
21 argument like that about why would there be a hole  
22 here or there or some other place. Essentially, it  
23 comes from breaking in a double-ended guillotine  
24 fashion a pipe of this size.

25 MR. WALLIS: But what the expert said is

1 a ten to the minus seven chance of the main piping  
2 breaking. Didn't they include in that it having a 20-  
3 inch hole in it?

4 MR. TEGONING: Well, again, partial  
5 failures of bigger piping is included in the smaller  
6 break diameter frequencies.

7 MR. WALLIS: But it's not a big  
8 contributor to that smaller break diameter.

9 MR. TEGONING: It depends on the plant.  
10 It depends on the plant and the expert. For BWRs,  
11 actually, if you look, the main partial failures of  
12 the recent piping was a significant contribution for  
13 smaller pipe failures, yes.

14 MR. WALLIS: Is it in PWRs?

15 MR. TEGONING: Not as significant for  
16 PWRs, but for BWRs --

17 MR. WALLIS: Really, a 20-inch hole in the  
18 main circulation piping is a contributor?

19 MR. TEGONING: It can be.

20 MR. WALLIS: Okay.

21 MR. TEGONING: Again, when you're looking  
22 at characterizing a break size, given that you've got  
23 -- I mean these, again, are large ruptures. Again,  
24 there's a good bit of uncertainty if that large  
25 rupture is going to result in double-ended guillotine

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1 break versus a 20-inch hole.

2 MR. WALLIS: Well, that's what bothers me,  
3 this uncertainty. Then it's likely to me.

4 MR. ROSEN: This is very troubling to me.  
5 I don't understand this.

6 MR. SHERON: There is an amount of  
7 defense-in-depth, let me call it non-mechanistic here.  
8 One way we could have defined this is we should have  
9 said -- we could have said you break the largest pipes  
10 -- you break the pipes that are attached to the  
11 primary coolant, which means you would only postulate  
12 a 12-inch break in the hot leg. The break you would  
13 postulate in the cold leg would only encompass maybe  
14 an RHR drop line or whatever, smaller size. You would  
15 not be postulating -- and the hot leg break is not the  
16 limiting break, typically, for a pressurized water  
17 reactor as an example. So you would be defining a  
18 break that is much, much smaller.

19 In other words, the Commission told us to  
20 pick the break size at the ten to the minus -- as a  
21 starting point, ten to the minus fifth, but they  
22 didn't say take it to the point where you only  
23 postulate a hot leg break of a surge line and a cold  
24 leg of a drop line and the like. We still interpreted  
25 that to mean that we should still be requiring

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1 licensees to look at that break being promulgated  
2 around the loop to find the worst location. It's an  
3 artificiality, it's a defense-in-depth, if you want to  
4 call it that.

5 Another way you could interpret it, I mean  
6 as George said I think at the Subcommittee meeting,  
7 you could take this best estimate approach and just  
8 apply it through the whole spectrum, okay? Why pick  
9 a transition break size?

10 The only difference really is the degree  
11 of conservatism that goes into the analysis model.  
12 Again, as Wayne said, regardless of what break size  
13 you pick, the system is still required to mitigate it.  
14 The only thing that's going to be different is that  
15 for the larger or the lower probability breaks, you  
16 will not have as much margin in those mitigating  
17 systems that you currently have. That's the only  
18 difference. But you still will have a system that has  
19 been analyzed and capable of mitigating the event.  
20 What you're not assuming is that you have 20 percent  
21 on decay heat, that you had a single act of failure  
22 that occurred. You're still assuming that you have a  
23 loss of off-site power, for example. You don't have  
24 the highest peaking factor at the same time you have  
25 the highest burnup. It's that kind of margin.

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1 MR. APOSTOLAKIS: I think we're going to  
2 come back to this the rest of the day. On 14, the  
3 next slide, the only bullet that maybe you want to  
4 mention is the first one.

5 MR. HAMMER: Okay. And we talked about  
6 that a little earlier about the power uprate condition  
7 effects.

8 MR. APOSTOLAKIS: Okay. So then we  
9 covered it. Thank you very much.

10 CHAIRMAN BONACA: Well, we haven't covered  
11 it enough, okay? Because this is dear to my heart.  
12 I want to hear about this and that. This rule is  
13 going to lead to power uprates and I'm trying to  
14 understand how they're going to control this. I would  
15 like to listen and hear about this.

16 MR. HAMMER: Yes. And we think that there  
17 will be a need for licensees to explain why their  
18 future uprate conditions don't significantly affect  
19 break frequencies. That's the key thing.

20 CHAIRMAN BONACA: That's the whole  
21 resolution. Just ask them and they will tell you.

22 MR. SHERON: No. It's required that they  
23 will be required -- as Rick said before, once a  
24 licensee decides to use this rule and make a change to  
25 their plant including an uprate, obviously they need

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1 to get a license amendment to go to a higher power  
2 level. That license amendment has to be reviewed by  
3 the staff. Part of the staff review, and will  
4 probably be incorporated in the reg guide, will be  
5 that they need to look and say what conditions in the  
6 plant have changed such that they are now outside the  
7 bounds, for example, of the parameters in the expert  
8 elicitation. If there are things like temperatures,  
9 pressures, whatever, that go beyond what was assumed  
10 in the expert elicitation, we are requiring the  
11 licensee's application to do a detailed analysis of  
12 what that means with regard to how that might affect  
13 the break frequency.

14 MR. WALLIS: How can they do that?

15 CHAIRMAN BONACA: The power uprate rule,  
16 though, is not --

17 MR. SHERON: At higher temperatures, you  
18 may be more --

19 MR. WALLIS: How can they do that? Then  
20 they have to convent the same Expert Panel? The  
21 Expert Panel doesn't give a formula for calculating  
22 these frequencies. How is the licensee supposed to  
23 calculate them?

24 MR. BARRETT: I think that realistically  
25 what you're going to find is that if, for instance,

1 PWRs decide to use the latitude provided by this rule  
2 to start proposing power uprates, it's probably going  
3 to have some sort of an owner's group effort in which  
4 they would look at the elicitation, look at the  
5 current inspection, inspection requirements, any new  
6 kinds of limitations they would like to put on the  
7 inspection requirements. This is something that would  
8 be looked at generically by the staff, I'm sure, with  
9 full participation by the ACRS. This would be a  
10 license amendment process that would start with some  
11 sort of a generic -- I think that would be the case.

12 MR. BISHOP: Somebody asked the question  
13 about how would you assess -- the way the Expert Panel  
14 did this, okay, is the break frequencies are driven by  
15 the degradation mechanisms, and you look at the  
16 potential degradation mechanisms and certainly if you  
17 have stress corrosion cracking which is very  
18 temperature dependent and you're changing the  
19 temperature, obviously that would factor in. If  
20 you're limited by some sort of vibration phenomenon or  
21 something like that and you're increasing the flow  
22 rate, okay, obviously that's an evaluation you can do  
23 to say would that have a chance of taking break  
24 frequencies?

25 But when we were doing this we also -- we

1 took the degradation mechanisms we knew and then  
2 somebody pointed out, okay, but we typically get a new  
3 degradation mechanism about every seven years, so we  
4 tried to put factors into the Expert Panel because I  
5 know we discussed this, how do you account for that?  
6 So there are factors, typically at least a factor of  
7 two, I would say, factored into that already to  
8 account for the next unknown degradation mechanism  
9 where you don't even know what the effects might be.

10 So I think a little bit of that is already  
11 considered in that allowance, and we know that I think  
12 most panel members that were familiar with plant  
13 experience knew that, okay, we are going to be making  
14 changes in the operating conditions, that we're going  
15 to be going to plant uprates, and I think put an  
16 allowance in there for some of that to occur. Now, if  
17 it was adequate or not is another question, but I  
18 think at least it was discussed and considered by the  
19 Expert Panel members.

20 MR. APOSTOLAKIS: When somebody requests  
21 some application for a power uprate, can you ask for  
22 this kind of thing -- can you bring risk into it?

23 MR. SHERON: Yes.

24 MR. APOSTOLAKIS: Frequency?

25 MR. SHERON: Yes. It's 1.174 and we



1 issued a risk 2001-02, which I just happened to have  
2 read last night. And if you remember, that emanated  
3 out of the Calloway situation with Electrosleeving,  
4 and what we did is we told -- in the risk, we told the  
5 industry that there -- basically, it says there are  
6 two conditions for assuring adequate protection. One  
7 is presumption that you meet the Commission's rules  
8 and regulation. The other is no undo risk. And the  
9 staff has the authority and obligation to ask  
10 questions about risk. Even if all the rules and  
11 regulations are being met, we can still ask questions  
12 about risk on that.

13 MR. KRESS: Let me ask a philosophical  
14 question about that second sub-bullet. It seems to me  
15 like you've developed a sort of generic distribution  
16 for frequencies of pop rank sizes, and now you're  
17 asking a specific plant to alter that generic  
18 distribution based on something he's going to do. But  
19 how do we know that specific plant has that  
20 distribution in the first place? It's a generic one.  
21 We're not even asking him to say, "Look at this  
22 generic distribution and say now does this generic  
23 distribution apply to your plant?" There seems to be  
24 a disconnect in going from generic distribution to a  
25 plant-specific application of that generic

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1 distribution, and I'm not quite sure I understand how  
2 that's dealt with.

3 MR. WALLIS: That's why they have the  
4 bottom bullet.

5 MR. BARRETT: Well, I think that could be  
6 a step in the reg guide, couldn't it, where it says in  
7 the reg guide that the first thing the plant has to do  
8 is come in and say that the generic distribution is  
9 valid for their plant for these reasons.

10 MR. SHERON: And the other thing, by the  
11 way, is that we have already had a meeting with the  
12 industry a couple weeks ago and I believe they're  
13 taking on the initiative of developing an evaluation  
14 guide, and I would strongly imagine that they would  
15 want to address this in their evaluation guide. In  
16 other words, they would propose to develop some method  
17 for showing how the licensee would evaluate or propose  
18 a method that they would evaluate the effect of an  
19 uprate on the pipe frequency. And we would obviously  
20 be interacting with them in the development of that.

21 MR. BARRETT: These are important  
22 questions, and this is the reason the rule is written  
23 the way it is. The actual rule has in it a prescribed  
24 change process and incorporates in it the criteria,  
25 very similar to Reg Guide 1.174 in which is a risk-

1 informed process will be used for the review of these  
2 proposed changes. This is the first step and do we  
3 believe there's an adequate technical basis for this  
4 first step, which is the enabling rule? I think the  
5 answer is yes.

6 CHAIRMAN BONACA: Okay. Thank you.

7 MR. HAMMER: Well, let me summarize real  
8 quickly.

9 MR. APOSTOLAKIS: No, please.

10 (Laughter.)

11 MR. APOSTOLAKIS: We understand what's  
12 going on.

13 CHAIRMAN BONACA: Yes. Thank you very  
14 much. We'll take a break now until the five of 11 and  
15 then start again. We're running about 40 minutes  
16 late. We have to try to catch up.

17 (Whereupon, the foregoing matter went off  
18 the record at 10:42 a.m. and went back on  
19 the record at 10:57 a.m.)

20 CHAIRMAN BONACA: Okay, let's get back  
21 into session and we have the second part of the  
22 presentation which has to do with the proposed rule  
23 for risk-informing 10 CFR 50.46. This time Dr. Shack  
24 is really the lead and the other time I was wrong.  
25 And you have a schedule, if you could try to stay

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1 within those times. That will push the meeting to  
2 about 12:30 whatever, to that point.

3 MR. SHACK: We will stay within --

4 CHAIRMAN BONACA: Thank you.

5 MR. COLLINS: That was a directive, I take  
6 it. I may begin then?

7 MR. SHACK: Yes.

8 MR. COLLINS: My name is Tim Collins and  
9 I'm with the Office of NRR and I'm here to discuss how  
10 the proposed rule conforms with the Commission's SRM.  
11 There's no -- you've asked for this presentation,  
12 right? I understand that you all have copies of the  
13 SRM? Okay.

14 What I intend to do is walk through it,  
15 paragraph by paragraph, and discuss basically what we  
16 saw as the key points in each paragraph and how the  
17 rule packages addresses each of those key points.

18 So the first paragraph basically says go  
19 do a rule and get it done in six months. Well, we're  
20 trying to meet that six month schedule by the end of  
21 December to get the package to the Commission.

22 Second paragraph. The key messages that  
23 we saw in this paragraph were that we should use the  
24 estimates from the Expert Elicitation Panel in  
25 conjunction with other relevant information in

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1 determining a transition break size. That we should  
2 look for a break size that corresponds to a frequency  
3 of about  $10^{-5}$  for reactor year, that we should require  
4 the use of a Reg. Guide 1.74 approach with emphasis on  
5 the word "require" and that breaks larger than the  
6 transition break size should not be treated as design  
7 basis exits.

8 I think it's clear from the previous  
9 presentation that we took into account the expert  
10 elicitation process and other considerations. We also  
11 tried to stay in the range of break sizes that  
12 corresponded to  $10^{-5}$ , that will be a point that will  
13 be debated forever, I expect.

14 As regards the use of Reg. Guide 1.174  
15 approach, we've assured its use by including the  
16 criteria and the guidance from Reg. Guide 1.174 right  
17 in the rule. And sometimes in the rule we use what I  
18 call a modified version of Reg. Guide 1.174 criteria.  
19 For example, we use efficiently small for the criteria  
20 for changes in CDF and LERF when the Reg. Guide  
21 actually has plots of CDF versus baseline. We didn't  
22 think we wanted to put plots in the rule.

23 MR. SHACK: Now, why did you feel that was  
24 necessary to put that in the rule?

25 MR. COLLINS: To put the --

1 MR. SHACK: The Reg. Guide 174 process  
2 type as a rule rather than -- you know, it's an  
3 enabling rule when they come in and propose a change.

4 MR. COLLINS: Right.

5 MR. SHACK: You know.

6 MR. COLLINS: Well, I point to the  
7 language in the SRM. The second sentence in the  
8 second paragraph says "the staff should use or require  
9 the licensees to use the approach and guidance in Reg.  
10 Guide 1.174." So we say require the licensee, well,  
11 that means put it in the rule. That's why we did it.

12 MR. SHERON: The other reason too, I  
13 think, and I'm probably practicing law without a  
14 license right now, but my understanding is that you  
15 know, in a regulation you have to put certain  
16 requirements as opposed to we can't sit there and rely  
17 on Reg. Guides and then go off and regulate via the  
18 Reg. Guides. Okay?

19 If you remember on 50.55A we ran into that  
20 problem where we were endorsing code cases in a Reg.  
21 Guide and the attorneys basically said that is de  
22 facto, you are implementing -- you're changing a rule  
23 without going through the Administrative Procedures  
24 Act and a rulemaking process. So we can no longer --  
25 I mean we can endorse code cases to a Reg. Guide, but

1 licensees still have to come in and get individual  
2 approval from the Staff. They can't just use them  
3 like they can the rest of the ASME code until that  
4 Reg. Guide is incorporated in 50.55A in that footnote.  
5 And I think it's the same type of logic that we have  
6 to put the criteria in the regulation.

7 MR. COLLINS: There's also some things in  
8 the third paragraph, the SRM encouraged us to put the  
9 Reg. Guide 1.174 in the rule as well which I'm going  
10 to get to now and unless there are other questions on  
11 paragraph 2.

12 MR. POWERS: Well, the paragraph dealing  
13 with  $10^{-5}$  probability it seems to cause the most  
14 heartburn. You have used the expert elicitation plus  
15 other relevant information. And you end up with a  
16 qualitative change in the approach in that you're  
17 focusing on piping hanging off the main coolant  
18 system. And then with a somewhat large break size  
19 than I would derive from the expert elicitation, but  
20 you can maybe argue that, based on the things that the  
21 elicitees did not consider.

22 Then you toss on that the double flow area  
23 on top of that. Doesn't that cause a little heart  
24 burn with the spirit of the SRM?

25 MR. COLLINS: It depends on which heart

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1 you're talking about. Some of the people think that  
2 we're too conservative. Others think we're not  
3 conservative enough.

4 I think this is one of the main reasons we  
5 need to get this out for public comment, so people can  
6 give us their opinions on have we gone too far, have  
7 we not gone far enough?

8 MR. POWERS: Well, I guess I'm under -- I  
9 guess what I'm trying to understand is why your  
10 selection plus the double flow area, that combination  
11 of things you think is consistent with the idea of  
12 something like  $10^{-5}$  and the expert elicitation?

13 MR. COLLINS: We believe that the expert  
14 elicitation provides a broad range of values that you  
15 could argue are  $10^{-5}$ . Remember, we're looking for --  
16 what we really want is the mean of the LOCA frequency  
17 from all contributors. What we have is the mean of  
18 the subjective judgment in the elicitation process for  
19 some fraction of the contributors.

20 Now we have to turn that into a value of  
21  $10^{-5}$  as the mean value for all contributors. And the  
22 real mean frequency, not just the mean of the experts'  
23 judgment. So we're not sure how to do that, okay?  
24 The most important considerations that we have in all  
25 of this process are got to maintain adequate

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1 protection of the health and safety of the public. We  
2 have to maintain stability in the regulatory process.  
3 Those are the most important things we have to do in  
4 this whole thing.

5 And since we don't know how to do an exact  
6 association with this  $10^{-5}$  mean value, we have to do  
7 the best we can and that's what we tried to do.

8 MR. POWERS: I mean what you see from the  
9 expert elicitation in broad view is that the  
10 probability of rupture kind of is about the same for  
11 range of pipe size up until you get somewhere around  
12 6 to 10 inches, somewhere around there and then it  
13 starts dropping off fairly sharply.

14 And that leads you to say okay, well, it's  
15 these pipes hanging off the main coolant system and so  
16 let's focus our attention there.

17 And everything is fine up to this point.  
18 We got a range. I can always find those pipes, one of  
19 them that will fit somebody's -- some expert's range  
20 and throw a little uncertainty on it to us, a few  
21 epistemics and alliatories in there and you got one of  
22 those pipes.

23 Then you go on and you say yeah, but I'm  
24 going to actually specify this as double the flow area  
25 which seems to come out of the blue some place.

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1 MR. COLLINS: It's not quite out of the  
2 blue. The Commission did say that we should continue  
3 to use the existing requirements for design basis  
4 breaks. And that is the implementation practice for  
5 existing design basis breaks.

6 MR. SHACK: But you could have used  
7 equivalent hole sizes from the elicitation than  
8 corresponding to the double flow area. I mean what  
9 they gave you was essentially a flow area -- they  
10 expressed it in terms of a diameter in the  
11 elicitation.

12 MR. WALLIS: Did they use a single throw  
13 area?

14 MR. SHACK: That is a six-inch diameter  
15 flow area.

16 MR. WALLIS: That was not clear when we  
17 were showing these figures this morning or maybe I  
18 didn't listen clearly enough, but I assume that when  
19 a pipe breaks it breaks into two pieces and that there  
20 are two ends to it.

21 MR. SHACK: They weren't looking at pipe  
22 breaks. They were looking at flow size.

23 MR. WALLIS: But it says here break  
24 diameter 10 inches and a pipe breaks, it has two ends.

25 MR. SHACK: On the other hand, Graham, it

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1 could be a big pipe --

2 MR. POWERS: If I'm going to break a surge  
3 line, I'm really not going to care about the flow out  
4 of one of the other ends.

5 MR. WALLIS: So when it says threshold  
6 break diameter, what does that mean? Does it mean a  
7 pipe which breaks in two or is it an area they're  
8 talking about? Or did the experts know?

9 MR. SHACK: It's a hole size.

10 MR. WALLIS: It's a whole size, so in a  
11 break --

12 MR. SHACK: Here's one of the experts --

13 MR. WALLIS: It's  $\pi r^2$ .

14 MR. BISHOP: This is Bruce Bishop. We had  
15 a lot of discussion on this and one of the things we  
16 decided after all the discussion is that all those  
17 frequencies and break corresponds because there was a  
18 break size and a flow rate because some people felt  
19 more comfortable estimating frequencies based on flow  
20 rates.

21 Other people with a PRA background felt  
22 more comfortable on the break size. And so the flow  
23 rates were always given for double-ended breaks to be  
24 consistent all the way down from small -- from the  
25 smallest break LOCA to the largest break LOCA.

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1                   So the frequencies always corresponded to  
2                   a double-ended break size.

3                   MR. WALLIS:     So it's double ended.  
4                   There's no argument about double-ended.

5                   MR. BISHOP:   The expert panel -- that's  
6                   what the expert panel considered in their frequency  
7                   estimates.

8                   MR. WALLIS:   It makes a factor of 2  
9                   difference.   It seems to be important to understand  
10                  that.

11                  MR. DENNING:   The other thing I don't  
12                  understand is when we look for the worst break  
13                  location, we recognize that could occur in one of the  
14                  large pipes and then we artificially give it the  
15                  double area in one of the large pipes.

16                  MR. WALLIS:   If it's in the search line,  
17                  as my colleague points out, you don't really care  
18                  about what's coming from the pressurizer.

19                  MR. DENNING:   No, no, I agree.   But what  
20                  I was thinking when I heard that they were talking  
21                  about looking at the largest pipes to, but not  
22                  including the big main coolant pipes, I was thinking  
23                  we were excluding those from breaks at all, but we're  
24                  not.   When we look for the worst area, the worst  
25                  location, we're going to take it and it could be in

1 the main coolant pipe and we're going to give it twice  
2 the area.

3 MR. LANDRY: This is Ralph Landry from the  
4 Staff again.

5 Graham, we do care what's coming from both  
6 ends of the pipe if it's a pressurizer surge line  
7 because you have primary coolant on both ends of the  
8 pipe. The pressurizer holds 2,000 cubic feet of  
9 primary coolant, so you do care.

10 MR. WALLIS: You've lost that. You've  
11 lost it all.

12 MR. LANDRY: When you take it as a double-  
13 ended guillotine rupture of a surge line, you're going  
14 to lose it. It is was a pipe such as an ECC line  
15 which did not have primary coolant from both  
16 directions, you would only care what was coming out  
17 one end, but when you look at a surge line, you do  
18 care what's coming out of both ends because you're  
19 losing inventory.

20 MR. WALLIS: You've lost the inventory  
21 from the pressurizer as soon as you've broken that  
22 pipe. You only care about how it comes out.

23 MR. LANDRY: You haven't lost it  
24 instantaneously. If it's a small pipe break, you're  
25 going to lose it, but that does affect the transient.

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1 MR. WALLIS: Yes, it does, but you've  
2 essentially lost all the stuff in the pressurizer when  
3 you break the pipe. It's never going to get back into  
4 it.

5 MR. LANDRY: That's correct.

6 MR. ROSEN: And it has effects on the  
7 containment response.

8 MR. LANDRY: Right.

9 MR. POWERS: These seem to be a very -- I  
10 don't argue with any of the comments, but it seems a  
11 peculiar way to -- I mean it seems to me, you're going  
12 to have a challenge in doing it this way to claim that  
13 you're in compliance with the clear language of the  
14 SRM.

15 MR. WALLIS: Well, the SRM says nothing  
16 about double-ended or single-ended, does it?

17 MR. POWERS: What it says is maintain the  
18 standards of the way -- something -- the way we've  
19 done it in the past. But it seems that they made a  
20 qualitative leap here.

21 MR. COLLINS: And I admire the leap. I've  
22 got no troubles with the leap, but it seems to me that  
23 that leads to a different way of evaluating things  
24 just to -- in the name of realism.

25 MR. SHERON: If I could just add a little,

1 in terms of the Staff's thought process, okay? If you  
2 remember, I think we told you that one of our ground  
3 rules in trying to get a rule out in six months was  
4 that we were not going to forge any new ground in  
5 terms of methods or create new data or anything and  
6 what we decided here was that in picking this break  
7 size, this transition break size, okay, and then  
8 looking at how the licensees would analyze breaks  
9 above this transition break size, we basically said  
10 we're going to keep everything the same. In other  
11 words, we would expect that they would analyze it the  
12 same way they do breaks currently.

13 All we've done is we've made the breaks,  
14 that design basis break size a little smaller, but for  
15 going above it, it's just going to be the same way.  
16 We will assume a double-ended guillotine. Obviously,  
17 if we had more time, we could have thought this  
18 through.

19 We could have said, can I assume, that  
20 these breaks will manifest themselves only as splits,  
21 you know, in the pipe so it's only a one-ended, it's  
22 a one-sided break, you might say.

23 Do you postulate it on the top of the  
24 pipe, on the bottom, you know, on the side? That has  
25 big effects, at least on the smaller size breaks when

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1 you have separated flow.

2 MR. SHACK: Let me take a different  
3 approach. I mean the reason we're changing this rule  
4 at all is we think there's some benefit to changing it  
5 and you know, are we going to maximize the benefits  
6 from changing the rule by picking the largest  
7 transition break size we can possibly justify rather  
8 than a somewhat smaller transition break size.

9 Go back to the leak before LOCA break. We  
10 had all sorts of uncertainties in whether we'd have  
11 pipe breaks, but everybody agreed -- as John O'Brien  
12 used to say we had those evil pipe restraints, you  
13 know. But the uncertainties we had in the pipe break  
14 frequencies didn't bother us too much. We went ahead  
15 and did leak before break and gave them relief from  
16 that.

17 It doesn't seem to be any thought in this  
18 thing of kind of maximizing the benefit we're going to  
19 get from the rule.

20 CHAIRMAN BONACA: But what kind of benefit  
21 are you talking about?

22 MR. SHERON: Well, first off, I would  
23 point out that we didn't pick the largest break size  
24 that we could justify. I mean we didn't go into it  
25 with that approach. We went in and we said what is a

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1 break size that we feel we can technically defend at  
2 this time, based on all the information we have in  
3 front of us and the fact that we have a limited period  
4 of time in which we can develop this justification and  
5 you heard that this morning.

6 MR. SHACK: I would argue like Dana, it  
7 seems to me that you've somehow interpreted this to  
8 really come up at the highest possible end of the  
9 break size as you could get out of the elicitation.

10 MR. SHERON: I think we would have a hard  
11 time. I mean we could be in here talking about an  
12 eight-inch break and then we'd probably be asking,  
13 quite honestly, a lot of questions about what about  
14 this, what about that? Why didn't you pick this?

15 MR. ROSEN: You can't win. You can start  
16 with that premise.

17 (Laughter.)

18 MR. SHERON: What I would point out is  
19 that at the last meeting we had with the industry, I  
20 mean one of the challenges we gave them is we said --  
21 because I think you'll hear later this morning that  
22 they would believe that there should be a smaller  
23 transition break size.

24 The question we have put to them is what  
25 is the safety benefit that is derived from a smaller

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1 transition break size. Okay? Instead of analyzing a  
2 12-inch break, you analyze an 8-inch break using a  
3 best estimate model, okay? What does that buy you?  
4 We don't know. We have no information right now from  
5 the industry in terms of what is that safety benefit?  
6 How will they use that? All right?

7 If they use it and they say you know,  
8 we're going to show you that the risk is going to go  
9 way down or qualitatively we're going to make the  
10 plants a lot safer, I think the Staff might be very  
11 receptive to say yes, if picking a smaller transition  
12 break size makes the plant safer, overall, we're  
13 receptive to it. If picking a smaller transition  
14 break size just says that they're going to crank out  
15 more megawatts and make more money, we're not that  
16 receptive. That's put in a nutshell.

17 CHAIRMAN BONACA: That's why they asked  
18 that question about what benefits.

19 MR. SHERON: We put a number out there, as  
20 Tim said, we want to get this rule out there. We want  
21 to get comments in from all the stakeholders. We want  
22 to hear what the benefits are, what the detriments  
23 might be and then you know we'll decide if it needs to  
24 be changed.

25 MR. APOSTOLAKIS: But it's not the largest

1 possible. I mean they still have to worry about the  
2 incompleteness of the expert.

3 CHAIRMAN BONACA: Absolutely.

4 MR. SHACK: We went through the arguments  
5 there. We kind of agreed the active LOCAs weren't a  
6 big deal. The seismic LOCA, I've got  $10^{-5}$  for my  
7 occurrence. I have to have a crack in the first  
8 place. That's another probability. By the time I  
9 multiply those probabilities together I'm not sure  
10 that I've thrown a whole lot away there. It seemed to  
11 me -- you can always argue over just how good -- an  
12 elicitation is only an elicitation. If we had the  
13 truth, we wouldn't be eliciting.

14 MR. APOSTOLAKIS: But you have to add some  
15 defense-in-depth, right?

16 MR. SHACK: We have defense-in-depth. We  
17 are going to mitigate all pipe breaks.

18 MR. APOSTOLAKIS: So you are saying  
19 defense-in-depth on the frequencies are not necessary?

20 MR. SHACK: You know, if we were going to  
21 say there was going to be nothing beyond the  
22 transition break size, I have a transition break size  
23 that looked about 48 inches, you know.

24 (Laughter.)

25 But since you are going to mitigate

1 everything --

2 CHAIRMAN BONACA: We don't know exactly  
3 how we're going to mitigate it.

4 MR. APOSTOLAKIS: It's the perennial  
5 question of how much defense-in-depth is enough?

6 MR. SHACK: I don't want to hold up the  
7 discussion here too much.

8 MR. APOSTOLAKIS: But that's the heart of  
9 the matter.

10 MR. ROSEN: And how many of the things,  
11 the classic things we've done for mitigation are we  
12 going to do? Are we going to continue to do all of  
13 those things as well as we always have done them in  
14 the past?

15 MR. SHACK: I would be willing to mitigate  
16 -- I'm always willing to -- if I'm sure that what I'm  
17 doing actually adds to my safety. The reason we're  
18 doing this rule in the first place, I think, is at  
19 least there's a conviction that this doesn't  
20 necessarily lead to an optimum safety status for the  
21 plant, the current rule with the large break as it  
22 stands.

23 MR. APOSTOLAKIS: I think it reduces the  
24 burden of licensees in some areas and in some cases --

25 MR. SHACK: That's another argument for

1 it.

2 That's okay. We don't mind --

3 CHAIRMAN BONACA: I don't have a problem  
4 with that. I am asking you to distinguish on the  
5 benefit because our task is one of focusing on the  
6 safety issue.

7 MR. SHACK: I'm only working on decreasing  
8 overall risk.

9 MR. WALLIS: I find this all very, very  
10 puzzling because if the whole purpose of this rule is  
11 to optimize the size based on what's the most safety  
12 benefit, then we need to have arguments which justify  
13 that safety benefit and we haven't seen a damn thing  
14 about it.

15 MR. SHACK: It's coming. It's coming. We  
16 have a presentation later on.

17 MR. WALLIS: We haven't seen anything  
18 qualitative about --

19 MR. APOSTOLAKIS: We will, we will.

20 CHAIRMAN BONACA: Correct.

21 MR. APOSTOLAKIS: Not quantitative.

22 CHAIRMAN BONACA: Maybe we will, if we  
23 have the time, right?

24 (Laughter.)

25 MR. APOSTOLAKIS: By 10 o'clock tonight,

1 that's very important.

2 (Laughter.)

3 MR. COLLINS: So now we can go to the  
4 third one.

5 MR. APOSTOLAKIS: Should we have that?

6 MR. COLLINS: Those are my notes. The  
7 third paragraph. It says number 3.

8 MR. APOSTOLAKIS: Number 3 is the third?

9 MR. COLLINS: Yes, number 3 is the third.

10 (Laughter.)

11 MR. ROSEN: Are you going to tell us about  
12 the security thing?

13 MR. APOSTOLAKIS: Let the man proceed.

14 CHAIRMAN BONACA: Let's go.

15 MR. COLLINS: On paragraph number three.  
16 We think the key points in this paragraph, that the  
17 rule should not be narrowly focused and the scope of  
18 changes allowed should not be limited in any way  
19 except as to meet the safety principles of Reg. Guide  
20 1.174 and to maintain security capabilities. We think  
21 this paragraph is pretty clear and we didn't  
22 intentionally, at any rate, preclude any particular  
23 type of change in the rule.

24 We addressed the requirement to constrain  
25 in areas needed to satisfy the safety principles of

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1 1.174 in the most direct way we could think of. We  
2 put them right in the rule. This is what I made  
3 reference to earlier.

4 As far as security is concerned, we sent  
5 a memo to the Commission in October, October 22nd, I  
6 believe it was that where we stated that we thought  
7 that security considerations could be better handled  
8 on a more global basis, since the need to review  
9 security impacts any change you make to the plant, not  
10 just those that are associated with this voluntary  
11 alternative rule. So we thought that that ought to be  
12 handled more globally elsewhere and we haven't  
13 included anything in this package to specifically  
14 address security.

15 MR. ROSEN: So there's no language in the  
16 rule that addresses security?

17 MR. COLLINS: That's right.

18 MR. ROSEN: That's consistent with what we  
19 did with the operator manual actions thing in fire  
20 protection area.

21 MR. SHERON: Let me explain that we do  
22 address security. We will address it, I should say,  
23 as part of any change and that is that we have -- we  
24 are putting in place a process right now where we will  
25 have a screening criteria developed, so any license

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1 amendment that comes in, whether it's related to 5046  
2 or something else, will be screened, first by the  
3 project manager.

4 If it trips any of the screening criteria  
5 that are developed, then it will go to a special  
6 committee which Ms. Brach chairs, Safety Security  
7 Interface Advisory Panel. And that is also staffed  
8 with members from MENSUR and they will make a  
9 determination as to whether a proposed change could  
10 affect plant security or whether -- and vice versa,  
11 actually, whether a security-related change might  
12 affect plant safety.

13 If they believe it does, then it will get  
14 a much more thorough security or safety review from  
15 that aspect. In other words, the Staff will make a  
16 very considered decision on its acceptability based on  
17 security considerations as well as safety.

18 MR. ROSEN: I think that's a good plant.

19 MR. SHERON: So we have a process in place  
20 to catch all that and 5046 changes will fall under  
21 that.

22 MR. ROSEN: A most unfortunate acronym  
23 though.

24 MR. SHERON: It's an unpronounceable  
25 acronym.



1 MR. ROSEN: ASAP?

2 MR. SHERON: How do you pronounce it?

3 (Laughter.)

4 MR. ROSEN: I thought it was intended to  
5 be unpronounceable. Anyway, I think that's a good  
6 plan. It puts it all in the right -- all in one place  
7 for whatever application, with the people who are  
8 involved, who have knowledge of the topic.

9 MR. SHERON: And we also, as Tim said, we  
10 told the Commission that it may be more appropriate if  
11 we want to actually codify this in the regulation, it  
12 may be better, in for example, either 5059 or 5073 or  
13 part 73, I mean. And we said we would take a look at  
14 that.

15 MR. ROSEN: Good thank you.

16 MR. COLLINS: Next paragraph, paragraph 4,  
17 comes after 3. The key points in 4, you see the  
18 mitigation capabilities for beyond TBS LOCAs should  
19 still be required, but should be relaxed relative to  
20 the design basis events.

21 Mitigation capabilities for beyond TBS and  
22 changes to them should be controlled by the NRC, but  
23 the level of control should be graded based on safety  
24 significance. That's the way we read this paragraph.

25 What we did in the rule, I think it's

1 clear that we require mitigation, all the way up to  
2 the double-ended guillotine break and I think it's  
3 clear that the requirements we have are related  
4 relative to the DBA. There's no single failure  
5 requirement, no loss of off-site power requirement.

6 By the way, Brian may have misspoke  
7 earlier. He said that it still required loss of off-  
8 site power. Beyond TBS, we do not require loss of  
9 off-site power.

10 MR. SHACK: I thought there was a last-  
11 minute revision to the rule.

12 (Laughter.)

