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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION  
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
+ + + + +  
MEETING OF THE SUBCOMMITTEE ON  
RELIABILITY AND PROBABILITY RISK ASSESSMENT

+ + + + +

THURSDAY

JANUARY 23, 2003

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ROCKVILLE, MARYLAND

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The Subcommittee met at the Nuclear  
Regulatory Commission, Two White Flint North, Room  
T2B3, 11545 Rockville Pike, at 8:32 a.m., Dr. George  
Apostolakis, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

DR. GEORGE APOSTOLAKIS, Chairman

DR. MARIO V. BONACA, Member

DR. F. PETER FORD, Member

DR. THOMAS S. KRESS, Member

DR. GRAHAM M. LEITCH, Member

DR. VICTOR H. RANSOM, Member

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1 SUBCOMMITTEE MEMBERS PRESENT: (CONT.)

2 DR. STEPHEN L. ROSEN, Member

3 DR. JOHN. SIEBER, Member

4 DR. WILLIAM J. SHACK, Member

5

6 NRC STAFF PRESENT:

7 MEDHAT EL-ZEFTAWI, Designated Federal Official

8 MICHAEL R. SNODDERLY, Cognizant ACRS Staff Engineer

9 LARRY BURKHARDT, NRR

10 NICHOLAS SALTOS, NRR

11 WALT JENSEN, NRR

12 MARIE POHIDA, NRR

13

14 PRESENTERS:

15 MICHAEL CORLETTI, Westinghouse

16 TERRY SCHULTZ, Westinghouse

17 SELIM SANCAKTAR, Westinghouse

18 JIM SCOBEL, Westinghouse

19 ED CUMMINS, Westinghouse

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C-O-N-T-E-N-T-S

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

(8:32 a.m.)

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, the Subcommittee on Reliability and Probablistic Risk Assessment.

I am George Apostolakis, Chairman of the Subcommittee. The Subcommittee Members in attendance are Tom Kress, Graham Leitch, Mario Bonaca, Victor Ransom, William Shack and Jack Sieber.

The purpose of this meeting is to review the PRA provided by Westinghouse Electric Company in support of its application to the NRC for certification of its AP1000 design. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberations by the full committee.

Medhat El-Zetawi is the Designated Federal Official, and Michael Snodderly is the Cognizant ACRS staff engineer for this meeting. The rules for participation in today's meeting have been announced as part of the notice of this meeting, and previously published in the Federal Register on December 27th, 2002.

A transcript of the meeting is being kept

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1 and will be made available as stated in the Federal  
2 Register Notice. It is requested that speakers first  
3 identify themselves and speak with sufficient clarity  
4 and volume so that they can be readily heard.

5 We have received no written comments or  
6 requests for time to make oral statements from members  
7 of the public regarding today's meeting. We have  
8 already reviewed some time ago the AP600 design and  
9 PRA as the members know, and this is a first in a  
10 series of meetings to support the future full  
11 committee meeting on the staff's last safety  
12 evaluation report on the AP-1000.

13 We will now proceed with the meeting and  
14 I call upon mr. Michael Corletti of Westinghouse to  
15 begin.

16 MR. CORLETTI: Thank you and good morning.  
17 My name is Mike Corletti from Westinghouse, and I am  
18 just going to take a couple of minutes to go over a  
19 few introductory slides. Are we able to deem the  
20 lights?

21 The first several slides are the agenda,  
22 which I was not planning to go over.

23 MR. SNODDERLY: I'm sorry, Mike, but can  
24 we go back to Friday's agenda.

25 MR. CORLETTI: Sure.

1 MR. SNODDERLY: To accommodate the  
2 committee would it be possible if we could look at the  
3 summary of -- I guess when were we going to do the  
4 uncertainty?

5 MR. CORLETTI: We were going to do the  
6 uncertainty -- yeah, we had moved the uncertainty  
7 assessment until today, and in the last session, and  
8 so the lone presentation tomorrow will be kind of a  
9 summary of the PRA insights.

10 MR. SNODDERLY: Fine.

11 MR. CORLETTI: So uncertainty assessments  
12 will be discussed this afternoon's presentation.

13 MR. SNODDERLY: Thank you, Mike?

14 MR. CORLETTI: Is that okay?

15 MR. SNODDERLY: Perfect. Thank you.

16 MR. CORLETTI: Okay. I just wanted to go  
17 over briefly the overall schedule. This really lists  
18 our past milestones on design certification, and we  
19 submitted our application.

20 We received the staff RAIs in September of  
21 last year, and we provided our responses to those RAIs  
22 by December of last year. We are now in the process  
23 of where the staff is reviewing those RAIs and  
24 assessing how many of those are acceptable and which  
25 of those do we need additional information to close

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1 out those issues.

2 The staff is working towards a June  
3 deadline for the draft safety evaluation report, and  
4 it has been our goal to provide sufficient information  
5 to the staff so that we could attempt to close out all  
6 open items for the DSER.

7 This is our goal. However, it is not  
8 necessarily a commitment, but it is a goal that we are  
9 working to. And we would then see that we would be  
10 looking for the ACRS letter sometime later this year.

11 Today we are going to provide hopefully a  
12 very thorough presentation of our PRA, including the  
13 Level 1, 2, and 3 PRA, supporting thermal hydraulic  
14 analysis that supports the success criteria for Level  
15 One, and the thermal hydraulic studies that we  
16 performed for level two.

17 MEMBER KRESS: Refresh my memory. Has  
18 either the AP600 PRA or this AP1000 PRA been subjected  
19 to the industry peer review process?

20 MR. CORLETTI: The AP600 PRA I believe was  
21 subjected to a peer review process. The AP1000 we did  
22 not. We followed the same model. And it is our  
23 intention to try to address all issues related to the  
24 PRA in today's meeting. That would be our goal for a  
25 successful meeting.

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1                   Finally, I just wanted to identify some of  
2                   our future interactions on some of the subject matter  
3                   that we would be discussing so that -- and I think  
4                   that we are flexible on the subject matter of the  
5                   future meetings, and so if during these next two days  
6                   you see something that you would want adjusted in  
7                   those future meetings, we could accommodate that.

8                   And with that, I am going to turn the  
9                   presentation over to Terry Schulz, where he is going  
10                  to give a presentation on the overview of AP1000  
11                  design.

12                  MR. SCHULZ: Thank you, Mike. My name is  
13                  Terry Schulz, and my objective here is to talk a  
14                  little bit about the plant, and especially the parts  
15                  about the plant that may relate to the PRAs, and some  
16                  of this I know that you have seen before, but I will  
17                  try to give a bit of a slant related to the PRA.

18                  Here you see a list of the key design  
19                  changes that we made in going from AP600 to AP1000.  
20                  So this will obviously increase the core size and the  
21                  number of assemblies and the length of the assemblies to  
22                  accommodate the increase in power, and the reactor  
23                  vessel got longer, and did not get bigger in diameter.

24                  We obviously have bigger steam generators  
25                  like the Westinghouse CE designs. We have maintained

1 the use of the canned motor pumps, and that is an  
2 important element in both the design and the PRA  
3 connections.

4 We used variable speed controllers during  
5 shutdown modes and not at power. So they don't affect  
6 the reliability of the pumps operating at power.  
7 There is a larger pressurizer to try to maintain the  
8 same kind of capabilities, in terms of riding out  
9 transients.

10 Containment capacity has been increased to  
11 accommodate the increased mass energy. Passive system  
12 components have been increased and I will talk  
13 specifically about that, and obviously the turbine has  
14 been increased.

15 Here you see some of the key power  
16 capability parameters. The AP1000, compared to the  
17 AP600 and the three loop plants at Westinghouse built  
18 in Europe that are of a similar core capability from  
19 the number of assemblies and the length of the core.

20 Some of the hot leg temperatures are a  
21 little higher than AP60, but still well below  
22 operating plant experience. As I mentioned the fuel  
23 is the same portion and length as we have operated in  
24 both South Texas and in these plants built in Europe.

25 The power density is higher than these

1 plants, but there are some operating three-loop plans  
2 that have power densities that are the same as AP1000  
3 will be.

4 And you can see some of the other numbers.  
5 The steam generators surface area has been increased  
6 significantly to accommodate the power.

7 MEMBER SIEBER: Is that portion of the  
8 steam generator harder? I mean, could we be looking  
9 at a Palo Alto drive out problem?

10 MR. SCHULZ: No, I don't think so. The  
11 combustion engineering at Westinghouse has built  
12 bigger steam generators than these. The design has  
13 lots of -- I think if you work out the square foot per  
14 megawatt that it is like AP600. So it is not really  
15 being pushed harder there.

16 I think that the moisture separation is  
17 very comparable

18 MEMBER SIEBER: Now, this is the same as  
19 the ALN1 steam generator, right?

20 MR. SCHULZ: It is similar.

21 MEMBER SIEBER: It's similar.

22 MR. SCHULZ: It is not the same design,  
23 no. I actually don't have a separate slide on steam  
24 generators in this presentation, but the design  
25 features are basically the Westinghouse design

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1 features, in terms of materials, tube supports, motion  
2 separators.

3 It is scaled up and we show that ALN  
4 generator because Westinghouse-Pittsburgh built that  
5 before we joined with Combustion Engineering. Now,  
6 since we joined with Combustion, we have consulted  
7 back and forth on the design of this bigger steam  
8 generator to take advantage of their experience.

9 So they have looked over the design to  
10 make sure that we weren't extrapolating beyond what we  
11 could do. And so then they would have an increased  
12 comfort factor on that.

13 MEMBER LEITCH: Terry, one of the Doel  
14 units that had pretty major steam generator problems  
15 with tube sheet cracking, and went to a big sleeving  
16 campaign, and eventually replacement of the steam  
17 generators, was that Doel 4 do you know?

18 MR. SCHULZ: I am not sure of all of the  
19 different generators that have had problems. However,  
20 we have had a lot of experience with replacement  
21 generators now using the latest tube materials, Zinc-  
22 690 thermally treated, and the way we expand the  
23 joints now, and we seem to be getting out of those  
24 problems with our steam generators.

25 And in terms of the number of tubes that

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1 we have problems with now, it is really, really small  
2 with the new technology and the latest design  
3 features.

4 MEMBER LEITCH: I am not really sure that  
5 the problems with Doel were with this particular unit.  
6 Okay.

7 MR. SCHULZ: There is no bottom-mounted  
8 instrumentation. This is like AP600. and so we have  
9 top-mounted fixed in-core instrumentation. This is a  
10 benefit when we get to in-vessel retentions. We don't  
11 have those kinds of penetrations at the bottom.

12 We have adopted a core shroud instead of  
13 a radial reflector as we had in AP600, and that was  
14 partially or mainly due to we added a few more fuel  
15 assemblies into the reactor, and that made some of the  
16 sections get to be rather thin.

17 So that was going to be a bit of a  
18 challenge from a design point of view, whereas, in an  
19 AP600 it was an easier design. The core shroud, the  
20 Westinghouse-Pittsburgh has not built, but the  
21 combustion engineering folks who are now part of us  
22 have extensive experience with this in very similar  
23 sized reactors.

24 So we are making use of that technology.  
25 There is some side effects which Jim Scobel will get

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1 into in terms of again that IDR core melt progression,  
2 and the amount of the material in the reactor. So  
3 there is some connection there.

4 MEMBER LEITCH: Are there any bottom  
5 mounted penetrations? You say no bottom mounted  
6 instrumentations.

7 MR. SCHULZ: No bottom mounted  
8 instrumentations at all. The lowest penetrations are  
9 up above the core to direct vessel injection  
10 connections, which are about at the bottom of the hot  
11 legs. So there is really nothing that is below a  
12 couple of feet above, or several feet above the core.