13 MR. APOSTOLAKIS: That the Committee had  
14 not seen.

15 MR. COLLINS: We allow the use of  
16 nonsafety-grade equipment. There's no specific  
17 modeling or input requirements and the acceptance  
18 criteria, the last proscriptive. Just coolable  
19 geometry.

20 MR. APOSTOLAKIS: I wonder whether we  
21 should keep using the words design basis events after  
22 we do all these things. Now we are beginning to  
23 dilute the meaning of DBA, aren't we?

24 MR. COLLINS: Abandoning the concept of a  
25 DBA for regulatory purposes would not be a bad thing,

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1 George.

2 MR. APOSTOLAKIS: As you have argued in  
3 the past. But really, this is a first step, is it  
4 not? It says you do certain things beyond design  
5 basis. We control not by voluntary means and all  
6 that, so we're beginning the dilution process, which  
7 is -- I'm not saying it's bad. But it makes -- so the  
8 whole issue here is whether we want the license --

9 MR. COLLINS: Dilution has a pejorative --

10 MR. APOSTOLAKIS: Sorry?

11 MR. COLLINS: Dilution has a pejorative  
12 sound to it, George.

13 MR. APOSTOLAKIS: And who says I didn't  
14 want to have that?

15 MR. POWERS: The challenge, George, that  
16 you face is your PRA technology has to be upgraded  
17 very, very substantially.

18 MR. APOSTOLAKIS: I am very busy these  
19 days, but --

20 MR. POWERS: I'm being generous in my  
21 vocabulary today.

22 MR. APOSTOLAKIS: All right.

23 MR. WALLIS: While you're on paragraph 4,  
24 these capabilities for beyond design basis, the  
25 mitigation capabilities, that's all left to a Reg.

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1 Guide?

2 MR. COLLINS: Yes, pretty much.

3 MR. WALLIS: Mitigation capabilities are  
4 commensurate with safety significance is all going to  
5 be spelled out in a Reg. Guide?

6 MR. COLLINS: Yes.

7 MR. WALLIS: It's going to be explained  
8 commensurate with the safety significance?

9 MR. COLLINS: Yes, that's correct. We've  
10 reflected in the Statement of Considerations how we  
11 are relaxing requirements, no single failure  
12 requirement, no loss of off-site power requirement,  
13 nonsafety grade equipment can be credited in the  
14 analysis. We don't specify -- there's not required  
15 input models for the analysis as there is in Appendix  
16 K. And the acceptance criteria is coolable geometry.

17 MR. WALLIS: I think you have not yet  
18 specified what you can require for mitigation  
19 capabilities that something is going to be worked out,  
20 it's going to be worked out in a rational way based on  
21 requirements commensurate with safety significance.  
22 It needs to be explained in some basis.

23 MR. COLLINS: We have based on what we are  
24 going to require. WE're going to require coolable  
25 geometry. We're going to implement it through

1 guidance --

2 MR. WALLIS: That's a very general thing.

3 MR. COLLINS: Well, that's what we're  
4 requiring. Okay, we're going to implement it through  
5 guidance given in the Reg. Guide which I think is what  
6 you're making reference.

7 MR. WALLIS: I'm saying that that guidance  
8 has not got to be whimsical. It's got to be based on  
9 being commensurate with the safety significance.

10 MR. APOSTOLAKIS: Is that pejorative too?

11 (Laughter.)

12 CHAIRMAN BONACA: Okay. The next  
13 paragraph defines this actually.

14 MR. COLLINS: There's one more item here  
15 in the SRM that I haven't -- yes, it does. Next  
16 paragraph, it's in there.

17 On paragraph 4, there is a requirement  
18 that the NRC controlled changes commensurate with the  
19 safety significance of the changes. And the way we  
20 intend to do that in the rule is to have consequential  
21 changes where licensees may make those without prior  
22 staff approval provided they have a process approved  
23 by the Staff, like in 5069.

24 MR. ROSEN: When you talk about that in  
25 the subcommittee, one of the suggestions which I made

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1 was an annual report of inconsequential changes, has  
2 that been incorporated?

3 MR. COLLINS: I don't think so.

4 MR. ROSEN: Was there a reason it was not  
5 incorporated?

6 MS. MCKENNAH: This is Eileen McKennah  
7 from NRR. At the time -- we have put a section in the  
8 Statement of Considerations that we sent to you where  
9 we discussed this concept and asked for comment as to  
10 the benefit of having the report.

11 We haven't actually modified the rule to  
12 put the language in there, but we're looking -- partly  
13 it's a question of who are the users of that  
14 information because the reports our Staff have access  
15 to the records. Other people may have only access to  
16 the report. So we're asking for the benefit of having  
17 reports of the inconsequential changes.

18 MR. ROSEN: Well, I thought that the  
19 benefit would be that the Staff would have ability to  
20 say no, this change which is inconsequential in this  
21 report, as is reported in the annual report, we don't  
22 think is inconsequential.

23 MS. MCKENNAH: As I say, that is a  
24 possibility, but as I said, since we require  
25 documentation of the changes also, the Staff has

1 access to that information.

2 MR. ROSEN: You don't require that it be  
3 submitted, right?

4 MS. MCKENNAH: That's correct.

5 MR. ROSEN: So you have to go out to each  
6 plant and ask them for what inconsequential changes  
7 are going to be made over the last year and inspect  
8 that.

9 MS. MCKENNAH: If that's what we wanted to  
10 do, yes, yes.

11 MR. COLLINS: We're trying to balance the  
12 level of oversight that's associated with the less  
13 significant items.

14 MR. SHERON: That's consistent with what  
15 we do with 50.59. The licensees make 50.59 changes  
16 and the Staff, but I think the project manager usually  
17 goes out about once a year and does an audit of the  
18 50.59.

19 MR. ROSEN: Does 50.59 no longer require  
20 an annual report?

21 It used to.

22 MR. COLLINS: Eileen?

23 MS. MCKENNAH: Eileen McKennah. It  
24 requires at least a two-year frequency of the reports.

25 MR. ROSEN: Of the written report. But

1 this doesn't.

2 MS. MCKENNAH: That's correct.

3 MR. ROSEN: That's very curious.

4 MS. MCKENNAH: As I said, I think it's  
5 something we really hadn't thought of at the time and  
6 you know -- but we wanted to at least invite the  
7 comment on it and then depending on the comment we may  
8 add that at the final rule stage.

9 MR. ROSEN: Okay.

10 MR. COLLINS: Okay, so changes other than  
11 inconsequential, that is, potentially consequential,  
12 would receive a risk-informed review by the Staff.  
13 And the rigor of that review increases with the  
14 significance of the proposed change, just like 1.174  
15 requires right now.

16 The fifth paragraph? This paragraph  
17 repeats the message of making requirements  
18 commensurate with safety significance and it also  
19 specifies that for the beyond TBS LOCAs, the rules  
20 should include a high level criterion of maintaining  
21 coolable geometry and also that the rules should  
22 include a requirement for containment integrity. And  
23 it also indicates that the capabilities for beyond TBS  
24 should be provided in a performance-based manner,  
25 consistent with the approach taken at 50.69.

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1 And finally, it suggests, depending on how  
2 you read it, that we include a requirement of severe  
3 accident mitigation strategies in the rule.

4 So the rule clearly has the high level  
5 criterion to maintain quanti-coolable geometry, again,  
6 transition break sizes, and it also has a specific  
7 containment integrity requirement.

8 And we believe that the acceptance  
9 criteria of coolable geometry is, in fact,  
10 performance-based. We don't prescribe how it's to be  
11 met. You can use nonsafety equipment. You can use  
12 realistic analysis methods. You can use realistic  
13 inputs, best estimate inputs and the licensees can  
14 even propose implementation criteria for coolable  
15 geometry, if they wish.

16 As regards the suggestion on severe  
17 accident mitigation strategies, in developing the  
18 rule, we considered requiring licensees to place  
19 guidance on the mitigation of beyond TBS breaks into  
20 their SAMGs, but when you look at the SAMGs, they  
21 really focus on actions that will be taken by the  
22 control room operators based on direction that they  
23 receive from the technical support center after core  
24 damage has already set in or core damage is imminent.  
25 But we really think the focus of this rule ought to be

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1 on preventing core damage for the beyond TBS breaks.

2 And then for such -- large break LOCA  
3 events are very fast events. And to keep the core  
4 cool you've got to get a lot of water in there really  
5 fast. And if we have to interact with -- the  
6 operators would have to interact with the TSC because  
7 they're using the SAMGs, we just don't think it's  
8 feasible from a time perspective.

9 And so we'd -- there would have to be a  
10 fundamental change to the scope, the philosophy and  
11 the implementation of the SAMGs if we wanted to rely  
12 on them for beyond TBS LOCAs and we just didn't think  
13 that made a lot of sense. So we decided not to do  
14 that.

15 MR. SHERON: The other piece of this, by  
16 the way is that we still have the EPGs in place and  
17 when we look at those, you know and the EPGs, the  
18 emergency procedure guidelines are what the operators  
19 actually use. They're symptom-based, so they do  
20 provide that when we call it, you know, I don't care  
21 how I got this loss of coolant, I'm going to deal with  
22 the symptoms. I'm going to initiate whatever I need  
23 to cool the core.

24 We believe that basically covers that  
25 aspect of accident management, you might say. We look

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1 at those, for example, when licensees do an ECCS  
2 analysis, if they take credit, for example, for  
3 operator actions, we obviously during our review,  
4 convince ourselves that these actions are feasible and  
5 can be taken in the amount of time that's specified.  
6 So they are, in fact, factored into the review, to  
7 some extent.

8 While we didn't exactly, as Tim said, we  
9 didn't see a way we could get to the SAMGs because it  
10 just didn't apply in this case since this action is  
11 still required to be mitigated. We think that we're  
12 covered with the EPGs.

13 MR. SHACK: We'd like to finish in 10  
14 minutes.

15 MR. COLLINS: Paragraph six. Paragraph  
16 six, I think the main message here is just a  
17 reinforcement that the oversight should be  
18 commensurate with the categorization. I don't think  
19 there's anything else new in this paragraph that we  
20 haven't already discussed.

21 So unless you have a specific question on  
22 something in that paragraph, I'll just go right by it.

23 Paragraph seven, I think the key points  
24 here were we should use existing processes where  
25 possible, but if necessary, include a change process

1 in the rule. Except for inconsequential changes, we  
2 use the existing processes of 50.90 and Reg. Guide  
3 1.174. And we've elevated the status of Reg. Guide  
4 1.174 by putting it in the rule, but the process  
5 itself is the same.

6 For inconsequential changes, we couldn't  
7 use 50.59 because in a risk-informed world, 50.59 does  
8 not include acceptance criteria for the metrics that  
9 are used in risk-informed evaluations, things like  
10 delta CDF, delta LERF and important considerations  
11 like how uncertainties are treated and how defense-in-  
12 depth is treated.

13 So we would have either had to change  
14 50.59 as part of this package or just put a process in  
15 this rule and we just put a process in this rule which  
16 basically took off in 50.69 and said licensees use a  
17 Reg. Guide 1.174 type process on your own. If we  
18 approve your process, then you can make your  
19 inconsequential changes without our prior approval.

20 Paragraph eight. This paragraph points  
21 out that regulatory stability should be an important  
22 consideration in the rulemaking. It also says,  
23 however, that if we do need to reverse changes due to  
24 new information or analysis, that backfitting should  
25 not be required and that we ought to make sure that

1 licensees are aware of that.

2 Okay, so we've modified the backfit rule  
3 as part of this package to preclude any reversibility  
4 considerations, to facilitate any reversibility  
5 considerations. And in the selection of the break  
6 size, I don't think the term stability was mentioned,  
7 but that was a major consideration that we had, that  
8 we didn't want to pick a break size which two or three  
9 years down the road we're going to be changing again  
10 because opinions of experts can change.

11 So we built in, I think we built in a  
12 margin to -- with stability on our minds.

13 As far as keeping licensees aware of the  
14 potential for backfitting, I think it's clear in the  
15 rule, it's clear in the SOC and we don't plan to make  
16 phone calls to everyone.

17 Ninth paragraph basically says that the  
18 rule should encourage the use of best estimate  
19 methods, but should not require the use of best  
20 estimate methods. I think it's just generally  
21 understood that the rule is structure that the more  
22 realistic your analysis methods are, the more  
23 flexibility you're going to have in the changes you  
24 want to make. So I don't think we need to go any  
25 further than that.

1 And we have not included any requirements  
2 that you'd have to use best estimate methods, small  
3 breaks, large breaks, any breaks.

4 Paragraph 10 says to risk inform the  
5 operating plants first and do future plants separately  
6 and more closely. Well, we can do anything more  
7 slowly and we're definitely going to risk inform.  
8 This rule does not address anything but operating  
9 plants and if we inadvertently constrain some future  
10 plant condition by what we've done in the operating  
11 plant rule, we can certainly do it in a future plant  
12 rule.

13 MR. APOSTOLAKIS: I'm sorry. On paragraph  
14 seven, it says you should follow the existing  
15 regulations and guidelines and mentions Reg. Guide  
16 1.174.

17 MR. COLLINS: Right.

18 MR. APOSTOLAKIS: In the presentations  
19 we've had and I see we have a whole presentation later  
20 about tracking the cumulative change in risk, 1.174  
21 requires you to be tracking the cumulative period or  
22 risk due to changes, but you are actually requiring  
23 the licensees to track the cumulative changes in the  
24 context of this rule, right?

25 So you are really going beyond what the

1 Commission is saying, aren't you?

2 MR. COLLINS: Well, I don't think so.  
3 Steve, do you want to?

4 MR. DINSMORE: Hi, this is Steve Dinsmore  
5 from the Staff. One way to read 1.174 is that the  
6 cumulative increase from all risk-informed changes  
7 whatsoever should not exceed 1 times  $10^{-5}$ . We  
8 actually interpret that to mean the cumulative risk  
9 increase from any particular set of changes or any set  
10 of related changes. So I think our interpretation is  
11 a little more flexible.

12 I think both interpretations could be  
13 taken from 1.174. The actual individual Reg. Guides  
14 are a little more specific in that they say you should  
15 look at the cumulative risk increase from the related  
16 application.

17 MR. KRESS: So we need to be creative in  
18 how we choose the types of changes we make? Break  
19 them up into smaller and smaller pieces?

20 MR. DINSMORE: No.

21 MR. APOSTOLAKIS: That's the bundling  
22 issue, that you can't really do that. You can't break  
23 it up into many, many pieces.

24 MR. SHACK: Down to five minutes, George.

25 MR. APOSTOLAKIS: What?

1 MR. SHACK: We're down to five minutes.

2 MR. APOSTOLAKIS: For what?

3 MR. SHACK: To finish this.

4 MR. COLLINS: I'm on the last paragraph,  
5 I believe.

6 MR. SHACK: You just may go back again.  
7 We're never sure.

8 MR. COLLINS: This paragraph talks about  
9 separating the loss of off-site power from the less  
10 than TBS breaks and what it would mean here. The  
11 Commission basically says we can do that in a separate  
12 action. So this rule leaves the loss of offsite power  
13 as part of the LOCAs that are less than the transition  
14 break size. Larger than the transition break size, we  
15 can move loss of off-site power. This initiative is  
16 for the design basis accidents.

17 That's my spiel. Are we within the time  
18 frame?

19 MR. SHACK: We're on time. Mr. Bishop, do  
20 you want to make a comment?

21 MR. APOSTOLAKIS: You can't make it from  
22 there.

23 I don't understand, is this a  
24 presentation?

25 MR. SIEBER: No, we are expecting a



1 presentation from Steve Dinsmore and Brian Thomas and  
2 then Mr. Harrison.

3 MR. SHACK: Is this a question or comment  
4 on this presentation or is this the thing we had  
5 scheduled for somewhat later?

6 MR. SIEBER: I'd rather do it later when  
7 we have it scheduled.

8 MR. APOSTOLAKIS: There's no later. Is  
9 there a later?

10 MR. SHACK: Later in this presentation,  
11 series of presentations.

12 MR. DINSMORE: Hi, this is Steve Dinsmore  
13 from the Staff again. How much time do you --

14 MR. SHACK: You have 20 minutes.

15 MR. DINSMORE: Twenty minutes.

16 MR. APOSTOLAKIS: That's a lot.

17 MR. SHACK: We'll have no problems if you  
18 take a little bit less.

19 MR. DINSMORE: Okay. These are two issues  
20 that the ACRS has expressed interest in before and so  
21 we're back to explain it a little more.

22 The two issues are, the first is that the  
23 rule requires the licensee to estimate and track the  
24 cumulative impact on risk of all changes related to  
25 the redefinition of large break LOCA and the second

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1 one which is related, but they're not completely  
2 dependent is the rule prohibits combining the risk  
3 impact of unrelated changes.

4 Now when we do a change in risk impact for  
5 changes, the way you do that is you run the PRA  
6 without the change. You redo the PRA with the change  
7 and you subtract the two. So this slide, you can look  
8 at it over a five-year period. The licensee makes 100  
9 changes. Twenty of them are due to 50.46 and 80 of  
10 them are due to other reasons.

11 After five years, the first bullet says  
12 the change in risk that you're reporting has to  
13 include all 20 changes. The second bullet says you  
14 can't include directly in that change in risk estimate  
15 the other 80 changes. They're indirectly in there so  
16 far as if you improve the risk provide at the plant,  
17 the risk impact to the first 20 would probably be  
18 approved, but you can't directly put them in there.

19 MR. ROSEN: Now is this consistent with  
20 your current practice for people doing 1.174 type  
21 applications? Do you make them go through the same  
22 process?

23 MR. DINSMORE: Yes. Sometimes -- we have  
24 to have confidence that the total impact of all the  
25 related changes are less than  $10^{-5}$ . If we believe

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1 that they don't have to do the calculation every time,  
2 we might not ask them to do the calculation.

3 MR. SHACK: But they have to have a  
4 tracking process?

5 MR. DINSMORE: They would have to be able  
6 to answer the questions we ask.

7 MR. APOSTOLAKIS: But wait, the cumulative  
8 change doesn't have to be less  $10^{-5}$ , does it in the  
9 current applications? Each time you approve, you have  
10 to bundle the related changes and then you say okay,  
11 this now has to be less than  $10^{-5}$ . But in the period  
12 of three years, they request six changes, the sum can  
13 be greater than  $10^{-5}$ . But  $10^{-5}$  is the current  
14 approval.

15 MR. DINSMORE: No. The  $10^{-5}$  is --

16 MR. APOSTOLAKIS: No.

17 MR. DINSMORE: Yes. Let's skip ahead  
18 here.

19 MR. SHACK: He's telling us the practice,  
20 George. You may be telling us the theory.

21 MR. APOSTOLAKIS: Well, what's written in  
22 the guide has to mean something.

23 MR. DINSMORE: Well, this is the cleanest  
24 one. If you look at the one in the middle here,  
25 1.175, in-service testing, the cumulative impact of

1 all the risk-informed IST program changes, initial  
2 approval plus later changes should comply with the  
3 acceptance guidelines.

4 That's cleanly said. The others in the  
5 other guidelines, it's less clear, but that's what  
6 we've been implementing.

7 MR. APOSTOLAKIS: And the acceptance  
8 guideline is  $10^{-5}$ ?

9 MR. DINSMORE: Right, yes.

10 MR. KRESS: It certainly, George, seems to  
11 me like this is an interpretation that the ACRS never  
12 made when we said we like 1.174. I think our  
13 interpretation was that you could have changes as long  
14 as bundled changes didn't exceed the 1.1095 and you  
15 can approach your way up to the limits. And then, as  
16 you approach it, you got more and more trouble trying  
17 to get it in the reg. and that's always been our  
18 interpretation and this is a different interpretation.  
19 I don't know how we arrived at this.

20 MR. DINSMORE: If you look at the first  
21 one here, Reg. Guide 1.174, it says the cumulative  
22 impact of previous changes -- which is what I was kind  
23 of indicating earlier that we could interpret this to  
24 say if you take all your risk-informed changes and you  
25 add them together --

1 MR. KRESS: This just doesn't make much  
2 sense.

3 MR. APOSTOLAKIS: It says available. It  
4 doesn't say that numerically they have to be less than  
5 something.

6 MR. RUBIN: This is Mark Rubin. There may  
7 be a misinterpretation here by limiting cumulative  
8 changes. These are only tightly related activities.  
9 There certainly would be multiple tech spec changes.  
10 Each of them would be  $10^{-5}$  at the maximum allowed  
11 delta. But if you have a program that is very related  
12 --

13 MR. APOSTOLAKIS: Let's stop there. Each  
14 run can be  $10^{-5}$ , so if I have three of them, the total  
15 will be 3 times  $10^{-5}$ ?

16 MR. RUBIN: If each number was at the  
17 limit, say they came in for each -- in practice,  
18 almost never are they at the limit.

19 MR. APOSTOLAKIS: But if they were.

20 MR. RUBIN: If they were.

21 MR. APOSTOLAKIS: A cumulative would be  
22 what?

23 MR. RUBIN: Well, they're not usually  
24 independent, but if they were truly independent, then  
25 it would be 3 times  $10^{-5}$ , but in fact --

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1 MR. APOSTOLAKIS: So this is the way we're  
2 interpreting it?

3 CHAIRMAN BONACA: And I would disagree  
4 with the interpretation. What you're setting here is  
5 a standard that says  $10^{-4}$  is really the goal and I  
6 could be planning on how expanding all my margins  
7 there, if I have  $10^{-5}$  to accomplish a lot of wonderful  
8 things, nothing to do with safety, okay, eroding that  
9 marginal  $10^{-4}$  I think is inconsistent with --

10 MR. KRESS: But you could interpret the  
11 statement that as you approach that limit and needs  
12 more regulatory scrutiny as being a cost benefit  
13 scrutiny, lots of the safety scrutiny, lots of others  
14 things.

15 MR. APOSTOLAKIS: The guide basically says  
16 that --

17 MR. KRESS: It said that because of that  
18 problem.

19 MR. RUBIN: This was discussed extensively  
20 when 1.174 was first put together and we had the same  
21 concern that was just mentioned by the Committee and  
22 we indicated we'd be following it closely and in fact  
23 we're not seeing changes at those limits, but we do  
24 look at the cumulative change of past applications to  
25 give us a sense of where the collective risk of the

1 plant may be changing, may be going to. But the point  
2 Mr. Dinsmore is trying to make is that within specific  
3 very tightly related programs, those programs are  
4 often assessed as a collective bundle of changes. If  
5 it's an IST program that comes in, that will be at a  
6  $10^{-5}$  limit. An ISI program, the ILRT, the type A  
7 tests that -- the test that is done --

8 MR. APOSTOLAKIS: That's consistent with  
9 my view and I think Tom's.

10 MR. KRESS: That's all right.

11 MR. WALLIS: Before we have a debate on  
12 this again, I'd like to say I like the bundling  
13 because we're told that this act is supposed to  
14 improve the risk state of a plant and all you're  
15 arguing about is ways to in-shop to make the risk to  
16 the plant worse. And I thought there ought to be some  
17 incentive for these guys to improve the risk state of  
18 a plant by bundling these changes in some way.

19 MR. KRESS: We're not arguing with that.

20 MR. APOSTOLAKIS: We're not arguing with  
21 that.

22 CHAIRMAN BONACA: It's a license to creep.

23 MR. WALLIS: License to creep, right.

24 MR. APOSTOLAKIS: No, it was never  
25 intended to be that.

1 MR. RUBIN: In fact, all the changes will  
2 be considered as a bundle within the context of  
3 50.46A. So all the changes will be considered as a  
4 group, some may well be safety improvement, some may  
5 be small increases and as a group, we'll be looking at  
6 the cumulative limit that's described as sufficiently  
7 small in the rule.

8 MR. KRESS: Let me ask about bundling.  
9 Does bundling have to be a simultaneous effect?  
10 Suppose I come in with a change that drops my CDF,  
11 delta CDF by 4 times  $10^{-5}$ , decreases it. And then  
12 later on I make a related change, based on the rule  
13 because I'm not going to make all the changes at the  
14 same time and I said this is related. Now I can make  
15 this change and it's going to 4 times  $10^{-5}$  increase  
16 because I've already had this previous change.

17 MR. RUBIN: Well, Mr. Dinsmore actually  
18 has a slide on that later in his presentation.

19 MR. DINSMORE: The rule actually requires  
20 you to combine those two; the rule requires you--

21 MR. KRESS: At the same time.

22 MR. DINSMORE: Cumulative. It requires you  
23 to credit the early -- in this case, if you've made a  
24 risk improvement earlier on but you could not have  
25 made because of 50.46.

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1 MR. KRESS: As long as they're related,  
2 they don't have to be simultaneously or even --

3 MR. RUBIN: That's correct.

4 MR. KRESS: -- close in time.

5 MR. RUBIN: That's correct.

6 MR. DINSMORE: That's right.

7 MR. APOSTOLAKIS: Why didn't you take the  
8 geometric average of all the changes?

9 (Laughter.)

10 CHAIRMAN BONACA: All right, let's move  
11 along.

12 MR. DINSMORE: I think the tech specs that  
13 the control of the cumulative risk increase in tech  
14 specs is that you're not allowed to run them at the  
15 same time. Now, I'm not quite sure where I am.

16 MR. APOSTOLAKIS: Keep going.

17 MR. DINSMORE: Well, this is just a  
18 definition of cumulative change that might answer your  
19 question --

20 MR. KRESS: Let me ask you another  
21 question about cumulative changes. Suppose I have two  
22 changes whose effect on the mean CDF, they're related  
23 changes, and they completely offset each other.

24 All changes within mean CDF are not  
25 equivalent. One of them may have a much bigger effect

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1 on the uncertainty. One of them may an effect on  
2 defense-in-depth, where the other one doesn't. Are  
3 you dealing with all delta CDFs as equivalent to each  
4 other if they're related?

5 MR. DINSMORE: We would deal with the  
6 cumulative impacts so that it would be both --

7 MR. KRESS: You deal with --

8 MR. DINSMORE: -- the earlier change plus  
9 the later one. Normally at this point in time we have  
10 not been. The only time we've been kind of concerned  
11 about the difference in uncertainty is if you're  
12 adding seismic changes to internal event changes.

13 MR. KRESS: So that I could do  
14 programmatic changes to offset the hardware changes?

15 MR. DINSMORE: We --

16 MR. RUBIN: That would not be significant  
17 programmatic changes that would be controlling risk;  
18 that would not be within the context of the guidance  
19 of 174 --

20 MR. KRESS: There not significant if  
21 they're one times  $10^{-5}$ .

22 MR. DINSMORE: Well, that's pretty  
23 significant change in CDF for a change in human  
24 actions.

25 MR. RUBIN: That sort of offsetting change

1 would probably not be well received.

2 MR. SIEBER: Scrutiny, I think.

3 MR. DINSMORE: Well, the reason you do the  
4 delta risk calculation is to compare it to an  
5 acceptance criteria which is generally  $10^{-5}$ . So we  
6 have to know what we're going to compare to that. And  
7 what this second bullet is, or this second set of  
8 bullets is, to do that again you have to calculate a  
9 CDF then you have to -- a before CDF and then an after  
10 CDF.

11 And the way it's set up right now, your  
12 before CDF you would calculate by taking all the  
13 changes out, including the benefits, and all the  
14 minuses. You'd calculate your CDF, you put them all  
15 back in, you'd calculate another CDF, you'd subtract  
16 those two and that's what you're comparing to the  
17 guidelines.

18 MR. KRESS: So this process, to me,  
19 implies that the object of the ruling is to make sure  
20 that the plants don't deviate too far from the current  
21 licensing basis.

22 MR. DINSMORE: Yes, well deviate too far.  
23 The reason the delta CDF risk guideline is there is to  
24 define how far you could deviate without a great deal  
25 of concern. So, it's to track and to monitor the

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1 deviation and try to keep it below a level that would  
2 give us concern.

3 MR. KRESS: So that a very good plant from  
4 the Fed point has a low risk status if you believe  
5 PRA. Is constrained to not make -- it doesn't get any  
6 benefit from that low-risk status.

7 MR. DINSMORE: Well, it does insofar as  
8 it's risk profile is real low and so the changes that  
9 it makes would probably not lead to as large increases  
10 as the plant which was already kind of --

11 MR. RUBIN: Let me supplement that. They  
12 would get full benefit of their lower starting point  
13 for just the point that Mr. Dinsmore indicated, the  
14 charges, hardware, setpoint changes, core power and  
15 thermal limit changes would all be starting from a  
16 much lower quantification, individual cut set  
17 sequences.

18 And the changes to the plant would have  
19 correspondingly lower impacts on risk so they could do  
20 more to the plant to start with than the plant that  
21 was pushing the limits in the first place.

22 MR. KRESS: That's certainly a debatable  
23 point. They're saying that the delta depends on the  
24 absolute value and I'm not so sure I buy that in the  
25 PRA spec.

1 MR. DINSMORE: Well, I said there's some  
2 relation -- but okay, these are the justifications, I  
3 guess there's still some discussion about that so I'll  
4 skip these unless you want to talk about them.

5 I'll just try to define, well, what the  
6 proposed implementation is right now is that they must  
7 estimate and track cumulative changes and risk from  
8 all related changes. Changes that cause cumulative  
9 risk increase to exceed sufficiently small would not  
10 be permitted and if the cumulative increase exceeds  
11 the sufficiently small guidelines following PRA  
12 updates or other changes to the plant.

13 In other words, if you're doing other  
14 stuff out there, and you impact the risk from these  
15 changes, and it excess the sufficiently small  
16 guidelines, the licensees must take appropriate action  
17 which we haven't completely defined yet.

18 MR. KRESS: Are you going to have any  
19 problems with deciding what related to --

20 MR. DINSMORE: Yes.

21 MR. KRESS: I might want to come in and  
22 make a change that could or could not be construed to  
23 be associated with this. I would say I'm going to  
24 leave it -- I'm going to not -- if it's an increase in  
25 CDF, I'm going to put it off somewhere else.

1 MR. RUBIN: At this point, the way we're  
2 viewing it as, as a related change is when you could  
3 not make, if you weren't incorporating the 50.46A  
4 authority.

5 MR. KRESS: Almost any change you can make  
6 as long as you can form the 174 --

7 MR. RUBIN: Most of them we think will be  
8 clear. Some of them will probably be fuzzy.

9 MR. APOSTOLAKIS: The first bullet there,  
10 why not? Will not be allowed. Why not? Isn't the  
11 purpose of all the regulations is to make the plant  
12 safer?

13 MR. RUBIN: Why not is partly because we  
14 don't want to -- when 174 was written, there were  
15 cautions in there. The way the change request was  
16 discussed about allowing plants to create new  
17 vulnerabilities is significant accident sequences.

18 By trading off other risked improvements  
19 to these old -- you didn't want them to create new  
20 vulnerabilities. And because we didn't want them to  
21 create new vulnerabilities, you can't infinitely  
22 trade off pluses with minus. We wanted to control  
23 that. And in 1.174 the control was with every  
24 application we would think about it, but if we thought  
25 it was too great a trade off, in other words you can't

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1 say well, I'm going to increase  $10^{-4}$  in this area  
2 because I can do my decrease to  $10^{-4}$  in some other  
3 area.

4 MR. KRESS: Doesn't this go against what  
5 I just heard, that the plants with low risk status  
6 would benefit greatly because the deltas would be --  
7 they'd make more changes to get the same amount of  
8 delta. Now that seems -- this seems to go against  
9 that because I would like to make some changes to my  
10 plant to get down there so that I can have this  
11 benefit. But you're saying no, no, I'm not going to  
12 let you do that.

13 MR. RUBIN: We're not saying they can't do  
14 it. We think it's a great idea if they want to  
15 improve safety in their plant in a bunch of unrelated  
16 areas. We applaud them for it. As far as this  
17 criteria in the rule, the intent here as Mr. Dinsmore  
18 has indicated was to prevent driving risk up  
19 inordinately in the areas related to 50.46A.

20 We didn't want to create risk outliers.  
21 We don't want to significantly increase the risk  
22 profile in areas that derive from this rule authority.  
23 We think  $10^{-5}$  is a pretty significant delta CDF. It's  
24 the maximum allowed in 174. In fact, significant  
25 changes to the plant that we've been seeing up at this

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1 point usually don't come anywhere near that in many  
2 cases in order of magnitude.

3 So we think there's significant changes to  
4 the plant that can be envisioned, that can be  
5 incorporated without coming anywhere near this limit.  
6 And there will be tradeoffs well within the 50.46  
7 regime that makes sense.

8 As far as unrelated changes, someone wants  
9 to offer substantial -- a new substantial enhancement  
10 improvement in the plant that will drive risk down, in  
11 the later slide Mr. Dinsmore has in his package,  
12 you'll see that we will consider that on a case by  
13 case basis. If a licensee wishes to propose an  
14 unrelated enhancement and use it to tradeoff or buy  
15 some additional 50.46A changes, we'll look at it.

16 It may make a lot of sense in which case  
17 the exemption would be granted. But as a matter of  
18 course, we do want to have an upper limit of  
19 acceptability for the group of 50.46A changes and  
20 that's the E<sup>5</sup>.

21 CHAIRMAN BONACA: I think it makes sense  
22 to me because I could propose to improve significantly  
23 improve the acceptability of the system at the  
24 expenses of my CCA, ECCS system. They are two  
25 different things and I still rely on ACCS, in my



1 judgment, even with the change in the rule for  
2 defense-in-depth.

3 And so this way I'll be trading some  
4 unmeasured defense-in-depth --

5 MR. APOSTOLAKIS: All those goes back to  
6 a point of reference which was the baseline CDF and  
7 LERF at some point, right? And then everything else  
8 is considered a change after that. If I improve my  
9 auxiliary feedwater system and bring it up to the  
10 level of SOC techs --

11 MR. KRESS: You've got a new baseline.

12 MR. APOSTOLAKIS: I have a new baseline.  
13 They don't let me do that. That's not my baseline.  
14 It's a change.

15 MR. DINSMORE: I'm sorry, sir, but  
16 actually you're half right and half not right.

17 (Laughter.)

18 MR. WALLIS: It seems to me we have an  
19 issue here, 1.174, which we can discuss at a last time  
20 and sort it all out.

21 MR. APOSTOLAKIS: What other place? We  
22 have to write our letter.

23 MR. WALLIS: I think that there are bigger  
24 issues than 46A that you've been talking about here.

25 MR. DINSMORE: I think Mr. Rubin got me to

1 this last slide, but I just want to be clear because  
2 it's fairly important when they do the change in risk  
3 calculation they use the current PRA. It's not --  
4 we're not comparing to an old PRA. We're comparing to  
5 the current PRA. They redo the calculation with the  
6 whole set of changes.

7 MR. APOSTOLAKIS: What does cumulative  
8 mean? Cumulative from --

9 MR. DINSMORE: Cumulative from the -- the  
10 cumulative risk increases of all the changes that have  
11 been allowed on your current plant.

12 MR. RUBIN: The calculation is very  
13 simple. You take the most current PRA model. You  
14 take the 50.46A changes out, calculate the CDFs and  
15 LERFs and put them back out and there's your delta.  
16 And we'll be using the most current PRA model to make  
17 the cumulative termination meet the limit. As far as  
18 taking -- getting benefit for unrelated changes as  
19 Steve was starting to point out earlier, you do get a  
20 significant benefit because as you make unrelated  
21 changes, the risk profile of the plant will decrease.

22 Many of the accident sequences that the  
23 systems that are related to 50.46A may also be driven  
24 down. Consequently, the deltas may in many cases be  
25 smaller because of unrelated changes that were made to

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1 the plant. It won't be true in all the cases, but it  
2 will be true in some of the cases. So there will be  
3 some benefit to unrelated changes that will buy them  
4 more authority, more flexibility within the 50.46  
5 arena.

6 MR. SHACK: Thank you very much. We're  
7 going to discuss the regulatory analysis.

8 MR. SHERON: While Brian is getting set  
9 there, I wanted to just give an introduction to this  
10 on the reg. analysis.

11 I wanted to remind the Committee that this  
12 rulemaking is part of a much broader activity in the  
13 Agency which is the implementation, the PRA  
14 implementation plan. If you remember, this is --  
15 there were three options, Option 1, Option 2, Option  
16 3.

17 Option 1 was we continue to process risk-  
18 informed license amendments.

19 Option 2 was we risk-inform the treatment  
20 requirements.

21 And then Option 3 was -- we actually go in  
22 and change part 50 and make the part 50 regulations  
23 risk-informed.

24 And this is actually -- this is that third  
25 option that we're doing here. So when you're looking

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1 at this from the cost benefit or if you want to call  
2 it -- that aspect of it, you need to look at it from  
3 that broader context as well that there is a broad  
4 benefit from risk-informing our regulatory structure  
5 and our regulatory processes that needs to be  
6 considered when looking at just the individual  
7 benefits of a particular rule.

8 MR. THOMAS: I'm Brian Thomas. I'm with  
9 the Financial and Regulatory Analysis Grump in NRR.

10 I think it's important to point out at the  
11 very outset that traditionally when we do reg analysis  
12 we look at all the aspects of the cost and the  
13 benefits that's associated with the proposed  
14 requirements.

15 In this reg analysis, we opted not to do  
16 that and I'll tell you why. Basically, as was said  
17 before, this is an enabling rule, so licensees may  
18 voluntarily choose to apply this rule and they may do  
19 so on a plant-specific basis.

20 For that reason, it's obvious that there  
21 are various aspects of facility design changes,  
22 operational changes that a licensee could get out of  
23 from implementing this rule. And for that reason we  
24 believe that there's a wide variety of uncertainty  
25 that's associated with this rule.

1           The intent of this rule is really to  
2           enable the benefit of giving the licensee operational  
3           flexibility and in so doing, the licensee, as I said,  
4           could implement a wide variety of design and  
5           operational changes. However, we do think that this  
6           rule does contribute to safety.

7           MR. APOSTOLAKIS: As opposed to other  
8           rules?

9           MR. THOMAS: Indirectly contributes to  
10          safety.

11          MR. APOSTOLAKIS: I thought all rules  
12          contributed to safety.

13          MR. THOMAS: The focus of this rule is  
14          primarily flexibility in operations. We're not going  
15          to try to --

16          MR. APOSTOLAKIS: I agree with you.

17          MR. THOMAS: We're not going to try to  
18          quantify the safety contributions with regard to this  
19          and that's --

20          MR. WALLIS: But you are taking measures  
21          to limit the decrease in safety? That's what we've  
22          been talking about for the last half hour.

23          MR. THOMAS: Right.

24          MR. APOSTOLAKIS: The rule itself won't do  
25          anything for safety.

1                   It may or may not. It's a subsequent  
2 request.

3                   MR. THOMAS: From a regulatory analysis  
4 standpoint, we'll get into exactly what's addressed in  
5 the safety space at this point in time.

6                   MR. APOSTOLAKIS: Good.

7                   MR. THOMAS: So the underpinning of this  
8 rule is the flexibility in plant operations. Some of  
9 the operational enhances that has been identified by  
10 industry, specifically the Westinghouse Owners Group,  
11 and keep in mind, we try to build on what's been  
12 identified in our interactions with industry. Some of  
13 those enhancements are power uprates --

14                  MR. WALLIS: Doesn't the first one dwarf  
15 all the others? Maybe -- sure, management helps, but  
16 you're not going to make much money out of diesel  
17 generator start times. You have a huge amount of  
18 power uprate.

19                  MR. THOMAS: Exactly, and that's why the  
20 primary focus of the reg. analysis in this case is on  
21 the economic benefits that come out of power uprates.  
22 The rest of the bullets here, as I said, we'll leave  
23 it up to industry to translate for us what that means  
24 in terms of the economic gain and in terms of safety  
25 improvements.

1 MR. WALLIS: I wouldn't underestimate the  
2 third bullet.

3 MR. THOMAS: Granted, but again, we -- to  
4 look at how you get there, what are the specifics of  
5 a plant application on the part of a licensee that  
6 would get us certain improvements in that area, we did  
7 not get into the details.

8 MR. WALLIS: Very often three is the key  
9 to one.

10 MR. THOMAS: True, true, even though we  
11 felt that the benefits in terms of the economics is so  
12 significant, the dollar figures in terms of cost  
13 savings is so significant that when you talk about  
14 power uprates and extended plant operations to license  
15 renewals, it didn't really warrant that we even go  
16 into the benefits in some of the other areas.

17 If you turn to the next slide, I think I  
18 already talked about this to some extent, safety  
19 benefits will vary on a plant-specific basis.

20 MR. WALLIS: I see that. I think we  
21 should stop saying that this rule is going to improve  
22 safety, although we have a general feeling it will  
23 because we don't have real evidence for that and  
24 you're making it clear that there isn't any.

25 MR. THOMAS: Right. I agree completely.

1 Our interactions with industry, you'll find that  
2 industry will claim that through --

3 MR. WALLIS: There might be some --

4 MR. THOMAS: Deficiencies in operations  
5 that would lead to economies in their operation which  
6 they think can --

7 MR. ROSEN: I think it's unfair to  
8 characterize the safety benefits when we have a  
9 presentation later on that subject. I think it's  
10 unfair now to characterize it.

11 MR. THOMAS: Basically, building on what's  
12 the driver of this being that it's the power uprates  
13 and EDG tech spec changes, the reg analysis, we pretty  
14 much did a simplistic reg analysis, if you will, by  
15 just taking a broad brush approach at what are the  
16 driving dollars, what is the balance in terms of  
17 benefit, in terms of cost savings to the industry?

18 So we used sort of a bounding approach in  
19 our reg analysis due to the uncertainty, due to the  
20 different levels of participation that's anticipated  
21 by licensees and due to not knowing what are the  
22 degrees, the various levels of power uprates to be  
23 achieved on plant specific basis.

24 So basically we assume that all the PWRs  
25 would take advantage of this rule and power uprates



1 would be perceived as a good thing to do, a great  
2 thing to do, very rewarding.

3 On this slide, basically, what you have  
4 before you is just basically our formula for arriving  
5 at the bottom line.

6 MR. ROSEN: But don't you recognize,  
7 Brian, that some plants won't be able to do power  
8 uprates because they'll be limited by secondary side?

9 MR. THOMAS: Yes.

10 MR. ROSEN: You said all 69 plants will do  
11 a power uprate, that's clearly not true.

12 MR. THOMAS: We're assuming that all of  
13 the plants would take advantage of the rule, but we do  
14 have in our backup slides some scenarios which we show  
15 that you would have a number of plants that would  
16 maximize their power uprates application as well an  
17 even lesser number that would have a lower power  
18 uprate application.

19 MR. ROSEN: Some plants will have zero  
20 capability because they're limited by their steam  
21 generators or turbine cycles.

22 CHAIRMAN BONACA: I think with the next  
23 one you're showing that you're evaluating a range, so  
24 --

25 MR. THOMAS: That's right. We have three

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1 scenarios and only one scenario has all the PWRs  
2 participating in using the rule.

3 MR. WALLIS: The numbers are so big that  
4 we don't need to quibble about them too much.

5 MR. THOMAS: That's right. Based on a  
6 formula, again, you see the bottom line as being  
7 significant economic gain. Again, without including  
8 any quantification of safety. We see a --

9 MR. WALLIS: Why is the ROC interested in  
10 economic gains to the industry?

11 MR. APOSTOLAKIS: Because that's what's  
12 required.

13 MR. WALLIS: Is it in its charter?

14 MR. THOMAS: That's right.

15 MR. APOSTOLAKIS: When you do a regulatory  
16 analysis, you have to consider that.

17 The question is why do you have to do a  
18 regulatory analysis?

19 MR. THOMAS: That's right.

20 MR. APOSTOLAKIS: Because it's in the  
21 books.

22 MR. THOMAS: Because it's policy.

23 MR. APOSTOLAKIS: Not because it's  
24 meaningful.

25 MR. WALLIS: It's interesting because --

1 MR. APOSTOLAKIS: This is not meaningful  
2 at all.

3 MR. WALLIS: -- and the cost is to you.

4 MR. THOMAS: This is a voluntary rule and  
5 on the outset we can recognize it's purely economic.  
6 We really --

7 MR. WALLIS: Why don't you do all your  
8 regulation based on economics, it would make a lot of  
9 sense.

10 MR. THOMAS: Here, here.

11 (Laughter.)

12 MR. APOSTOLAKIS: I don't think this means  
13 anything. I'm sorry. I don't think it means  
14 anything. If you want to save time, keep going.

15 MR. SIEBER: Well, you can go to the last  
16 slide.

17 MR. WALLIS: Don't you think \$13 billion  
18 means anything? You come from a rich university and  
19 \$13 billion doesn't mean anything.

20 MR. THOMAS: This is done purely for us to  
21 be in concert with policy.

22 MR. APOSTOLAKIS: That's right.

23 MR. THOMAS: It merely gives us a data  
24 point from which we can judge what's the impact on  
25 society.

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1 MR. WALLIS: I think it means a great deal  
2 because the public is going to think this is why  
3 you're doing it.

4 MR. APOSTOLAKIS: \$700 million into \$13  
5 billion is what? Is it an order of magnitude plus  
6 something?

7 MR. THOMAS: \$13 billion.

8 MR. SHERON: We may be doing this because  
9 I think -- I think there's a legal requirement we have  
10 to do it as part of a rulemaking package.

11 What answer you get is probably anybody's  
12 guess. As Brian said, depending upon what assumptions  
13 you make. We don't know right now what assumptions to  
14 make, you're right. Probably all the plants won't be  
15 able to do a power uprate.

16 I imagine there are other benefits that  
17 they'll get, for example, changes in tech specs where  
18 they don't have to meet rigid requirements, for  
19 example, on accumulator pressures or levels. If  
20 they're out of spec, they don't have to take action  
21 immediately. They might be able to take accumulators  
22 out of service. They can run with three instead of  
23 four, so they don't need to have all four in service  
24 or stuff like that.

25 They may be able to get some relaxation on

1 diesel generator start time. I imagine some licensees  
2 may be able to do flux reduction, so they can get more  
3 life out of their vessel because they'll be able to  
4 get higher peaking factors.

5 We just don't know yet how -- they're  
6 going to have to analyze their own plants and see what  
7 the actual limits are. My guess is some utilities are  
8 going to go in there and they're going to start  
9 jacking up the peaking factor and they're going to run  
10 into a DMBR limit. And then they're going to have  
11 figure out what to do. Or they're going to realize  
12 that they can't get a lot of benefit because they're  
13 still going to be limited by a steam line break in the  
14 containment.

15 We're looking at this from the standpoint  
16 of we believe there are safety benefits that can be  
17 obtained from optimizing a lot of their safety  
18 systems.

19 You shouldn't be picking 600 pounds, for  
20 example, set all the accumulators, okay? Maybe if you  
21 set them you staggered them. At different pressures,  
22 you may wind up that even for small breaks you don't  
23 uncover any small breaks. Right now, you do. You're  
24 limiting small breaks, uncover the core. They may be  
25 able to set accumulators so that for any small break

1 you don't uncover the core. I think that's a benefit.  
2 So I think there's a lot to be seen.

3 MR. APOSTOLAKIS: How sensitive are the  
4 results of the choice of transition break size.

5 MR. THOMAS: I'll turn to my contractor  
6 assistant over here.

7 MR. BAILEY: They're not.

8 MR. APOSTOLAKIS: Who are you?

9 MR. BAILEY: I'm Paul Bailey. I'm the  
10 contractor supporting NRR.

11 MR. WALLIS: These are not sensitive to  
12 transition break size? They're not sensitive?  
13 That would make a tremendous difference.

14 MR. APOSTOLAKIS: If I read the  
15 Westinghouse --

16 MR. SHACK: Let's let Mr. Harrison make  
17 his presentation.

18 Thank you very much.

19 MR. KRESS: Let me ask one question about  
20 this presentation. For some reason it strikes me as  
21 rather strange because I'm used to backfit analyses  
22 that look at a rule change to impose requirements on  
23 a plant and it's justified on the basis of the person  
24 REMs that it's going to save related to the cost.

25 And this seems a little strange to me

1 because I don't see that kind of consideration in it  
2 at all. It's not what I'm used to as a backfit in a  
3 regulatory requirement. So you know, it just seems  
4 strange that I see any of this.

5 MR. SHERON: Because it's not requiring  
6 anything.

7 MR. KRESS: I know, but this is the sort  
8 of thing, I think the industry would do to see if they  
9 want to make changes, but not a regulatory body to  
10 justify a rule. That's what bothers me.

11 MR. SHERON: As I said, we have to do  
12 this, I think, as a legal requirement. We have to do  
13 a reg analysis.

14 MR. KRESS: Yes, but I don't think this is  
15 a reg analysis is what I'm saying. It's something  
16 else.

17 MR. THOMAS: Like I said, it's a very  
18 simplified approach of the reg analysis backfit being  
19 that this is voluntary.

20 MR. KRESS: Reg analysis, even if it's  
21 voluntary, when you make it is supposed to be a reg  
22 analysis and this is not. It's a cost benefit to make  
23 a change.

24 MR. THOMAS: 51.09, the backfit does not  
25 apply in this case.

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1 MR. KRESS: I know, but you don't have to  
2 do a reg analysis, but you do it anyway. But what I'm  
3 saying is this is not a reg analysis. Even if you  
4 didn't have to make it.

5 MR. SHACK: Let's move on.

6 MR. SIEBER: Why don't we just go to the  
7 last slide.

8 We're finished here. We discussed it  
9 enough. This is the end of it.

10 MR. WALLIS: Your analysis says that  
11 industry is going to save billions. It's going to  
12 cost the Agency tens of millions. That's what it  
13 says. That's the bottom line.

14 MR. THOMAS: Bottom line is, the cost to  
15 the Agency is negligible and the benefits --

16 MR. WALLIS: The cost to the Agency is  
17 millions --

18 MR. THOMAS: -- when compared to the  
19 billions of dollars to the industry.

20 MR. WALLIS: And the cost to the Agency is  
21 tens of millions on page 4.

22 MR. THOMAS: There is a backup slide that  
23 shows that.

24 MR. WALLIS: I don't think that the  
25 Agency's budget is so large that that's trivial.



1 MR. SIEBER: It's all reimbursed.

2 CHAIRMAN BONACA: All right, let's hear  
3 from Mr. Harrison.

4 MR. SIEBER: Forty-seven slides.

5 MR. APOSTOLAKIS: Forty-seven?

6 MR. HARRISON: There's only 11 and I have  
7 to only go over about 5 of them.

8 MR. APOSTOLAKIS: Okay.

9 MR. HARRISON: All right, thank you.  
10 First, I want to tell everyone I appreciate the  
11 opportunity to be here today and make these comments.  
12 I will be brief because a lot of the information  
13 that's in here we've already discussed.

14 My name is Wayne Harrison. I'm from South  
15 Texas Project and I'm representing the Westinghouse  
16 Owners Group. I'm the chairman of the Westinghouse  
17 Owners Group Large Break LOCA Redefinition Working  
18 Group.

19 One of the things I did want to mention  
20 was that this is very important to us, to the industry  
21 and WOG has already committed substantial resources,  
22 about \$2 million, to the project authorizations  
23 working on this effort.

24 Another thing I wanted to say here is I  
25 think it's important that we recognize this is our

1 only opportunity to redefine the large break LOCA  
2 size. It's the window of opportunity. I think there  
3 is an opportunity here to optimize safety and  
4 operational benefits and going back to something that  
5 was said earlier, I think we would say when in doubt,  
6 don't double count.

7 MR. WALLIS: You're going to optimize  
8 safety benefits? Would you give us a measure of them  
9 and explain how you optimize in some way?

10 MR. HARRISON: I'm not going to be able to  
11 quantify that. I'll come out at the outset and say  
12 that.

13 One point of perspective I want to make  
14 here -- I think that it's been talked about -- is  
15 that the safety benefits on this are probably in  
16 realistically quantifiably close to risk-neutral, just  
17 simply based on the large break LOCA event frequency  
18 itself, because you're probably talking that when you  
19 go core damage frequency -- CDF -- somewhere in the  
20 neighborhood of minus six absolute value one way or  
21 the other for a delta CDF.

22 So, that's just my gut feeling for the  
23 order of magnitude we're talking about, something  $10^{-6}$   
24 or something less.

25 MR. WALLIS: How can you have a

1 safety benefit which is risk-neutral and is not a  
2 benefit --

3 MR. HARRISON: There are  
4 benefits though and that's what I wanted to point out  
5 -- even for the fuel utilization. We talked about  
6 power uprates, but there's another effect of improved  
7 peaking factors that comes from the reduction in the  
8 break size that you can have power burn-ups, which can  
9 result in longer fuel cycles, which results in less  
10 thermal challenges and less thermal cycles on the  
11 plant.

12 You could have fewer fuel assemblies that  
13 require storage and transport. Now, I don't know how  
14 exactly to quantify that, but that's definitely a  
15 benefit to the public safety. It's about four -- our  
16 analysts tell me it's about four to eight assemblies  
17 per cycle. So, that's less fuel that we have to  
18 handle on-site; that's less fuel that we have to store  
19 on-site or in a repository.

20 MR. ROSEN: That's per 18 months at South  
21 Texas out of typically 80 or so assemblies --

22 MR. HARRISON: Yes sir --

23 MR. ROSEN: So, you're saying 10 percent  
24 less per cycle per --

25 MR. HARRISON: Could be, could be --

1 MR. ROSEN: Could be. Five to 10.

2 MR. HARRISON: And again, again, per  
3 plant, your milage will vary.

4 CHAIRMAN BONACA: That's because you have  
5 higher enrichments?

6 MR. HARRISON: You'll be able to improve  
7 the enrichment --

8 CHAIRMAN BONACA: Right.

9 MR. HARRISON: Improve or increase the  
10 peaking factor; burn the fuel longer and so forth --

11 CHAIRMAN BONACA: Yes, so it's as if you  
12 were not --

13 MR. HARRISON: Right.

14 CHAIRMAN BONACA: -- do something like  
15 that because the cost may be going up, I -- that's  
16 okay.

17 MR. HARRISON: Another benefit that I  
18 really don't know how to quantify for the power up-  
19 rate is the adverse environmental emissions from non-  
20 nuclear generation capacity, and I don't know how you  
21 quantify that, but it's a benefit.

22 So that's really the only thing I wanted  
23 to -- I want to talk a little about the equipment  
24 safety that we talked about. Conceptually, when we  
25 talk about potential safety benefits on this slide I'm

1 talking about peak clad temperature, primarily, and we  
2 said what is the differences or difference between the  
3 break size -- transition break size -- on peak clad  
4 temperature.

5 It's not pronounced, but it does have an  
6 effect, we've determined, on the Westinghouse small 2-  
7 loop plants that, if your have -- there's a difference  
8 between if you have to postulate two times the break  
9 size versus if you have to postulate one times the  
10 break size. Whether it moves down on the peak clad  
11 temperature versus break size curve -- you're kind of  
12 dependent upon that. But it's primarily it looks like  
13 it affects the 2-loopers more than it does the other  
14 plants.

15 MR. APOSTOLAKIS: What would it be? I  
16 mean, can you give me an idea of what the limit on the  
17 peak clad temperature could be if we approve a certain  
18 size?

19 MR. HARRISON: I don't have that at my  
20 fingertips. I can probably get you some information  
21 on that from George --

22 MR. APOSTOLAKIS: Roughly, do you remember  
23 roughly about? It doesn't have to be accurate.

24 MR. HARRISON: Probably 100 degrees or  
25 so.

1 MR. DENNING: I missed that. How is this  
2 a safety benefit? The plant isn't changed at all.

3 MR. HARRISON: I was saying for the 2-loop  
4 plants, we're talking about the transition break size  
5 of why the benefits of having a smaller transition  
6 break size is better for the 2-loop plants because  
7 they will still be large break limited even with two  
8 times the largest pipe and they don't get -- they  
9 don't really get any PCT benefit at the new break  
10 size.

11 MR. DENNING: Yes, but I argue this isn't  
12 a safety benefit at all.

13 MR. HARRISON: It's an economic benefit or  
14 they would be able to have the same safety benefits  
15 that we identified in the previous slide for increased  
16 burn-up or the peaking factor will affect the increase  
17 burn-up or --

18 MR. DENNING: If you don't do anything and  
19 you just change the small --

20 MR. HARRISON: Then we get nothing.

21 MR. DENNING: There's nothing.

22 MR. HARRISON: Nothing for that.

23 MR. SIEBER: They would actually get  
24 something, that it's already hidden into the  
25 calculation, so you can't quantify it.

1 I mean the margin is there. And it's just  
2 because of the way you do the calc.

3 I have a question. When you move from an  
4 appendix K calculation to a realistic calculation, you  
5 get a pretty big benefit just by doing that.

6 MR. HARRISON: Yes sir.

7 MR. SIEBER: And that's probably bigger  
8 than you get out of changing the transition break  
9 size?

10 Is that true or not?

11 MR. HARRISON: I don't know the answer to  
12 that.

13 MR. SIEBER: If I wanted to get --

14 MR. HARRISON: I think of the --

15 MR. SIEBER: If I wanted to get margin,  
16 that would be the first thing I would do.

17 MR. HARRISON: Right, but I think -- I'd  
18 have to defer to an analyst, a safety analyst on that  
19 one because I can't -- I believe we're looking at  
20 like, for changing the transition break size, peak  
21 clad temperature for a large break, something 400 to  
22 600 degrees.

23 MR. SIEBER: You get that out of --

24 MR. HARRISON: Out of changing the break  
25 size, but --

1 MR. SIEBER: -- by changing the  
2 calculation regimen too.

3 MR. ROSEN: Well, 400 to 600 degree  
4 reduction in the peak clad temperature? That's  
5 enormous, right?

6 MR. SIEBER: Yes.

7 MR. ROSEN: Especially where we're maybe  
8 hundreds of degrees away from the limit, the 2700  
9 degree limit.

10 MR. HARRISON: That happens though  
11 primarily in the large break LOCA. What that makes,  
12 it makes a small break LOCA your most limiting event  
13 for peak clad temperature, so you still have to  
14 consider that.

15 MR. WALLIS: You can get an economic  
16 benefit. I don't see any safety benefit.

17 MR. DENNING: Exactly, that's exactly it.  
18 It just gives you an apparent margin that you can take  
19 back up by increasing the power. In reality, you've  
20 undoubtedly decreased safety when you've done that.  
21 It's just that it's within some acceptable regulatory  
22 balance.

23 MR. HARRISON: I'm going to talk a little  
24 bit about some of the benefits like Brian was  
25 mentioning earlier and these are going to vary from

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1 plant to plant. These -- because it depends upon the  
2 size of your containment. It depends upon the  
3 capacity and the capability of your safety injection.  
4 It depends upon whether you cool with containment  
5 spray or you cool with reactor containment fan  
6 coolers. And all the plants are somewhat different.

7 We talked about containment spray system  
8 may not have to start automatically. Safety  
9 advantages of that are you won't have safety injection  
10 to compete with containment spray for refueling water  
11 storage tank inventory, more water to cool the core.  
12 Would it clearly have effect on debris transport to  
13 the sump and increases your nominal pump suction head.

14 MR. WALLIS: All of this should improve  
15 your CDF.

16 MR. HARRISON: It could.

17 MR. WALLIS: I think that's the measure of  
18 safety benefit.

19 MR. DENNING: I agree, that's real. Now  
20 the question is would the utility make those changes?

21 MR. HARRISON: I think the answer to that  
22 is yes, if they could make those changes because my  
23 perspective on containment spray and I'm speaking for  
24 myself, for many plants containment spray does nothing  
25 but evil.

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1 MR. DENNING: Especially if it goes off  
2 when the --

3 MR. ROSEN: That's right, the containment  
4 spray inadvertent actuation is a very damaging event  
5 to the economics of the plant, so if there was a  
6 safety rationale for not having it automatically --

7 MR. HARRISON: It does bad things too.

8 MR. APOSTOLAKIS: I'm sorry, I have to  
9 understand that. Why do you call it evil?

10 MR. HARRISON: I'll use my plant for an  
11 example. South Texas does not need containment spray  
12 to mitigate steam line break or the design basis  
13 accident, particularly if we were to credit the  
14 alternate source term, we don't need it for dose. So  
15 here we have this system that automatically actuates  
16 I think at 9 PSI or so in containment.

17 So that if you do have something that  
18 causes containment spray to -- it's -- the only thing  
19 you can do is something bad for us because we get  
20 adequate cooling from reactor containment fan coolers.  
21 It's water that could be going to the core. There's  
22 just nothing positive it's going to do for us, George.

23 MR. ROSEN: It competes the loading time -  
24 -

25 MR. HARRISON: This is not true --

1 MR. APOSTOLAKIS: That's not necessarily  
2 evil.

3 MR. HARRISON: Well, it is because --

4 MR. ROSEN: You're washing down the whole  
5 containment.

6 MR. HARRISON: You're washing down the  
7 whole containment. So something that's -- Murphy's  
8 Law is going to apply. Something that was qualified  
9 for it isn't going to work.

10 CHAIRMAN BONACA: But have we ever had  
11 industry spurious actuation of this price system?

12 MR. HARRISON: Have we ever had spurious  
13 actuation? Not at South Texas, I don't think.

14 CHAIRMAN BONACA: Jack says yes.

15 MR. SIEBER: Yes, there have been. It's  
16 a mess.

17 MR. APOSTOLAKIS: And we forced it on  
18 8600.

19 MR. HARRISON: And what's true of South  
20 Texas can apply to everybody.

21 MR. POWERS: I want to point out that the  
22 spray is the most effective way to eliminate  
23 radioactive aerosols in severe accident. It's of  
24 overwhelming safety significance there.

25 MR. APOSTOLAKIS: You mean in 8600

1 situation or in general?

2 MR. POWERS: At any plant, the spray is  
3 the best thing you've got going for you.

4 MR. HARRISON: I think though if you have  
5 that kind of source term generated in the appropriate  
6 place, I'm not advocating that you take spray out of  
7 the design, but you make spray a manually initiated,  
8 so that if you needed in your severe accident  
9 management you can actuate it manually.

10 MR. ROSEN: That's all your slide says, by  
11 the way, right? It says may not have to start off  
12 automatically.

13 MR. HARRISON: Exactly.

14 MR. ROSEN: It doesn't say anything more  
15 than that.

16 MR. HARRISON: That's correct. More  
17 effective use of accumulators, this is something we  
18 need to quantify and we talked to the Staff about that  
19 and Westinghouse is looking at doing this and we  
20 talked -- Brian talked about it earlier on the, just  
21 a few minutes ago on staggering the initiating set  
22 point of the accumulators.

23 Diesel generators' start times can be  
24 increased beyond 10 seconds. I think this is probably  
25 more broadly beneficial than some of the other effects

1 because you're not -- it's not something that depends  
2 upon peaking factors. It's something that depends  
3 upon time sequencing of the accident and how big the  
4 break is and so forth and this is a benefit to the  
5 diesel, a safety benefit to the diesels because you're  
6 not having to -- they will be more reliable for you,  
7 reduces wear on the on-going testing and reduces need  
8 for invasive troubleshooting.

9 Again, I want to stress here that we were  
10 doing some quantitative evaluations on this and  
11 hopefully, we can come back to you guys at a future  
12 meeting and give you some more specific information.  
13 I know you want to have -- I want to have it because  
14 when I go back and talk to my management committee and  
15 my management, I need to tell them here are your  
16 safety benefits, how good it is and here are the  
17 economic benefits and so forth. It's a complete  
18 package. I think they're there.

19 What we proposed is a transition break  
20 size equal to the double-ended break of a Schedule 160  
21 8-inch pipe which is 6.9 inch ID and you can see if  
22 you take the double-ended break of that, that's  
23 comparable to a single-ended break at the most RCS  
24 branch connections.

25 And that's a factor of five margin on the

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1 initiating event frequency over the E<sup>-5</sup> Commission  
2 guidance for nominal event frequency and we've taken  
3 that from I think Table 3 in SECY 04-60.

4 MR. APOSTOLAKIS: What SECY is that? Is  
5 that new reg we're reviewing?

6 MR. ROSEN: No. That's the April version  
7 of the elicitation.

8 MR. APOSTOLAKIS: Where did you go to get  
9 this again? Explain to me.

10 MR. HARRISON: I'll show you a table and  
11 a picture.

12 MR. WALLIS: You got a table from the  
13 elicitation?

14 MR. APOSTOLAKIS: Where was the table?

15 MR. HARRISON: In the SECY paper. 04-  
16 0060.

17 MR. WALLIS: Where does the pipe size come  
18 from?

19 MR. HARRISON: I picked the pipe size  
20 because instead of just looking at the break sizes or  
21 what we asked ourselves, well what pipe size, what  
22 nominal pipe size that you use in the real world  
23 corresponds to this?

24 MR. WALLIS: How did you determine the  
25 margin of 10<sup>-5</sup>?

1 MR. HARRISON: Well, we used the  
2 initiating event -- if you look here, the 8 inch is a  
3 6.9 inch ID which corresponds to estimated mean break  
4 frequency from --

5 MR. WALLIS: From where?

6 MR. HARRISON: From the SECY 04-600.

7 MR. WALLIS: That's not from an expert  
8 elicitation.

9 MR. HARRISON: Yes sir. That was a  
10 summary of the expert elicitation.

11 MR. WALLIS: Is it a draft first or  
12 something?

13 MR. HARRISON: Yes. That's from the mean  
14 frequency, yes. So that corresponds to E<sup>-6</sup> mean break  
15 frequency.

16 MR. APOSTOLAKIS: Has that changed since  
17 that time?

18 It has?

19 MR. POWERS: Yes. That version was an  
20 earlier version, George. It doesn't include the over  
21 confidence adjustment and the other sensitivities that  
22 we talked about. It would be closer to the -- in the  
23 executive summary, the baseline.

24 MR. APOSTOLAKIS: Yes. I thought we  
25 reproduced the calculations. We're using their

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1 baseline table. But it came very close to what you  
2 guys did.

3 MR. HARRISON: Let me back up here. The  
4 point I want to make with this curve and this is a  
5 similar curve to what was shown earlier on the Staff's  
6 presentation. It's similar to the arithmetic mean,  
7 PWR plot. But what you can see here, the point is  
8 that the break frequency of the largest attached pipe  
9 which is down here is only a little different from the  
10 RCS loop piping break frequency which is basically  
11 right here.

12 MR. WALLIS: I didn't get that impression  
13 at all. It seemed like the largest pipe seemed to be  
14 way below all the others.

15 MR. HARRISON: Well, actually, this is  $1E^{-7}$   
16 ' and  $2E^{-7}$ , so when you're talking about  $E^{-7}$   
17 frequencies, there's not much difference there, a  
18 factor of 2.

19 MR. WALLIS: It doesn't look like that at  
20 all. Does it?

21 MR. APOSTOLAKIS: What is the --

22 MR. HARRISON: I'm sorry?

23 MR. WALLIS: That figure that they showed  
24 us this morning, earlier this morning, really fell off  
25 on the right hand end and yours is leveling off. Is

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1 this because of a bundling or something?

2 MR. HARRISON: I think you can look at  
3 their arithmetic mean. I think it's leveled off  
4 similar to this.

5 MR. POWERS: All of these tabulated values  
6 don't recognize that significant list of things that  
7 were not recognized or considered in the expert  
8 elicitation, so how do you compensate for that?

9 MR. HARRISON: Well, I'm glad you asked  
10 that. And the point I'm going to make with these two  
11 charts. And I'm going to come to your question right  
12 after that, is that what we're recommending is that we  
13 don't need to postulate two times the largest break  
14 size, that one times that and still move it to the  
15 worse location within the reactor coolant system, but  
16 one time the diameter of the largest connected piping  
17 would be, I think, a better application of an expert  
18 elicitation.

19 Now for the uncertainty that you were just  
20 asked about, I think the first and key thing, we've  
21 mentioned it before and I can't stress it enough is  
22 that the requirement to mitigate breaks beyond the  
23 transition break size is still there as the backup and  
24 that substantially compensates for any uncertainty.

25 We talked earlier and Mr. Tregoning's

1 discussion and I'm not going to go through all these  
2 because they're the same points I think that he made  
3 that much of the items of uncertainty were, in fact,  
4 discussed by the expert elicitation and accounted for  
5 there.

6 MR. APOSTOLAKIS: How long did it take  
7 them to consider the unknown degradation mechanisms?

8 MR. HARRISON: I'll let Bruce --

9 MR. POWERS: I still need an answer to my  
10 question, this doesn't answer it at all. This just  
11 says I don't need to consider all these things and --

12 MR. HARRISON: I think we're saying they  
13 have been considered.

14 MR. APOSTOLAKIS: That's what the report  
15 says.

16 MR. HARRISON: It has been factored into  
17 the uncertainty already and when in doubt, don't  
18 double count is the message we're sending.

19 MR. POWERS: It's certainly not apparent  
20 to me.

21 MR. BISHOP: In the voluminous report, I  
22 agree that it's not completely apparent, okay, of all  
23 the discussions that were held by the expert panel.

24 George asked the question, okay, about how  
25 do we take into account and I think -- the question

1 was is in the next mechanisms what's the chance that  
2 you think it might not have any precursors, you might  
3 not have small leaks or you might not find a crack  
4 during -- during your normal ISI or something to give  
5 you an indication that there's something going on that  
6 you could get in trouble to hurry.

7 I think what people typically did, okay,  
8 is they put a factor of 2 to 10 on the current  
9 frequency to account for that. And that's just based  
10 on discussions we had when the expert panel was  
11 talking about this, how do you deal with something  
12 like that? That was what we came up with and I think  
13 -- speaking for myself -- I put at least a factor of  
14 2 on it. I don't remember exactly, but it was more  
15 than a factor of 2.

16 Other people may have put in a factor as  
17 high as 10 is what I heard in discussions.

18 MR. APOSTOLAKIS: The eight inch, well,  
19 actually 6.9, this is the mean of the distribution of  
20 or the 95th percentile of the distribution?

21 MR. WARD: That was the mean which had a  
22 mean initiating event frequency about  $2E^{-6}$ . I think  
23 the 95th percentile was right at  $1E^{-5}$ .

24 MR. BISHOP: In the SECY paper, the 95th  
25 percentile tended to be about a factor of four greater

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1 than the mean value.

2 And so again, that's one of the reasons we  
3 came up with a factor of five on the mean value. We  
4 thought that that would cover that.

5 MR. APOSTOLAKIS: The mean value of the  
6 frequency?

7 MR. POWERS: You put up there a factor of  
8 five margin. It looked to me, recollecting the  
9 curves, that that my level of uncertainty was a little  
10 tainted. And so a factor of five is not -- doesn't  
11 strike me as any margin at all.

12 MR. BISHOP: There was a factor -- like I  
13 said, in the SECY 0460 paper, the table 3 showed the  
14 difference between, for the PWRs, the difference  
15 between the 95 percent and the mean.

16 Again, the experts were asked to estimate  
17 the best estimate value which was the median value and  
18 then the uncertainty affects the mean value and again,  
19 the uncertainty typically the mean value tended to be  
20 about a factor of 2 greater than what we would call  
21 the best estimate median value and the 95th percentile  
22 was about a factor of four or about almost a factor of  
23 10 higher than the 4 times 2, a factor 10 higher than  
24 the median value or the best estimate value.