13 MEMBER KRESS: Is the bottom head  
14 insulated?

15 MR. SCHULZ: The bottom head is insulated,  
16 and we will show you some pictures about how that  
17 insulation is arranged. It is similar to AP600, in  
18 that it stands off of the reactor vessel, and so there  
19 is a gap --

20 MEMBER KRESS: So it allows the flooding  
21 to --

22 MR. SCHULZ: Right. So we have engineered  
23 inlets of water in the bottom and the steam water  
24 vents at the top. We have changed that design to  
25 optimize the performance for AP-1000, and we will talk

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1 specifically about that.

2 The canned motor pumps are like what we  
3 were using for AP600, and the next slide will talk a  
4 bit more about those. There have been a lot of these  
5 pumps built mainly for the nuclear Navy, but also  
6 early commercial reactors have used these kinds of  
7 pumps, and they tend to be very reliable, and require  
8 very little maintenance, and so they are a very good  
9 fit with the plant design.

10 The loop connections are simplified  
11 versions of our operating plants, and this is  
12 basically a weld at either end of the pipe, which  
13 reduces the amount of weld significantly, and the way  
14 we connect the steam generators into the reactor  
15 coolant pumps, and also greatly reduces the amount of  
16 supports that we have.

17 So that the loop is significantly  
18 simplified and the pressurizer is larger. A little  
19 more information on the reactor coolant pump, and I  
20 just want to mainly point out that there is no shaft  
21 seals.

22 This has good implications relative to the  
23 PRA, because if a shaft seal is leaking, or failing,  
24 is a source of challenge to the safety systems and is  
25 modeled in the PRAs as one of the ways that you can

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1 get small LOCAs.

2 It is also a benefit if you lose all  
3 station power and have to sit on a station blackout.  
4 You don't have issues with this pump in terms of again  
5 leakage, or a possible failure of seals.

6 Another PRA related connection is the use  
7 of water lubrication of the bearings. There is no oil  
8 in this pump. Oil can leak and can cause fires, and  
9 so fires inside containment are reduced by this kind  
10 of pump design.

11 The high inertia flywheel we have  
12 increased its capacity in AP1000, and have actually  
13 improved the loss of flow performance of AP1000,  
14 versus AP600. So the minimum ABWR margin is better in  
15 the AP-1000 than AP-600.

16 For AP-600, we did perform some tests in  
17 terms of manufacturing and testing of the flywheel.

18 CHAIRMAN APOSTOLAKIS: The 12-year mean  
19 time between repairs, how was that estimated?

20 MR. SCHULZ: This was experience from  
21 nuclear Navy type operations. They have or basically  
22 don't do much to these pumps. They don't have to.  
23 There is very little scheduled maintenance on them.

24 The bearing don't really wear, and there  
25 is no seals, and which is a very stark contrast to our

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1 operating pumps with the seals. They have to be --  
2 the pumps have to be taken apart and the seals  
3 replaced on a periodic basis.

4 MEMBER LEITCH: Your mentioned, I think,  
5 if I understood you correctly that the shutdown there  
6 was at a variable speed?

7 MR. SCHULZ: Yes.

8 MEMBER LEITCH: But a constant speed at  
9 power?

10 MR. SCHULZ: Right, a constant speed at  
11 full power, without use of a variable speed frequency  
12 controller, and so that is bypassing that power.

13 MEMBER LEITCH: Oh, so that is completely  
14 bypassed?

15 MR. SCHULZ: Yes.

16 MEMBER LEITCH: And then at shutdown there  
17 is variable -- can you vary the speed up to full-  
18 speed?

19 MR. SCHULZ: Yes.

20 MEMBER LEITCH: So then I guess what I am  
21 envisioning in a start-up situation that you vary the  
22 speed up to full-speed and then bypass the speed  
23 controller?

24 MR. SCHULZ: Well, basically when you are  
25 at colder temperatures, you need to slow the pump

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1 down, because it tends to draw out more power. And  
2 one of the ways that we have limited the horsepower of  
3 the pump, which is a challenge in these bigger canned  
4 pumps, is that we have minimized the size of the pump  
5 motor by not having to over-design it for cold  
6 conditions, and this is why we are doing this.

7 So at cold conditions, we need to use the  
8 -- to slow the pump down. Now, as the temperature  
9 comes up, then we can increase the pump speed, and  
10 eventually go to the point where we can go to the full  
11 speed, and then cut out the variable speed drive.

12 So there is a bumpless transfer then if  
13 you will from this variable speed mode to the full  
14 speed mode?

15 MR. SCHULZ: I don't know exactly how that  
16 is.

17 MR. CORLETTI: It is an electrical  
18 parallel and transfer. You have two separate  
19 electrical supplies, and you transfer, and you  
20 synchronize, and transfer to the regular plant bus.

21 MEMBER SIEBER: So it is a hot transfer?

22 MR. SCHULZ: Yes.

23 MR. CORLETTI: The pump keeps running, and  
24 you do this before you start the reactor up. So you  
25 are in good shape by the time that you do that.

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1 MEMBER LEITCH: Thanks.

2 MEMBER RANSOM: Excuse me, but how do you  
3 mount the pump to the steam generator to prevent  
4 things like fatigue and also a possible breaking off?  
5 I mean, is that one of the design basis accidents?

6 MR. SCHULZ: No, the casing of the pump is  
7 welded in the factory directly to the channel head of  
8 the steam generator, and typically those kind of -- it  
9 is considered part of the pressure vessel.

10 So we don't normally postulate breaks of  
11 pressure vessels.

12 MEMBER RANSOM: Was that designed, or I  
13 guess the maximum stress there such that over the life  
14 of the power plant that you would not expect fatigue  
15 to be an issue?

16 MR. CUMMINS: This is Ed Cummins again.  
17 This is an ASME code pressure vessel, and we have to  
18 meet all of the stress and fatigue limits of the ASME  
19 code, and it is treated like a pressure vessel though.  
20 I think a break there would be very similar to a --

21 MR. SCHULZ: It is still basically limited  
22 by the hot leg-cold leg typing, which we take full  
23 breaks of to analyze for large LOCAs. Now I would  
24 like to move on to the safety systems and the approach  
25 to safety. I think that most of you have heard this

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1 slide, where the use of the passive systems, and what  
2 we mean by that, in terms of we have a few active  
3 valves, and most of which are fail safe, that have to  
4 be activated when the systems are aligned.

5           Once they are aligned, then the plant can  
6 continue operation indefinitely in that mode of  
7 operation. We don't have to reclose valves, and we  
8 don't have any continuously operating equipment --  
9 pumps, fans, diesels -- that have to run in our safety  
10 systems.

11           We have a greatly reduced dependency in  
12 operator actions, in terms of operator action timing.  
13 It is greatly extended over the operating plants. In  
14 the PRA, when you start talking multiple failures,  
15 there are some operator actions that are beneficial,  
16 and that will come out when we talk about the PRA.

17           When I&C Systems fail, there is some  
18 backup manual actions that can happen. If the core  
19 makeup tanks completely fail, they produce a signal  
20 that actuates ADS. So the operators can get by with  
21 just accumulators in most LOCAs if they turn on ADS in  
22 20 minutes or so.

23           But even that, if we look at -- you will  
24 see PRA studies of where we turn off the operators  
25 completely, fail them, and AP1000 has pretty good

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1 answers, and much better than operating plants without  
2 operators.

3 We also have active non-safety systems in  
4 the plant. They are primarily in the design to  
5 support normal operation or anticipated transients.  
6 It is typically redundant equipment, powered by our  
7 non-safety diesels. These systems also minimize  
8 challenges to the passive systems, and they are not  
9 required to mitigate the design basis accidents.

10 MEMBER KRESS: Let me ask you maybe a  
11 strange question about that. When you look at your  
12 design basis accidents, and you take no credit for  
13 those and just look at passive systems, did you do the  
14 inverse of that?

15 Did you take no credit for passive  
16 systems, and see if the non-safety related systems  
17 would handle the design basis accidents?

18 MR. SCHULZ: Well, we do that in the PRA.

19 MEMBER KRESS: In the PRA?

20 MR. SCHULZ: Yes. When the PRA -- and I  
21 will be talking later today about the thermal  
22 hydraulic analysis, and I am going to concentrate  
23 mainly on the passive systems, because that's where  
24 there has been more questions.

25 MEMBER KRESS: Of course.

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1 MR. SCHULZ: But we look at both mixed  
2 operations, where we use some passive and some active,  
3 and we have some cases where that is beneficial. And  
4 there is some cases where it is active systems alone

5 Now where we have or where we take credit  
6 for active systems to mitigate an accident, or a mixed  
7 situation, we have analyzed those, and not necessarily  
8 with design basis codes and assumptions. But we have  
9 analyzed it to justify in the PRA, taking credit for  
10 start up feed water to mitigate a loss of feed water  
11 or the RHR to provide low pressure injection.

12 MEMBER KRESS: Yes. I guess my question  
13 is motivated because there are questions as to how you  
14 determine the reliability of the passive systems, and  
15 although they tend to be very reliable, and one way to  
16 address those questions and put our minds at ease  
17 would be to say, okay, we have got this whole set of  
18 non-safety related systems, and if we didn't have the  
19 passive systems, we could still meet the design basis  
20 accidents with these.

21 I have just never seen you look at it from  
22 that viewpoint yet, and I recognize that you take  
23 credit for them in your PRA, and they show up as part  
24 of the LOCA CDF, but I have never seen them that way.

25 MR. SCHULZ: Well, the active systems

1 don't have the same capabilities as a passive system,  
2 in terms of the extreme accident, like large LOCA, and  
3 you could not mitigate with just active systems. You  
4 need accumulators. They are a safety.

5 There aren't non-safety accumulators,  
6 okay? So there are certain things, in terms of some  
7 accidents, like shutting down the reactor with control  
8 rods. Those are safety, and there aren't non-safety  
9 rods.

10 MEMBER KRESS: I guess I included those  
11 though in the -- I would just -- the non -- the safety  
12 related systems I would turn off would be the ECCS  
13 related, and I would keep the other ones.

14 MR. CUMMINS: Maybe I can make a comment.  
15 In general, the challenge is that we have  
16 automatically actuated the safety systems with a very  
17 reliable ANC system. In general, the active systems  
18 would mitigate the types of accidents that you are  
19 talking about, but require manual action.

20 So in a probablistic sense, you have this  
21 sort of unreliable operator requirement that is  
22 required to have the active systems work. But I think  
23 that for most of the cases they do provide first-line  
24 mitigation.

25 MEMBER KRESS: Okay. Thank you.

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1 MR. SCHULZ: Here you can see the passive  
2 core cooling system, and you will see some capacity  
3 increases here that we have incorporated into AP1000,  
4 and it gives you a feeling for how we sized up the  
5 equipment, and later on when we talk about success  
6 criteria and the T&A capabilities, this would give you  
7 a little feeling for that. The power has gone up  
8 about 76 percent, and the passive RHR capacity has  
9 almost matched that.

10 So in terms of transient mitigation the  
11 passive RHR capacity is essentially the same as AP600.  
12 For the makeup tank flow, it has not been increased as  
13 much and this was an insight that we got out of both  
14 testing and analysis of AP600 that we felt that we had  
15 extra margin there, and we didn't have to increase the  
16 core makeup tank as much as the power went up.

17 And in our subsequent detailed safety  
18 analysis, and PRA analysis that confirmed that this  
19 kind of core makeup tank increase has put us in terms  
20 of success criteria into the same situation as AP600.

21 On the other hand, the ADS-4, which is  
22 very important in getting to low pressures and gravity  
23 injections, and recirculation, we have increased a  
24 little more than the power level, and the same with  
25 RWC injection capability, and recert capabilities.

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1           So we have invested some time, money and  
2 design effort in scaling up and in actually improving  
3 the margins in some of what we feel were the really  
4 key passive modes of operations and features.

5           And as a result of that, for example,  
6 small break LOCA, we have maintained the AP-600  
7 capability of low core uncover for small LOCAs,  
8 something that is less or equal to a DVI line break.  
9 We have also maintained the capability of not  
10 requiring any operator actions following a steam  
11 generator tube rupture.