25 So again, I think -- now again, there have

1       been some minor adjustments, okay, made in the -- like  
2       this is an on-going process of the numbers from the  
3       expert elicitation with the adjustments and so forth.  
4       But again --

5               MR. SHACK:     The eight inches would  
6       correspond to the elicitation with the error factor  
7       adjustment at the 95th confidence level.

8               MR. BISHOP:   That's right, that's right.

9               MR. HARRISON:  I think the question is how  
10      much margin do you need to -- and like 16 inch is the  
11      largest surge line I know of.  It's an STP surge line  
12      which has a 12.8 inch inside diameter.  And that's  
13      over two orders of magnitude over the SRM guidance of  
14      1E<sup>-5</sup>.

15              MR. WALLIS:    I want some clarification  
16      here.  Since these inside diameters are very different  
17      from the outside, the nominal pipe sizes, when  
18      Tregoning was presenting, was he presenting based on  
19      nominal pipe sizes or real areas?

20              MR. HARRISON:  I understand areas.

21              MR. WALLIS:    So when he says a 12-inch  
22      pipe, he really means a 16-inch pipe in terms of  
23      nominal --

24              MR. APOSTOLAKIS:  You mean the inside  
25      diameter?

1 MR. HARRISON: That's inside diameter.  
2 That could be related to break area.

3 MR. APOSTOLAKIS: Okay. So the Staff is  
4 proposing 14, right?

5 MR. WALLIS: Which is really 11 in terms  
6 of area.

7 MR. APOSTOLAKIS: No, but the 14 is the  
8 inside.

9 MR. HARRISON: We're proposing the largest  
10 attached pipe. So for South Texas, it's the next to  
11 last row --

12 MR. SHERON: So for South Texas, that  
13 would be a 14-inch outside diameter, 11.2 inch inside  
14 diameter.

15 CHAIRMAN BONACA: No, that's not right.

16 MR. APOSTOLAKIS: No.

17 MR. SHERON: I'm sorry, 16. I am sorry,  
18 26 inch.

19 CHAIRMAN BONACA: So when you report the  
20 14 inches like you were saying before, you meant  
21 really 11.2 inches?

22 MR. APOSTOLAKIS: No, he meant 16.

23 MR. SHERON: We said the largest attached  
24 pipe.

25 I think someone on the Staff said gee,

1 what's the largest attached pipe and someone said,  
2 gee, that's South Texas and we think it's 14 inches  
3 and obviously it's a larger --

4 CHAIRMAN BONACA: Some of the numbers that  
5 you gave us -- I'm confused now. I'm trying to  
6 understand now. We have an elicitation with break  
7 size, nominal. Are those in the elicitation nominal  
8 pipe sizes?

9 MR. SHERON: No, they're inside diameters.

10 CHAIRMAN BONACA: So I should compare  
11 really the inside diameter.

12 MR. SHERON: Yes.

13 CHAIRMAN BONACA: And not what Members are  
14 continuously quoting.

15 MR. SHERON: That's right.

16 CHAIRMAN BONACA: Okay. All right, so  
17 when we say for most PWR, the pressurizer line is 14  
18 inches, not South Texas. We really mean 11.2 inches.

19 MR. APOSTOLAKIS: It seems to me that the  
20 heart of the argument is that there is enough defense-  
21 in-depth in the fact that we are requiring mitigation  
22 of breaks larger than the TBS, so this choice can be  
23 almost purely risk based, I mean frequency based. Is  
24 that really what you're arguing?

25 MR. HARRISON: That's part of it. I think

1 that when you take two times -- if you take this and  
2 we were saying this is a double-ended break, okay, so  
3 that's equivalent basically to the single-ended break  
4 of a 12-inch line which is 10 inches ID and if you  
5 look at the expert elicitation of what is the  
6 initiating event frequency for a 10-inch break from a  
7 risk perspective, you're going to see that that has an  
8 even greater margin to -- from a risk perspective,  
9 pipe doesn't, of course, know what the flow area is.

10 CHAIRMAN BONACA: Let me ask a question.  
11 I need to ask a question because I'm confused about  
12 this too.

13 I've just heard the presentation here from  
14 the gentleman from Westinghouse that said all these  
15 things were really pretty much considered. But then  
16 we had the presentation this morning from Mr. Hammer  
17 that listed over four slides all the things that were  
18 not considered and those included all the active  
19 LOCAs, dropped heavy loads, seismic LOCAs with a  
20 hammer and certain piping, etcetera, etcetera.

21 So what's the story? I'm trying to  
22 understand whether it's included or not included.

23 MR. BISHOP: Since I'm the one that made  
24 the comment, let me try to clarify. In the Staff  
25 discussions they made the statement that it was not

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1 considered in what -- what that implies is that wasn't  
2 discussed. In the final numbers, that was not  
3 considered because based on the discussions there were  
4 a number of panel members that actually provided  
5 estimates for these rare events, like seismic events  
6 and water hammer events.

7 We actually were provided input for that  
8 and we discussed it and the conclusion was that it was  
9 not a significant contributor. So when the final  
10 numbers were rolled up, it was not included because it  
11 -- the feeling was that of the panel that that would  
12 not significantly change the numbers. So yes, it was  
13 not considered, but it was discussed and there were --  
14 and again, the point I made, the active component  
15 failures were not included, but typically for the  
16 largest safety relief valve, that corresponds to a  
17 transition break size, would not have any effect on a  
18 transition break size greater than four inches.

19 MR. HARRISON: I think we're elaborating  
20 on what Bruce is saying and what is said by the Staff  
21 earlier. If you look at the nonpiping components and  
22 the active components, I think that we're, from what  
23 I heard, we're in agreement here that these things are  
24 still within the existing design basis. In other  
25 words, they don't exceed the transition break size, so

1 we would still be designing for those failures the  
2 same as we currently do within our existing design  
3 basis.

4 MR. BISHOP: I think it was a matter of  
5 interpretation.

6 MR. HARRISON: And for the seismic issue,  
7 the -- our point was that the probability of the very  
8 high loads is very low and when you -- and that  
9 compensates for the increased conditional failure  
10 probabilities and I think the implementation process  
11 that Rich and Brian were talking about would -- for  
12 each plant that adopts this rule, you would look at  
13 that and confirm that to the Staff's satisfaction for  
14 your plant in your license amendment request.

15 Thank you.

16 MR. WALLIS: Well, I'm still concerned  
17 about the single and double-ended thing. You go from  
18 7-inch, you get  $2E^{-6}$  in your table. You've got a 10-  
19 inch,  $2E^{-7}$ , well, the 10-inch single-ended break is  
20 equivalent to a 7-inch double-ended break. Certain  
21 pipes which attach to the main system don't really go  
22 anywhere. They break -- you only care about single-  
23 ended break. There are pipes where you really do care  
24 about a double-ended break. It makes a difference.  
25 You can't just lump them all together. And it makes

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1 a big difference if two 7-inches and one 10-inch --  
2 maybe I have to require you consider the 10-inch  
3 because it's only flowing one way essentially in an  
4 accident. So I don't quite know how to make that  
5 comparison.

6 MR. HARRISON: It is a difficult  
7 comparison to make. I think in looking at this what  
8 we were a little troubled by, if you will, is taking  
9 the equivalent of two times across a sectional area of  
10 a surge line and postulating that anywhere at the  
11 worst point in the reactor coolant system --

12 MR. WALLIS: That's far less important  
13 than the flow --

14 MR. HARRISON: Which didn't seem  
15 appropriate. Now I think in discussing the  
16 implementation of this with the Staff and we're going  
17 to be doing a lot of that and working, as Brian said,  
18 on some implementation guidance, I think we would be  
19 willing to say let's look at the surge line and take  
20 the surge line and take the actual effects of the  
21 break of a surge line. That's not a limiting event  
22 for us.

23 MR. WALLIS: It's a single-ended break.

24 MR. HARRISON: Well, you would take the  
25 actual effects of that break, surge line analysis.

1 MR. WALLIS: Rather than doubling its  
2 area.

3 MR. SHERON: Could I read, excuse me,  
4 could I read from the SRM that we got on July 1st?  
5 This was paragraph 4. It says "licensees should be  
6 required by regulation to retain the capability to  
7 successfully mitigate the full spectrum of LOCAs for  
8 break sizes between the new maximum break size and the  
9 double-ended guillotine break of the largest pipe of  
10 the reactor coolant system."

11 We're interpreting that to say is that  
12 wherever you pick your transition break size, if you  
13 remember the Commission said for transition break  
14 sizes below -- I mean for breaks below the transition  
15 break size, you do your analysis the way you always  
16 have which is you assume a spectrum of break areas,  
17 okay, up to that area, all right? And you postulate  
18 them around the loop to occur in the worse location  
19 and you do your analysis and you calculate your clad  
20 temperature.

21 What this says is that for transition  
22 breaks, for breaks above the transition, we have to  
23 consider up through the double-ended guillotine,  
24 double-ended, okay? It doesn't matter. We're going  
25 to have to take that double-ended guillotine

1 everywhere in the primary loop.

2 MR. WALLIS: Yes, that's fine. The  
3 double-ended primary loop, you've got two holes if you  
4 break apart.

5 MR. SHERON: Yes.

6 MR. WALLIS: But if you break a surge  
7 line, you've essentially got one and a little bit.

8 MR. SHERON: We're only using that as a  
9 surrogate to pick a break size.

10 Once you've picked the break size and I  
11 don't care --

12 MR. WALLIS: Some other space. I mean the  
13 reality space, the surge line break is not the same.  
14 The double-ended guillotine break --

15 MR. SHERON: The licensee can pick a surge  
16 line and say fine, it's equivalent of a single-ended  
17 break. But once I've picked that size of that surge  
18 line, in this case it's 12.8 inches, the Commission  
19 says take that --

20 MR. WALLIS: That's fine. We might  
21 recommend that you take a surge line, but only a  
22 single-ended break of a surge line to get your  
23 approval and area. Move it around a little, but you  
24 wouldn't move two surge line areas around the loop.

25 MR. SHERON: Well, the Commission says we

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1 have to mitigate up to the double-ended guillotine, so  
2 you're still --

3 MR. SHACK: Graham is arguing for the  
4 design basis accident.

5 MR. WALLIS: Yes, the design basis, the  
6 transition break area.

7 MR. SHACK: We all agree that above --  
8 you're all still going to have to deal with the  
9 double-ended guillotine break.

10 MR. WALLIS: Yes.

11 MR. SHERON: But below that, at 12.8  
12 inches or below, the Commission said do it the way you  
13 normally have done it, all right? The way we've  
14 normally done it is we have postulated that break  
15 around the loop --

16 MR. WALLIS: Brian, the thing is what do  
17 you use to calculate this mysterious area which  
18 appears on the main loop somehow? Do you use one  
19 times the cross sectional area of the surge line or  
20 two times.

21 MR. APOSTOLAKIS: Two times.

22 MR. WALLIS: That's independent of the way  
23 the --

24 MR. KRESS: You guys have to realize that  
25 reality space and design basis space are two different

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1 things and there is no rational way to look at design  
2 basis space and choose the way it's implemented. It's  
3 all a kind of judgmental defense-in-depth thing --

4 MR. WALLIS: We're talking about an  
5 equivalent area of a transition break size and that's  
6 a new rule and has nothing to do with the way you've  
7 been doing stuff in the past.

8 MR. KRESS: Yes, it does. We're still  
9 dealing in design basis space.

10 MR. POWERS: Tom, isn't the spirit, at  
11 least, of the SRM to say look, our technology is an  
12 understanding, are vastly improved. Let us move in  
13 the direction of greater realism and even though we  
14 may not be able to take a complete step here, let's  
15 take a partial step?

16 MR. KRESS: That's exactly right and these  
17 people are making a partial step.

18 MR. WALLIS: You still have to define this  
19 mysterious area, this transition break size is an  
20 area. What area is it? Is it twice --

21 CHAIRMAN BONACA: I think we can have this  
22 discussion when we go to letter writing.

23 MR. KRESS: This is a letter writing  
24 discussion.

25 CHAIRMAN BONACA: We have people waiting

1 for us for the meting and we have to take lunch in  
2 between for the next meeting.

3 MR. WALLIS: Okay, that's it.

4 MR. SIEBER: Are we done?

5 MR. HARRISON: I'm done. I can be done.  
6 I think I made my key things. One thing I will say,  
7 I think we'll be coming back to talk to you guys with  
8 some more specific information on quantification.

9 CHAIRMAN BONACA: All right, let's take a  
10 break for lunch. Since we're running so late, take  
11 like 45 minutes. Is that okay? Forty-five minutes.  
12 So we get back at quarter of one, quarter of two,  
13 quarter of two.

14 (Whereupon, at 12:58 p.m., the meeting was  
15 recessed, to reconvene at 1:45 p.m.)

16 CHAIRMAN BONACA: We are back into  
17 session, and the next item on the agenda is the  
18 technical basis for potential revision of the  
19 pressurized thermal shock. Dr. Shack will lead us  
20 through the presentation.

21 MR. SHACK: Okay. We had a subcommittee  
22 meeting on that this week. I think most of the  
23 committee members were in attendance, but we're going  
24 to go over some of this material again today for the  
25 benefit of those who weren't.



1 MR. POWERS: Mr. Shack, before we get  
2 started, I'll mention that, first of all, Nathan Sui  
3 is definitely not part of the Probabilistic Assessment  
4 Branch of Sandia National Laboratories. Donnie  
5 Whitehead is. I have no idea what Donnie Whitehead  
6 actually does on this project, but I do work with him,  
7 so anything I have to say on this should be understood  
8 with a reasonable amount of doubt, as the Committee  
9 usually does.

10 MR. ERICKSONKIRK: My name is Mark  
11 Ericksonkirk. I'll be leading the first part of the  
12 briefing, which will be the project overview, as Dr.  
13 Shack suggested the contents for that yesterday. And  
14 then after that, we'll go over the high points of the  
15 final comments we received from our peer review  
16 committee just recently.

17 MR. POWERS: And hopefully it will be more  
18 accurate than the author listings, right?

19 MR. ERICKSONKIRK: Hopefully, so, yes.

20 MR. SHACK: How are you going to launch  
21 your time, Mark?

22 MR. ERICKSONKIRK: I'm planning on getting  
23 through this as quickly as possible, so you can pick  
24 on somebody else. No. I have 15 view graphs here on  
25 the overview, so half an hour, 45 minutes max.

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1 MR. SHACK: You get 45 minutes.

2 MR. ERICKSONKIRK: Okay, good enough.  
3 Okay. So what I'll be covering in the next 13 view  
4 graphs --

5 MR. APOSTOLAKIS: What is integrated  
6 systems?

7 MR. ERICKSONKIRK: That's our thermal  
8 hydraulics contractor. See, my title slide is -- but  
9 I did get my new name right, so there.

10 MR. APOSTOLAKIS: Even your name.

11 MR. ERICKSONKIRK: No, my name is Greg.

12 MR. APOSTOLAKIS: Shouldn't there be a  
13 space between Erickson and Kirk?

14 MR. ERICKSONKIRK: No, check my driver's  
15 license. You know how hard it is to get the  
16 Department of Motor Vehicles to not put a space there?  
17 That took a while.

18 CHAIRMAN BONACA: That's conjoined.

19 MR. SHACK: Onward.

20 MR. ERICKSONKIRK: Onward. You're wasting  
21 my 45 minutes. Okay. We're going to talk about the  
22 scope of the analysis we performed and focus on the  
23 factors that contribute, most significantly, to the  
24 vessel failure probability, those being material  
25 factors and transient classes. We will also highlight

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1 factors that we believe suggest that these findings  
2 can be applied with confidence to PWRs in general. We  
3 will propose a reference temperature-base screening  
4 criteria, screening limits. I tried to eliminate the  
5 use of the word "criteria," so I don't mess it up,  
6 that are consistent with reg guide 1.174 guidance on  
7 LERF. We'll compare the state of operating PWRs at  
8 end of license with those proposed screening limits  
9 and discuss conservatisms and non-conservatisms that  
10 remain in the calculations from which we derived those  
11 screening limits.

12 So the scope of our analyses, first we  
13 focused on performing three plant-specific analyses  
14 using one vessel from each of the three major PWR  
15 manufacturers. We then worked on generalizing those  
16 results to apply to all PWRs. As I said, we have a  
17 frequency limit of 1 times 10 to the minus six. It's  
18 consistent with guidance on LERF. And on the basis of  
19 that limit and the three plant-specific analyses, we  
20 proposed a revision to the PTS screening limits for  
21 NRR to consider.

22 So first off, we're going to look at what  
23 material factors control vessel failure. The first  
24 statement is perhaps obvious, that in order to have  
25 any hope of correlating or predicting the failure

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1 frequency of a vessel, we need to know the toughness  
2 properties at the flaw locations. And so in order to  
3 characterize those toughness properties, we use a  
4 reference temperature approach, and that's useful  
5 because a single reference temperature tells us what  
6 the temperature dependency and the scatter  
7 characteristics are of all the fracture toughness  
8 measures that we use in our calculations, as  
9 illustrated in the figure at the bottom of the slide.

10 So in order to know what reference  
11 temperatures to pick for these metrics, we need to  
12 know where the flaws are. And so that's illustrated  
13 on the next slide, where the big blocky thing is my  
14 attempt to show the interior roll-out of a vessel, at  
15 least schematically, so you can see the axial welds  
16 and the circ welds. You see that there's a layer of  
17 stainless steel cladding overlaid on it, and then the  
18 red squiggly lines indicate that the axial and  
19 azimuthal variations of fluence.

20 So some observations on where the flaws  
21 are. We've got embedded weld flaws that populate the  
22 fusion lines, so the axial flaws contain only axial  
23 welds and the circ flaws contain only circumferential  
24 - yes, that's it. The circ welds contain only  
25 circumferential flaws.

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1           We have a population of surface-breaking  
2       flaws associated with the cladding layer because our  
3       destructive inspections and our physical understanding  
4       showed that if you were to get a particularly severe  
5       lack of inter-run fusion between the cladding weld  
6       beads, you could have a surface flaw. Because the  
7       cladding weld beads are laid down only in a  
8       circumferential direction, all of those flaws are  
9       oriented only circumferentially. And then, finally,  
10      the plates have a flaw population that's distributed  
11      throughout their volume with no preferred orientation,  
12      and that's what we simulate in FAVOR.

13           So in order to construct our reference  
14      temperature metrics, we use this information to guide  
15      us. And so we said okay, well, let's take the axial  
16      welds for example. What's going to control or be the  
17      worst case for a flaw in an axial weld? Well, it  
18      would be, it would certainly happen at the maximum  
19      fluence location along the axial weld, and then you'd  
20      need to figure out -- so say the maximum fluence  
21      location is there on the axial weld, just for example,  
22      and then you'd need to figure out what embrittlement  
23      properties to associate with it, so you can choose.  
24      It's either going to be the plate properties or the  
25      axial weld properties, the worst of the two, so that's

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1        what we pick.

2                    And as you can notice from the schematic,  
3        the placement of the axial welds can have a  
4        significant influence on their fluence loading.  
5        Sometimes they're near the cross, sometimes they're  
6        near the peaks, and that needs to be accounted for.

7                    Conversely, for circumferential welds and  
8        for plates, because both of those effectively go all  
9        the way around the vessel, you can be very sure that  
10       the circumferential welds and the plates will always  
11       see the maximum fluence in the vessel.    So in  
12       calculating, say, the reference temperature for the  
13       circ weld, you just need to know the maximum fluence  
14       in the vessel.    And then you figure out, then you  
15       calculate the embrittlement, I'm sorry, the RTNDT  
16       irradiated at the maximum fluence using the plate  
17       properties and the circumferential weld properties and  
18       again, pick the highest, because it's going to be  
19       controlled by the least material.    And then for the  
20       plates, again, just calculate the RTNDT at the max  
21       fluence because the plate is always going to hit that  
22       and pick the maximum value.    And that's really all  
23       this slide says, so I'll bypass the math, but the math  
24       is a representation of how we do what I just said.

25                    And in doing that, we can now look at the

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1 results from the probabilistic fracture mechanics  
2 calculations. On the vertical axis over on the left-  
3 hand side, we've got through-wall cracking frequency  
4 associated, a through-wall cracking frequency caused  
5 by the axial weld flaw population plotted versus the  
6 reference temperature for the axial weld. In the  
7 middle graph, we've got the through-wall cracking  
8 frequency for the plate generated by the flaws in the  
9 plates plotted versus the reference temperature for  
10 the plates. And on the third graph, the through-wall  
11 cracking frequency associated with the flaws in the  
12 circumferential welds plotted versus the reference  
13 temperature for the circumferential welds.

14 And one thing I would note in passing is  
15 that all of these reference temperatures can be  
16 computed based on information that's available and  
17 docketed by each of the plants. So we're not  
18 requiring anything new of the licensees here, other  
19 than perhaps more elaborate calculation.

20 The take-away point from this graph is  
21 that the through-wall cracking frequency from each of  
22 these weld populations is reasonably consistent from  
23 plant to plant for reasons that I'll go into in just  
24 a minute. The other thing to take away is that the  
25 axial weld flaws are dominating the through-wall

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1 cracking frequency, simply because they tend to be the  
2 largest and they're axial-oriented. Then the plate  
3 flaws contribute the next portion, but that's at an  
4 equivalent level of embrittlement. That's 100 times  
5 lower, and that's because the plate flaws are smaller  
6 than the weld flaws.

7 And then third and almost negligible  
8 contribution to the through-wall cracking frequency is  
9 made by the circumferential weld flaws, not because  
10 they're small but simply because they're  
11 circumferentially-oriented. So we'll get back to  
12 these graphs in a little bit because it's on the basis  
13 of these lines fit through our results that we derive  
14 a through-wall, I'm sorry, that we derive reference  
15 temperature limits that are consistent with the  
16 through-wall cracking frequency limit of 1 times 10 to  
17 the minus 6 events per year.

18 But before I go there, just a couple of  
19 slides on why the through-wall cracking frequencies  
20 for, you know, three, what I think people would regard  
21 as being different plants made by different  
22 manufacturers with different materials in them and so  
23 on and so on and so on show such remarkably consistent  
24 behavior in the frequency of through-wall cracking.  
25 And that's in large part due to the fact that the

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transients and the transient classes that are controlling, that are contributing the most to the through-wall cracking frequency are pretty consistent from plant to plant, and that point is made on this slide and on the next slide.

First, we observe that it's primary side failures that dominate risk. Seventy-five percent of the risks of the through-wall cracking frequency or more in all of these plants comes from either the medium to large diameter pipe breaks on the primary side or stuck open valves on the primary side, and then they reclose later. You can notice from looking at the graphs that there's a crossover in these two that, at lower levels of embrittlement, it's the primary side. It's the stuck-open valves on the primary side that may later reclose the control because, at the lower levels of embrittlement you need that re-pressurization in order to derive the crack through the wall, whereas when you crank up the level of embrittlement and get out the very high levels of embrittlement approaching the 1 times 10 to the minus 6 limit, then you find that the pipe breaks are dominating because, in that situation, I'm sorry, at those high levels of embrittlement, pretty much getting a crack going is all you need and it will go

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1 through the wall.

2           The other thing to note from this is,  
3 unlike in the previous analyses of pressurized thermal  
4 shock, the main steamline break and, indeed, all  
5 secondary side events are making a much smaller  
6 contribution relative to the primary side breaks. And  
7 the reason for that is simply that, in a secondary  
8 side break, the minimum temperature in the primary  
9 can't go below the boiling point of water at the  
10 pressure of the break location. And that keeps the  
11 toughness of the material high enough to, in large  
12 part, resist frequent crack initiations and through-  
13 wall cracking.

14           The other thing I'd note, which is  
15 indicated by the parenthetical comment under the main  
16 steamline break, is that there, and I won't go into  
17 details here unless asked, but there are various  
18 conservatisms in our model of main steamline breaks,  
19 the most prominent of which is the most severe  
20 steamline breaks are breaks which occur inside  
21 containment. However, even for a break inside  
22 containment, we've modeled the minimum temperature as  
23 being 212 degrees Fahrenheit, which is to say we don't  
24 account for the beneficial effect of the break inside  
25 containment, pressurizing containment and delaying the

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1 boiling point of water to something like 450 or 460  
2 degrees Fahrenheit.

3 So that's a 30 or 40-degree conservatism  
4 that, if we were to include it, would drive the  
5 through-wall cracking frequency contribution to main  
6 steamline breaks --

7 MR. POWERS: You mean 240 or 260?

8 MR. ERICKSONKIRK: Yes, I'm sorry. I'm  
9 sorry, yes. Would drive the main steamline break  
10 contribution even lower than we're showing.

11 MR. POWERS: And the motivation for not  
12 including this?

13 MR. ERICKSONKIRK: I'm not sure I could  
14 speak to why we excluded it originally. Maybe Dave  
15 can?

16 MR. POWERS: Well, we would have had to  
17 have added some type of containment model, coupled  
18 with RELAP. Basically, that would simplify the  
19 analysis.

20 CHAIRMAN BONACA: That raises a number of  
21 issues then regarding the steamline break during the  
22 subcommittee meeting that I think they're going to  
23 look at. The first one is the generalization. I  
24 know, for one, the behavior of the steamline break in  
25 a B&W plant is critically different from the one, just

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1 simply because of the huge inventory of water in the  
2 steam generators of those plants, and B&W not having  
3 any steam generator inventory. So, therefore, you  
4 have a much more rapid cool-down. I was told that  
5 this cool-down that they assumed anyway bounced that  
6 valve, so I think the cool-down rate for the B&W plant  
7 is much more severe.

8 The other issue that I just brought up was  
9 the concern that it was a steamline break is because  
10 you have cool-down and then you have the re-  
11 pressurization of the plant. And it was assumed,  
12 after TMI, no credit for the operator to shut off a  
13 high-pressure injection. And the reason is that they  
14 have no symptom-rated procedures. It was 1980. We  
15 were very concerned about the operator simply not  
16 taking action. But I was told during the presentation  
17 that re-pressurization doesn't count, doesn't matter  
18 anymore. So those issues I just brought up, and I  
19 think it's good we have it in the record.

20 MR. ERICKSONKIRK: Yes. I think we  
21 certainly intend to respond to your comments with  
22 better explanation and documentation. Since you  
23 brought it up again, I did want to throw this up.  
24 These are, on the top, temperature transients, and the  
25 bottom, pressure transients for main steamline breaks

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1 at hot-zero power, and the numbers are just the  
2 transient numbers in Oconee, Beaver, and Palisades.

3 And the thing I wanted to point is that  
4 the smaller inventory in Oconee relative to Beaver and  
5 Palisades indeed does lead to a very rapid initial  
6 cooling rate, which you almost can't see here because  
7 it's right at the tip of my cursor. So, indeed,  
8 Oconee does cool off very fast initially, but because  
9 the steam generator boils dry so very, very fast, it  
10 can't cool down the primary anymore. So, in fact, the  
11 cool-down rate in Oconee is much more gradual over the  
12 long haul than in Beaver and Palisades, and that's  
13 consistent --

14 CHAIRMAN BONACA: Actually, because you  
15 assume isolation of the water.

16 MR. ERICKSONKIRK: That's right.

17 CHAIRMAN BONACA: Well, okay. The  
18 original calculation didn't have that.

19 MR. ERICKSONKIRK: Yes.

20 CHAIRMAN BONACA: Okay. And what is the  
21 second, the pressure of what, primary system pressure  
22 --

23 MR. ERICKSONKIRK: Primary system  
24 pressure.

25 MR. SHACK: It might also be useful to

1 plot that graph as a conditional probability of  
2 failure, as well as a through-wall, so you'd know how  
3 much was due to the fracture mechanics and how much  
4 was due to the frequency of the events.

5 MR. ERICKSONKIRK: Yes. In order, the  
6 graph, though, I think the graph you're referring to  
7 is this one. You can only do -- and I've gotten  
8 myself caught in this before, so I'm not going there  
9 again; bad experience. You need to find -- I think we  
10 can do that, and that would be a useful comparison.  
11 But you need to do head-to-head comparisons of  
12 individual transients to compare conditional  
13 probabilities. You can't add up all the conditional  
14 probabilities from various transients without waiting  
15 by the frequencies, or the PRA people start to throw  
16 things at me, and I don't like that.

17 So, anyway, you're absolutely right.  
18 There are differences between the two plants that we  
19 need to --

20 CHAIRMAN BONACA: Most of all, I mean, I  
21 think, as I suggested the day before yesterday, it's  
22 good in the report to have historical perspective.

23 MR. ERICKSONKIRK: Yes.

24 CHAIRMAN BONACA: You know, isolation of  
25 water was unassumed. So you had a cool-down and as

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1 rapid as the beginning to the end.

2 MR. ERICKSONKIRK: All the way to the end.

3 CHAIRMAN BONACA: And so that's the  
4 questions that Tom Burley has asked.

5 MR. ERICKSONKIRK: Yes.

6 CHAIRMAN BONACA: He was thinking out of  
7 memory as I did.

8 MR. ERICKSONKIRK: And that would  
9 certainly be more severe, and that illustrates the  
10 point very well, so we'll include that.

11 Okay. We already made, or I already made  
12 in the last slide the first point here regarding the  
13 transients controlling failure to, generally, the  
14 secondary side breaks are much less damaging than  
15 primary side simply because you can't drive the  
16 temperature in the primary anywhere near as cold as  
17 you can when you have a primary side break. The other  
18 point to make is that, while we've made what we feel  
19 to be reasonable and appropriate credits for operator  
20 action, in the end, when you look at the transients  
21 that are dominating, that are making the largest  
22 contribution to the through-wall cracking frequency,  
23 operator action credits have relatively small  
24 influence on those results.

25 For example, a pipe breaks on the primary

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1 and no operator action credits whatsoever. And for  
2 the stuck-open valves on the primary, while we did  
3 make operator action credits, the operator has to act  
4 very rapidly and then can only prevent re-  
5 pressurization under hot-zero power conditions. So  
6 the net effect on the transients that contribute to  
7 the through-wall cracking frequency is, again, small.  
8 And as we said, operator actions influence main  
9 steamline break, but they're just not severe enough to  
10 count.

11 So this is a really short summary of why  
12 we believe our findings can be applied without too  
13 many reservations to PWRs in general, the first being  
14 a point I made that transients that contribute most of  
15 through-wall cracking frequency have approximate equal  
16 occurrence rate and approximately equal severity  
17 across plants. Operator actions don't count for much.

18 Other factors that contribute are the PWRs  
19 that we're regulating have very similar designs,  
20 similar operating pressures, similar vessel  
21 thicknesses, and so on. Our sensitivity studies have  
22 shown that the calculational models we use are robust  
23 to credible changes in the sub-models and parameter  
24 inputs subject to some reservations, which may be  
25 discussed later, hopefully when I'm not up here.

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1           We have many conservatisms left in the  
2 model, and I'll provide a list of those. We do have  
3 two equivocations that we put forward regarding the  
4 general applicability of these results, and one is  
5 with regard to forgings that are prone to sub-clad  
6 cracking. If those were taken to very high  
7 embrittlement levels, we would suggest that the  
8 licensee or interested parties would be well advised  
9 to do a more detailed analyses than we've done here.

10           And, also, our analyses have been  
11 performed on vessels that are in the range of eight to  
12 nine inches thick. And that's as thick or thicker  
13 than all but three vessels in the PWR fleet. As you  
14 go up to thicker vessels, you get a systematic  
15 increase in through-wall cracking frequency.  
16 Fortunately, the three very thick vessels are the  
17 Paulo Verde vessels, and they all have fairly low  
18 levels of the radiation embrittlement. So in  
19 principle, there's a limitation there, but, because  
20 the Paulo Verde vessels aren't very embrittled, I  
21 don't think it's a practical one.

22           Again, more formulas. The formulas shown  
23 on this view-graph are simply the equations that were  
24 fit to the through-wall cracking frequency results  
25 that I showed before. And so we're proposing an

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1 estimation formula, if you will, that says the total  
2 through-wall cracking frequency is equal to the sum of  
3 the through-wall cracking frequency produced by the  
4 axial welds, by the plates, and by the circumferential  
5 welds.

6 And then we can use this formula together  
7 with the 1 times 10 to the minus 6 limit on through-  
8 wall cracking frequency to derive combinations of  
9 these various reference temperatures that are either  
10 above or below the 1 times 10 to the minus 6 limit.  
11 So, for example, if we want to derive the acceptable  
12 limits on reference temperatures for a plate-welded  
13 plant, we already said that the circ weld contribution  
14 is very small, so, for purposes of illustration, you  
15 can just set that to zero.

16 And that leaves us with two variables in  
17 the equation: reference temperature for the axial weld  
18 and reference temperature for the plate. Set the  
19 total through-wall cracking frequency to your proposed  
20 limit of 1 times 10 to the minus 6, and then just  
21 simply set it up in a spreadsheet and plug in values  
22 for reference temperature axial weld and calculate  
23 what the value is for reference temperature plate to  
24 get you to 1 times 10 to the minus 6 total. And if you  
25 do that again and again and again, you trace out

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1 failure low sides that look like this, which, as one  
2 of my colleagues in NRR pointed out, is effectively a  
3 box with the corner cut off.

4 Be that as it may, these are now low side  
5 of constant through-wall cracking frequency. And  
6 we've highlighted the low side associated with the 1  
7 times 10 to the minus 6 limit in red, so that would,  
8 effectively, become the proposal for your new  
9 screening limit. So that's to say that for plate-  
10 welded plants, reference temperature of the axial  
11 welds has to be below 210 degrees, reference  
12 temperature for plates needs to be below, I think  
13 that's like 475 degrees.

14 For forging plants, since they don't have  
15 axial welds, you don't need to worry about that.  
16 Reference temperature for the circ weld is 460, which  
17 is too high to matter to anyone. And, again,  
18 reference temperature for the forging is the same as  
19 reference temperature for the plate, and that's about  
20 375.

21 So then the question, of course, comes up,  
22 well, where are the plants that are operating today  
23 relative to that limit? So we use the information  
24 that's available in ARVID to calculate these various  
25 reference temperatures for all the PWRs that are

1 currently in operation. This shows the results of  
2 that assessment at end of license or 40 calendar  
3 years, and, as you can see, the plate-welded plants  
4 are, generally, a bit worse off than the forging  
5 plants but none of them have a failure frequency above  
6 1 times 10 to the minus 7 events per year, and none of  
7 them are within even, I think, 60 degrees Fahrenheit  
8 of the screening criteria, screening limit. I'm  
9 trying not to use the word criteria.

10 If you go up, if you crank up fluence to  
11 EOLE and, of course, in doing that, you have to assume  
12 constant fuel loading, the plants all move 10 to 20  
13 degrees Fahrenheit closer to the screening limit. The  
14 histogram here shows the estimated through-wall  
15 cracking frequency for the population of all the PWRs  
16 made out of rolled plates and all the PWRs made out of  
17 forgings out to 32 effective full-power years or EOL.  
18 And you see that, by and large, certainly, the mean of  
19 the distribution is very far from 1 times 10 to the  
20 minus 6 limit. And even when you go the upper bounds,  
21 the plate vessels are more than an order of magnitude  
22 away, and the forge vessels are like four orders of  
23 magnitude away.

24 So now the question arises should someone,  
25 could someone take the limits that are proposed and

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1 just use them straight out, or should you add some  
2 sort of a margin term to it? And that's obviously a  
3 judgment that doesn't get made by me, although, like  
4 everybody else, I'm entitled to my opinion. But I  
5 would propose and, indeed, one of our reviewers, Dr.  
6 Murley, proposed that an appropriate way to make that  
7 judgment would be to sit and get a piece of paper out  
8 and write down all of the residual conservatisms and  
9 all the residual non-conservatisms that have been left  
10 in the analysis.