12           What we actually did to the passive RHR,  
13 it is exactly the same configuration, in terms of  
14 where the pipes connect, and the heat exchange  
15 location inside the IRWST, and were there pipes  
16 returned, and the valve alignments, and the types of  
17 valves.

18           The same elevations, and we did increase  
19 the pipe size from 10 inch to 14 inch to the heat  
20 exchanger, and back to the steam generator. This of  
21 course reduced the pressure drop so that we could get  
22 more flow.

23           We also increased the surface area, and  
24 put a few more tubes in, and increased the horizontal  
25 lengths of the tubes to give us some more heat

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1 transfer surface area. So in the natural circulation  
2 mode of operation, both the pressure drop through the  
3 heat exchanger, or through the piping system and more  
4 surface area, gives us the 72 percent or so increase  
5 in capacity.

6 MEMBER LEITCH: So a couple of questions  
7 about that.

8 MR. SCHULZ: Sure.

9 MEMBER LEITCH: First of all, the motor  
10 operated valve there at the top, that is normally  
11 open?

12 MR. SCHULZ: Right.

13 MEMBER LEITCH: And I guess I am wondering  
14 -- well, I am picturing this head exchanger as being  
15 something like -- something like a steam generator.  
16 In other words, it is sitting there, and exposed to  
17 the full reactor pressure.

18 MR. SCHULZ: Full reactor pressure, but  
19 cold temperatures.

20 MEMBER LEITCH: Cold temperatures, yes.

21 MR. SCHULZ: This is actually relatively  
22 realistic here, in that the motor valve is in the high  
23 point, and the piping does drop down into the top of  
24 the heat exchanger, which cold traps the heat  
25 exchanger.

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1 MEMBER LEITCH: Okay.

2 MR. SCHULZ: The heat exchanger is  
3 obviously sitting in a cold tank of water also.

4 MEMBER LEITCH: So the in containment  
5 refuel water storage tank, it is vented to where it is  
6 internally in the containment?

7 MR. SCHULZ: Yes. Yes.

8 MEMBER LEITCH: So it is really looking at  
9 containment pressure then?

10 MR. SCHULZ: Yes.

11 MEMBER LEITCH: Okay. So you have got  
12 reactor pressure on one side, and containment pressure  
13 on the other side, and I guess what I am thinking  
14 about is there only one motor operator valve?

15 MR. SCHULZ: There is only one motor  
16 operator valve.

17 MEMBER LEITCH: So suppose you get a leak  
18 in that heat exchanger? That motor operator valve has  
19 got to close, right?

20 MR. SCHULZ: Well, it doesn't have to  
21 close. There are tech specs on the leakage through  
22 the steam generator or through these tubes like there  
23 are tech specs in the steam generators. Now, a steam  
24 generator tube leak, you obviously cannot isolate and  
25 there is a lot of tubes, and the conditions on these

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1 tubes is in our opinion more severe, in terms of flow,  
2 vibration, temperature, heat transfer.

3           Whereas, these tubes, although they do see  
4 high internal pressure, the other conditions are less  
5 severe. So we don't -- and the type of construction,  
6 in terms of tube material is the same.

7           The connection with the tubes to a flat  
8 tube sheet here is done the same way as the steam  
9 generator tubes are done. So we are taking advantage  
10 of our experience painfully gained on steam generators  
11 to design this heat exchanger to be reliable.

12           If it does develop a leak, then we have  
13 the opportunity of closing that valve. This is true,  
14 and if that valve is closed, then you have eliminated  
15 the possibility of an accident caused by a tube  
16 rupture in the passive RHR.

17           And of course you would have to shut the  
18 plant down right away.

19           MEMBER LEITCH: Right. Right. But say,  
20 for example, that --

21           MR. SCHULZ: Of course, these are normally  
22 closed, but that is normally open.

23           MEMBER LEITCH: But suppose you cannot  
24 close that valve? You have a leak in the heat  
25 exchanger and you for some reason cannot close that

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1 valve. Then what you have is an in-containment leak.  
2 In other words, that is vented to the containment and  
3 so such a leak is no a leak to atmosphere, but it is  
4 a leak to --

5 MR. SCHULZ: That's right, and so it is  
6 less safety important than a leak to a tube, which has  
7 a more direct path outside of a containment.

8 MEMBER LEITCH: Right. So there is no  
9 manual valve or anything else on that line? I mean --

10 MR. SCHULZ: That's right. There is no  
11 operator valve. So you would shut the plant down. It  
12 is a high point so that it would be relatively easy  
13 once you were shut down and you go to reduced  
14 pressures, even if you couldn't close that valve, the  
15 leakage would stop.

16 MEMBER LEITCH: Yes. Now, what about the  
17 chemistry in that heat exchanger? In other words,  
18 there is no blow down if you will, or small flow  
19 through that to keep that to keep it -- I mean, I am  
20 picturing that as being a spot in which solids may  
21 concentrate?

22 MR. SCHULZ: There is no mechanism that I  
23 would know of to concentrates, such as boil off or  
24 heating. This heat exchanger would see some flow  
25 during a refueling outage so that the water left in

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1 here would be reactor grade refueling water  
2 concentration.

3 And then it would be isolated, and then  
4 during power operation, you would not put flow through  
5 the heat exchanger intentionally. There is no bleed  
6 flow that we have, and we hope that these valves are  
7 leak tight.

8 MEMBER LEITCH: So assuming that they are  
9 a good run, it sits there full of cold water, and no  
10 flow, for 18 months?

11 MR. SCHULZ: Right.

12 MEMBER LEITCH: Or 24, whatever the case  
13 may be?

14 MR. SCHULZ: Right. Probably very much  
15 like a normal RHR heat exchanger in an operating plant  
16 does until you shut the plant down. Then you would  
17 put flow through it, but normally you wouldn't.

18 MEMBER SIEBER: You would have lower  
19 pressures then.

20 MR. CUMMINS: The chemistry of the water  
21 in the tank is refueling water storage chemistry, and  
22 so primary water with boron, or whatever, 2500 PPM, or  
23 something like that.

24 MEMBER LEITCH: So it would have that  
25 boron concentration associated with the beginning of

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1 the refueling cycle; is that right?

2 MR. SCHULZ: Inside the heat exchanger  
3 would also be, yes.

4 MEMBER LEITCH: So as the boron  
5 concentration goes down through the cycle, it just  
6 stays at high boron concentration and just sits there?

7 MR. SCHULZ: That's right, which is safe.

8 MEMBER LEITCH: I was just wondering if  
9 there was some kind of purge there, but there is no  
10 provision for doing that?

11 MR. SCHULZ: No.

12 MEMBER LEITCH: Okay.

13 MR. SCHULZ: The rest of the passive core  
14 cooling system, again we have maintained the same  
15 configuration in terms of the numbers of valves, and  
16 types of valves throughout the system. It is exactly  
17 the same as AP600.

18 Again, the same elevations, in terms of  
19 where the tanks are located, and where the pipes are  
20 located. We have maintained the accumulator capacity.  
21 So the size of the tank, and the water level, the  
22 injection line resistance is the same.

23 Now that ends up resulting in some  
24 increased heat clad temperatures for large LOCA, and  
25 in the PCD, those numbers actually are in an RAI

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1 response, and we have said those numbers are as high  
2 as 2100 degrees.

3 And as a result of that we have changed  
4 the success criteria for large LOCA in the PRA. AP600  
5 could get away with one accumulator working because it  
6 had a lot of margin in peak clad temperatures. But  
7 for the AP-1000, we have to take credit for both  
8 accumulators working.

9 And you will hear more about that in the  
10 probabilistic side of the discussion. As I mentioned,  
11 the core makeup tank has gotten 25 percent bigger, and  
12 we have increased the flow, but we didn't have to  
13 change the pipe size. We were able to just open up  
14 the orifice that we had on AP600, which was relatively  
15 restrictive to a bigger hole, and get 25 percent more  
16 flow without changing any of the piping.

17 The IRWST logs and the recirc lines in  
18 there here, we changed. They were basically 6 inches,  
19 and we went up to 8 inches, and that was one of the  
20 reasons why we could get more flow.

21 In addition, we made some changes, which  
22 I don't detail here, that increases the containment  
23 flood levels. So in a long term cooling situation,  
24 where we are depending on the water level and the  
25 containment to drive flow through the system, we have

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1 increased that water level probably in the range of 1  
2 to 2 feet, which is pretty significant relative to the  
3 delta that we have.

4 So part of the reason why we have more  
5 recirc capability in AP-1000 is because of this  
6 increased water level. ADS stages 1, 2, and 3 are  
7 exactly the same as AP-1000, in terms of pipe size,  
8 flow capabilities, and so it is largely the same  
9 design.

10 We found from AP600 that what was really  
11 important was ADS Stage 4, and when you turned down  
12 ADS Stage 4, you in fact tended to starve flow through  
13 stages 1, 2, and 3. It almost stopped. And stage 4  
14 was really the important thing, in terms of getting  
15 down to gravity injection and recirc capabilities.

16 And there again we increased pipe sizes  
17 and valve sizes so that the lines coming from the hot  
18 legs and out are bigger.

19 MEMBER LEITCH: I am always concerned  
20 about the nitrogen and the conflict with maintenance  
21 activities, and people getting exposed to a nitrogen  
22 atmosphere. Is there any situation here where you  
23 could -- in other words, I guess what I am saying is  
24 that during shutdown for maintenance, the accumulator  
25 is fully depressurized?

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1 MR. SCHULZ: We don't require that. What  
2 we do require is that you close this valve, and this  
3 motor operative valve, which is normally open, has  
4 provisions to remove the power. It is required in  
5 fact by the tech specs.

6 And we do that at power mainly to make  
7 sure that this valve can't spuriously close or an  
8 accident. Now, during shutdowns, we do close the  
9 valve and also remove power so that it can't  
10 inadvertently open and then inject water rapidly into  
11 the reactor coolant system, which you know could  
12 possibly inhibit operations maintenance and whatever,  
13 and so that presents a hazard.

14 And this is no different for AP-1000 and  
15 AP600 than what we do on operating plants. But we  
16 don't require that the nitrogen be removed, the  
17 pressure.

18 MEMBER LEITCH: But it could be, right?

19 MR. SCHULZ: It could be.

20 MEMBER LEITCH: There is no reason why it  
21 has to be there.

22 MR. SCHULZ: Well, we basically with that  
23 valve being closed and locked out, we are saying that  
24 we don't need that feature and it is not going to be  
25 available on any rapid response time anyways. So it

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1 is not that important when you are in shutdown.

2 MEMBER LEITCH: Okay. I just -- you know,  
3 there has been some bad experience, and maybe not in  
4 the nuclear industry, but in other industries, where  
5 there is nitrogen used in that situation where people  
6 have succumbed to the nitrogen.

7 MR. SCHULZ: Well, of course, if you ever  
8 had to do inspection maintenance inside that tank, you  
9 would want to take the water out, and of course take  
10 the nitrogen out and be very careful with your  
11 breathing of anybody who would go into that tank.

12 MEMBER LEITCH: Yes. Okay. Thank you.

13 MR. SCHULZ: This is a picture of the long  
14 term cooling mode, and what you are seeing here is you  
15 are in recirculation, and water is coming from the  
16 containment through the -- you can't it very well in  
17 this picture, but there is a recirculation screen  
18 here, and water comes in, and goes back into the DVI  
19 line and back into the reactor, and the reactor  
20 coolant system is partially full of water.

21 This paints a kind of a picture where  
22 maybe there is a distinct water level which is  
23 probably really not accurate, in terms of what is  
24 going on, and in terms of boiling and two-phase  
25 mixtures in this part.

1                   But in any case the density of this stuff  
2                   inside the core and above the core will be a lot less  
3                   than the density of the water outside, and there will  
4                   also be a significant water level difference between  
5                   there.

6                   There are some accidents were you can have  
7                   a pipe break, a DVI break, that is actually in this  
8                   valve room. And if that is the case, there is  
9                   actually two of these separate rooms for the passive  
10                  core cooling system, a sort of A and B.

11                  One of the rooms where it floods with a  
12                  break, and that result in a little bit lower water  
13                  level in the containment, and we account for that when  
14                  we look at long term cooling both in design basis, and  
15                  in PRA space.

16                  MEMBER KRESS: The ultimate heat sync is  
17                  the passive containment cooling system?

18                  MR. SCHULZ: Right. So you don't see the  
19                  whole thing here, but -- with the steel containment,  
20                  but what you see with this little arrow is indicating  
21                  that condensate would be coming down and normally  
22                  corrected in the gutter, and the line to the waste  
23                  sump would be closed as indicated, and the condensate  
24                  would run into the IRWST.

25                  So what would be tending to happen is that

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1 coming out of the fourth stage, you would have a two-  
2 phased mixture, of water and -- and probably more  
3 water than steam. The water is going to tend to fall  
4 out into the containment water level, and that water  
5 will have to return through the sump screen.

6 The steam roll for the most part will go  
7 up into the area to be condensed, and the vast  
8 majority of that will come down as condensate to the  
9 gutter, and go back into the IRWST.

10 So even in long term cooling there will be  
11 a substantial portion of flow coming into the IRWST  
12 and continuing to come in through the DVI line. Now,  
13 typically when we do our long term cooling analysis,  
14 we make what we claim to be a conservative assumption  
15 and ignore this flow coming through the IRWST and in  
16 a sense force it all to come through the recert path,  
17 which increases the pressure drop through the sump  
18 screen and the recert line here.

19 Moving on to the containment, you see a  
20 picture here of how we have increased the height of  
21 the containment, and the diameter didn't change, and  
22 the free volume didn't change. The free volume goes  
23 up about 20 some percent, and the design pressure was  
24 increased.

25 An increase in the design pressure was a

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1 result of making the shell a little bit thicker. It  
2 still doesn't require post-weld heat treatment. We  
3 have changed the material, and which helps us with the  
4 design pressure.

5 So the combination of more volume and a  
6 higher design pressure actually increases the design -  
7 - the margins during design basis accidents. You will  
8 hear more about the capabilities of the system in the  
9 PRA and severe accidents.

10 MEMBER LEITCH: Does that increase the  
11 volume and improve the ease of maintenance in there?

12 MR. SCHULZ: Not really, because the  
13 diameter didn't change, and in essence below the  
14 operating deck is essentially the same, and that was  
15 one of the strong drivers from our commercial point of  
16 view, that we really wanted to maintain the design  
17 detail, because there is a tremendous amount of work  
18 that goes on in routing piping, and routing cables,  
19 and HVAC ducts, and making sure that all works.

20 MEMBER LEITCH: Sure.

21 MR. SCHULZ: Now, we did have to worry  
22 about some stuff, because you can see that the steam  
23 generators, they get fatter, as they need to because  
24 they have a lot more tubes in them. But it turns out  
25 that we were able to accommodate that inside the loop

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1 compartments.

2           The reactor coolant pumps get a little bit  
3 longer, and that had some perturbations in some minor  
4 concrete in there, but for the most part the concrete  
5 stayed unchanged, and the steam generator has got a  
6 bigger reactor vessel, and gets a little bit longer.  
7 But the bottom force was able to stay exactly the  
8 same.

9           MEMBER LEITCH: Can you change out steam  
10 generators? Does the containment accommodate that  
11 without cutting the containment?

12           MR. SCHULZ: Not without cutting the  
13 containment. For this design, I think like  
14 essentially all the combustion engineering tech  
15 designs, these steam generators are big in handling  
16 them, and trying to get them out through an equipment  
17 hatch is not very practical.

18           So what our intention is that we would  
19 actually take it out through this vent area, and so we  
20 wouldn't have to cut concrete, but we would have to  
21 make a hole in the steel containment in the center  
22 here and for the steam generator out through the top.

23           MEMBER LEITCH: I see. That area with the  
24 two X's on it there, I don't know exactly what that  
25 represents.

1 MR. SCHULZ: They represent some screens.  
2 So, both on the inlet and the outlet, we have some  
3 screens to keep large creatures from crawling in  
4 there.

5 MEMBER LEITCH: Okay. Thanks.

6 MR. SCHULZ: This shows you more of the  
7 passive core cooling system valve arrangement. The  
8 tank has grown in size, and we have a requirement as  
9 an AP-600 and in AP-1000 for that tank to last at  
10 least three days.

11 And after 3 days, we would normally  
12 provide water back into this tank. To get from 3 days  
13 to 7 days, we have on-site water in our ancillary  
14 water storage tank, and we have pumps and some small  
15 diesel generators which will allow us to put water  
16 back into that tank to go for 7 days.

17 And then after 7 days, we would -- and if  
18 we are still on passive systems, we would rely on  
19 other water supplies, either on-site or off-site.

20 MEMBER KRESS: When you analyze the  
21 cooling capacity of this, what outside temperature do  
22 you normally use for that amount?

23 MR. SCHULZ: Well, in design basis, it is  
24 like 115 degrees fahrenheit.

25 MEMBER KRESS: So it is not as high there

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1 then as the --

2 MR. SCHULZ: Very, very high temperatures,  
3 yes.

4 MEMBER KRESS: Do you assume that the  
5 water in the tank is at that temperature also?

6 MR. SCHULZ: I think so, yes. Which is  
7 not really practical because of the day and night air  
8 cycles, you would never get the water up that high.  
9 But just to simplify our analysis, we do that. When  
10 we do this air only cooling --

11 MEMBER KRESS: Without the water?

12 MR. SCHULZ: Without water, okay. For AP-  
13 1000, if we assumed like 80 degrees fahrenheit air and  
14 water, then air-only cooling is sufficient. It will  
15 stay below the rupture pressure of the containment.

16 If we do it so that the 115 degree air and  
17 water, and conservative decay heat, then there is a  
18 chance that the containment could rupture, especially  
19 in later times of frequency, and then there is an  
20 analysis in our PRA that looks at sort of the  
21 convoluted probabilities of --

22 MEMBER KRESS: When you say rupture that  
23 doesn't mean it less exceeds the design pressure. You  
24 have an actual failure rate?

25 MR. SCHULZ: That's right. And we have

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1 put some probabilities on failure versus how much we  
2 exceed design pressure. So we have tried to look at  
3 that. Now, AP-600 had a little more margin here with  
4 the lower power density and the surface area of the  
5 containment that it had.

6 So it could be more conservative here, but  
7 it looks like that we have dealt with it in the PRA  
8 and you can hear some more about that.

9 MEMBER KRESS: You mean power or power  
10 density?

11 MR. SCHULZ: In this case power density  
12 doesn't mean anything.

13 MEMBER KRESS: Absolute power.

14 MR. SCHULZ: Absolute power, versus like  
15 surface area, that is important, yes. The flow rates  
16 are -- the initial flow rate is almost the same, or  
17 slightly higher, for AP-1000. It is not really  
18 related to power. It is more related to quickly  
19 covering the surface of the containment to establish  
20 cooling, and that is what really drives that flow.

21 We have got a little bit more vertical  
22 height and so we increase the flow a little bit, but  
23 not very much. Later on after we uncovered the first  
24 steam piping, we slow the flow down more to decay heat  
25 levels, and now we have increased the flow

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1 proportionately to power.

2 So as a result the tank gets bigger. Now,  
3 another thing that we did from a PRA point of view is  
4 that we added a third valve path. The top two paths  
5 is all that AP-600 has. Two valve open air operated  
6 valves to initial the water drain, and either one  
7 works and you are fine.

8 For AP-1000, we added a third path and we  
9 made the active valve a motor valve to make it  
10 different or diverse from the first two valves, to  
11 increase the reliability of water drain.

12 And one of the reasons that we did that  
13 was because of the fact that we had less margin in the  
14 air only cooling storage was a kind of compensation  
15 for that.

16 Here you see a summary of the safety  
17 margins' AP-1000, 600 and a typical plant, loss of  
18 flow, and DNBR margin. As I mentioned, AP-1000 is a  
19 bit better than AP-600, which are typically quite a  
20 bit better than the operating plants.

21 Feedline break margins that improve, and  
22 I mentioned the operator action, and no operator  
23 action for tube ruptures. For small LOCA, we have  
24 maintained the no core uncover, and for a large LOCA,  
25 the peak clad temperature has gone up.

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1           One thing that I would point out here is  
2 that we did a large LOCA analysis for the PRA, and the  
3 PRA -- and the reason that we did it was for this  
4 analysis, we had containment isolation work, because  
5 you assume that in the design basis.

6           There is a slight delay before you close  
7 valves, but basically you close off the containment  
8 isolation. For the PRA in many cases we look at  
9 containment isolation not working, and we try to show  
10 that the core can ride out that capability.

11           And so even though the number of  
12 accumulators is the same in both cases, two, we have  
13 to reanalyze the large break without containment  
14 isolation.

15           And because we were close to the 2200  
16 degree limit, we wanted to make sure that we didn't go  
17 over that. We made one other change in that this  
18 number of design basis analysis assumes that loss of  
19 off-site power occurs at the time that the break  
20 happens or the reactor trips I should say, which is  
21 almost instantly with the break.

22           That has an adverse affect on the load,  
23 and electrical pumps start coasting down right way.  
24 It terms of that, if you take this same case and you  
25 do two things to it -- one, you leave the containment

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1 open, which tends to detract, and you leave the off-  
2 site power on for about 15 seconds until the  
3 electrical pumps trip anyway, this number drops down  
4 to less than 1900 degrees.

5 So this is a -- in the case of AP-1000,  
6 the probability of having this kind of thing happen is  
7 extremely low, because you have to lose off-site power  
8 instantly with reactor trip, and if it only runs for  
9 15 seconds, then that number is 1900 degrees or less.

10 So even though this looks like it is close  
11 to the limits, we have really got from a safe  
12 probability point of view more margin. Hydrogen  
13 mitigation, design basis. We have maintained the use  
14 of the PARS, although we have reduced the safety  
15 classification of them.

16 Some of the operating plants are working  
17 towards taking out recombiners, and we weren't sure  
18 that you wanted to get because of the timing of that,  
19 especially when we submitted the DCD for AP-1000.

20 We were not sure that we wanted to go that  
21 aggressively. We are maintaining the igniters in an  
22 almost essentially identical design with the AP-600.  
23 They are important in the severe accident  
24 capabilities.

25 MEMBER KRESS: You used MAAP-4 to get the

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1 hydrogen iteration, right?

2 MR. SCHULZ: Yes, we looked at different  
3 sequences, and different release points, timings, yes.  
4 We did make one change to help us in the release  
5 points. AP-600, if you look at the IRWST vents, many  
6 of them are located close to the containment wall.

7 We tried to put some hoods on them so that  
8 vent flow would go away from the containment, and this  
9 was an attempt to minimize the potential of hydrogen  
10 standing flames to overheat the containment.

11 But there was a bit of a debate between  
12 Westinghouse and the staff on whether that was fully  
13 effective on AP-600. So on AP-1000, we have got more  
14 hydrogen, and so these flames can be a bit bigger and  
15 last a little bit longer. So the issue was becoming  
16 a bit more of concern.

17 MEMBER KRESS: You have more hydrogen  
18 because you have more circ?

19 MR. SCHULZ: More fuel.

20 MEMBER KRESS: More fuel?

21 MR. SCHULZ: Yes.

22 MEMBER KRESS: So that is how you got it  
23 down?

24 MR. SCHULZ: Yes. So what we did, and let  
25 me just finish this, is that we changed the vent

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1 designs so that the vents that are close to the  
2 containment are spring loaded so that they will not  
3 open in a case where you are just venting hydrogen.