11 And we've taken a cut at doing that. We  
12 tried to make it comprehensive. There are probably  
13 things that we missed here, but I think these are the  
14 type of factors that people need to keep in mind when  
15 saying, you know, do I need to apply a margin to this.  
16 Now, some of these are unequivocally conservative or  
17 unequivocally non-conservative. For example, we  
18 clearly have over-represented the contribution of main  
19 steamline break because we've modeled the minimum  
20 temperature as being too cold. Having said that, main  
21 steamline break doesn't matter too much anyway.

22 We've unquestionably overestimated the  
23 plant-specific variability in copper, nickel,  
24 phosphorous, and fracture toughness relative to any  
25 plant-specific analysis. Other things are more

1 subject to judgment, but I think this is an  
2 appropriate approach to look at this.

3 MR. SHACK: Would the neutron attenuation  
4 function be a big player? Somehow, it seemed to me it  
5 would.

6 MR. ERICKSONKIRK: I think so, but, and  
7 I've got to say the but, is that neutron attenuation  
8 is going to be a much bigger player in the heat-up and  
9 cool-down limits than it is here because, if you  
10 remember the plot that I had yesterday, it showed that  
11 everything that's contributing to the through-wall  
12 cracking frequency is within one inch of the inner-  
13 diameter of the vessel wall. So, I mean, the further,  
14 the deeper you go into the vessel wall, the more the  
15 attenuation function you use counts, whereas you're  
16 just not attenuating all that much in the first inch.

17 MR. SHACK: I was hoping it would give you  
18 more crack arrest.

19 MR. ERICKSONKIRK: Well, no, no. I'm  
20 sorry. You're absolutely right. You're absolutely  
21 right.

22 MR. SHACK: It wouldn't do anything for  
23 initiation.

24 MR. ERICKSONKIRK: It wouldn't do anything  
25 for initiation. It would do something for crack

1 arrest. You're absolutely --

2 MR. ROSEN: How about if a plant started  
3 using a lot of MOX fuel? What would that do to this?  
4 Would that have an effect?

5 MR. ERICKSONKIRK: And that would increase  
6 the -- yes.

7 MR. ROSEN: -- towards a harder spectrum  
8 or --

9 MR. ERICKSONKIRK: I think what would, I  
10 don't think it would change the limits in particular.  
11 What it would change is the rate at which you're  
12 approaching the limits. It would change how -- I  
13 mean, if a plant decided to change to MOX fuel and it  
14 had a failure point that was moving out, you know,  
15 sort of on that slope, it might change to a higher  
16 slope and approach the limits faster.

17 MR. POWERS: Let me point out that most of  
18 the plants that use MOX don't have it out on the outer  
19 perimeter, so it's basically shielded, so it really  
20 doesn't see the harder spectrum at all.

21 MR. ROSEN: So the wall wouldn't see it?

22 MR. POWERS: It doesn't really see it.

23 MR. ROSEN: Pardon me?

24 MR. POWERS: It doesn't really see it. I  
25 mean, essentially, when we looked at the LTAs, it was

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1 just --

2 MR. RANSOM: How about power-up?

3 MR. ERICKSONKIRK: Well, again, I think  
4 anything you do to change the, anything you do to  
5 change the fluence, change the rate of which you're  
6 damaging the vessel is going to manifest itself not in  
7 a change in these failure loci, but it's going to  
8 change how fast a particular plant is getting there.

9 MR. RANSOM: I thought the general  
10 conclusion was that this stuff didn't seem to be a  
11 problem, and I think we've heard that as far as power-  
12 up is concerned, too. And I'm just wondering is that  
13 a problem?

14 MR. ERICKSONKIRK: I think yes, it would  
15 depend upon the plant. And that's something you're  
16 going to find out because you're doing surveillance.  
17 I guess the other point I want to -

18 MR. POWERS: Do these plants have coupons  
19 for doing surveillance on a regular basis?

20 MR. ERICKSONKIRK: Bruce can probably  
21 answer that better than I, but when somebody goes for  
22 a license extension, in a lot of cases don't they put  
23 in extended surveillance?

24 MR. BISHOP: Yes, yes, you have to.

25 MR. ERICKSONKIRK: You have to.



1 MR. BISHOP: You have to. The comment  
2 about the power uprights, if you did power uprights  
3 very early in life, it could have a big effect. But  
4 because the fluence effects tend to saturate once you  
5 get above a certain level, power uprights later in  
6 life have much less effect.

7 MR. ERICKSONKIRK: I guess the other point  
8 that I wanted to bring out, just in terms of people  
9 thinking about margins because I'm sure we're going to  
10 be thinking about what to do with this for some time,  
11 is that, you know, effectively, what you're doing when  
12 you're putting a margin on these curves is you're  
13 saying that my acceptable limit is not 1 times 10 to  
14 the minus 6, it's something lower. So there is a  
15 rough equivalence there, and if we've spent all this  
16 time on establishing what an appropriate limit is, is  
17 it then appropriate to apply a margin to that, or  
18 perhaps we should just think that we need a more  
19 restrictive limit.

20 Because that is, indeed, what you're  
21 doing. I mean, I counted it out. Every 80 degrees  
22 Fahrenheit of margin or whatever you want to call it  
23 that you move, you're knocking off two orders of  
24 magnitude. No, I'm sorry, one order of magnitude is  
25 80 degrees of Fahrenheit on RTAW. Go ahead, I'm

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1       sorry.

2                   MR. DENNING:    I think I look at it  
3       differently, which is that instead of coming up with  
4       the best estimate value and putting uncertainties on  
5       it, you've built in conservatisms into your model.

6                   MR. ERICKSONKIRK:   Yes.

7                   MR. DENNING:    And so I think the question  
8       of margins is a question of do we really believe that  
9       the conservatisms that you've built in adequately  
10      account for the uncertainties.   The margins that you  
11      put in, do they adequately account for that?   So I  
12      don't think anybody is going to argue, particularly 1  
13      times 10 to the minus 6.   I think it's a question of  
14      have you really built in the conservatisms.

15                  MR. ERICKSONKIRK:   That was the end of my  
16      prepared remarks.    If there aren't any further  
17      questions on this, we can move to the final comments  
18      from the --

19                  MR. RANSOM:    A quick question.   On your,  
20      I think, third slide that material factor is  
21      controlling vessel failure.   You have three curves on  
22      that.

23                  MR. ERICKSONKIRK:   Yes.

24                  MR. RANSOM:    With this comment to  
25      reference temperature characterizes all of the

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1 toughness properties of interest, I don't recall you  
2 talking about that the other day.

3 MR. ERICKSONKIRK: Well, what that says  
4 is, and I guess I might have given that the short  
5 shrift, is that the reference temperature, once you  
6 establish the reference temperature for the cleavage  
7 crack toughness initiation curve, all of the other  
8 reference temperatures, if you will, where the arrest  
9 fracture toughness curve is, where you hook on the  
10 ductal upper shelf fracture toughness curve, they're  
11 all linked. They all can be calculated from that as  
12 a unique function.

13 MR. RANSOM: Do they play any role?

14 MR. ERICKSONKIRK: To those other curves?  
15 Oh, absolutely, because, well, the arrest toughness  
16 curve is what we use as we propagate. Once the crack  
17 initiates, then we need to decide has it arrested, has  
18 it stopped. So that plays a very big role in whether  
19 the crack gets all the way through or not. And then --

20 MR. RANSOM: I thought this reference  
21 temperature was used to just as a parameter for  
22 through-wall cracking frequency.

23 MR. ERICKSONKIRK: It's both. It's  
24 something that characterizes the position. For  
25 example, if you were doing experiments in the

1 laboratory, you could figure out by conducting  
2 cleavage crack initiation test where your reference  
3 temperature is to characterize that. And then if you  
4 were to do subsequently arrest fracture toughness test  
5 and a ductal upper shelf fracture toughness test, you  
6 could estimate where those test data would lie based  
7 on the knowledge of this. But then you also use it  
8 on, it's a convenient parameter to use on the back-end  
9 simply because it does characterize all of the  
10 fracture toughness values that are what's stopping the  
11 fractures.

12 MR. RANSOM: Well, do these other  
13 toughness factors come into play in those plots that  
14 you make up for the three different kinds of  
15 transients?

16 MR. ERICKSONKIRK: Yes, yes. It's all in  
17 there.

18 MR. RANSOM: They play a role?

19 MR. ERICKSONKIRK: Yes. Because the  
20 through-wall cracking, remember the through-wall  
21 cracking frequency is the integration of how all these  
22 toughness values are acting to resist the applied  
23 loading. Any other questions? Okay, then we'll go  
24 through the peer review comments and the usual and  
25 customary PRA thermal hydraulics PFM order, if that's

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1       okay.

2                       So we'll start with PRA.     And Donnie  
3       Whitehead will make that presentation.

4                       MR. WHITEHEAD:     My name is Donnie  
5       Whitehead, and I will talk about the one additional  
6       new comment that we received from the peer review  
7       group. Dr. Murley provided --

8                       MR. APOSTOLAKIS: I'm sorry, who were the  
9       peer reviewers?

10                      MR. WHITEHEAD:    The peer reviewers? I  
11       know Dr. Murley was one. There's a list. I can't  
12       recall all of their names.

13                      MR. HISER:       This is Alan Hiser from  
14       research. Dr. Catton from GRS Germany, Eric VonWalle  
15       from SEKC in Belgium.

16                      MR. APOSTOLAKIS: Who was the PRA expert  
17       reviewer?

18                      MR. HISER:       David Johnson from ABS  
19       Consulting.

20                      MR. APOSTOLAKIS: ABS.

21                      MR. HISER:       Thermohydraulics was Ivan  
22       Catton and Cumard Brohotki.

23                      MR. WHITEHEAD:    Dr. Murley had a comment  
24       dealing with the assumption that was made for the SRV  
25       opening size being uniformly distributed, and he said

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1 that he believed that that was intuitively incorrect.  
2 Our initial response is to agree with the comment that  
3 he's made and that we probably shouldn't have made  
4 this assumption.

5 What we're going to do is we're looking in  
6 and investigating to see what kind of effect that  
7 would have on the overall results. It's not expected  
8 to have, you know, too big of an impact on the  
9 results, but, at this point in time, we've got the  
10 comments like the day before yesterday, and we just  
11 simply haven't had enough time to determine its, you  
12 know, total impact on the results but --

13 MR. POWERS: Donnie, is it the wings that  
14 are the ends of the distribution that will have an  
15 effect, or is it the mean?

16 MR. WHITEHEAD: The value that we used for  
17 this SRV opening was just simply a fraction, so  
18 there's no real, we did not sample any uncertainty  
19 associated with this. So it would be a matter of just  
20 simply taking out that particular basic event from all  
21 of the cut sets that we calculated.

22 MR. POWERS: I mean, typically, any high  
23 entropy distribution, if it's the wings that are doing  
24 it for you, it didn't matter which one you pick.

25 MR. WHITEHEAD: And we don't really expect

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1 a substantial change from this, but we just simply  
2 haven't had the opportunity to --

3 MR. POWERS: What's holding you up?

4 MR. WHITEHEAD: I guess I'm just slow.

5 MR. POWERS: You're just slow, I guess.

6 MR. WHITEHEAD: And that's actually the  
7 only additional comment that we had.

8 MR. APOSTOLAKIS: That's it? That's all  
9 Dave Johnson said? He didn't say anything.

10 MR. ERICKSONKIRK: That was the only  
11 negative comment. Dr. Johnson commented that he  
12 thought that our modeling of stuck-open valves in the  
13 primary that later re-closes is grossly conservative.

14 MR. APOSTOLAKIS: So he disagreed with  
15 Murley.

16 MR. ERICKSONKIRK: Yes. Dr. Johnson  
17 commented that he felt that if a valve was going to  
18 reclose, it was likely to reclose very early in the  
19 transient rather than later, which would lead to a  
20 much lower through-wall cracking frequency than is  
21 incorporated in our models. So yes, he disagreed with  
22 Murley on that point.

23 MR. BESSETTE: I'm going to try to briefly  
24 review the main issues that were discussed with  
25 respect to the thermohydraulic analysis. These come

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1 under the general heading of the three boundary  
2 condition parameters that we provide to the fracture  
3 mechanics analysis, namely pressure, temperature, and  
4 heat-transfer coefficient.

5 One of the comments that most important  
6 parameters that were evaluated in the uncertainty  
7 analysis relate to system boundary conditions rather  
8 than physical phenomena modeled by RELAP itself. And  
9 examples of boundary conditions of break size, break  
10 location, ETCS flow, ETCS temperature, and those sort  
11 of things.

12 MR. RANSOM: Is that a negative comment?

13 MR. BESSETTE: It wasn't negative. It was  
14 like is this really factually correct or, you know,  
15 how can it be that boundary conditions play such an  
16 important role? It's like an observation or  
17 something. It's, in a sense, can you show me why this  
18 is so.

19 We did all the analyses, but, basically,  
20 the all the analysis for RELAP5, which is one-  
21 dimensional thermohydraulic code. And our questions  
22 with respect to fluid temperature or thermal  
23 stratification and mixing in the cold leg and  
24 downcomer and also questions with respect to the  
25 treatment of convective heat transfer in a downcomer

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1 in the fluid to the wall.

2 And this shows an example of, tries to  
3 show an example of why the boundary conditions tend to  
4 dominate the analysis. These are the five transients  
5 that represent the small break LOCA for Palisades, and  
6 you can see that, basically, within the regime of  
7 small-break LOCA, you get a very wide range of  
8 behavior. This is temperature on the left and  
9 pressure on the right. You can see variations of 100  
10 degrees K or more for a class of transient called  
11 small break LOCA.

12 And the reason for that, of course, is  
13 that the system in-flow and out-flow, the break flow,  
14 and ECCS flow dominate the parameters of temperature  
15 and pressure to the system and overwhelm other  
16 effects. These are the issues, main issues with  
17 respect to the treatment of the adequacy of RELAP for  
18 PTS analysis. This prediction of downcomer temperature  
19 and pressure. The question of are there substantial  
20 non-uniformities in downcomer temperature that are not  
21 captured by RELAP? Like I said, the wall heat  
22 transfer.

23 So to address these, we performed  
24 substantial PTS-specific assessment, and we used the  
25 best available integral system test data that was

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1 available to us from past programs. This included  
2 UPTF, LOFT, ROSA, APEX, and MIST. And MIST was a  
3 facility that was configured according to B&W design.  
4 The other facilities were all scaled according to CE  
5 Westinghouse-type reactors.

6 From these five facilities, we selected 12  
7 experiments that represented the same types of  
8 sequences that show up as risk-dominant PTS  
9 transients. And using these 12 experiments, we  
10 assessed the code for downcomer temperature and system  
11 pressure and performed statistical comparison between  
12 RELAP and experimental data, and we found that,  
13 overall, RELAP predictions were within four degrees K  
14 of the total body of experimental data.

15 MR. DENNING: Excuse me. I really have to  
16 object to that 4 K and what its meaning is. The way  
17 you've taken differences between downcomer  
18 temperatures for these, some of them much greater than  
19 4 K positive, a lot of them much less than 4 K  
20 negative, average them together, that just doesn't  
21 make sense. That's not a characteristic of the  
22 accuracy. Your second one, the 11 K, is certainly  
23 much closer to a true characterization, but the way  
24 the 4 K is done, it's just nonsensical to think that  
25 that represents a measure of the accuracy with which

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1 RELAP has predicted the behavior of those facilities.

2 MR. BESSETTE: Well, certainly, standard  
3 deviation captures what you're talking about. If you  
4 prefer using absolute value, 4 K becomes 8 K, 7 or 8  
5 K. I personally think that 4 K, using arithmetic  
6 average is appropriate because you're interested in  
7 what boundary condition is being fed to FAVOR. And,  
8 it's true that, sometimes, during any given transient,  
9 RELAP may be sometimes over-predicting temperature and  
10 under-predicting temperature. That total behavior is  
11 captured by standard deviation, but you're also  
12 interested in absolute accuracy.

13 MR. DENNING: That didn't help my comment,  
14 I don't think.

15 MR. BESSETTE: I do. I certainly listened  
16 to your comment yesterday. Like I say, if for anyone  
17 who prefers absolute value, it comes out to about 7 K  
18 instead of 4 K.

19 And it's the same thing, the comment  
20 applies to system pressure. And we come up with an  
21 average. You might call this the average deviation is  
22 like a bias, an average bias between RELAP and the  
23 data. And that's about 9 psi for pressure for the  
24 standard deviation of about 60 psi.

25 MR. RANSOM: Well, is that comment

1 relative to the transient behavior with time?

2 MR. BESSETTE: Yes, this is over the  
3 duration of the entire transient, entire experiment.

4 MR. RANSOM: And as I understand it,  
5 probably the more important thing is whether or not  
6 the rate of change of temperature is correct.

7 MR. BESSETTE: Well, you want to know that  
8 your rate of change is correct, certainly, yes.  
9 You're interested to know if your -- see, the vessel  
10 time constant as a whole is on the order of a thousand  
11 seconds or more. So if your fluid temperature is  
12 roughly accurate over that kind of a time constant,  
13 then that's one figure of merit.

14 You also have to be concerned about  
15 shorter times, like in the order of ten or tens of  
16 seconds because the short thermal variations do effect  
17 the near-surface temperature of the vessel, which is  
18 where the flaws are that cause the vessel failure.

19 MR. RANSOM: Well, did you provide these  
20 two papers, the one by Ivan Catton on the impact of  
21 heat-transfer coefficient and the other one on the,  
22 more or less, the mixing in the downcomer? They seem  
23 to support what you were saying yesterday that these  
24 results are somewhat insensitive to heat-transfer  
25 coefficient and also the things are relatively well

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1 mixed, I guess.

2 MR. DENNING: I didn't think that the  
3 Catton paper really provided much evidence that his  
4 heat-transfer correlation would be applicable here  
5 because he certainly was dealing with an established  
6 plume. And from everything we've been hearing, it's  
7 really well mixed and not an established plume.

8 MR. BESSETTE: Well, Catton, you know,  
9 Catton wasn't really dealing with plumes. He was  
10 dealing with average behavior. I mean, he wanted to  
11 know how much mixed convection would enhance heat  
12 transfer.

13 MR. DENNING: But if you look at his  
14 theoretical development, he's got a plume that moves  
15 down, well defined, and he looks at what happens at  
16 the interfaces of that plume.

17 MR. RANSOM: Well, one point was that he  
18 was arguing, you know, modeling the natural convection  
19 that occurs with the cold water/warm water, and that  
20 that resulted in a well-mixed situation apparently or  
21 enhanced mixing.

22 MR. SHACK: Yes. What I took away was he  
23 got a heat-transfer coefficient that's about three and  
24 a half times Dittus Boelter.

25 MR. BESSETTE: Yes.

1 MR. SHACK: And that's a little bit larger  
2 than yours.

3 MR. BESSETTE: No, well, you know, he  
4 compared his to Dittus Boelter, had low-flow  
5 conditions, Churchill-Chu was invoked was in RELAP,  
6 and Churchill-Chu is, the reason it's invoked is  
7 because the higher value in Dittus Boelter. So if you  
8 compare Catton to Churchill-Chu, you don't get this  
9 three and a half times.

10 MR. SHACK: What do I get?

11 MR. BESSETTE: Twenty percent. Well, I  
12 should say, overall, it's 20 percent. It can be more  
13 than that or less. It can be up to twice as much as  
14 Churchill-Chu.

15 MR. WALLIS: Okay. But it looks more like  
16 the sensitivity results you were showing us yesterday.

17 MR. BESSETTE: Yes.

18 MR. WALLIS: So there is a basis for those  
19 sensitivity results?

20 MR. BESSETTE: I didn't make them up. But  
21 at any rate, so you're dealing, basically, during  
22 these transients, you're dealing with overall  
23 temperature changes of about 200 or 250 K during the  
24 course of the transient. So RELAP has to track an  
25 experiment which starts off at 550 F and ends up at

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1 about 100 to 150 F. And so you can see that it's  
2 tracking this behavior pretty well.

3 And then the final point is we looked at  
4 the available experimental data with respect to  
5 temperature stratification, non-uniformities, you  
6 know, particular plumes in a downcomer. And we looked  
7 at the integral system test data and went back and  
8 looked at the separate effects tests that were done  
9 during the 1980s, and we find plumes to be either very  
10 weak or essentially non-existent. I mean, the  
11 definition of weak or non-existent is about 5 to 20 K.

12 All the experiments show substantial  
13 stratification in the cold leg due to ECC injection.  
14 I'm just going to show one example, and that's from  
15 APEX. Typically, you see stratification in the cold  
16 leg of about, oh, in this case, anywhere from 50 to  
17 100 degrees K, and you can see for this experiment the  
18 stratification is very nearly the difference between  
19 the initial system temperature and the ECC  
20 temperature. So you get most of the mixing that  
21 occurs is not occurring in the cold leg. You get some  
22 cold leg mixing, but that's, you do get substantial  
23 stratification in the cold leg. And, of course, RELAP  
24 cannot account for this kind of behavior.

25 But then we turn to the data from the

1 downcomer. This is the same experiment from APEX.  
2 And you can see, like, taking this at random. We ran  
3 about 20 different experiments in APEX in support of  
4 the PTS program, where we tried to run as a variety of  
5 PTS-type transients, and this is one of the  
6 experiments.

7 The other experiments saw the same  
8 behavior. On the left is the measurements at, this is  
9 axial variation in downcomer temperature from just  
10 underneath the cold leg, at one point three diameters  
11 down, to eight diameters, it's around the top or mid-  
12 plane of the core. So there's no evidence of axial  
13 variation. And the RELAP calculation for this  
14 experiment is on the right.

15 MR. WALLIS: Why does it get that zero?  
16 When it comes in with this tremendous stratification?  
17 It all disappears at zero? What's that mean? The  
18 bottom of the cold leg? What does zero mean there?  
19 In the caption down below, it says fluid temperatures  
20 at zero.

21 MR. BESSETTE: Oh, okay. I think the one  
22 at zero is in between cold legs.

23 MR. WALLIS: It says, I think what it  
24 means is the below each cold leg centerline, isn't it?

25 MR. BESSETTE: I thought it was measuring



1 distance down --

2 MR. WALLIS: Below cold leg centerline,  
3 isn't it?

4 MR. BESSETTE: Bill, you want to say  
5 something?

6 MR. ARCIERI: Yes, this is Bill Arcieri  
7 from ISI. I think zero is just basically at the cold  
8 leg, and then you go 1.3 diameters down, and then 8  
9 cold leg diameters down. I believe that's the case.

10 MR. WALLIS: -- cold water is coming out  
11 of the cold leg.

12 MR. BESSETTE: I think this is in between  
13 cold legs, though, not right in front, but I can't  
14 remember for sure.

15 MR. WALLIS: Because it can't instantly  
16 change its temperature.

17 MR. BESSETTE: No, I agree with that.  
18 We'll check on that. From my recollection, it's not  
19 in front of that cold leg, but it's alongside of it.  
20 It's just cold water coming in, it won't see that cold  
21 water. And this is azimuthal variation looking down  
22 the downcomer for that same experiment.

23 MR. WALLIS: On the outside wall.

24 MR. BESSETTE: Kind of in the mid-plane of  
25 the gap.

1 MR. WALLIS: Well, then they're in the  
2 gap.

3 MR. BESSETTE: They're in the gap. And so  
4 on the left is the overall --

5 MR. WALLIS: But if the plume were on the  
6 wall and were not very thick, you wouldn't see it at  
7 all?

8 MR. BESSETTE: I can't imagine a plume  
9 running down the wall all the way down.

10 MR. WALLIS: I don't know what you can  
11 imagine. It's dangerous to imagine.

12 MR. BESSETTE: Yes. It's only a two-inch  
13 gap.

14 MR. POWERS: I am shocked.

15 MR. BESSETTE: As you can see, we start  
16 out just at the initial condition, and we end up down,  
17 this experiment runs from initial condition down to  
18 the final injection temperature. And on the right-  
19 hand side is a blow-up of this from 800 seconds to  
20 1600 seconds.

21 I'm going to turn to heat-transfer  
22 coefficient. In the PTS transients, the downcomer  
23 heat-transfer mode is predominantly what I would call  
24 a buoyancy-opposed mixed convection, which means you  
25 have a heated wall - in this case, you have heated

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1 walls on both sides with a colder fluid running down  
2 the middle.

3 Now, RELAP in this situation applies the  
4 maximum of Dittus Boelter, which is a turbulent force  
5 convection, and Churchill-Chu, which is pre-  
6 convection. And like I say, for low-flow conditions,  
7 low-velocity conditions, Churchill-Chu gives higher  
8 values of heat transfer than Dittus Boelter.

9 Now, going back to the original IPTS  
10 study, Catton has been very interested in the subject,  
11 and he had a program supported by EPRI back in the  
12 mid- to late-80s, where he ran experiments on this  
13 type of geometry.

14 MR. SHACK: It's Krillov now. It was  
15 somebody else yesterday.

16 MR. WALLIS: It was a Pole yesterday, now  
17 it's a Russian.

18 MR. BESSETTE: Yes, that reflects kind of  
19 what happened. See, when Catton did his work, he  
20 compared it to Petukhov Krillov, and when we  
21 implemented this into RELAP, we used Petukhov Yulinsky  
22 because it's very similar, except that Yulinsky  
23 extends the correlation down to lower values of  
24 Reynolds Number.

25 MR. SIEBER: You're making this all up,

1       aren't you?

2                   MR. WALLIS: I'm very puzzled. There's a  
3       friction factor, which you have to calculate somehow  
4       in this Petukhov correlation. Where does that come  
5       from?

6                   MR. BESSETTE: The calculation of friction  
7       by RELAP? It's done by RELAP. You've exhausted my  
8       knowledge at that point as to how it's implemented.

9                   MR. WALLIS: Well, I think what you have  
10      to do is show us some data from real downcomers, show  
11      that these correlations have some relationship to  
12      reality.

13                  MR. BESSETTE: Well, certainly. I mean,  
14      Ivan compared this to his own data. You know, he -  
15      based on this correlation, he applies a correction  
16      factor for low-flow conditions.

17                  Now, this is a comparison of the base-case  
18      RELAP modeling with what I'll call Petukhov-Catton,  
19      and that red being the base-case RELAP and the green  
20      being Petukhov-Catton. So you can see I picked four  
21      dominant transients from the 12 such cases from  
22      Palisades. I'm showing here, for hot leg break, 16-  
23      inch hot leg break, our main steamline break. And you  
24      can see that Petukhov-Catton does consistently flow  
25      above RELAP.

1 MR. WALLIS: Theory versus theory.

2 MR. BESSETTE: Which is, you know, what  
3 you'd expect. And this is four-inch surge-line break  
4 and a stuck-open pressurized SRV.

5 MR. WALLIS: Are you serious that APEX  
6 didn't measure heat-transfer coefficient?

7 MR. BESSETTE: They measured, they had  
8 thermocouples in the wall, but they couldn't get real  
9 precise numbers.

10 MR. WALLIS: But they got something.

11 MR. BESSETTE: They got something, and it  
12 looked --

13 MR. WALLIS: Did it compare with these, or  
14 was it off-scale somewhere?

15 MR. BESSETTE: As I recall, they compared  
16 it against Dittus Boelter, and they got reasonable  
17 results.

18 MR. WALLIS: I think that would be useful  
19 evidence.

20 MR. BESSETTE: Yes.

21 MR. HISER: It might even turn us into  
22 believers.

23 MR. BESSETTE: If the meeting was  
24 tomorrow, I could have dug that out.

25 MR. SIEBER: Well, we're here tomorrow.

1 MR. WALLIS: Maybe your final report can  
2 compare these theories with data?

3 MR. BESSETTE: Yes.

4 MR. WALLIS: Then we might be believers.

5 MR. BESSETTE: Yes. So you can see the  
6 results are similar, generally speaking. Petukhov-  
7 Catton is a little bit higher and, overall, for the 12  
8 Palisades transients, it's about 20 percent higher.

9 MR. WALLIS: So what does this do to the  
10 through-wall cracking?

11 MR. BESSETTE: It's down here. We ran all  
12 the 12 cases, both Palisades cases, through FAVOR, and  
13 we came up with a factor of three increase in --

14 MR. WALLIS: That's between the green and  
15 the red curve, your factor of three?

16 MR. BESSETTE: Yes.

17 MR. WALLIS: But they look fairly close.  
18 Well, how can that change the heat-transfer  
19 coefficient by 20 percent and create a factor of three  
20 increase in the CPF?

21 MR. BESSETTE: Well, I'll try to show you  
22 that.

23 MR. WALLIS: It looks as if it's important  
24 to know the heat-transfer coefficient pretty well.

25 MR. BESSETTE: Yes. Well, it's not

1 negligible, the effects are not negligible. Now, I  
2 have to remind you, when I say it's a factor of three  
3 in CPF, that's what I mean. It's not a factor of  
4 three in risk. We didn't go as far as to carry this  
5 through the --

6 MR. WALLIS: Does that mean that if these  
7 curves were wrong by a much bigger amount you might  
8 get a factor of ten, say, in CPF?

9 MR. BESSETTE: It's probably more likely  
10 they could be less. And we didn't multiply these by  
11 frequency of the transient, so we didn't carry this as  
12 far as to actually know how much the risk number  
13 changed.

14 MR. SIEBER: The heat-transfer  
15 coefficient, I would hope, is not a function of what  
16 causes the transient.

17 MR. BESSETTE: Could you say that again?

18 MR. SIEBER: Well, the thing you want to  
19 multiply should have nothing to do with heat-transfer  
20 coefficient. You want to multiply it by the frequency  
21 of the transient.

22 MR. BESSETTE: That's right, yes.

23 MR. SIEBER: I can't imagine the frequency  
24 of the transient effecting the heat transfer.

25 MR. BESSETTE: No, but the idea is that

1 not all these transients have equal frequency. And  
2 this factor of three may come from a low frequency or  
3 a low -- we're only comparing CPFs, and we went pretty  
4 far down, so some of these CPF --

5 MR. SIEBER: Well, for Palisades, you say  
6 you multiplied it by the risk-dominant transients.

7 MR. BESSETTE: Yes.

8 MR. SIEBER: Okay. And if that gave you  
9 a factor of three, your other transients, I don't care  
10 what they do, they're not going to effect that.

11 MR. BESSETTE: No, what I mean is that you  
12 could have a transient with a CPF of 10 to the minus  
13 9 that increased a 10 to the minus 8. It's still a  
14 miniscule number, but it's now changed by a factor of  
15 ten. So in order to get the risk, you have to sum up  
16 the things that are down here with things that are up  
17 here, you multiply it by the frequency --

18 MR. WALLIS: But you say transients,  
19 plural, so I'm assuming that they change by a factor  
20 of --

21 MR. BESSETTE: No, this is a total number.

22 MR. WALLIS: The risk-dominant one.

23 MR. BESSETTE: Yes, but not all risk-  
24 dominant ones are equal.

25 MR. WALLIS: Well --

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1 MR. POWERS: Now, that's a concept I want  
2 to explore a little bit.

3 MR. BESSETTE: Well, if you look at  
4 transients, for example, one might contribute 60  
5 percent of the total, one might be 20 percent, one  
6 might be one percent. We went down to about a tenth  
7 of one percent here.

8 MR. POWERS: Well, 20 percent is about the  
9 same number in PRA space. One percent, I'll agree, is  
10 different than 20 percent.

11 MR. BESSETTE: Yes. At any rate, so this  
12 is an indicator but not exactly a bottom line.

13 MR. POWERS: It's not a 20 percent for  
14 heat-transfer coefficient, it's a factor of five  
15 between what they calculate and what reality is.

16 MR. BESSETTE: It might be; I don't know.

17 MR. POWERS: Well, you don't know.

18 MR. WALLIS: So the 20 percent change in  
19 heat-transfer coefficient is quite easy to get because  
20 you have uncertainty in which correlation to use. You  
21 have this leverage of a factor of three on the wall.

22 MR. BESSETTE: Yes.

23 MR. WALLIS: And it could quite easily be  
24 a factor of 50 percent change or 50 percent error.

25 MR. BESSETTE: This shows you the effect

1 of varying the heat-transfer coefficient, but we --

2 MR. POWERS: It doesn't show it on the  
3 bottom line.

4 MR. BESSETTE: No, I know. But to give  
5 you an idea how bad can things be, we --

6 MR. WALLIS: Heat-transfer coefficient.

7 MR. BESSETTE: This, roughly, corresponds  
8 to something like about a one and a half-inch break to  
9 about a two and a half-inch break, so it's in the  
10 small-break region. On the right, we take the  
11 transient, we take this transient corresponding to  
12 this one here, where the decay constant is 30 minutes.  
13 And we varied the heat-transfer coefficient, and you  
14 can see here its effect on the delta T between the  
15 wall and the fluid.

16 MR. WALLIS: You have no idea how much  
17 leverage that has on --

18 MR. BESSETTE: Yes. And we varied it from  
19 800 up to 10,000, and I recall that RELAP is  
20 predicting heat-transfer coefficients in the region of  
21 1700, thereabouts, between 1700 and 3400.

22 So how far off can I be in terms of heat  
23 transfer? Well, if you go from the heat transfer of  
24 1700 to infinite, you would vary this delta T by about  
25 25 degrees Fahrenheit.

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1 MR. WALLIS: Well, what effect does that  
2 have on the backing of the wall?

3 MR. BESSETTE: It would have the same  
4 effect as a 25-degree change in fluid temperature. My  
5 point is that fluid temperatures during these  
6 transients is changing by about 300 to 400 F, and so  
7 to give you an order of magnitude comparison between  
8 the importance of fluid temperature --

9 MR. WALLIS: I don't have the whole  
10 perspective. It may well be that whether you get 300  
11 degrees temperature difference or 325 makes a big  
12 difference to thermal shock. I don't know. I think  
13 thermal shock is kind of a cliff-like phenomenon where  
14 all of a sudden you've shocked it too much and it's  
15 gone. It may be that that changed, that little bit of  
16 temperature change makes a big difference.

17 MR. BESSETTE: Yes, well, I agree. This  
18 is why, and I think the point I'm trying to make is  
19 that you have to consider the total fluid temperature  
20 change, which gets back to the RELAP calculation of  
21 downcomer fluid temperature --

22 MR. WALLIS: Surely you have some sort of  
23 influence on the bottom line? I don't think you're  
24 telling us very much.

25 MR. BESSETTE: You only get that influence

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1 through a full FAVOR calculations.

2 MR. ERICKSONKIRK: If I could interject,  
3 and I think the point is well taken that we need to do  
4 what both of you gentlemen just proposed, but just for  
5 point of information, when you look at the ten  
6 transients that Davis is talking about that are  
7 dominant for Palisades, the most dominant transient is  
8 the stuck-open pressurizer SRV that re-closes after a  
9 hundred minutes. That contributes, of any of the  
10 transients, the largest two - the through-wall  
11 cracking frequency, and the base-case CPF for that is  
12 6.5 times 10 to the minus 5. When you go with the  
13 modified heat transfer coefficient, the CPF actually  
14 goes down to 4.2 times 10 to the minus 5. Now, in the  
15 interest of providing a --

16 MR. WALLIS: Would you increase the heat  
17 transfer --

18 MR. ERICKSONKIRK: Yes. On that  
19 particular transient, yes. Now, in the interest of  
20 providing a balanced perspective, the next most  
21 important transient for Palisades is the 16-inch hot-  
22 leg break. The base-case CPF for that was 4.3 times 10  
23 to the minus 5. When you go to the Catton heat-  
24 transfer coefficient, you go up to 5 times 10 to the  
25 minus 4, a factor of ten increase.

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1 MR. WALLIS: A big change.

2 MR. ERICKSONKIRK: Yes. So I think the  
3 point is very well taken that to see the effect of  
4 this change of heat-transfer coefficient, things need  
5 to be weighted by the initiating event frequencies and  
6 --

7 MR. WALLIS: -- a factor of ten, I wasn't  
8 really wrong.

9 MR. ERICKSONKIRK: For that particular  
10 one. I'm still betting that the factor of three is  
11 right, but we'll do that and get back with you.

12 MR. BESSETTE: But you see these kind of  
13 sensitivities, for example in a stuck-open pressurizer  
14 SRV, it's not, this is kind of a long drawn-out  
15 transient. It's not particularly sensitive to age.  
16 In this case, the CPF went down. What it's most  
17 sensitive to is the re-pressurization.

18 MR. WALLIS: Well, I think what we need to  
19 do is we need to do exactly what Mark was saying. We  
20 also need to see what the APEX data looks like. I  
21 mean, if you point a data point on it, you know, where  
22 is it? And you have data from APEX. I don't think  
23 it's good enough to say you didn't think it was very  
24 good and it was only compared somewhere with Dittus  
25 Boelter or something.

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1 MR. BESSETTE: But you have the whole  
2 report. You should have the whole report.

3 MR. WALLIS: I'm not going to go --

4 MR. BESSETTE: I know what you mean. It's  
5 a 100-page report; I know what you're getting at. So  
6 when you look at the effect of this range of heat-  
7 transfer coefficient has on the -- now we're getting  
8 closer to what you want to see here. This is the  
9 predictions of K 1C and K 1 from FAVOR on the left-  
10 hand side. On the right-hand side is the K ratio. So  
11 you can see a factor of ten change in heat-transfer  
12 coefficient gives you, roughly, this kind of change in  
13 the K ratio.

14 MR. RANSOM: Is that the same by group,  
15 Palisades or --

16 MR. BESSETTE: Actually, well, this is  
17 this, it's a simple exponential --

18 MR. RANSOM: Oh, okay.

19 MR. POWERS: I guess I still don't  
20 understand. Earlier, you said it made a 20 percent  
21 change in the heat-transfer coefficient and it caused  
22 a three percent change in the conditional failure  
23 probability. And here you show factors of ten, and  
24 these parameters, they change a little bit. Either  
25 it's very, very sensitive to those parameters, or

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1 those aren't the appropriate parameters.

2 MR. DENNING: Well, explain what the value  
3 of one means.

4 MR. BESSETTE: Yes. So, for example, this  
5 transient looks like it just barely gets to one. This  
6 transient, let's say this is at .99. This generates  
7 a zero CPF; whereas this one up on top, it may  
8 generate a CPF of 10 to the minus 7 or whatever. So  
9 you've got the difference to zero and --

10 MR. DENNING: Well, the crack will start  
11 to run, right? And then it's a question of whether it  
12 arrests or not. So at one, if we reach one, a crack  
13 will start to run.

14 MR. BESSETTE: A crack could start to run.

15 MR. DENNING: Well, isn't it that at one  
16 for the K 1C, it will start to run, and then the  
17 question is will it arrest or not? Or am I wrong?

18 MR. BESSETTE: No, it cannot, a crack  
19 cannot possibly start below one. There's some  
20 probability that a crack could start greater than one;  
21 but it's a probability, it's not a definite.

22 MR. WALLIS: Does it depend on the flow  
23 size and things like that?

24 MR. BESSETTE: And so on, yes, all the  
25 distributions. And as you go up, certainly as you go

1 up in this ratio, the probability increases. So we  
2 seek for the dominant transients, K ratios reach two  
3 or three.

4 MR. ERICKSONKIRK: I think this is one of  
5 those odd cases where Dr. Wallis and Mr. Bessette are  
6 both right because there is a cliff, and you're going  
7 from zero failure probability in the K ratios David  
8 showed as below one to a very small failure  
9 probability, although that's zillions percent above  
10 zero when you go above one. So you're talking about  
11 changes in small numbers, but there is, I mean,  
12 there's a bifurcation. You can't have fracture  
13 toughness values below the minimum value, and so there  
14 is something of a cliff there, albeit for small  
15 numbers once you start falling.

16 MR. WALLIS: But a factor of ten could be  
17 a factor of ten on something miniscule?

18 MR. ERICKSONKIRK: That's right.

19 MR. WALLIS: That's also in the example  
20 you gave.

21 MR. ERICKSONKIRK: No, we need to do the  
22 weighted analysis to give you the right perspective.

23 MR. WALLIS: So you're right, too?

24 MR. BESSETTE: Oddly enough, yes. So,  
25 basically, you just can't take a factor of three out

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1 of context.

2 MR. WALLIS: That's why it's so  
3 misleading. I mean, presenting all these curves and  
4 say, "Well, look, it looks as if it has a big effect  
5 or a little effect." Until you put it in the context  
6 of what it does to the fracture of the vessel, you  
7 give completely the wrong message.

8 MR. ERICKSONKIRK: Or else compare it to  
9 the real world. I mean, you know, if the heat-  
10 transfer coefficient is the heat transfer, you know,  
11 we take whatever it gives us.

12 MR. WALLIS: No, that's the other message.

13 MR. BESSETTE: So I think the basic  
14 conclusions are, is RELAP predicts pressure and  
15 temperature adequately for the PTS analysis.

16 MR. WALLIS: We haven't compared it with  
17 any reality here, so how do we know that?

18 MR. BESSETTE: Well, we've compared it,  
19 I've shown you reality in the sense of comparisons  
20 with --

21 MR. WALLIS: But, you see, the analysis is  
22 a new geometry. The only one that you've really tried  
23 to model in any way seems to have been Catton.

24 MR. BESSETTE: Yes. But what I've shown,  
25 at least for pressure and temperature, the relevant

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1 experiments are integral system tests, and we've  
2 looked at a large body of integral system tests, and  
3 we get what I would say is --

4 MR. WALLIS: Well, this is all  
5 temperature. This isn't heat-transfer coefficient.

6 MR. BESSETTE: No, I said I was talking  
7 about temperature and pressure.

8 MR. WALLIS: Oh, okay. So you're talking  
9 about not the wall temperature, you're talking about  
10 the fluid temperature.

11 MR. BESSETTE: Fluid temperature, yes.  
12 Fluid temperature. Experimental data show large  
13 thermal stratification in coalesce but nearly uniform  
14 downcomer temperature distribution.

15 MR. WALLIS: It's mysterious how it  
16 suddenly mixes so quickly at the cold leg.

17 MR. BESSETTE: Well, I wouldn't go as far  
18 as to say mysterious; it's interesting.

19 MR. WALLIS: I'll have to look back at the  
20 APEX reports, because in some of the early APEX  
21 reports, they seem to be plumes that were significant.  
22 In a later report, I couldn't see anything like the  
23 old plumes.

24 MR. BESSETTE: Well, if you notice, he  
25 doesn't talk about plumes, but then you look at these

1 numbers and then he's talking about 5 degrees K or  
2 less.

3 MR. WALLIS: Well, maybe it was a question  
4 of the scale on the pictures he was showing.

5 MR. BESSETTE: And in the scheme of  
6 things, the sensitivity of CPF to heat-transfer  
7 coefficient is generally small compared to such things  
8 as a boundary conditions with the PRA. We're dealing  
9 with ranges of 100 degrees K of boundary conditions  
10 compared to -- from this kind of result, you would say  
11 the uncertainty for the heat transfer is something  
12 like, perhaps, 10 degrees F, 15 degrees F, or  
13 thereabouts.

14 MR. SHACK: Now, I'm confused. I thought  
15 a bin had a thermohydraulic history, so it's between  
16 bins? Are we on uber-bins and --

17 MR. BESSETTE: Well, this, for example, is  
18 my uber-bin.

19 MR. SHACK: Okay, the uber-bin.

20 MR. BESSETTE: This is the uber-bin that  
21 represents what is a small-break LOCA.

22 MR. SHACK: Okay, so it's within a PRA  
23 uber-bin?

24 MR. BESSETTE: Yes.

25 MR. WALLIS: You're satisfied?

1 MR. BESSETTE: I'm satisfied we  
2 discretized, for example, the LOCA bins, as well as  
3 could be justified.

4 MR. SHACK: If there are no more questions  
5 for Dave, we can move on to the probabilistic  
6 fraction.

7 MR. POWERS: An exact science.

8 MR. SHACK: It has one constant, 10 to the  
9 minus 45<sup>th</sup> per year.

10 MR. POWERS: Let me ask you a question,  
11 Dave, since I don't know, especially on main steamline  
12 breaks, but I suppose also on any kind of LOCA, you  
13 get substantial vibrations and shocks to the system.  
14 Do those have an impact on your fracture mechanics at  
15 all, or is it just too weak of a phenomenon?

16 MR. ERICKSONKIRK: That's not something  
17 that's been considered, no. Vibrations causing then  
18 what?

19 MR. POWERS: Affecting the probability of  
20 cracking and things like that.

21 MR. WALLIS: It's not so much the  
22 vibration, but, when you have a large-break LOCA,  
23 there's a big bump to the vessel, in some cases.

24 MR. ERICKSONKIRK: That wouldn't have been  
25 considered in the analyses we're talking about. That

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1 would have been considered in the work that Nathan and  
2 his colleagues did in establishing the through-wall  
3 cracking frequency limit because that gets to what  
4 happens after the vessel fails.

5 MR. WALLIS: After the vessel fails?

6 MR. ERICKSONKIRK: Yes, what happens.  
7 Does vessel failure lead to core damage? Does vessel  
8 failure lead to --

9 MR. SHACK: No, but the pressure comes  
10 early. The pressure thump comes, you know, with all  
11 these little cracks in here, that vessel just --

12 MR. POWERS: I guess I'm not following --

13 MR. SHACK: This vessel is very robust  
14 until you put a big crack in it. You don't put a big  
15 crack into it until very late in this transient, all  
16 things considered.

17 MR. POWERS: Plus, the vessel is hot when  
18 that occurs.

19 MR. SHACK: It's hot, it's cracked, you  
20 know, it's very robust at that point until you get  
21 through it.

22 MR. SIEBER: Is it that time again?

23 MR. POWERS: This I understand. This is  
24 true.

25 MR. ERICKSONKIRK: Okay. This is the

1 review of the final comments we got with regards to  
2 probabilistic fracture mechanics. I would, however,  
3 before I get into that, just point out as I did  
4 yesterday that there were a few comments that our  
5 reviewers made that we felt were so significant that  
6 we had to take account of them by modifying our model.

7 One was that Dr. Schultz pointed out that  
8 we had ignored the effect of pressure-loading on the  
9 crack face in calculating our driving forces, and we  
10 realized that he was, in fact, right and, therefore,  
11 put it in. And, also, based on comments from Dr.  
12 VanWalle, we modified some of the details of our  
13 upper-shelf model.

14 But in terms of final comments, and I  
15 apologize, I thought I took the animation away, here  
16 I'm summarizing comments made on probabilistic  
17 fracture mechanics by Dr. Schultz, Dr. VanWalle, and  
18 then Dr. Murley also commented. I put a summary at  
19 the top, and I will spare you my recitation of it, but  
20 pretty much all these gentlemen said that, generally,  
21 things looked pretty good, but they had some niggling  
22 details that they wished to go on record as saying  
23 that they thought could either be done better or  
24 should be changed.

25 The two, the points that Dr. Schultz made

1 was that he didn't feel that we had adequately  
2 demonstrated that the fall distribution that we used  
3 applies to all plants; and, therefore, he recommended  
4 that, in order to use any rule drawn out of these  
5 results, the licensees should be required to somehow  
6 demonstrate the appropriateness of the assumed flaw  
7 distribution to their vessels.

8 And Dr. Schultz also commented that he  
9 believed we could do a better job at demonstrating our  
10 ability to accurately predict crack initiation, run  
11 arrest, and re-initiation events. And the interchange  
12 on that particular topic between Dr. Schultz and  
13 Richard Bass and Clark at Oakridge is preserved in an  
14 appendix in NUREG 1680, so that the committee may read  
15 it and reach their own conclusions. From Dr.  
16 VanWalle, again, generally nice words regarding the  
17 overall strategy. His remaining issues regarded the  
18 fact that we do not sample on correlation  
19 uncertainties for the embrittlement relationships and  
20 Sharpie-to-toughness conversions. We discussed that  
21 yesterday in the subcommittee. And while Dr. VanWalle  
22 accepted that there aren't any procedures currently  
23 for mathematically representing mixed uncertainties,  
24 he found that somehow unsatisfying.

25 His closing recommendations were that

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1 continued in-service inspection should be used to  
2 substantiate the applicability of the flaw  
3 distribution that we used in the PWR of interest, that  
4 over time we should be continuing to require  
5 surveillance, in particular surveillance involving  
6 actual fracture toughness tests, not simply Sharpie  
7 tests, so that, over time, we can move from  
8 correlative approaches based on Sharpies and RTNDTs  
9 toward direct approaches using fracture toughness.  
10 And also, he recommended continued and further  
11 validation of, indeed, both the crack-arrest models  
12 and the upper-shelf toughness models.

13 MR. WALLIS: I think we like that second  
14 bullet there.

15 MR. ERICKSONKIRK: So do I. It should  
16 keep me in business for a while. That's why I put it  
17 up. From Dr. Murley --

18 MR. SHACK: Just out of curiosity, if we  
19 ever built a new reactor, would we take that into  
20 account when we started a new surveillance program?

21 MR. ERICKSONKIRK: I'm not sure if we  
22 would. I think it would be a good idea, and I know  
23 that, indeed, some of the licensees, as they've put  
24 capsules into their vessels looking at license  
25 extension, they've intentionally put in pre-crack



1 samples. So at least the licensees are looking  
2 forward to the future.

3 Again, generally, good comments from Dr.  
4 Murley. He did, however, point out that he had some  
5 residual issues and concerns, but he didn't think that  
6 they'd seriously challenge the general validity of  
7 what we'd done. Those remaining issues -- and, again,  
8 I'm focusing here just on the PFM.

9 In his write-up, it was clear that there  
10 were some things that we hadn't explained well enough  
11 or clearly enough for him to understand, so we're  
12 iterating with him on that to try to make sure that  
13 doesn't happen again. And when does that not happen?  
14 And then, also, he made a comment regarding the need  
15 for more thorough discussion of what he called, and I  
16 think appropriately so, the residual uncertainties,  
17 both conservative and non-conservative in our  
18 analysis. And that was my closing slide at the  
19 beginning of this presentation, so we thought that was  
20 a very good suggestion that we took on board.

21 He again, and this is a consistent theme  
22 from all three of the fracture or fracture-oriented  
23 reviewers, questioned the applicability of the flaw  
24 distribution, however admitted that we're kind of in  
25 a bind because we're using all and the best

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1 information that we have. So, again, his comment had  
2 to do with some sort of administrative procedure using  
3 continued in-service inspection to continue to check  
4 the situation in the same vein that we use  
5 surveillance to continue to check the validity of our  
6 embrittlement correlations.

7 And that was it. Any questions?

8 MR. RANSOM: Aren't thermal sleeves used  
9 in some of the nozzles on the vessels to reduce  
10 thermal --

11 MR. ERICKSONKIRK: I don't know.

12 MR. HISER: I don't think the inlet  
13 nozzles upper-head on CRDMs, things like that, they're  
14 used in those cases.

15 MR. WALLIS: There are shields in these  
16 downcomers, aren't there, in some reactors? Thermal  
17 shields, cylindrical. Does that make a difference to  
18 anything here, or do we have to start from scratch  
19 when we're dealing with them? The effect of hydraulic  
20 diameters change the mixing in the downcomer.

21 MR. BESSETTE: Well, some plants, I  
22 believe, had thermal shields, Palisades for example,  
23 but they took theirs out.

24 MR. WALLIS: They took them out?

25 MR. BESSETTE: Yes, Palisades took it out,

1 I know.

2 MR. WALLIS: There aren't anymore there?

3 MR. BESSETTE: I can't say that there are  
4 no plants with thermal shields left.

5 CHAIRMAN BONACA: There are some still.  
6 I think so.

7 MR. WALLIS: I thought they all came out.

8 CHAIRMAN BONACA: You may be right.

9 MR. ERICKSONKIRK: If there are no further  
10 questions, back to you, Mr. Chairman.

11 CHAIRMAN BONACA: You should be commended  
12 for having controlled --

13 MR. WALLIS: I have other questions.

14 CHAIRMAN BONACA: All right, go ahead.

15 MR. WALLIS: Way out in this transient is  
16 a large break. The downcomer is full of water all the  
17 time, is it?

18 MR. BESSETTE: Yes. The downcomer  
19 refills, well, within about 40 seconds or so.

20 MR. WALLIS: Well, is there some part of  
21 your transient where the downcomer is not full of  
22 water?

23 MR. BESSETTE: Yes, during a blow-down.

24 MR. WALLIS: At the very beginning.

25 MR. BESSETTE: Yes. The first, well,

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1 within the first 30 seconds. Yes, the blow-down takes  
2 about 30 seconds. During that time, the downcomer is  
3 mostly empty.

4 MR. WALLIS: Right.

5 MR. BESSETTE: And then it refills very  
6 quickly, within --

7 MR. WALLIS: But it's refilling with  
8 really cold water.

9 MR. BESSETTE: Yes.

10 MR. WALLIS: It has nothing to mix with.

11 MR. BESSETTE: Well, yes, there is.  
12 Actually, it mixes with the steam that's still coming  
13 out through the --

14 MR. WALLIS: You have to get your  
15 condensation model right.

16 MR. BESSETTE: That's correct.

17 MR. WALLIS: Do you do that?

18 MR. BESSETTE: That's one of the  
19 assessment cases we ran, those UPTF test six to look  
20 at condensation, and we got pretty good results.

21 MR. WALLIS: Okay. So that's all been  
22 taken care of?

23 MR. BESSETTE: Yes.

24 MR. DENNING: Well, we know in that regime  
25 that things are just terribly chaotic and just grossly

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1 chaotic.

2 MR. SIEBER: Get a big water healer.

3 MR. BESSETTE: Yes, that's very right. It  
4 empties within the first 30 seconds, and then it  
5 refills within another 10 seconds or so, 20 seconds.

6 MR. WALLIS: And the grossly chaotic would  
7 make it, more or less, equilibrium, thermodynamic, so  
8 it's a saturation temperature.

9 MR. BESSETTE: Well, you're injection,  
10 you're pretty much --

11 MR. WALLIS: Chaotic would give you an  
12 enormous heat-transfer coefficient. The wall must be  
13 pretty well above the water temperature during this  
14 chaotic period. I just don't know if that matters.  
15 I mean, if you've only shocked the wall during that  
16 very early part of the transient, is this something  
17 which is being missed by all this analysis?

18 MR. BESSETTE: Well, you might initiate  
19 some cracks, but you're not going to propagate them  
20 because most of the wall is hot.

21 MR. DENNING: Well, just thinking large  
22 LOCA here, where there's no pressure? I mean, that's,  
23 you know, that's my experience, large LOCA, no  
24 pressure.

25 MR. WALLIS: So what matters is the

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1 thermal shock, just the thermal effects. You're  
2 talking about plumes and all this stuff, this is late  
3 in the transient, when everything is full of water.  
4 I just want to make sure that you covered the effects  
5 during the large LOCA and this is not full of water.

6 MR. BESSETTE: I thought about that, and  
7 I think we're okay.

8 MR. WALLIS: If RELAP has done it all --

9 MR. BESSETTE: Well, I'm not saying it's  
10 perfect, but we thought about condensation during  
11 these EC injections.

12 MR. WALLIS: This goes into the analysis  
13 then properly?

14 MR. BESSETTE: Sure.

15 MR. WALLIS: FAVOR does all this stuff at  
16 the right time?

17 MR. BESSETTE: Well, you know, we only  
18 carried our break spectrum up to 22 inches, which is  
19 pretty large but not all the way. But I don't think  
20 we get any further change beyond 22 inches.

21 MR. WALLIS: So your answer is that your  
22 analysis and the FAVOR code properly models the part  
23 of the transient where the analysis is full of some  
24 kind of chaotic mixture, which might be quite cold?  
25 At the beginning of the transient, before it's full of

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1 water.

2 MR. BESSETTE: Well, we've looked at --

3 MR. WALLIS: In a large break situation.

4 MR. BESSETTE: Yes. In other respects,  
5 we've looked at downcomer temperatures during large  
6 break LOCAs, and you get a tremendous amount of  
7 condensation during the ECC injection.

8 MR. WALLIS: What's the period of your -  
9 from the slides your heat-transfer coefficient is off  
10 scale pretty well.

11 MR. BESSETTE: In fact, what you tend to  
12 end up with, rather than a sub-cooled downcomer, is a  
13 saturated downcomer that has boiling from the vessel  
14 --

15 MR. WALLIS: I just want to make sure it's  
16 properly taken care of in the whole analysis and the  
17 PTS part of it.

18 MR. BESSETTE: Yes. But at any rate, you  
19 tend to end up with boiling in the downcome rather --

20 MR. WALLIS: I just want to make sure it  
21 was taken care of because you're not giving me great  
22 assurance. I'm not quite sure. Anyway, bear that in  
23 mind.

24 CHAIRMAN BONACA: When will we have a  
25 final report?

1 MR. BESSETTE: You mean on this  
2 supplemental thermohydraulics report?

3 CHAIRMAN BONACA: Well, I was talking  
4 about everything.

5 MR. SHACK: Yes, the final reports. I  
6 think we now have copies, at least drafts, of  
7 everything except the thermohydraulics; is that  
8 correct?

9 MR. ERICKSONKIRK: Yes, that's correct.  
10 The drafts that you have will be changed only insofar  
11 as tech editing, you know, response to comments that  
12 have been made here. I mean, we're not anticipating  
13 major technical changes to those.

14 MR. WALLIS: In what sense do we have  
15 them? Because I think before we came here we didn't  
16 have them all.

17 MR. SHACK: Well, they're waiting for you  
18 in your mail.

19 MR. WALLIS: What are they? Something  
20 like this in my mail, or is it --

21 MR. SHACK: They're PDF files, so, you  
22 know, they're only that big.

23 MR. WALLIS: So they're waiting for me in  
24 my mail.

25 MR. ERICKSONKIRK: But did you get, were

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1 you inquiring as to when the missing report is going  
2 to be available?

3 CHAIRMAN BONACA: Well, I think we would  
4 not write a letter because we don't have the report.  
5 So I was trying to understand when you would come up  
6 again for us to be able to comment in writing.

7 MR. SHACK: I think that's the plan is  
8 that we would like to have the final reports before we  
9 write a letter.

10 MR. ERICKSONKIRK: Yes.

11 MR. HISER: Just for the big picture, our  
12 expectation is that we will publish the reports that  
13 you had been provided with, including the two that got  
14 lost in the ether somewhere sometime in the January -  
15 February timeframe. So the one report will be the one  
16 missing link, if you will, in that chain that provides  
17 the basis.

18 MR. ERICKSONKIRK: I should have that to  
19 you by the end of this month.

20 CHAIRMAN BONACA: Make a decision whether  
21 or not we need another update or not.

22 MR. SHACK: I think we may want to have a  
23 presentation on the thermohydraulics again after we've  
24 had a chance to review the report. I don't think we  
25 want to go through everything else.

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1 CHAIRMAN BONACA: I agree with that. All  
2 right. Okay. I think we have an idea. Thank you.  
3 Any further comments on this? If not, I think we,  
4 first of all, we can get off the record now for the  
5 rest of the day.

6 (Whereupon, the foregoing matter was  
7 concluded at 3:29 p.m.)  
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C E R T I F I C A T E

This is to certify that the attached  
proceedings before the United States Nuclear  
Regulatory Commission in the matter of:

Name of Proceeding: 518th Meeting of the  
Advisory Committee on Reactor Safeguards

Docket Number: not applicable

Place of Proceeding: Rockville, Maryland

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# Technical Basis to Support Revision of the PTS Rule (10CFR50.61)

→ *Project Overview*

---



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Mike Junge**

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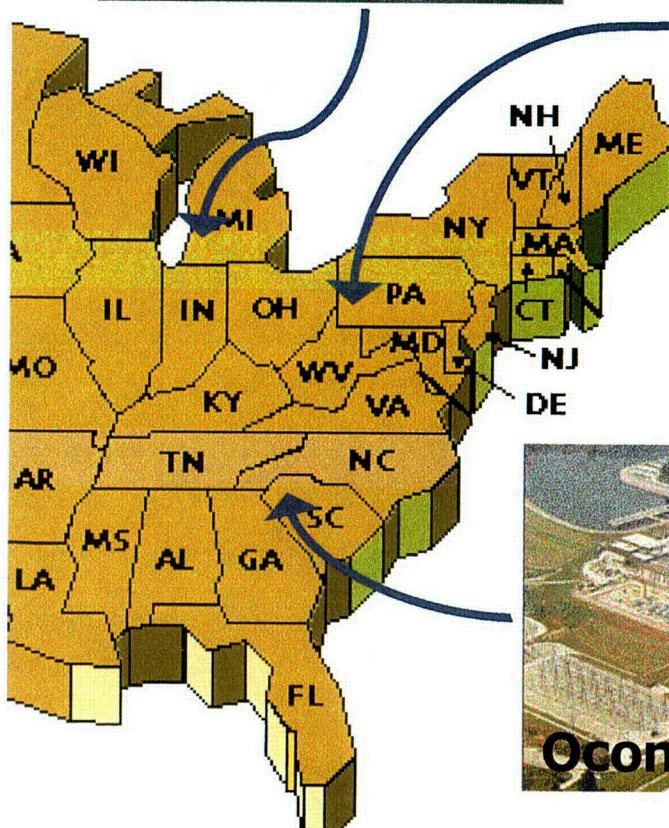
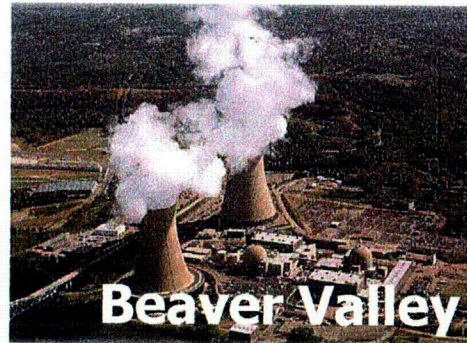
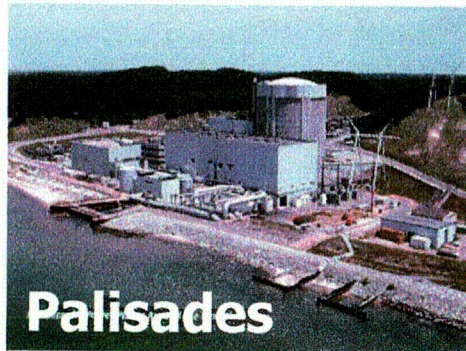
ACRS Briefing  
NRC Headquarters • Rockville, MD • 2<sup>nd</sup> December 2004

# Overview

---

- **Scope of analysis performed**
- **Factors that contribute most significantly to vessel failure probability**
  - **Material factors**
  - **Transient classes**
- **Generalization of findings to PWRs *in general***
- **Proposed RT-based screening limits consistent with RG1.174 guidance on LERF**
- **Comparison of operating PWRs with these screening limits**
- **Conservatisms / non-conservatisms that underlie screening limits**

# Scope of Analysis

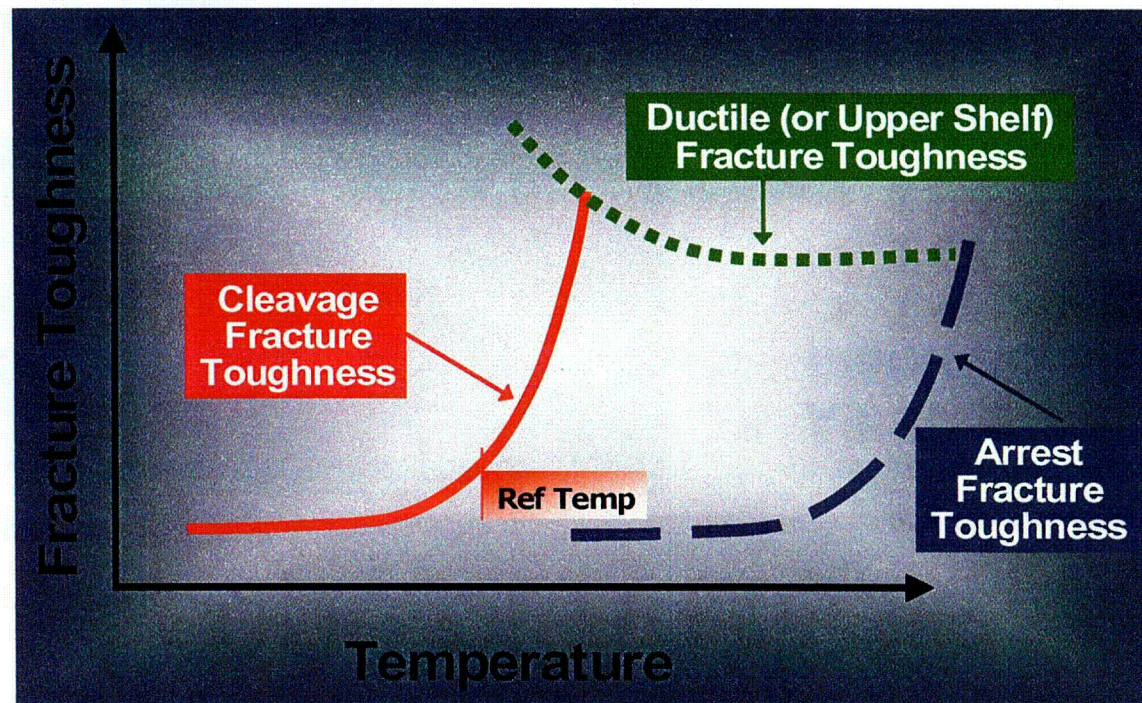


- All PWR manufacturers
  - 1 Westinghouse
  - 1 CE
  - 1 B&W
- 1 plant from original (1980s) PTS study
- 2 plants very close to the current PTS screening criteria
- Generalization to all PWRs
- TWCF criteria consistent with RG 1.174 guidance on LERF



# Material Factors Controlling Vessel Failure

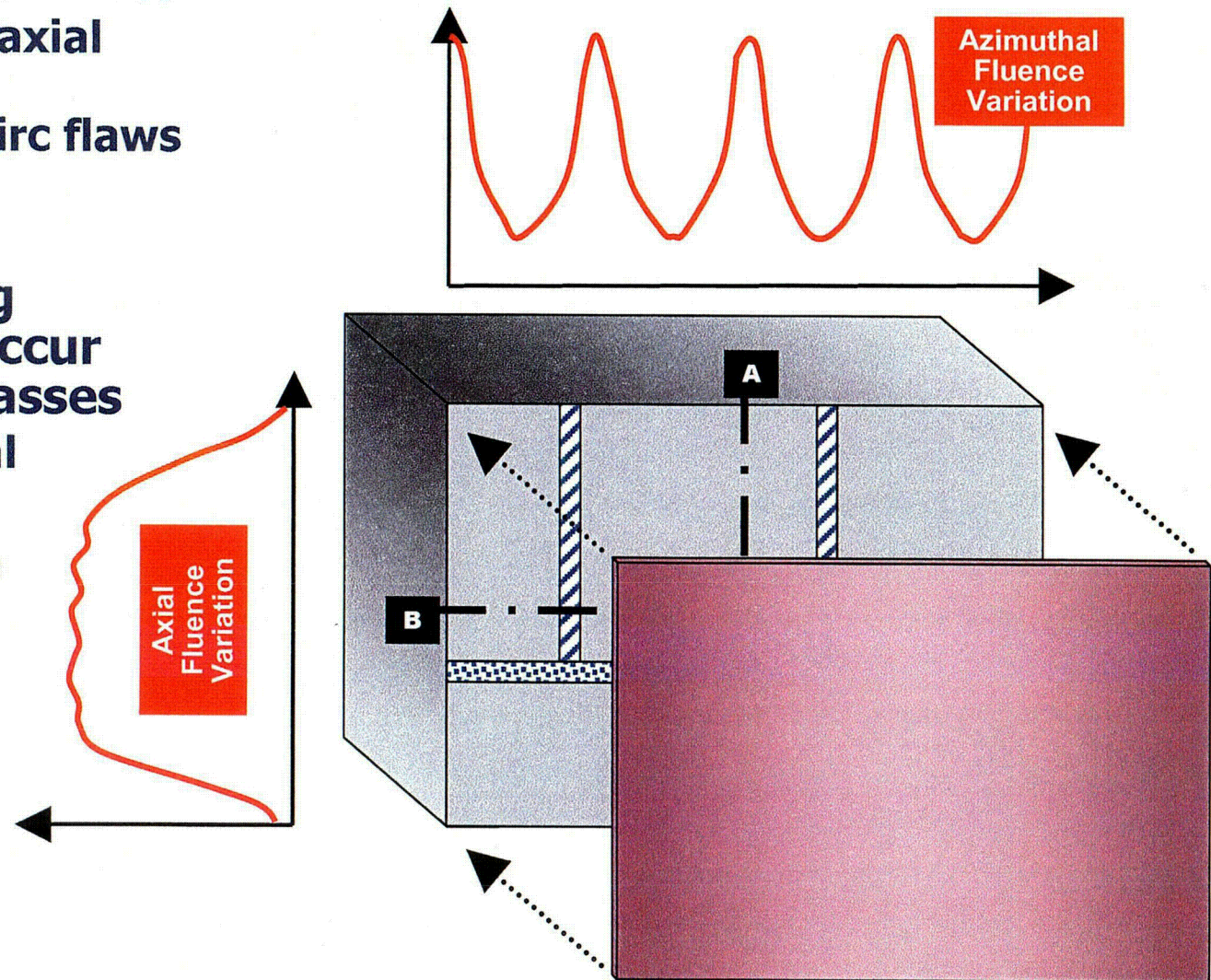
- To correlate / predict vessel failure the toughness properties at the flaw location need to be known
- A reference temperature ( $RT$ ) characterizes all of the toughness properties of interest
- So flaw locations are needed to determine the reference temperature(s) that control the vessel failure probability





# Locations of Simulated Flaws

- **Embedded weld flaws follow weld fusion lines**
  - Axial welds → axial flaws only
  - Circ welds → circ flaws only
- **Surface breaking cladding flaws occur between weld passes**
  - Circumferential
- **Plate flaws have no preferred orientation**





# Flaw Location Specific Reference Temperatures ...

... are needed to characterize accurately toughness properties at the different flaw locations

$$RT_{MAX} \equiv \text{MAX} \left\{ \left( RT_{NDT(u)}^{plate} + \Delta T_{30}^{plate} (\phi_{FL}) \right), \left( RT_{NDT(u)}^{axialweld} + \Delta T_{30}^{axialweld} (\phi_{FL}) \right) \right\}$$

$$RT_{AW} = \frac{\sum_{i=1}^{nfl} RT_{max}^i \cdot \ell_{FL}^i}{\sum_{i=1}^{nfl} \ell_{FL}^i}$$

Failure of **axial weld flaws** controlled by axial weld or plate toughness properties & by the fluence along the axial weld fusion lines

Failure of **circ weld flaws** controlled by circ weld or plate toughness properties & by the peak fluence in the vessel