4 These vents are designed to release lots  
5 of water and steam in a design basis kind of accident.  
6 If you are into a core melt severe accident, you are  
7 basically by the time that you are releasing hydrogen,  
8 you are not releasing water and steam.

9 And the amount of stuff that you have to  
10 vent is really rather little. So we have got some  
11 other vents that are located well away from the  
12 containment, and these ones will preferentially open  
13 because they are not spring-loaded and biased to open.

14 And from that we have moved to standing  
15 flames well away from the containment. So we think we  
16 have made a nice improvement in this story.

17 MEMBER KRESS: From heat sources being  
18 close to the wall?

19 MR. SCHULZ: Right.

20 MEMBER KRESS: How many total igniters do  
21 you have in there?

22 MR. SCHULZ: There are 64 igniters, and  
23 their are paired, and so that is like at 32 locations.

24 MEMBER KRESS: 32 locations? How did you  
25 decide where to put them?

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1 MR. SCHULZ: Again, math analysis, and  
2 looking at -- Jim Scobel, when he talks about the  
3 hydrogen, can talk some more about that. I think he  
4 has actually got some pictures that he may be able to  
5 show, and he knows exactly why we put things where.

6 MR. CUMMINS: Dr. Kress, we do have backup  
7 slides on igniter location that shows where they are,  
8 and we could add that to the discussion tomorrow  
9 during the severe accident if you would like.

10 MEMBER KRESS: How are those igniters  
11 powered?

12 MR. CORLETTI: The same as the control  
13 system, the non-1EAC (phonetic).

14 MEMBER ROSEN: Does that mean in a station  
15 blackout that there is no power?

16 MR. CORLETTI: No, there is kind of like  
17 instrument power. They have a battery backed invertor  
18 for a period of -- a limited period in the case of  
19 non-safety, and we would expect that they would last  
20 two hours on that power supply, something like two  
21 hours.

22 All the loads would last something like  
23 two hours on that power supply.

24 MEMBER ROSEN: Is that long enough for the  
25 igniters to function if they were needed with station

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1 blackout?

2 MR. CORLETTI: I will have to defer that  
3 to Jim.

4 MR. SCHULZ: One thing to keep in mind is  
5 AP-1000, as in AP-600, station blackout is not a risk  
6 important event. It is very different from other  
7 operating plants, where a loss of -- where operating  
8 plants are dependent on AC power, very dependent on it  
9 to protect the plant.

10 AP-1000 isn't, okay? Passive systems  
11 don't need AC power, and so if you look at what causes  
12 coolant melt, and what causes severe accidents, it is  
13 not a loss of power. It is LOCAs or something like  
14 that.

15 So one of the reasons why we don't think  
16 that is so important is that if you get into a core  
17 melt, it is most likely that you will have AC power in  
18 this plant, which is different than operating plants.

19 I wanted to just say a few words about the  
20 non-safety systems. I had mentioned that they are  
21 typically redundant power by the on-site diesels.  
22 They are simplified from their, say, companion or  
23 cohort systems that would be in an operating plant.

24 So the start-up feedwater system has two  
25 motor driven pumps in this plant, whereas an aux heat

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1 system in an operating plant would have three or more  
2 pumps. The redundancy that we have put into the  
3 design is for more probable failures. We typically  
4 don't worry about pipe leaks or passive failures in  
5 these non-safety systems.

6 The equipment is a reliable experience-  
7 based, and not ASME code for the most part. One size  
8 may -- well, in some cases we have put based on our  
9 written evaluation of the safety importance of these  
10 non-safety, we have put some limited seismic wind  
11 capabilities.

12 Typically the equipment that we require to  
13 support post-72 hour operation, and we have a tank and  
14 a couple of pumps that we put some limited seismic and  
15 wind capability on those. But for the most part, we  
16 don't require this kind of hazard protection.

17 We invest that into the passive systems,  
18 with the full seismic wind and fire protection on  
19 those systems. We typically don't put tech specs on  
20 these equipment, but we have put on two many of them  
21 availability controls and this case out again of our  
22 RTNSS evaluations, the same controls that we put on  
23 AP-600.

24 MEMBER KRESS: Did you do or determine  
25 importance measures (inaudible) for these AP systems?

1 MR. SCHULZ: We have. We used those  
2 numbers mainly in determining whether they were in the  
3 D-RAP program, which we have listed those systems that  
4 captured that way. When we looked at the RTNSS. we  
5 didn't use the risk importance measures directly.

6 We did a more conservative evaluation,  
7 where we like took out all of the non-safety systems  
8 at the same time, and then recalculated the core melt  
9 frequency and large release frequencies, and if we  
10 could still meet the NRC safety goals without these  
11 systems, we said they are not safety important from  
12 that point of view.

13 And it turns out that in AP-1000 that we  
14 end up putting in some -- we need some DAS manual  
15 controls to meet that. So we put tech specs on the  
16 DAS manual controls, which is a little different.

17 MEMBER KRESS: And subjected them to  
18 Option 2 process? Which one of the boxes would they  
19 show?

20 MR. SCHULZ: I am not conversant in that,  
21 but I think our system is a little different than what  
22 people are talking about now.

23 MEMBER KRESS: Yes, and Option 2 is a risk  
24 informed process.

25 MR. SCHULZ: And I just wanted to show you

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1 the picture of the normal RHR system and this is what  
2 is normally used in a shutdown cooling mode for AP-  
3 1000 two pumps, but you see that there is some carbon  
4 piping in and out, and again this is a non-safety  
5 system, and it doesn't have to work to remove decayed  
6 heat in any accident.

7 It does have a connection to the IRWST and  
8 containment recirculation. So it actually can be used  
9 and the operators have instructions to line up and use  
10 this system in case ADS has been activated, for  
11 example. It is to provide a low pressure backup, and  
12 low pressure injection, just as it was in AP-600.

13 One difference is that the water supply in  
14 that case would be taken from the spent fuel coolant  
15 loading pit. We maintain that pit full of water  
16 normally and you do use this system to provide low  
17 pressure injection.

18 Water would be taken from outside  
19 containment, and we did this to minimize an adverse  
20 interaction that we found with AP600, where if you  
21 take the IRWST water and pump it, if you had a DVI  
22 line break, what you end up doing is pumping the water  
23 into containment, because of the way that these lines  
24 are arranged up.

25 If you have one of these lines broken, all

1 the water goes there, and so you in essence pump down  
2 the IRWST and you get your recirc quicker. Now, the  
3 AP-600, we could tolerate that, although it may be  
4 absent at worse.

5 The AP-1000, it was going to be more  
6 challenging for us, and instead of trying to design  
7 for that, we have changed the plant design operations  
8 so that we would require the operators to take suction  
9 from this outside water supply.

10 So if this system works, instead of going  
11 to recirc sooner, we would go to recirc at the same  
12 time with real water. So you can't make the accident  
13 worse than, which we think is a nice improvement.

14 So we are always looking for adverse  
15 interactions and trying to make sure that the plant  
16 works good and better. The next couple of slides talk  
17 about the I&C systems in the plant, and there are  
18 basically three; a control system, safety, and a  
19 diverse system.

20 The safety control in a safety system are  
21 microprocessor-based software and multiplexed  
22 communications. The safety system is obviously a 1E  
23 system for the divisions, nicely separated and all of  
24 that.

25 The diverse system is also a

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1 microprocessor-based system. It will use different  
2 hardware and software than a safety system to make it  
3 diverse. It has its own separate sensors, and so it  
4 doesn't have to have sharing and isolators between it  
5 and the other systems.

6 It has a limited scope, which we  
7 determined using the PRA, and on which functions was  
8 PMS most important and where did we need it, and where  
9 was its failure due to common mode failure most  
10 important in the PRA.

11 And where it was most important, and we  
12 put those sensors and capabilities into the DAS to  
13 protect us. Basically, the DAS operates passive  
14 safety systems, like passive RHR, core makeup tanks in  
15 a different way.

16 MEMBER SIEBER: What is the framework for  
17 the instrument system? What is it built on amongst  
18 the standard --

19 MR. SCHULZ: Are you talking about  
20 hardware design?

21 MEMBER SIEBER: Yes.

22 MR. SCHULZ: We are not licensing AP-1000  
23 based on a hardware design. We are trying to design  
24 an architecture, a minimum set of instrumentations and  
25 functions, and then when we actually build the plant,

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1 because of the rapid, evolving nature of INC systems,  
2 we would use the latest design.

3 Now, that said, our current product line  
4 would be a common Q product, which Combustion  
5 Engineering used on System 80 plus or a similar  
6 design. AP-600 at that time was an Eagle product.  
7 But in a couple of years or five years, it will  
8 probably be something else.

9 MEMBER KRESS: So these are ITAACs then?

10 MR. SCHULZ: Yes, there is -- to certain  
11 minimum commitments that we make in the ITAACs, in  
12 terms of inventories of sensors and controls, of  
13 functions to perform. Exactly how it is done is more  
14 of a design process ITAAC kind of thing.

15 MEMBER KRESS: Your piping is an ITAAC  
16 also?

17 MEMBER SIEBER: Right.

18 MR. CORLETTI: The DAC, the design  
19 acceptance criteria, which is covered during the time  
20 of the COL application, this is a similar.

21 MEMBER KRESS: This is similar to AP-600?

22 MR. CORLETTI: Right. It is the same as  
23 the AP-600, the approach, as far as the licensing  
24 approach.. We have broadened our application to --  
25 like Terry said, when we did AP-600, our product, our

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1 only product at that time for a 1E PMS was Eagle.

2 We have now expanded our application to  
3 include either an Eagle product or the common Q  
4 product, which is going through -- some licensing has  
5 been approved with the NRC as far as the application  
6 of the common Q, to an existing plant.

7 MEMBER SIEBER: Well, from the standpoint  
8 of the PRA then, since you really haven't said that  
9 this is the architecture, and that is the  
10 architecture, and that is the way that it will  
11 function, and here is what the equipment is, how do  
12 you estimate the error rates with any kind of  
13 accuracy, you know.

14 MR. SCHULZ: What we did was we in AP-600,  
15 we analyzed the Eagle product line in detail for the  
16 PRA. So the PMS failure rates were based on that.

17 MEMBER SIEBER: And who makes the Eagle  
18 product line?

19 MR. SCHULZ: Westinghouse.

20 MEMBER SIEBER: And where has it been  
21 applied? Do you have operating plants with this  
22 equipment?

23 MR. SCHULZ: Yes, we do.

24 MEMBER SIEBER: How many of them --

25 MR. SCOBEL: This is Jim Scobel, and I

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1 think Sequoia and I think several others.

2 MEMBER SIEBER: Okay.

3 MR. SCOBEL: I think Sizewell as well.

4 MEMBER SIEBER: For their main control  
5 system and not this separate instrument loops?

6 MR. SCHULZ: That's correct.

7 MR. SCOBEL: For their protection system.

8 MR. SCHULZ: Okay. The control room would  
9 be a compact control room, with overview panel  
10 displays, and work stations, and a small number of  
11 dedicated displays, some of which are safety related  
12 to the PMS post-accident, and some of which are --  
13 separate ones are related to the diverse actuation  
14 system.

15 And from a plant control point of view, we  
16 have soft controls which are part of the non-safety  
17 part of the plant for normal operation, and we have a  
18 small number of dedicated switches which are related  
19 to or connected to the passive safety system, or the  
20 I&C system that are 1E.

21 These are typically system level type  
22 switches, and we also have some switches related to or  
23 associated with the diverse actuation system. There  
24 is the advanced alarm management and computer based  
25 procedures.

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1                   MEMBER ROSEN:     That small number of  
2 dedicated switches, do you have for example an analog  
3 SCRAM switch, manual SCRAM switch?

4                   MR. SCHULZ:     There is a manual SCRAM.

5                   MEMBER ROSEN:   That doesn't go through the  
6 computer system.

7                   MR. SCHULZ:     Right. Well, the DAS one  
8 does not go through the computer system at all. It  
9 goes directly out to --

10                  MEMBER ROSEN:   Well, something that opens  
11 the breaker. So on the --

12                  MR. SCHULZ:     Yes, on the PMS --

13                  MR. CUMMINS:   The PMS does not move over  
14 manual. It directly trips the plant.

15                  MR. SCHULZ:     The PMS goes to the breakers  
16 directly without going through the computer. The DAS  
17 --

18                  MEMBER ROSEN:   So this is a real switch,  
19 and not a mouse click or something like that that the  
20 operator can do?

21                  MR. SCHULZ:     Well, all of these dedicated  
22 switches are not soft controls. They are dedicated,  
23 and that's what I mean. They are sitting here on the  
24 board, and you can touch them, and they always do the  
25 same thing.

1                   There is a reactor trip which goes  
2 directly to the breakers, and now the other ones, like  
3 SI, is a dedicated switch, but it goes through the  
4 computer because it goes and generates an S signal,  
5 which then have to propagate through the valves.

6                   MEMBER ROSEN:       I wa asking you  
7 specifically about manual SCRAM.

8                   MR. SCHULZ: Manual SCRAM is directly to  
9 the breakers.

10                   MEMBER KRESS: Normal operating plants  
11 nowadays have what, four operators in the control  
12 room, and a supervisor? How as it that you decided  
13 that one reactor operator, and one supervisor, was  
14 sufficient?

15                   MR. SCHULZ: From a -- this was done as  
16 trying to look at the workload on the operators, in  
17 terms of what automatic controls they needed?

18                   MEMBER KRESS: Is it some sort of task  
19 analysis?

20                   MR. SCHULZ: Task analysis. Now, I think  
21 from a --

22                   MR. CUMMINS: Can I comment on that?  
23 First of all, there are utility requirements documents  
24 that told us that that was our design criteria for the  
25 AP-600.

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1                   MEMBER ROSEN:     What was your design  
2 criteria?

3                   MR. CUMMINS:   That the plant be able to be  
4 operated by a single operator and the concept of the  
5 utilities was a single operator and a supervisor who  
6 didn't operate. So that is our design challenge. The  
7 actual implementation and task analysis is similar to  
8 Terry's discussion on INC. It is an ITAAC.

9                   We still have yet to prove that a single  
10 operator is adequate, but we certainly intend to prove  
11 that.

12                  MEMBER KRESS:   Would your control room  
13 accommodate more operators?

14                  MR. CUMMINS:     Yes, the utility  
15 requirements document also required that it  
16 accommodate at least three operators. So we are  
17 pretty well covered with our requirements.

18                  CHAIRMAN APOSTOLAKIS:   How many now are  
19 there in the control room?

20                  MEMBER KRESS:   I think normally they have  
21 about four.

22                  MEMBER BONACA:   Two not three.

23                  MEMBER SIEBER:   There are two licensed  
24 operators, and a supervisor, which is the minimum for  
25 tech specs that usually have more hands available.

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1 MEMBER KRESS: Yes.

2 MEMBER SIEBER: But that would be the  
3 normal requirement.

4 MEMBER ROSEN: For a one-unit plant.

5 MEMBER SIEBER: For a single unit, yes.  
6 Two units sometimes -- some tech specs say you can  
7 have three if each has a license on both units. But  
8 in other cases where you have two units that are  
9 single licenses, two operators per unit, plus --

10 MEMBER ROSEN: And it is complicated by  
11 the fact that some dual unit sites have only one  
12 control room, and so they have a common control room  
13 for both. So you have a shift manager who manages the  
14 shift for both units, and then you have unit  
15 supervisors.

16 MEMBER SIEBER: Right.

17 MEMBER ROSEN: So you can't say a whole  
18 lot about it. The only real way to convince me that  
19 it is adequate is to do a task analysis.

20 MR. SCHULZ: And we have yet to prove  
21 that, and so that would be something that we would  
22 have to do.

23 MEMBER LEITCH: I think the more  
24 challenging thing there is perhaps not operating the  
25 plant under normal circumstances, but in the exercise

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1 of the emergency plan, for example, and making the  
2 necessary phone calls, particularly if you couple that  
3 with a fire, and so you have got fire brigade people,  
4 and not necessarily licensed operators.

5 But it is those kinds of situations I  
6 think where you have, say, a fire, and you are  
7 actuating the fire brigade, you need someone to make -  
8 - you need an emergency director to run the --

9 MEMBER ROSEN: And the fire causes a loss  
10 of coolant accident and opens --

11 MR. SCHULZ: What's that?

12 MEMBER LEITCH: And the fire causes a  
13 spurious ADS actuation. So you have a LOCA, a small  
14 LOCA, at the same time. Now, if you have enough  
15 people to handle that, you are going to be okay.

16 MR. SCHULZ: Well, we have tried to deal  
17 with that a little bit and to prevent the LOCA from  
18 being caused by the ADS fire. So that is a  
19 requirement. But, yes, you're right. We have yet to  
20 prove that and that has yet to be done.

21 PMS reliability features, and this is the  
22 safety I&C again for divisions completely separated,  
23 and improved isolation versus current plants for the  
24 use of fiberoptics. Each with its own independent  
25 batteries, and 2 out of 4 bypass logic when

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1 appropriate, like reactor trip and SI.

2 Typically we use different plant  
3 parameters to provide a functional diversity.  
4 Extensive verifications and validation and equipment  
5 qualification. Improved in-plant testing and built-in  
6 continuous testing, and manual and periodic testing,  
7 and extensive experience with these kinds of designs,  
8 and that we have upgraded on operating plants.

9 Similarly from a mechanical systems point  
10 of view, and why we think these systems will work, and  
11 why would they be reliable, you see a number of  
12 different elements, starting with conservative design,  
13 and equipment specifications, development testing, and  
14 this is largely the AP-600.

15 Conservative safety analysis, using the  
16 codes that are verified against this testing.  
17 Additional PRA and T&H analysis, which I will be  
18 talking about this afternoon, and in some cases using  
19 different codes, and looking at multiple failures, and  
20 we learned things from this that we don't learn from  
21 the design basis analysis.

22 The PRA itself and its probabilities is  
23 obviously a reliability input and measure. Emergency  
24 procedure T&H analysis. We do yet more analysis here  
25 looking at procedures and operator actions.

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1           And again finally once the plant is built,  
2           there are things done in the plant there are things  
3           done in the plant. For example, start-up testing, and  
4           ITAAC verifications, in-service testing inspections,  
5           that all contribute to the overall reliability story.

6           MEMBER KRESS: Refresh my memory. How do  
7           you do a level 3 without a site?

8           MR. SCHULZ: We do releases, probability  
9           of releases, and maybe you should save that for the  
10          level-3 guys that are going to talk later, okay?

11          MEMBER KRESS: Okay.

12          MEMBER ROSEN: I have a question on  
13          development testing of the block on the right, where  
14          you talk about component testing, and system testing,  
15          and interval tests. My questions are specifically  
16          about testing of the 14 inch squib valves. Is there  
17          someone who is going to talk about what kind of data  
18          you have to support the spurious actuation estimates  
19          that are in the PRA, and the reliability of the 14-  
20          inch ADS valves?

21          MR. SCHULZ: Well, those are two separate  
22          questions. I had a back-up slide which would probably  
23          relate to the design and understanding of the  
24          spurious.

25          MEMBER ROSEN: Well, I don't want you to

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1 that right now unless that is the right part, but  
2 sometime between the end of the day and -- between now  
3 and the end --

4 MR. SCHULZ: Are you talking about the  
5 valve design?

6 MEMBER ROSEN: Valve design and  
7 reliability.

8 MR. SCHULZ: The reliability part would be  
9 better handled later of the valve itself.

10 MEMBER SIEBER: These are the (inaudible)  
11 valves?

12 MR. SCHULZ: Right. You see a picture  
13 here of the valve design that we would use. This  
14 piece here is actually machined out of -- with an end  
15 cap on it, and it is all one piece, and it has got a  
16 sheer point designed into it at this point.

17 So that when the valve is actuated, and  
18 the valve is actuated with igniters that are connected  
19 in here, this valve design is actually three separate  
20 igniters, any one of which can actually actuate the  
21 valve.

22 Two of those are wired to -- each to a  
23 different PMS division, and the third one is wired  
24 directly to the DAS division. So the DAS -- and DAS  
25 has only manual ADS actuation. So those controls are

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1 hard wired from the control room in DAS, out to the  
2 stage-4 valves.

3 The PMS connections come through the I&C  
4 cameras, and once they leave the PMS division, they go  
5 directly to the valves. And in actually firing any  
6 one of those igniters, a two-stage circuit has to be  
7 activated, and it is basically an armed fire-type  
8 circuitry which has to work in series in a proper  
9 fashion for any one of those three to work.

10 And this prevents a failure within that  
11 circuit from causing actuation. So if the fire  
12 circuit inadvertently goes off, the valve won't work  
13 because there is not enough power to set off the  
14 igniter. The arm basically surges up additional power  
15 that is not normally available to the fire circuit.

16 So if either of these circuits spuriously  
17 goes off the valve will not open and cannot open.  
18 Now, in addition to that, you could -- well, you could  
19 get a false signal into the valve control cabinet that  
20 says fire.

21 Well, that comes from two kinds of things.  
22 One is automatic from the PMS. Now, DAS doesn't have  
23 automatic, and so only the PMS could automatically do  
24 this, and this is based on two other 2 of 4 logic,  
25 which starts with an SI signal, and also because 2 out

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1 of 4 signal (inaudible) also requires that (inaudible)  
2 tank low level signal, and with (inaudible) being less  
3 than 1300 psi.

4 So if all those things are in existence  
5 based out of 2 out of 4 logic, you can get a PMS  
6 signal. So we think that that provides a high degree  
7 of prevention capability of spurious automatic signal,  
8 obviously combined with the armed fire circuitry, the  
9 (inaudible) can come from POS soft controls, and you  
10 can do it that way.

11 But there is a two-step kind of armed fire  
12 thing that the operators have to do, and in addition  
13 the pressure has to be less than 1300 psi. So two of  
14 the soft controls, even if the operator goes through  
15 the right two step procedure, he can't get the water  
16 valves to open if he is at normal operating pressures.

17 The PMS has dedicated switches that would  
18 go to the four stage valves, and there is two  
19 switches, and they both have to be activated at the  
20 same time to get these valves to work.

21 And the same is true of the gas. So we  
22 have tried to do a lot of things to make it extremely  
23 difficult for these things to go off when they are not  
24 supposed to.

25 MEMBER KRESS: When the cap is sheared

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1 off, where does it go? Does it lay down? The pole is  
2 left to right?

3 MR. SCHULZ: Yes, this is the high  
4 pressure and this is the outlet of the valve, and the  
5 cap is captured in a pin, and when the motor is  
6 energized, it sets off a charge propellant that builds  
7 up gas pressure above the piston.

8 And then there is a tension bolt here and  
9 it holds the piston back until pressure builds up to  
10 a high point, and then that shears as you can see here  
11 and this piston is driven down and hits and impacts  
12 the top of this assembly here, and shears off the  
13 joint here, and then the flow, the pressure, pulls  
14 that down, and then it is out of the way. So the flow  
15 can just exit the valve.

16 MEMBER KRESS: It can't sit there and flap  
17 then?

18 MR. SCHULZ: I won't close until you  
19 refurbish it out.

20 MEMBER SIEBER: You have to replace it.

21 MR. SCHULZ: That's right. You have to  
22 replace the internal.

23 MEMBER ROSEN: And is the 14 inches the  
24 outlet prevention?

25 MR. SCHULZ: No, the 14 inches is the pipe

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1 size coming into the valve here.

2 MEMBER ROSEN: Okay.

3 MR. SCHULZ: Now, this inlet is a little  
4 bit smaller as depicted here, and so this is the choke  
5 point in the valve.