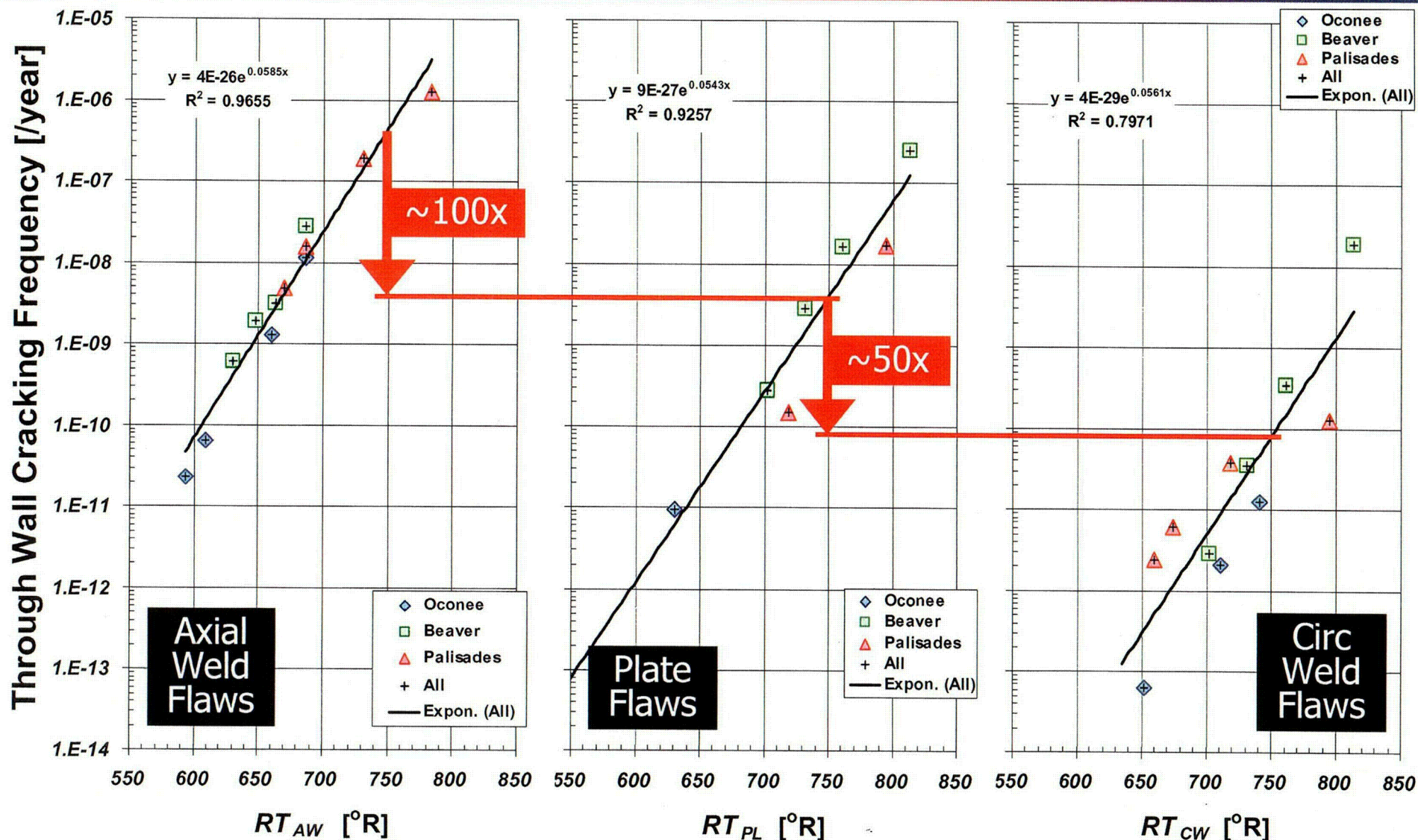
$$RT_{CW} \equiv \text{MAX} \left\{ \text{MAX}_{i=1}^{ncw} \left( RT_{NDT(u)}^i + \Delta T_{30}^i (\phi_{MAXID}) \right), \text{MAX}_{j=1}^{npl} \left( RT_{NDT(u)}^j + \Delta T_{30}^j (\phi_{MAXID}) \right) \right\}$$

Failure of **plate flaws** controlled by plate toughness properties & by the peak fluence in the vessel

$$RT_{PL} \equiv \text{MAX}_{i=1}^{npl} \left( RT_{NDT(u)}^i + \Delta T_{30}^i (\phi_{MAXID}) \right)$$



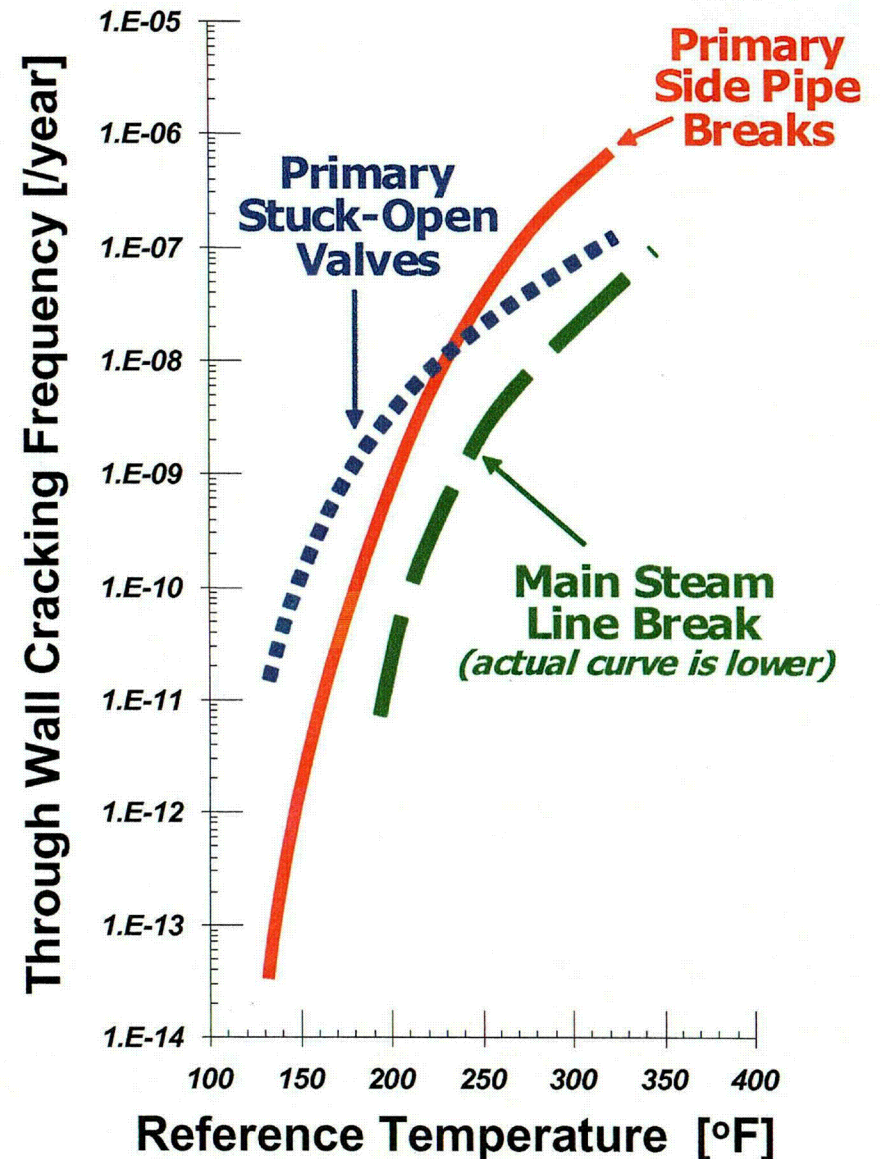
# Materials Factors Controlling Vessel Failure



# Transient Classes Controlling Vessel Failure

- **Primary side failures dominate risk (75% or more)**
  - Low embrittlement: stuck open valves that later re-close
  - Higher embrittlement: medium & large diameter pipe breaks
- **Secondary side failures**
  - main steam line breaks
  - stuck open valves

of much smaller consequence, & only at extremely high embrittlement levels





# Transient Classes Controlling Failure

---

- **Secondary side breaks much less damaging than primary side**
  - Initial cooling rate similar, scales with break size
  - Minimum temperature much higher for secondary breaks (212°F) than for primary breaks (40°F)
  
- **Operator action “credits” have small influence on overall results**
  - Pipe break: no operator actions possible
  - Stuck-open valves (primary circuit): Only very rapid action has any effect

# Findings applicable to PWRs *in general*

---

- The transients that contribute the most to TWCF have  $\approx$  occurrence rate and  $\approx$  severity across plants
- Operator actions, though modeled, do not influence significantly the calculated TWCF
- Similarity of PWR designs
- Calculational models robust to credible changes
- Conservatisms intentionally left in model
- Equivocations
  - Forgings prone to sub-clad cracking at high embrittlement levels
  - Thick vessels

# TWCF Estimation Based on TWCF vs. RT Correlations

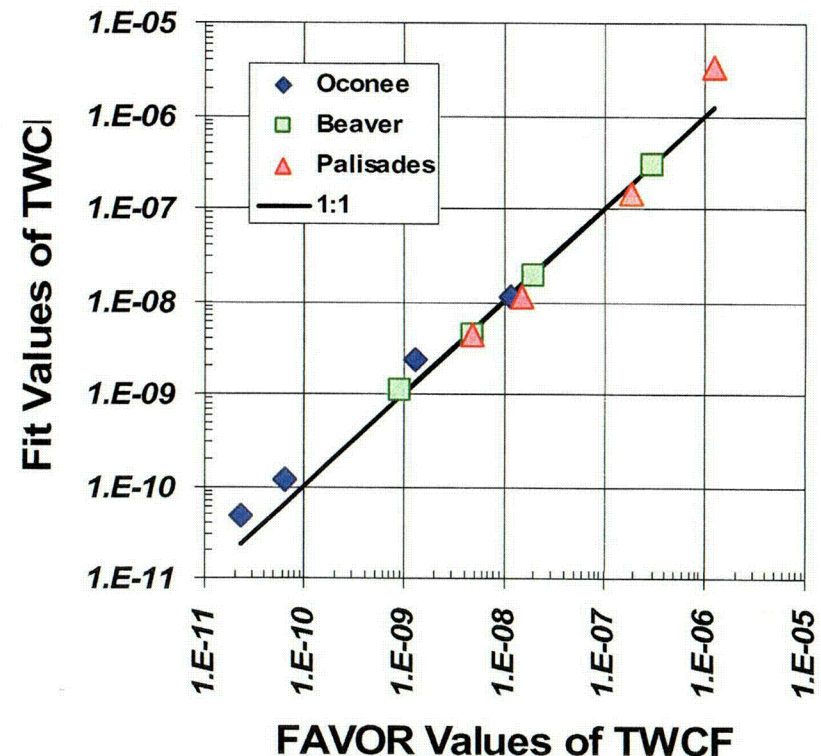
$$TWCF_{TOTAL} = TWCF_{AXIAL-WELD} + \alpha_{PL} \cdot TWCF_{PLATE} + TWCF_{CIRC-WELD}$$

$$TWCF_{AXIAL-WELD} = 4 \times 10^{-26} \cdot \exp\{0.0585 \cdot (RT_{AW} + 459.69)\}$$

$$\alpha_{PL} = 2 \quad TWCF_{PLATE} = 9 \times 10^{-27} \cdot \exp\{0.0543 \cdot (RT_{PL} + 459.69)\}$$

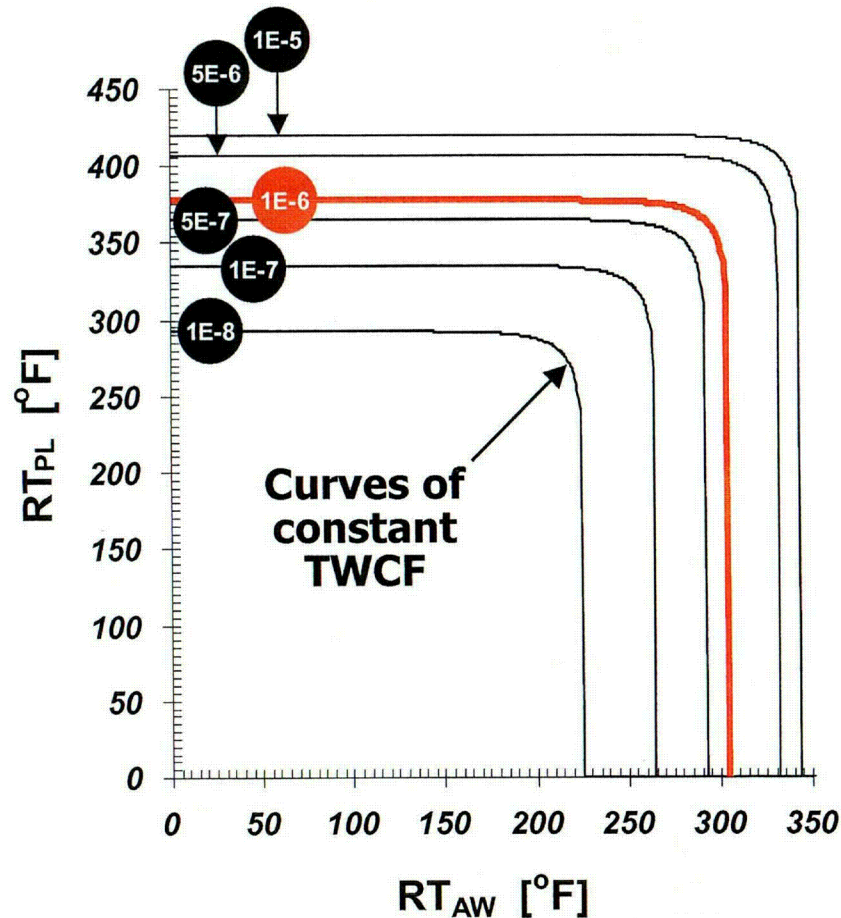
$$TWCF_{CIRC-WELD} = 4 \times 10^{-29} \cdot \exp\{0.0561 \cdot (RT_{CW} + 459.69)\}$$

- TWCF due to plate flaws multiplied by 2 to prevent under-estimation of Beaver Valley
- Setting  $TWCF_{TOTAL} = 1E-6$  permits derivation of RT-based screening limits consistent with LERF limit

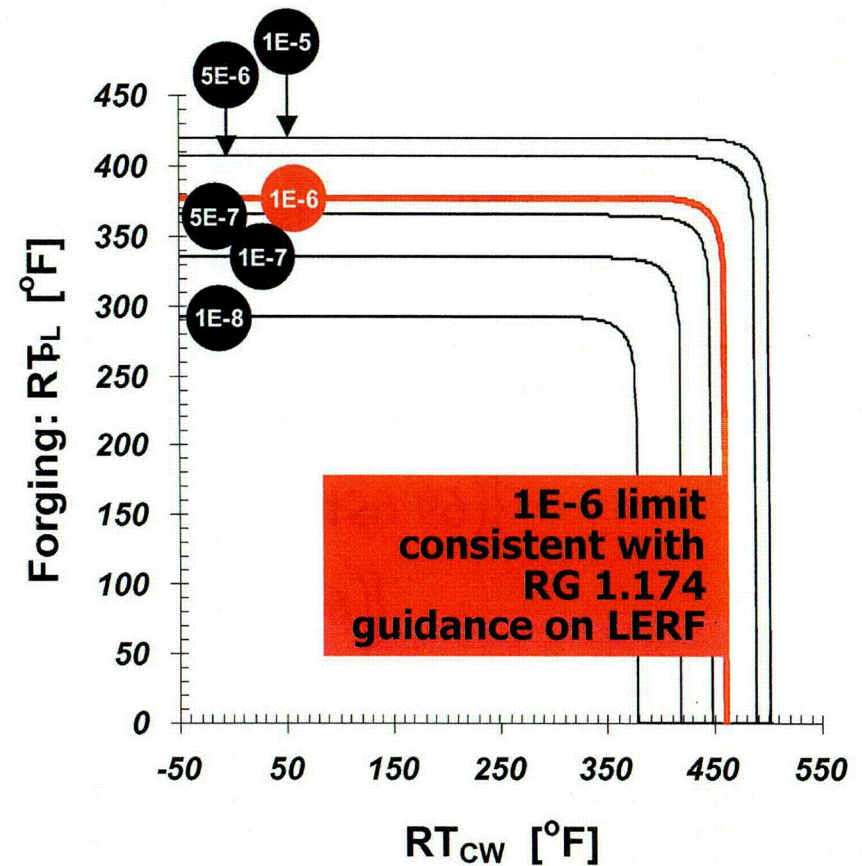


# Proposed PTS Screening Limits

## Plate Welded Plants



## Forging Plants

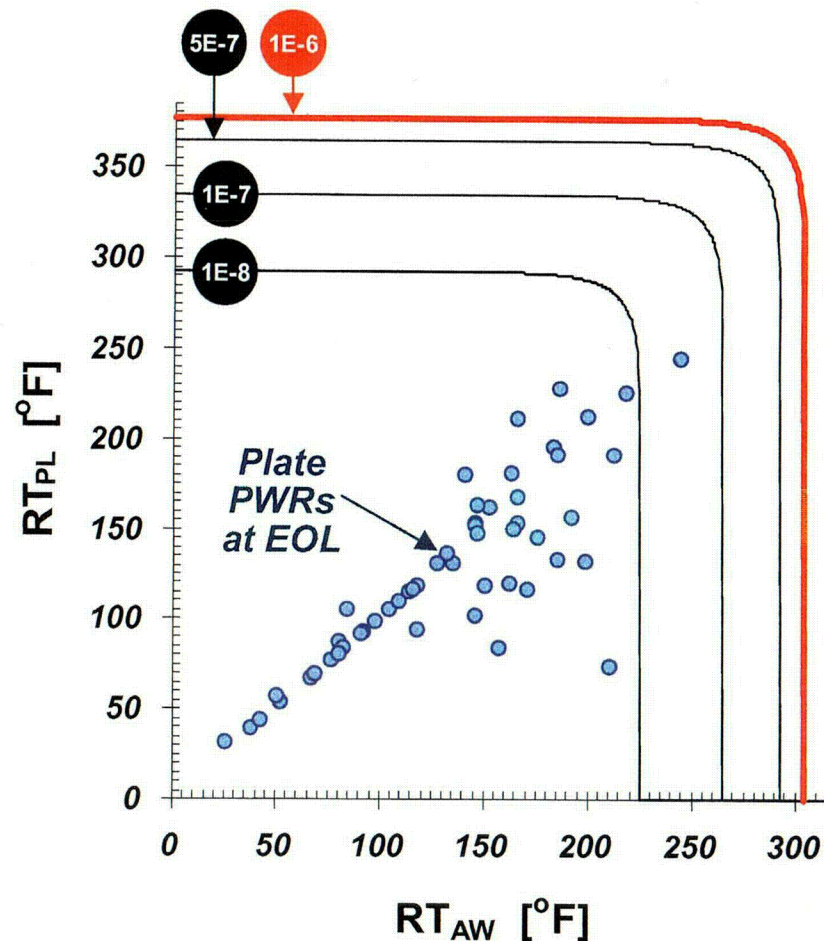


Provisos: Forgings at very high embrittlement & thick wall vessels.

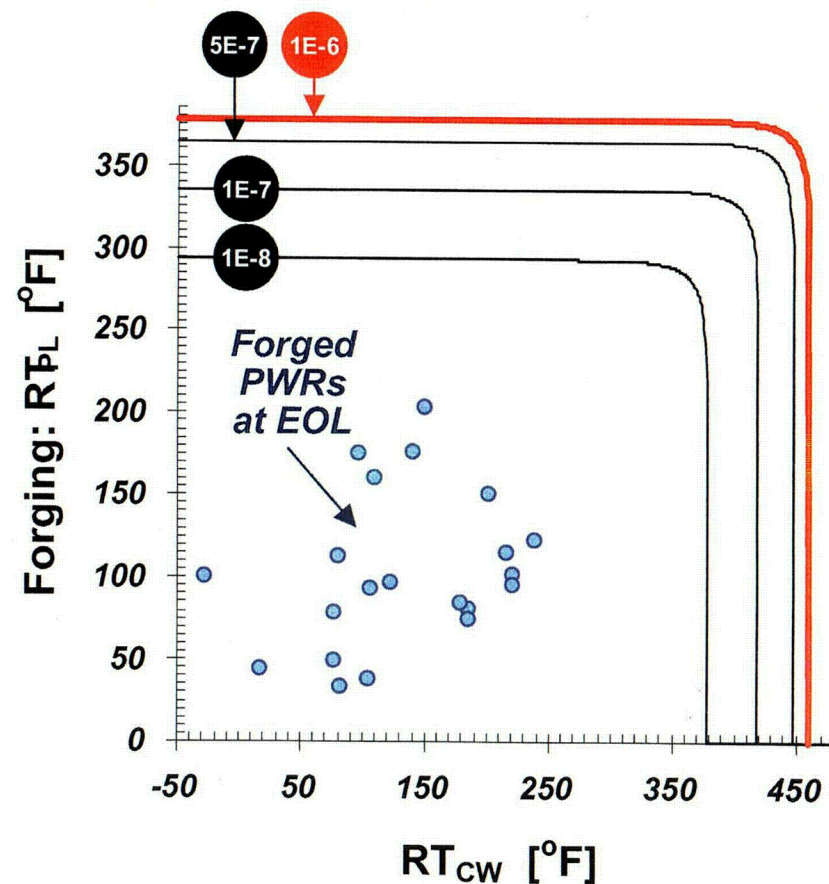


# Assessment of U.S. PWRs at EOL Relative to Proposed PTS Screening Limits

## Plate Welded Plants



## Forging Plants

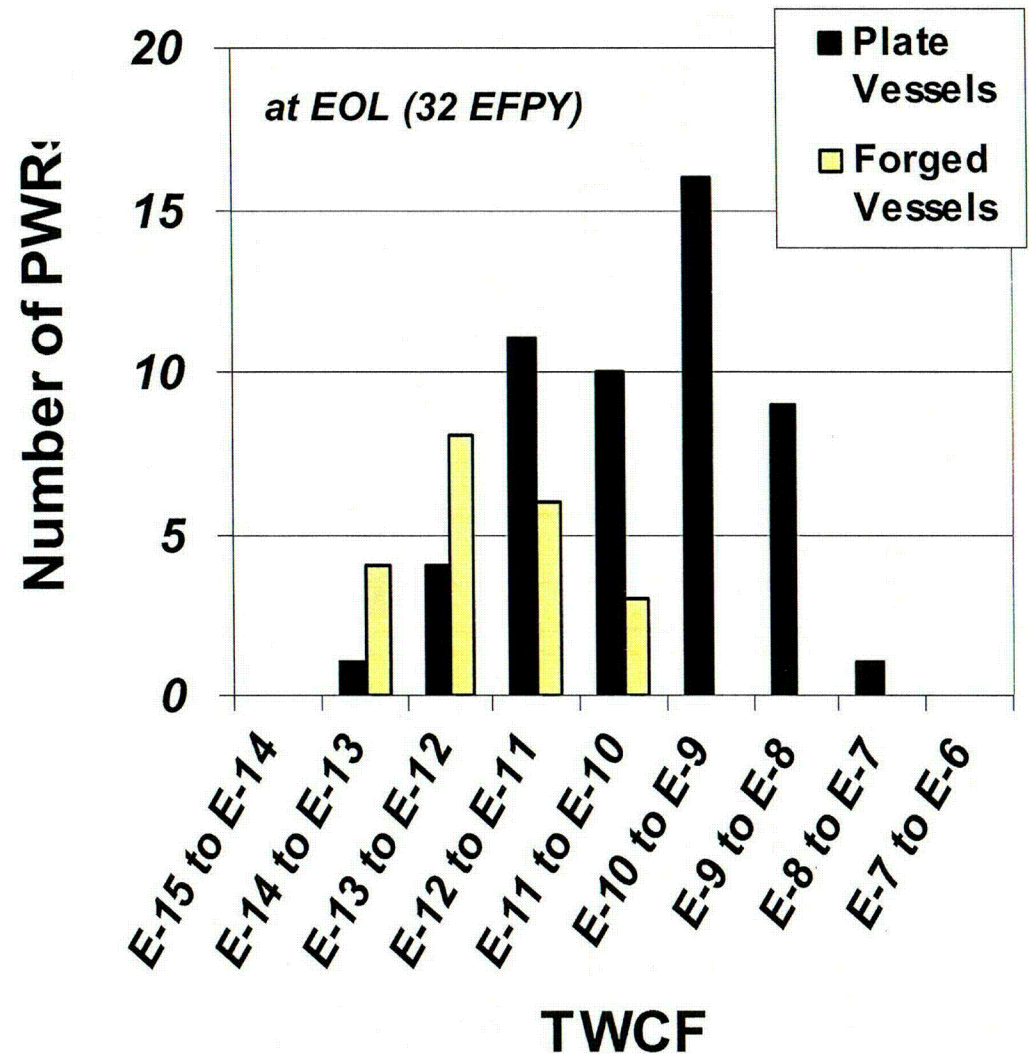




# Proposed PTS Screening Limits & Current Plant Status

## ■ Plant status

- PWRs all an order of magnitude away (or more) from  $1E-6$  LERF limit
- At least  $60^{\circ}\text{F}$  (& usually much more) separates any PWR from the proposed screening limit at EOL (compare with  $<1^{\circ}\text{F}$  per current regs.)
- Plants move  $10\text{-}20^{\circ}\text{F}$  closer to screening limits at EOLE





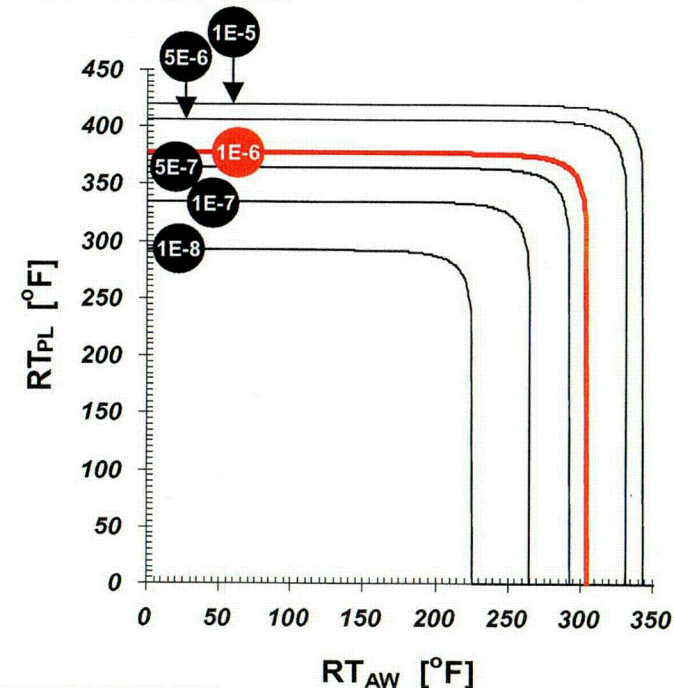
# Uncertainties that Underlie Proposed PTS Screening Limits

## Conservatism

- Vessel failure always leads to LERF
- Conservative binning to account for lack of knowledge
- MSLB min temperatures  $\sim 40^\circ\text{F}$  too cold
- SO-2 transients conservatively modeled
- Infinite length axial flaw propagation assumed
- Full circumferential crack propagation assumed
- Material variability / uncertainty overestimated (both chemistry and unirradiated toughness)
- Neutron attenuation function
- Systematically conservative assumptions made in developing flaw model (e.g., all defects characterized as flaws, etc.)
- Initiation / arrest interdependency model
- Model of RT shift due to embrittlement
- Increasing embrittlement by increasing EFPY

## Non-Conservatism

- Plume effects, if present, have been ignored
- External events ignored
- Heat transfer model
- Through-wall chemistry layering
- Air oxidation



Many more/larger residual conservatisms than non-conservatism suggests that there is no need for a "margin" term.

---

# PRA Response to Draft Final Peer Review Comments

**Donnie W. Whitehead**

**12/02/04**

**Sandia National Labs  
505-844-2632  
dwwhite@sandia.gov**

# Dr. Murley Comment

---

## ■ **Comment**

**The assumption that SRV opening size is uniformly distributed seems intuitively wrong.**

## ■ **Response**

**Initial response is to agree that we should not make this assumption.**

**Additional investigation to be performed.**

# Backup Slide

---

**A sensitivity analysis to determine the importance of this assumption was performed (set the basic events that represent the SRV opening size to 1.0).**

**Total TWCF estimates (at 60 EFPY) increased.**

- **Oconee: Factor of 1.5**  
**8.4E-10/5.5E-10 (sensitivity/original)**
- **Beaver Valley: Factor of 1.4**  
**9.9E-9/7.0E-9**

**Should not affect the overall conclusion (i.e., sufficient technical basis exists for rule modification).**

# **Pressurized Thermal Shock Technical Basis for Rule Revision**

## **PTS Thermal Hydraulic Analysis**

**David E. Bessette**

**December 2, 2004**

**518th. ACRS Meeting**

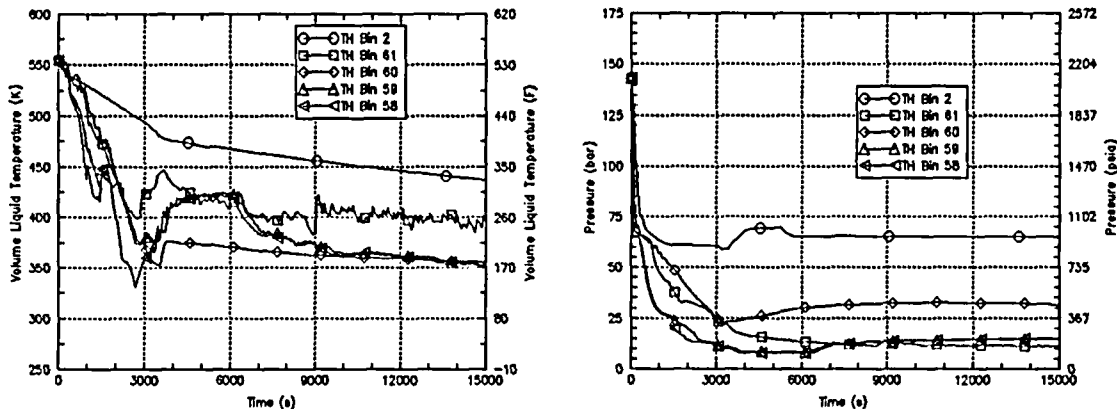
**TH-1**

## **Main Peer Review Group Comments**

- 1. Most parameters in PIRT are system boundary conditions rather than physical models. (e.g break size, ECCS flow, etc.)**
- 2. Effect of thermal stratification and mixing in the cold leg and downcomer from ECCS injection (adequacy of 1-dimensional code)**
- 3. Uncertainty in downcomer fluid to wall heat transfer coefficient and its impact on conditional probability of vessel failure (CPF).**

**TH-2**

## Palisades Small Break LOCA Spectrum



Boundary conditions dominate determination of temperature and pressure.

TH-3

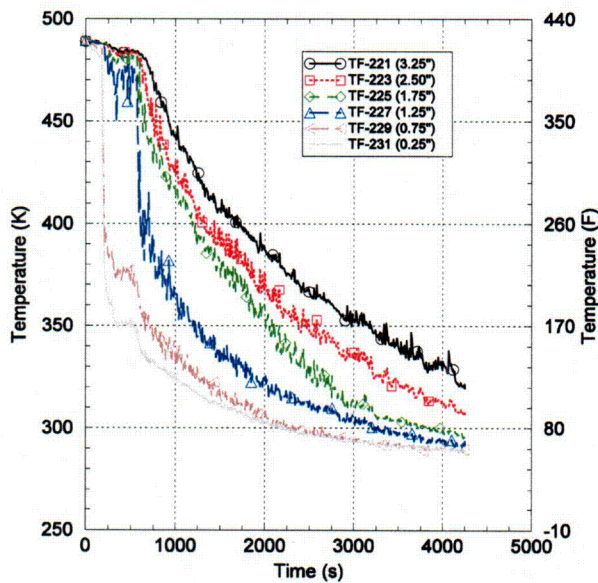
## Adequacy of RELAP for PTS Analysis

- Issues:
  - Prediction of average downcomer temperature and pressure
  - Possible downcomer temperature variations due to plumes
  - Downcomer fluid to wall heat transfer coefficient
- RELAP compared to best available system test data. Facilities include UPTF, LOFT, ROSA, APEX, and MIST.
  - 12 tests selected that are representative of risk dominant PTS transients.
- Downcomer average temperature predicted to within 4 K of the body of the experimental data with a overall standard deviation of 11K by RELAP5.
- System pressure predicted to within -0.06 MPa [9 psi] with a standard deviation of 0.39 MPa [57 psi] by RELAP5.
- Facility temperature measurements show plumes to be weak or nonexistent (< 5 - 20 K).