6 MEMBER ROSEN: So it is bigger on the  
7 outlet?

8 MR. SCHULZ: It is bigger on the outlet,  
9 yes.

10 MEMBER ROSEN: And that is the one that  
11 just goes right to the containment right there?

12 MR. SCHULZ: That's right. So in our  
13 design there aren't actually using any piping or  
14 flanch connected to the outside of the valve. It just  
15 goes to the lube compartment.

16 MEMBER KRESS: Now, that thing laying on  
17 its side, it is held down there by the flow and the  
18 gravity; is that what holds it down?

19 MR. SCHULZ: That's right, and there is  
20 also a sensor here that will be connected back to the  
21 control room to tell the operators that this thing has  
22 opened up.

23 MEMBER ROSEN: How many times have you  
24 fired these things?

25 MR. SCHULZ: We have not built one of

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1 these valves ourself. A company that we talked to  
2 built one and fired it several times for another  
3 company. These valves are -- squib valves are custom  
4 type designs.

5 They are not like an MOV. Each one of the  
6 valves is pretty much built to the specifications of  
7 the company that is buying it. The company has -- and  
8 the valves are obviously a very simple design. There  
9 is no packings, and there is no torque switches, and  
10 no electric motors.

11 There are very few moving parts. There is  
12 lots of margin built into the gas pressure that they  
13 generate. The performance of the propellant is  
14 something that has come out of ammunition explosive  
15 technology over the years, in terms of how do you  
16 control the materials that you mix together, and what  
17 kind of samples do you take when you mixed it up, and  
18 how do you test it in the field.

19 Do you take the charge out and you set it  
20 off to see if it would have worked. That whole  
21 process is very well understood from a design point of  
22 view, from a probability point of view.

23 And we would be buying this valve with a  
24 reliability specification, which is not something that  
25 we can do in other valves. The motor operator valve,

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1 and inner operative valve vendors will not quote you  
2 a reliability, in terms of your specification. These  
3 guys will, okay?

4 MEMBER KRESS: Based on testing umpteen  
5 dozen of them or --

6 MR. SCHULZ: Not the testing of this  
7 valve. The testing of the propellant and its design,  
8 and its reliability, and the igniter reliability, and  
9 the parts and pieces to assemble a calculated  
10 reliability based on actual reliabilities of  
11 components.

12 MR. CUMMINS: These valves are currently  
13 in use of nuclear power plants, and not Westinghouse  
14 plants, and not at this size, but in smaller sizes.  
15 But the squib valves are being used for safety  
16 applications by some of our competitors.

17 MEMBER ROSEN: What numbers did you use  
18 for the reliability?

19 MR. SCHULZ: Okay. You are talking about  
20 valve reliability and I would like to postpone that to  
21 a guy that is going to talk about probabilities,  
22 because I don't really know the answer to that.

23 MEMBER ROSEN: The question is what  
24 numbers did you use for reliability for actuation on  
25 command, and what numbers did you use for reliability

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1 or spurious actuation, and why do you think the  
2 numbers that you used from whatever source are  
3 appropriate to use for this 14 inch valve? That is  
4 the question.

5 MR. SCHULZ: Okay.

6 MEMBER KRESS: How is the gate there that  
7 blows off, how is it -- in the closed position how is  
8 the seal maintained there? What is the --

9 MR. SCHULZ: That is not a seal. That is  
10 a solid piece of metal. This sleeve and part of the -  
11 - the piece that flops down is actually a two-piece  
12 assembly that is screwed together and bolted together.

13 The part that is on the high pressure side  
14 is actually machined out of one piece of metal. It  
15 doesn't show it very well, but there is a narrow  
16 point, or I call it a shear point, that is a weak  
17 spot. It is designed to hold the pressure, but when  
18 it is impacted by this piston here, it shears at that  
19 point. So there is no seal, which is something that  
20 is very nice that the valve won't weight.

21 MEMBER ROSEN: What is it made of, that  
22 piece that is exposed to the coolant?

23 MR. SCHULZ: I don't know the exact --  
24 stainless steel.

25 MEMBER ROSEN: Is that a guess, or --

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1 MR. SCHULZ: I don't know. I'm sorry.

2 MEMBER ROSEN: Well, what I am thinking  
3 about is corrosion of that, and if it cracks in that.  
4 You know, you have a circular ring that forms the  
5 seal, and I don't know how thick it is, but I assume  
6 that it is fairly thin.

7 MR. SCHULZ: Yes.

8 MEMBER ROSEN: And if that cracks, and  
9 there are ways to crack materials in PWRs, especially  
10 materials that are under stress.

11 MR. SCHULZ: The specification of that  
12 material will be important yes.

13 MEMBER ROSEN: If it cracks during normal  
14 operation, you will have a spurious -- that thing will  
15 flop because it is under pressure.

16 MR. SCHULZ: If it is enough of a crack,  
17 yes.

18 MEMBER ROSEN: Right.

19 MEMBER KRESS: That tension bolt, is it  
20 required that you torque down to a certain point  
21 before it will fail under tension?

22 MR. SCHULZ: No. It is not -- I don't  
23 believe it is under tension initially. It is holding  
24 --

25 MEMBER KRESS: It is holding the thing up

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1 there.

2 MR. SCHULZ: It is holding it up there and  
3 I think it is just in contact with --

4 MEMBER KRESS: Is there a release path for  
5 the gas to go up around that bolt?

6 MR. SCHULZ: There is as you see there is  
7 an O-ring there under the head here, and around the  
8 cap, and also there is several O-rings around that  
9 assembly where you can take it apart.

10 MR. CORLETTI: Terry, this is Mike  
11 Corletti from Westinghouse. It sounds like we are  
12 getting into a lot of discussion on the details of the  
13 valve design, which I think maybe what we could do is  
14 if we have not resolved all the questions on the  
15 details of the design, we could bring that up at the  
16 plant meeting, and maybe we could even arrange to have  
17 the vendor participate.

18 MEMBER KRESS: We think that it is very  
19 important that the ADS 4 system work.

20 MEMBER SIEBER: Only when required.

21 MEMBER ROSEN: One of the key parameters  
22 is the reliability of this valve, but as Mike  
23 Snodderly reminds me, also the temperature of this  
24 valve, and so I don't know anything about what  
25 temperature this operates at.

1 Can you tell me, for instance, what the  
2 temperature is of that after normal operations?

3 MR. SCHULZ: Of the fluid in here?

4 MEMBER ROSEN: Yes.

5 MR. SCHULZ: It is going to be hot. We  
6 have a small cold trap, but it is not going to be  
7 fully effective and so that water temperature -- we  
8 have specified to the valve vendor that the water  
9 temperature in here can be hot leg temperature, 600 to  
10 610. There is obviously metal pieces, and this part  
11 of the valve has a bunch of fins, and it is kind of  
12 depicted by this cut-out in this outer edge, and that  
13 maintains the -- the (inaudible) temperature sensitive  
14 really is the propellant up here.

15 So there fins around the top part and also  
16 along here, and you also see fins here.

17 MEMBER ROSEN: It is good to make sure  
18 that the propellant charge works.

19 MR. SCHULZ: Absolutely.

20 MEMBER ROSEN: But what I am worried about  
21 is that in this discussion right now is that the  
22 cracking of that small section that has the shear, but  
23 cracking during normal operation, which propagates  
24 around this seal in some way until the 2000 psi  
25 reactor pressure opens the valve and creates a

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1 spurious actuation.

2 MR. SCHULZ: Yes.

3 MEMBER ROSEN: And that is the question  
4 that we need to talk some more about.

5 MR. CORLETTI: Okay. I think we could  
6 probably discuss more of the details for the plant  
7 discussion meeting on the valve. Terry, you are out  
8 of time, but we could -- could you do in five minutes  
9 maybe one of your defense in depth to just kind of  
10 illustrate the defense in depth of the plant?

11 CHAIRMAN APOSTOLAKIS: Or another  
12 alternative is that I suspect that defense in depth is  
13 going to have some questions.

14 MR. CORLETTI: We can just keeping go and  
15 run over --

16 MEMBER BONACA: Or we can break now and  
17 come back. Is that a good time?

18 CHAIRMAN APOSTOLAKIS: You seem to be  
19 going into other topics, right?

20 MR. SCHULZ: Slightly different, yes.

21 CHAIRMAN APOSTOLAKIS: Right. Can we do  
22 that?

23 MR. CORLETTI: Whichever you prefer, yes.

24 MEMBER ROSEN: You are in charge.

25 CHAIRMAN APOSTOLAKIS: I don't think it is

1 going to be five minutes. So we will recess until  
2 10:25.

3 (Whereupon, at 10:08 a.m., the hearing was  
4 recessed and resumed at 10:27 a.m.)

5 CHAIRMAN APOSTOLAKIS: Okay. We are back  
6 in session. Let's see if we can finish this in 5 or  
7 6 minutes.

8 MR. CUMMINS: This is Ed Cummins, and just  
9 one comment. Dr. Kress asked about how non-safety  
10 systems could be used to mitigate accidents, and I  
11 think that this set of view slides is a way to answer  
12 his question as you go in the presentation.

13 CHAIRMAN APOSTOLAKIS: So you skipped the  
14 defense in depth slide?

15 MR. SCHULZ: Yes. Yes, it basically said  
16 that AP-1000 has different ways of handling accidents.  
17 The first way is usually a non-safety means, and you  
18 see that here. This is a loss of off-site power  
19 event, and the first level of defense, and these  
20 things are ordered in their anticipated likelihood of  
21 use, okay?

22 We can't guarantee that it is going to be  
23 this way, but if you lose off-site power, you still  
24 have that feed water system will be actuated, and if  
25 it is actuated and works properly, passive RHR will

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1 not be actuated the way the logic and controls are set  
2 up.

3 And the start up feed water is a non-  
4 safety system, and it is two prompts, and it feeds the  
5 steam generators, and if it operates successfully  
6 decayed heat is removed, and that is the end of the  
7 event.

8 If it fails to work, both pumps don't  
9 work, and AC power is not available, or whatever, the  
10 passive RHR is automatically actuated. This is the  
11 level of defense that we take credit for in the DCD  
12 for a loss of off-site power event.

13 If that system is actuated eventually the  
14 passive containment cooling system will also  
15 automatically be actuated, assuming the heat exchanger  
16 runs for more than a couple of three hours, which is  
17 not necessarily going to happen.

18 But if it does, the PCF will also be  
19 operated, and again if those systems features work,  
20 then that is -- you know, you can go indefinitely that  
21 way. If the passive RHR completely fails, for  
22 example, then you can go into a couple of different  
23 feed and bleed type cooling mechanisms, using some  
24 different equipment.

25 The first one uses the core makeup tanks,

1 and I say partial ADS, and this basically means one or  
2 two stage 2 or 3 ADS valves. If they open, there are  
3 sufficient to get the pressure down so that the low  
4 head RHR pumps can inject. They are not sufficient to  
5 get down to gravity injection, but they are sufficient  
6 to get to R&S. And if that system works, then again  
7 the core is cooled, and you have opened up your R&S.

8 Now, you can take some failures to some of  
9 this equipment. For example, if the R&S doesn't work,  
10 and you get full ADS, you can go through the full  
11 small LOCA protection kind of steam, where IRWST  
12 gravity injection and containment recirculation works  
13 with full ADS.

14 And full key here is 4 stage. We don't  
15 recall need any stage 1, 2, or 3 if you look at the  
16 PRA results. We do need stage 4, and we take credit  
17 here only for 3 out of 4 stage fours if we take a  
18 single failure there.

19 Again, if that works, we are okay. And  
20 then there is the case of what if the core makeup  
21 tanks don't work. Well, if the core makeup tanks  
22 don't work, and we get the accumulators available,  
23 then the operator in this case will have to manually  
24 actuate ADS, because the core makeup tank level is  
25 what normally actuates ADS.