TH-4



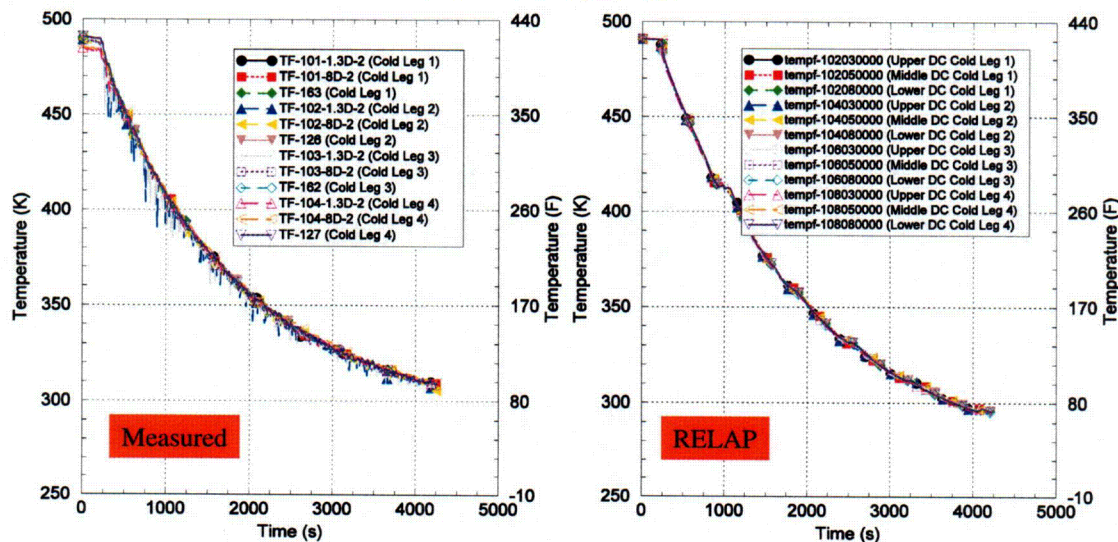
## Cold Leg Thermal Stratification APEX-CE-05



- 50 to 150 K [90 - 270°F] thermal stratification seen in the two instrumented cold legs.
- ECCS injection temperature is 285 K [54°F].
- Maximum possible thermal stratification is 200 K [360 °F]

TH-5

## Axial Downcomer Temperature Variation APEX-CE-05

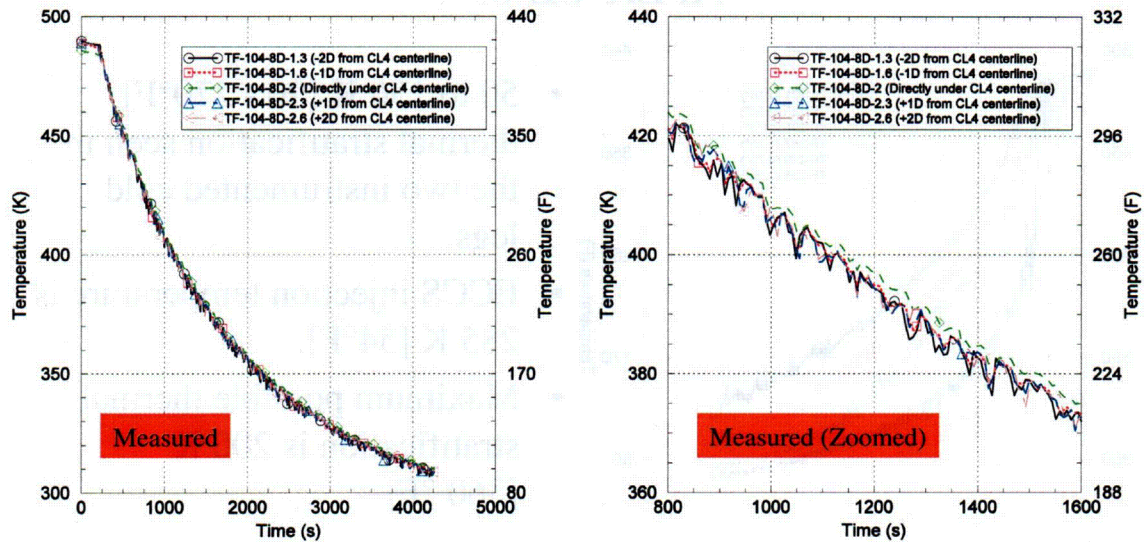


- Fluid temperatures at 0, 1.3 and 8 cold leg diameters axially along each cold leg centerline.
- No evidence of plumes based on the above temperature data

TH-6



## Azimuthal Downcomer Temperature Variation APEX-CE-05



- Fluid temperatures at top of core elevation +/- 1 and +/- 2 cold leg diameters azimuthally from CL4.
- No evidence of plumes based on the above temperature data

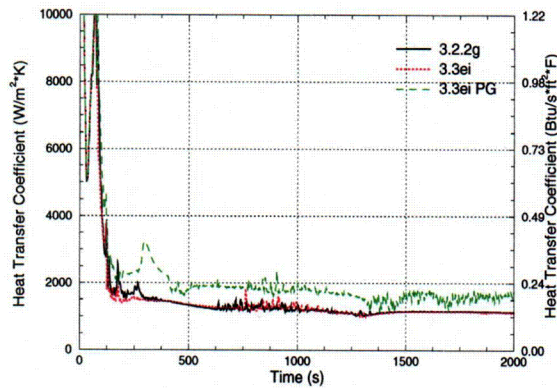
TH-7

## RELAP5 Adequacy for PTS Analysis Heat Transfer Coefficient

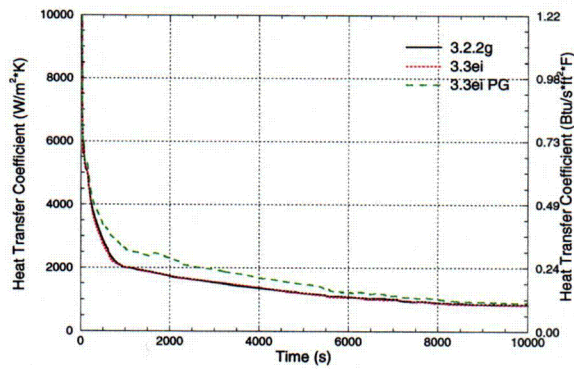
- Dominant heat transfer mode in the downcomer is buoyancy-opposed mixed convection (cold fluid flowing downwards past heated walls).
- RELAP5 applies the maximum of the Dittus-Boelter (turbulent forced convection) and Churchill-Chu (free convection).
  - Churchill-Chu gives higher values of HTC for low-flow conditions.
- Ivan Catton suggested the use of the Petukhov-Kirillov correlation with an enhancement factor (Petukhov-Catton).

TH-8

## Comparison of Heat Transfer Models



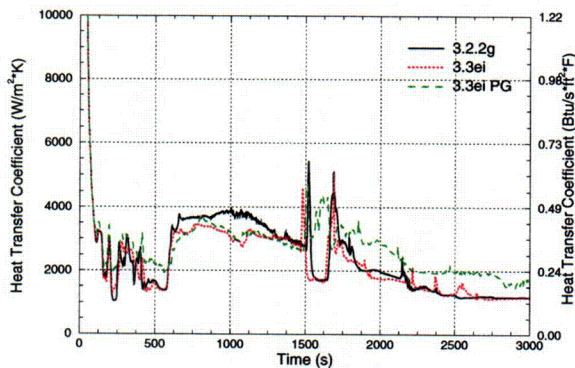
16-inch Hot Leg Break



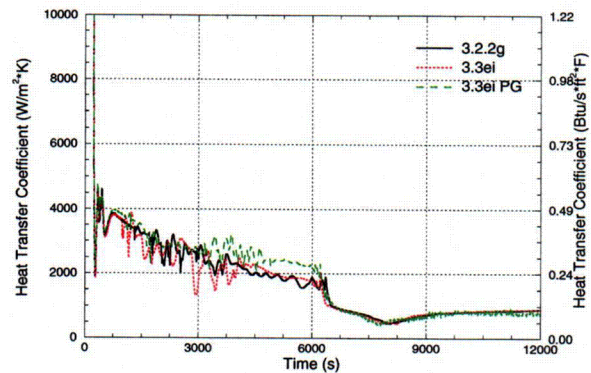
Main Steam Line Break

TH-9

## Comparison of Heat Transfer Models



4 inch Surge Line Break



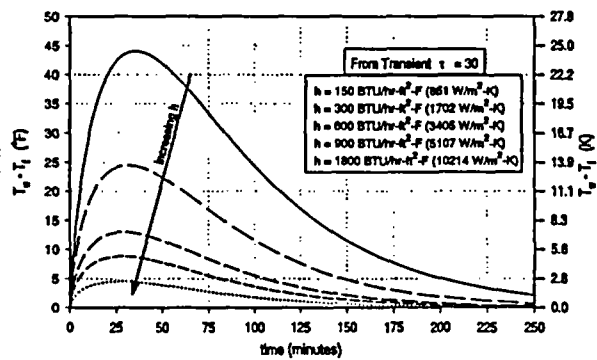
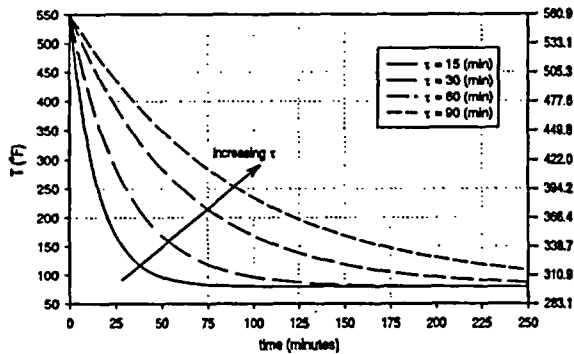
Stuck-open Primary SRV

Overall, Petukhov-Catton predicts HTC to be 20% higher than the default RELAP5 models.

Sensitivity study on risk-dominant Palisades transients showed a factor of 3 increase in CPF.

TH-10

# Heat Transfer Sensitivity Study



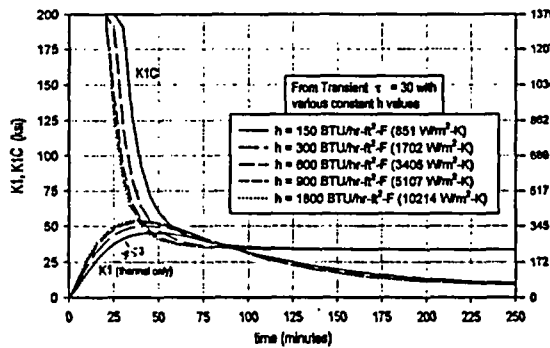
$$T_{dc}(t) = T_{ECC} + (T_0 - T_{ECC})e^{-\beta t}$$

Effect of Varying  $h$

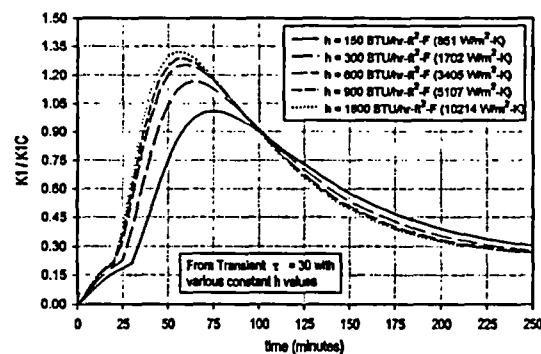
Sensitivity Study by C.F. Boyd and T. Dickson (NUREG-1667, Feb. 1999)

TH-11

# Heat Transfer Sensitivity Study



Plot of  $K_1$ ,  $K_{1C}$  vs. time



Plot of K-ratio vs. time

TH-12

## Conclusions

- RELAP5 predicts pressure and temperature adequately for the PTS analysis.
- Experimental data show large thermal stratification in the cold legs, but nearly uniform downcomer temperature distribution.
- Sensitivity of CPF to heat transfer coefficient uncertainty small compared to the boundary condition variation within a PRA bin.

TH-13

# Technical Basis to Support Revision of the PTS Rule (10CFR50.61) → PFM Review Comments, Appendix B



**Mark EricksonKirk**  
*Materials Engineering Branch*

ACRS Briefing  
NRC Headquarters • Rockville, MD • 2<sup>nd</sup> December 2004

VG 1

## Comment Categories

- **Comments that led to model changes**
- **New (final) comments from reviewers**

VG 2

## Comments that led to Model Changes

- **23: Crack face pressure (Schultz)**
  - Previously not modeled
- **40: Allowance of upper shelf fracture (VanWalle)**
  - Reviewer pointed out unreliability of correlative approach, suggested adoption of a physically-based model [EPRI MRP-101] as both more accurate and more in line with the project's overall modeling philosophy
  - FAVOR modified (FAVOR 04.1) to incorporate upper shelf model per reviewer comments

VG 3

## Final Comments (Schultz)

- **Summary**
  - *"The work performed shows clearly advancements compared to previous studies. It is well founded in most parts. My major comments are directed to the flaw distribution and connected requirements to the plant specific applicability, as well as some reservation concerning the level of validation of crack arrest."*
- **Remaining issues**
  - As noted under "summary"
- **Recommends**
  - Licensees be required to demonstrate appropriateness of the assumed flaw distribution to their vessels.

VG 4

## Final Comments

(VanWalle)

### ■ Summary

- *"The newly proposed PTS-methodology is worked out well and has a logical and acceptable pattern ... The methodology is very well established, explained, and documented in NUREG-1806 ... The reviewer recommends that ... the PFM procedure as implemented in FAVOR 04.1 shall be used in the overall approach of the PTS methodology."*

### ■ Remaining issues

- Not sampling correlation uncertainties for embrittlement relationships and Charpy to toughness conversions
- Difficulty in mathematically representing "mixed" uncertainties.

### ■ Recommends

- Continued In-service inspection to substantiate applicability of flaw distribution to all PWRs
- Over time, the direct use of fracture toughness measurements made on surveillance specimens instead of correlative approach.
- Continued / further validation of crack arrest models.

VG 5

## Final Comments

(Murley)

### ■ General summary

- *"The NRC RES staff is to be congratulated for producing the breadth and quality of world class PTS research represented by this material ... While I have some issues & concerns {regarding the PRA, TH, & PFM}" analysis, these concerns do not rise to the level that would seriously challenge the logic of the overall approach or the general validity of the PRA, TH or PFM calculational methods."*

VG 6

## Final Comments, Cont.

(Murley)

- **New or remaining issues (PFM only)**
  - **Errors in understanding indicating that improvements in writing are needed**
    - ✓ Non-conservatism of  $RT_{AW}$
    - ✓ Why weld layer model reduces TWCF
    - ✓ FAVOR chemistry sampling protocol when multiple flaws are simulated to exist in the same sub region of a vessel
  - **Need for a more thorough discussion of the residual uncertainties (both conservative and non-conservative) that underlie the proposed RT-based screening limits. Discussion would serve as the basis for determining if "margin" is needed along with the RT-based screening limits.**
    - ✓ Addressed in this presentation
  - **Applicability of flaw distribution to all PWRs**

VG 7





# **Selection of Transition Break Size for 10 CFR 50.46 Revision**

---

**Charles Hammer  
NRR**

**Robert L. Tregoning  
Lee Abramson  
RES**

**Advisory Committee on Reactor Safeguards  
December 2, 2004**



## Presentation Objectives

---

- Provide overview of elicitation scope, results, and uncertainty.
  
- Describe approach for selecting transition break size (TBS).
  - Use elicitation passive-system LOCA frequencies as a starting point.
  - Consider uncertainty and variability in elicitation results.
  - Incorporate adjustments to account for other LOCA frequency contributions.



## **Elicitation Objectives and Scope**

- Develop generic BWR and PWR piping and non-piping passive system LOCA frequency distributions as function of break size and operating time.
  - LOCAs which initiate in unisolable portion of reactor coolant system.
  - LOCAs related to passive component aging, tempered by mitigation measures.
  - Small, medium, and large-break LOCAs examined. Large break category further subdivided to consider LOCA sizes up to complete break of largest RCS piping.
  - Time frames considered: 25 years (current day), 40 years (end of original license), and 60 years (end of life extension).
- Primary focus: frequencies associated with normal operating loads and expected transients.
- Assume that no significant changes will occur in the plant operating profiles.



## Other LOCA Risk Contributors

---

- LOCA frequency contributions occur from other events that were beyond the scope of the elicitation.
- Active system LOCAs.
  - Stuck-open valves.
  - Pump seal LOCAs.
- Seismically-induced LOCAs.
- Other rare event loading LOCAs.
  - Rare water hammer events.
  - Heavy load drops from overhead cranes.



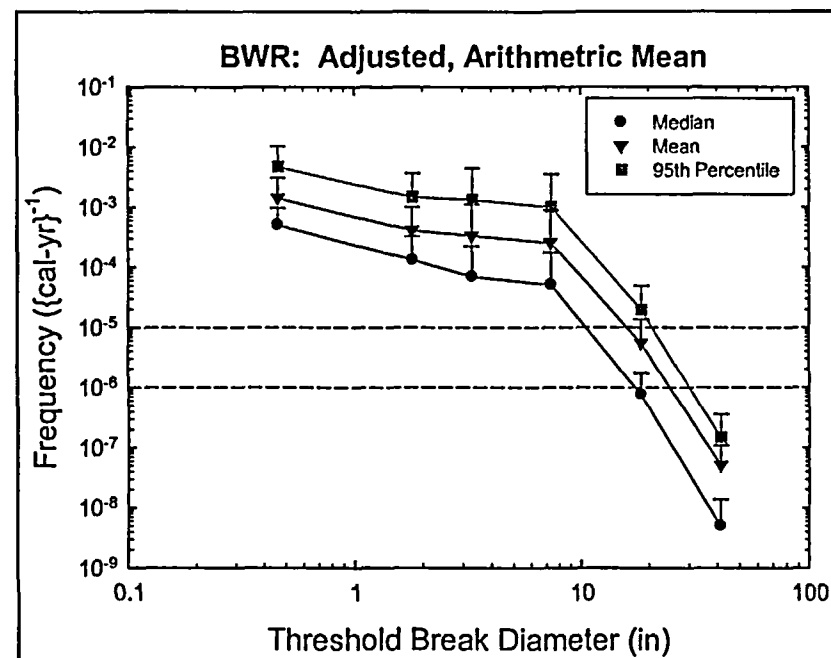
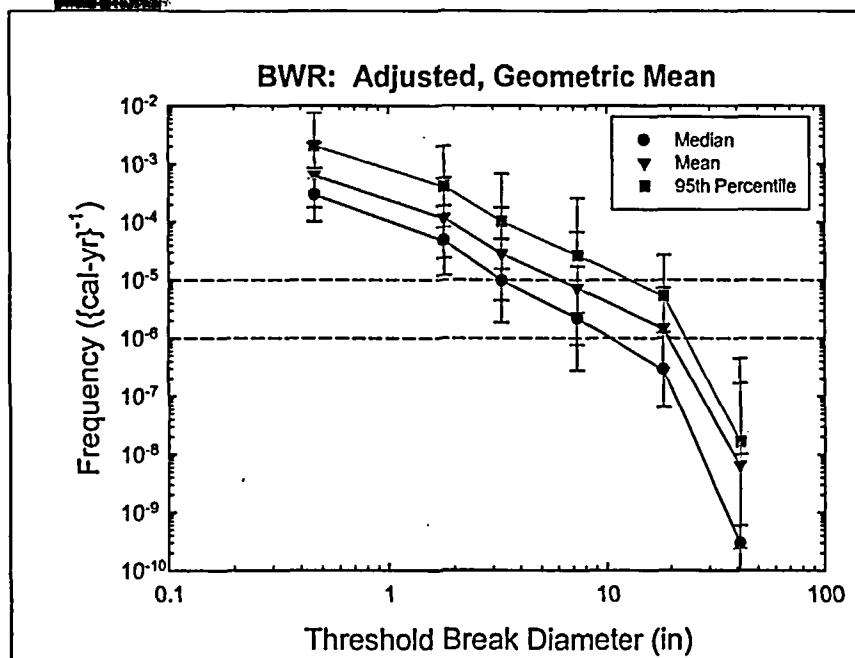
## Elicitation Results

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- Baseline results developed with measures of both individual uncertainty and group variability.
- Sensitivity analyses conducted in five broad areas.
  - Effect of distribution shape on mean.
  - **Overconfidence adjustment.**
  - Correlation structure of panelist responses.
  - **Aggregating expert opinion.**
  - Panel diversity measurement.
- Baseline results modified by important sensitivity analyses for TBS selection.
  - Results modified to incorporate overconfidence adjustment.
  - Geometric mean aggregation and mixture distribution used to provide range of elicitation results which capture process uncertainty.



# Total LOCA Frequencies: BWR Current Day Estimates

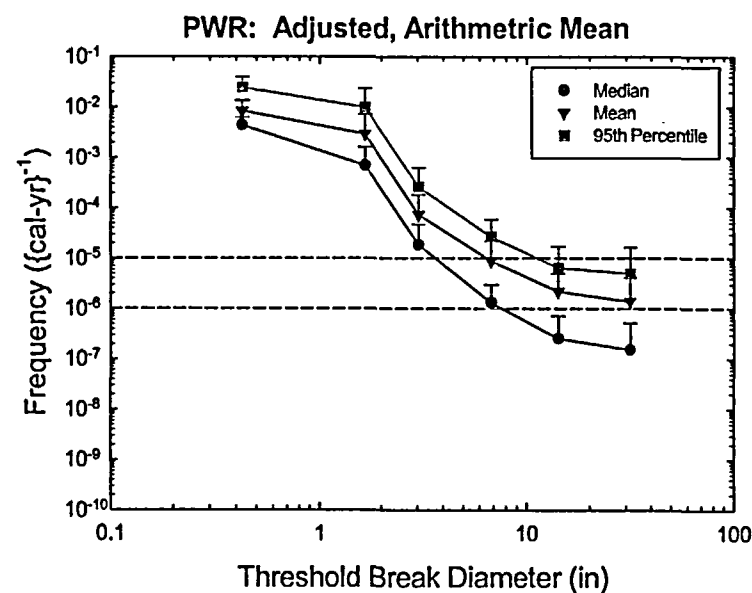
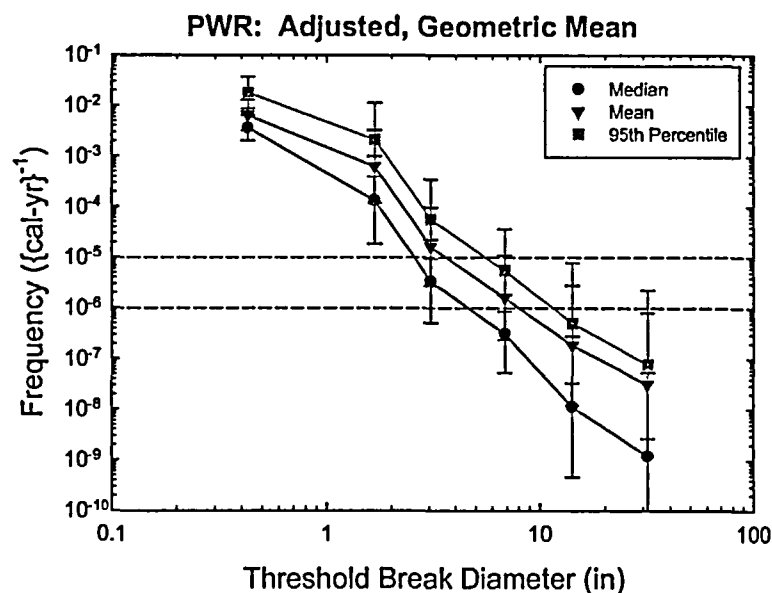


**Elicitation Results: BWR Break Size @  $1 \times 10^{-5}$  ( $\text{cal-yr}^{-1}$ )**

Aggregation	Mean	Mean with 95% Conf.	95 <sup>th</sup> Per.	95 <sup>th</sup> Per. with 95% Conf.
Geometric Mean	6	16	13	22
Arithmetic Mean	16	19	21	24
Mixture Distribution	16		20	



# Total LOCA Frequencies: PWR Current Day Estimates



## Elicitation Results: PWR Break Size @ $1 \times 10^{-5}$ (cal-yr)<sup>-1</sup>

Aggregation	Mean	Mean with 95% Conf.	95 <sup>th</sup> Per.	95 <sup>th</sup> Per. with 95% Conf.
Geometric Mean	4	7	6	14
Arithmetic Mean	7	10	11	31
Mixture Distribution	7		10	



## Selection of TBS

---

- Use Expert Elicitation results as a starting point.
- There is a range of pipe sizes which correlate to pipe break frequency of  $1\text{E-}5/\text{cal-yr}$ .
- Selection should accommodate various uncertainties.
- There are other considerations which could impact the TBS selection.
  - Active LOCAs.
  - Load-generated LOCAs.
- Actual plant piping design and operating experience should be considered in final selection.





## Other Considerations Not Addressed by Expert Elicitation

---

- Active LOCAs.
  - Stuck-open valves, failure of seals and gaskets.
  - Generally result in small-break LOCAs.
  - Higher frequency than pipe break LOCAs.
  - Limited in size by the size of associated pipe.
  - Not larger than largest attached pipe to main loop.
  
- Dropped heavy loads.
  - Studied in NUREGs-0612 and -1774 and in GSI-186.
  - LOCA frequency contribution not significant.
    - Most lifts made during shutdown conditions.
    - Fewer and lighter loads lifted during power operation.



## Other Considerations Not Addressed by Expert Elicitation (cont)

- Seismically-induced LOCAs.
  - Seismic events at  $1E-5$ /cal-yr are large magnitude.
  - Some plant sites may have higher failure frequencies especially with piping degradation.
  - Undegraded piping not expected to have significant effect on failure frequency.
  - For small flaw sizes, undegraded and degraded failure probabilities are similar.
  - For worst case flaw sizes, unacceptable increase in failure probabilities.
  - Confirmatory studies are ongoing and to be published.
  - Guidance to be provided by the staff in RG.
  - Licensees need to ensure inspection plans are adequate such that no breaks larger than TBS expected.



## **Other considerations Not Addressed by Expert Elicitation (cont)**

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- Water hammer.
  - No water hammers expected during normal operation.
  - Condensation-induced water hammer following SBLOCA (NUREG/CR-3895).
  - Narrow range of SBLOCAs (plant-specific) requiring level drop and higher pressures believed to be low probability.
  - Licensees need to ensure plants are not susceptible to damaging water hammer.
  - Screening criteria to be provided by the staff in RG.



## **Preliminary TBS Selection and Consideration of Actual Piping**

- Certain piping is more susceptible within their size range.
  - Pressurizer surge lines in PWRs (thermal fatigue).
  - Feedwater lines in BWRs (flow accelerated corrosion).
- Preliminary TBS values of 14" for PWRs and 20" for BWRs.
  - Includes necessary adjustments for uncertainties.
  - Includes pipes of most concern.
- These sizes are also similar to the sizes of the largest pipes attached to the main loop piping.
  - Pressurizer surge line in PWRs.
  - RHR suction line and feedwater line in BWRs.
  - Actual sizes do vary somewhat among plants.
- The next larger size pipes are the large main coolant loop piping.
  - Hot and cold legs in PWRs.
  - Recirculation and main steam piping in BWRs.



## TBS Selection

- TBS is selected as the size of the largest pipe attached to the main coolant loop.
  - For PWRs, based on the size of the largest pipe attached to the cold or hot leg main loop piping.
  - For BWRs, based on the size of the largest pipe in either of the RHR or Feedwater systems inside primary containment.
  - Next larger pipes are significantly less likely to break.
  - Accommodates uncertainties and provides regulatory stability.
- TBS is actually defined in the proposed rule as twice the cross-sectional flow areas of these size pipes.



## Future Plant Modifications and TBS Adjustments

---

- Expert elicitation did not consider power uprate conditions in estimates of break frequencies.
  - Recent operating experience indicates higher rates of degradation are possible.
  - Licensees need to explain why future uprate conditions do not significantly increase break frequencies.
- The staff will continue to assess pipe break frequencies and update as necessary.
- However, because significant uncertainties are accommodated, staff does not expect to have to adjust TBS in future.



## TBS Selection Summary

- Elicitation results used as starting point for TBS selection.
  - Consider individual uncertainty, panel variability, and process sensitivity.
  - Determine break size at  $1 \times 10^{-5}$ /cal-yr associated with different elicitation metrics.
- Other considerations not evaluated in the elicitation were incorporated to adjust TBS.
- The final TBS selections are risk-informed, accommodate attached piping of most concern, and promote regulatory stability.

# Tracking the Cumulative Change in Risk

Stephen Dinsmore  
Probabilistic Safety Assessment Branch – NRR  
Advisory Committee on Reactor Safeguards  
December 2, 2004



# Issues Identified by ACRS for Additional Clarification

- The Rule Requires the Licensee to Estimate and Track the Cumulative Impact on Risk of all Changes Related to Redefinition of LBLOCA
- The Rule Prohibits Combining the Risk Impact of Unrelated Changes with Changes Related to Redefinition of LBLOCA in the Cumulative Impact
  - A Related Change is any Change Enabled by the New Rule and not Permitted by the Current Rule

# Cumulative Change in Risk

- The Proposed Rule Requires the Combination of the Risk Impacts of Related Changes Made at Different Times
  - Compare the Total Change in Risk from all Related Changes to the Acceptance Guidelines
  - The same concept is utilized in all current risk-informed applications since they provide for measurement and control of cumulative risk from related changes
- Change in Risk - Initial and the Final Risk Must be Estimated Using an Updated PRA
  - (the current facility configuration excluding all related changes)  
» Compared to
  - (the current facility configuration including all related changes)

# Justification for Tracking Cumulative Change in Risk

- There may be a Wide Variety and Large Number of Changes that are Enabled by the Rule
- The Combined Impact of the Changes Enabled by the New Rule should not Result in an Inordinate Increase in Risk or Create New Vulnerabilities
- Consistent with RG 1.174 and Numerous Risk-Informed Applications
- Requirement on Processing and Tracking Changes Precisely Defined Because this is a Rule

# Cumulative Change in Risk – Original Applications

- RG 1.174 - the cumulative impact from all risk-informed changes should be available when necessary
  - Cumulative impact of previous changes should be submitted when acceptance guidelines are approached
- RG 1.175: Inservice Testing
  - The cumulative impact of all RI-IST program changes (initial approval plus later changes) should comply with the acceptance guidelines
- 50.69 Categorization
  - If the categorization of SSC's is done at different times, the sensitivity study should consider the potential cumulative impact of all SSCs categorized
  - The results of the risk sensitivity study must be confirmed to still be acceptable following each revision or update of the PRA to ensure that the categorization process is maintained valid

# Cumulative Changes in Risk – Rulemaking

- 50.46a Proposed Implementation
  - Must Estimate and Track Cumulative Change in Risk from all Related Changes
  - Changes that Cause the Cumulative Risk Increase to Exceed Sufficiently Small will not be Permitted
  - If the Cumulative Increase Exceeds the Sufficiently Small Guidelines Following PRA Updates the Licensee must take “appropriate action”

# Combined Change Requests

- Changes Unrelated to LB LOCA Redefinition Will not be Allowed to Directly Offset Risk Increases from Changes Related to LB LOCA
- If Direct offset was Allowed
  - The Change in Risk - Initial and the Final Risk Must be Estimated Using an Updated PRA would become
    - (the current facility configuration excluding all related and **“selected” unrelated** changes)
    - » Compared to
    - (the current facility configuration including all related and **“selected” unrelated** changes)

# Justification for Not Allowing Combined Change Requests

- All Changes at the Facility that Impact the Risk Profile of the Plant may also Indirectly Impact the Risk of the 50.46 Changes – this Impact is Always Included in PRA Updates and the Cumulative Change in Risk Estimate
- There may be a Wide Variety and Large Number of Changes that are Enabled by the Rule
- RG 1.174 Cautions that Staff should not Allow Risk tradeoffs in Combined Change Request that could Create Significant Sequences or Vulnerabilities
- Rule would Require Criteria to Specify what must be Combined and what can not Combined – Significant Challenge to Develop Appropriate Criteria in Rule Language that Provides the Necessary Confidence that such Vulnerabilities are not Created.
- CCR would only be Necessary if the Risk Increase Exceeds the Significantly Small Guidelines and the Staff Believes that many Changes could be Made without Challenging these Guidelines

# Combined Change Request Rulemaking

- 50.46a Proposed Implementation
  - Unrelated Changes may not be Combined with Related Changes in the Cumulative Risk Impact
  - However, there may be Situations where a New Plant Improvement Results in a very Desirable Safety Enhancement
  - Licensee could make an Exemption Request using 50.12(a)(2)(iv)  
The exemption would result in benefit to the public health and safety that compensates for any decrease in safety that may result from the grant of the exemption



# Regulatory Analysis for 10 CFR 50.46 Proposed Rule

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ACRS Briefing  
December 2, 2004

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Brian Thomas, NRR Financial and Regulatory Analysis Section  
U.S. Nuclear Regulatory Commission

## 10 CFR 50.46 Regulatory Analysis (Redefinition of Large Break LOCA)

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- Enabling rule (licensees may voluntarily choose this rule in lieu of current ECCS requirements)
- Licensees can change aspects of facility design and operations
- Intent is to enable flexibility in design and operations; rule can also contribute to improving safety

# 10 CFR 50.46 Regulatory Analysis

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Examples -

## Operational Enhancements Identified by Industry

- More power uprates
- Relaxation of emergency diesel generator start times
- Improved fuel management
- Changes in number of accumulators
- Potential for load removal in load sequencing of electrical equipment

# 10 CFR 50.46 Regulatory Analysis

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- Some design and operational benefits are not quantifiable at this time
- Safety benefits will vary on a plant-specific basis (no specifics on what licensees will do)

# Regulatory Analysis Approach

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- Builds on WOG submittals from 2000 and 2004
  - PWRs to benefit from uprates and EDG tech spec changes
- Uses scenario approach for bounding uncertainty
  - Due to different levels of participation by PWRs and different degrees of possible power uprates
- Assumes all 69 PWRs will obtain license renewals

# Quantified Benefits

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Value of Increased Power from Uprates

Plus

Labor and Materials Savings from Reduced Scope of EDG Maintenance (mechanical work on EDGs)

Plus

Replacement Power Savings from Reduced Outage Time for EDG Maintenance (cost of replacement power)

# Bottom Line

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- Although many potential operational benefits – including safety – cannot be quantified, the rule can be justified based on the quantifiable benefits and costs
- The net present value of the proposed rule is positive, regardless of discount rate or scenario, and is estimated at \$700 million to about \$13 billion
- For any given discount rate, the economic value to society increases as more plants undertake greater uprates facilitated by the rule

# Background

Selected Tables



Net Present Value in 2004 in millions of 2004\$  
Annual Discount Rate = 7%

Quantitative Attributes		Present Value Estimates (Millions of 2004\$)		
		Scenario 1	Scenario 2	Scenario 3
Power Uprating Benefits		\$1,151	\$3,108	\$8,633
EDG Benefits		\$237	\$213	\$178
Licensee Costs	Capital Costs	(\$185)	(\$500)	(\$2,493)
	Initial Licensing Costs	(\$120)	(\$108)	(\$91)
	Recurring Monitoring/PRA Costs	(\$353)	(\$317)	(\$266)
NRC Costs	Initial Regulatory Costs	(\$21)	(\$24)	(\$29)
	Deferred/Recurring Regulatory Costs	(\$11)	(\$10)	(\$9)
Overall Net Present Value		\$697	\$2,362	\$5,923

*Note: Totals are subject to round-off error*

Net Present Value in 2004 in millions of 2004\$  
Annual Discount Rate = 3%

Quantitative Attributes		Present Value Estimates (Millions of 2004\$)		
		Scenario 1	Scenario 2	Scenario 3
Power Upgrading Benefits		\$2,148	\$5,801	\$16,113
EDG Benefits		\$429	\$386	\$321
Licensee Costs	Capital Costs	(\$215)	(\$582)	(\$2,900)
	Initial Licensing Costs	(\$128)	(\$115)	(\$97)
	Recurring Monitoring/PRA Costs	(\$682)	(\$613)	(\$514)
NRC Costs	Initial Regulatory Costs	(\$25)	(\$28)	(\$34)
	Deferred/Recurring Regulatory Costs	(\$23)	(\$21)	(\$18)
Overall Net Present Value		\$1,504	\$4,829	\$12,871

*Note: Totals are subject to round-off error*

# Power Uprate and EDG Scenarios

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Scenario	Participation	# Plants	Degree of Power Uprate
1	100%	69	1%
2	90%	62	3%
3	75%	52	10%

Note: Scenario 3 may even be conservative

# Summary of Estimated 50.46a Direct Application Costs to Licensee (2004\$)

Best estimate of the cost of implementing the proposed rule

Activity	Burden	Estimated Cost
ECCS Re-Analysis based on new TBS (pipe break size)	2,500 hours	\$392,500
Describe Proposed Change	700 hours	\$109,900
Engineering Analyses	2,500 hours	\$392,500
Develop Monitoring Plan	850 hours	\$133,450
Synthesize Proposal	540 hours	\$84,780
License Amendment Process	384 hours	\$60,288
Upfront Total		\$1,173,418
PRA Updates (Reevaluations)	400 hours @ 3 years	\$62,800 @ 3 years
Implement Monitoring	1,150 hours/year	\$180,500/year

## Summary of Estimated 50.46a Costs to NRC (2004\$)

	<b>Review Submission</b>	<b>Process License Amendment</b>
Scenario 1	1,248 hours x \$88/hour = \$109,800 per application	200 hours x \$88/hour = \$17,600 per application
Scenario 2	2,340 hours x \$88/hour = \$205,900 per application	200 hours x \$88/hour = \$17,600 per application
Scenario 3	5,070 hours x \$88/hour = \$446,200 per application	200 hours x \$88/hour = \$17,600 per application

Note: Review hours increase as level of power uprates increases

## Estimated NRC Costs (2004\$)

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- Prepare Reg. Guide(s) - \$402K
- Review Submissions and Process License Amendments over three years (3% discount rate)
  - Scenario 1    \$24.2 million (all 69 units)
  - Scenario 2    \$27.0 million (62 units)
  - Scenario 3    \$33.7 million (52 units)
- Review PRA Updates - 200 hours per review
- Review LOCA Frequencies - \$2.4 million  
(10-year review)