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1           And if the core makeup tanks don't work,  
2 you don't get that signal. So the operators would  
3 have to manually. Now, they have got 20 minutes to  
4 actuate ADS in this case.

5           So again you have got -- so the  
6 combination of these three things, which aren't  
7 completely separate, but do have separate pieces, adds  
8 up to a lot of failure tolerance, diversity,  
9 reliability.

10           So this kind of thing is specifically  
11 modeled in the PRA, in terms of the event trees. The  
12 PRA obviously specifically calculates how many valves  
13 have to work, and what are the reliability of the  
14 valves, and operator actions is automatic or whatever.

15           Another thing that is interesting to look  
16 at if that it is this same event, if you look at,  
17 well, what controls what. What support systems have  
18 to work, and you see here a matrix that is a bit  
19 complicated, and so I am not going to go over the  
20 whole thing.

21           But it basically on the left column, you  
22 see all the different features that were used in the  
23 previous slide. For example, for heat removal, the  
24 first feature listed on this table is start up feed  
25 water. That was in the first box in the previous

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1 slide.

2 Now, for start up feedwater to work, it is  
3 automatically actuated by the POS. The POS requires  
4 non-safety DCD power, and AC power is required for  
5 this start-up feedwater pumps.

6 The component coolant water and  
7 (inaudible) are both required. Now none of the other  
8 safety features are required, and so that has a bunch  
9 of non-safety features that have to work to make it  
10 work.

11 If it doesn't work, then the passive RHR  
12 can be actuated automatically from the PMS. Now, I  
13 actually don't list AC power being required there,  
14 because if AC power failed, the passive RHR has fail  
15 safe valves and the valves will open.

16 If AC power is available, then the PMS  
17 actually has to generate a signal using the DCD power  
18 that powers it. So that is a kind of quirky thing  
19 there the way it is shown.

20 If the PMS doesn't work, passive RHR is  
21 separately actuated by the DAS automatically. Now,  
22 the DAS actually requires non-safety DCD power, which  
23 makes it completely separate from PMS. You use  
24 different DCD supply.

25 And then you can go on and you can look at

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1 what the different feed and bleed features require.  
2 So this is a way of seeing some of the redundancy  
3 diversity that is a detailed model in the PRA, and it  
4 helps you understand I think a little bit the  
5 reliability.

6 Now, we have these for tube rupture, and  
7 again there tends to be fewer different things in  
8 operating plants, and in tube rupture, all of these  
9 levels of defense have operator action involved.

10 Operators have to do things to mitigate a  
11 tube rupture in operating plants. AP-1000, the first  
12 level of defense shown here is actually the non-  
13 safety, which is very similar to what is going on  
14 here, in terms of plant operations.

15 You feed the steam generators, and you  
16 isolate the faulty generator, and you cool down on the  
17 intact generator, and you reduce the RCS pressure  
18 manually. That is what is involved here.

19 If that doesn't work, then the automatic  
20 case, which uses safety, and is what is analyzed so  
21 far using core makeup tanks, passive RHR, isolation of  
22 CVS and start-up feed water which can adversely  
23 interact in this scheme.

24 Steam generator isolation and passive  
25 containment cooling operation, and that is all

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1 automatic. If that works, the leak is isolated, and  
2 the core decayed heat is removed, and everything is  
3 fine. If that doesn't work, then again the small LOCA  
4 type feed and bleed cooling schemes can protect the  
5 plant.

6 MEMBER SHACK: Now, is there anything that  
7 the operator can be doing with regard to (inaudible)?

8 MR. CUMMINS: It is hard, but he basically  
9 would have to block automatic signals, and then do  
10 things that are contrary to the emergency procedures.

11 What tends to happen is that if he is  
12 involved in this scheme here, some of these features  
13 may get turned on because of the nature of this event.  
14 You will probably get an SI signal, unless this is a  
15 really small break, and he kind of gets going manually  
16 before th reactor trips automatically on an SI signal.

17 One of the things that he is doing here  
18 are supportive of this, and so they are not in  
19 conflict, okay? So for him to really screw this up,  
20 he has got to do lots of things. You know, turn off  
21 passive features completely, and again things that are  
22 contrary to the emergency procedures.

23 MEMBER RANSOM: What is the bottom line  
24 given, say, a steam generator tube rupture, what is  
25 the difference in the probability of core damage in

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1 those two cases?

2 MR. SCHULZ: I don't have that. I have  
3 that number on another slide. Selim, I don't know if  
4 you know it, but you can look up what the AP-1000 tube  
5 rupture core melt frequency is from your data. Do you  
6 have anything on operating plants with you? I don't  
7 remember off the top of my head.

8 MR. CUMMINS: Terry, I have that  
9 comparison, and I can get it later.

10 MR. SCHULZ: Okay.

11 MR. CUMMINS: The comparison for operating  
12 plants, and --

13 MR. SCHULZ: We worked hard at pushing  
14 tube rupture down because if you get a core melt with  
15 a tube rupture, containment tends to be bypassed,  
16 okay? Because you have got this hole through the  
17 tube.

18 So it is a contributor to a large release  
19 in our models.

20 MEMBER RANSOM: I was just wondering how  
21 much these additional levels buy you in terms of  
22 reduction and its probability of occurrence?

23 MR. SCHULZ: Well, if you go back, for  
24 example, to the loss of off-site power, it is probably  
25 buying you somewhere in the order of three orders of

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1 magnitude, versus current plants, and again Mike can  
2 provide -- we have a table which looks at by  
3 initiating events the core damage frequency versus  
4 operating plants, versus AP-1000.

5 MR. CORLETTI: This is Mike Corletti from  
6 Westinghouse. Based on previous presentations we have  
7 made, steam generator tube rupture for a standard  
8 plant for core damage frequency is on the order of 1.7  
9 E to the minus 6. And for AP-1000, it was about 4 E  
10 to the minus 9.

11 MEMBER SHACK: You have a higher number on  
12 the table.

13 MR. CORLETTI: Okay. You have got me on  
14 that one, yes.

15 MEMBER SHACK: When you are 10 to the  
16 minus, that's high.

17 MR. CORLETTI: Sorry. Yes, I read it from  
18 the wrong column.

19 MEMBER SIEBER: It is a rather  
20 considerable uncertainty in numbers that are around 10  
21 to the minus 9.

22 MR. SCHULZ: Why don't I -- and maybe I  
23 will just point out that we also have looked at, for  
24 example, at shutdown conditions, and (inaudible) is  
25 from our PRA evaluations, and one of the risk

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1 important shutdown modes.

2 Current operating plants, typically if you  
3 lose power, you really need to get the normal HR back  
4 working, and that is really your only level of  
5 defense. There are some temporary things plants can  
6 sometimes do, but usually you have to get this back.

7 For AP-1000, the R&S automatically  
8 restarts, and instead of it having to be manually  
9 restarted. If it doesn't work, we have basically a  
10 feed and bleed pulling system using R&S IRWST  
11 injection.

12 In this case the operator is opening some  
13 manual MOVs, which we can get water into the RCS  
14 through, and then backing that up is the squib valve  
15 IRWST injection path.

16 CHAIRMAN APOSTOLAKIS: Yes, let's keep  
17 going.

18 MR. SCHULZ: Basically we have used PRA  
19 and AP-600 and we have taken credit for that  
20 evolution, and added to it for AP-1000, and we have  
21 done a lot of changes in improving AP-600 based on the  
22 PRA. Some of them are operational, and some of them  
23 are analysis, and some of them are design changes.

24 We have continued doing that in AP1000,  
25 and here are some of the things that we have done

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1 during the development of AP-1000 as we interacted  
2 with the PRA that we did. A lot of these I have  
3 already mentioned.

4 MEMBER ROSEN: You also at the fourth  
5 stage ADS, is it the same, or is it just larger in AP-  
6 1000 than it is in 600?

7 MR. SCHULZ: The same number of valves are  
8 in the design. The capacity is larger. Now, AP-600,  
9 the final PRA quantification assumes 2 out of 4 stage  
10 4s are required. Near the tail end of AP-600, when we  
11 were looking at TH uncertainty, there was some low  
12 probability cases that we came up with where that  
13 would not work 2 out of 4.

14 So we did a sensitivity study for AP-1000  
15 and said, well, if it was 3 out of 4, the core damage  
16 frequency would only go up a little bit. Now, for AP-  
17 1000, we said we are not going to cut it that finely.  
18 We are just -- we did the PRA from the start, with 3  
19 out of 4 being required.

20 So it is a more conservative or robust  
21 success rate criteria that we have used for stage 4.  
22 Even though stage 4 is actually bigger relatively  
23 speaking to power per megawatt on AP-1000. So we have  
24 actually gotten more margin, but we don't have enough  
25 margin to comfortably make to be always successful.

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1 MEMBER ROSEN: So you went to three, and  
2 the valve is much larger, and it gives you more  
3 capacity if it opens properly?

4 MR. SCHULZ: Yes.

5 MEMBER ROSEN: And of course the thing  
6 that we just talked about is the question about its  
7 reliability and service condition, and corrosion, and  
8 what not --

9 MR. SCHULZ: Right.

10 MEMBER ROSEN: -- will be dealt with  
11 later.

12 MR. SCHULZ: Yes. And I think that is the  
13 more AP-1000 changes, and so we can move on to what  
14 you really wanted or came here to hear and that we  
15 came here to tell you about the PRA.

16 MR. CORLETTI: The next speaker will be  
17 Selim Sancaktar from Westinghouse.

18 MR. SAMCALTAR: My name is Selim  
19 Sancaktar, and I work for Westinghouse, in the  
20 Reliability and Risk Assessment Group. We actually  
21 started this presentation a couple of months ago in  
22 front of all of you, or almost all of you. Are there  
23 new people here that were not there before? I mean,  
24 am I repeating?

25 I don't want to repeat if everybody is

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1 here today if they were here before.

2 MR. SNODDERLY: Selim, this is Mike  
3 Snodderly. This is a subset of the people that you  
4 presented to on November 7th, and so you can use that  
5 to start.

6 MR. SAMCALTAR: Well, if I repeat the same  
7 things, just tell me that you know it and I will skip  
8 that or something else. I don't want to bore you,  
9 because I am trying to figure out how to optimize.

10 I have two hours to give you a synopsis,  
11 the goods, and I will be happy to, plus answer  
12 specific questions, because remember I have two hours.  
13 So you choose how you want to use it. I am happy with  
14 whichever way you want to do it.

15 Most of these slides are the slides that  
16 you had before. So you can --

17 CHAIRMAN APOSTOLAKIS: Then you can go to  
18 slide 43.

19 MR. SAMCALTAR: Could I?

20 CHAIRMAN APOSTOLAKIS: Yes. 43, yes.

21 MR. SAMCALTAR: So this is like basic --

22 CHAIRMAN APOSTOLAKIS: Yes, 43. Okay.

23 MR. SAMCALTAR: I tried to discuss this  
24 before a little bit, but we can go again back to this.  
25 To put this in perspective, as I mentioned before, we

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1 used AP-600 models very heavily. However, we had to  
2 find a balance between totally doing something new,  
3 versus rubber stamping something that is done  
4 (inaudible) unacceptable.

5 The event tree that has changed most  
6 dramatically is this one, and so I am using this as an  
7 example. And already Terry discussed this, the design  
8 reasons that kind of led to this. This also brings us  
9 to geography a little bit, you know. Flow field  
10 design and flow field PRA, and how do you try to  
11 balance these.

12 One of the funny things that happened here  
13 is after a large LOCA, what is the success rate of the  
14 other accumulators? It was 1 out of 2 in AP-600, and  
15 it gave us a certain frequency for this sequence, and  
16 this is the most frequent one in this particular event  
17 tree.

18 In this plant, you should try to retain  
19 that success rate criteria, or tell me that you lax it  
20 a little bit, and not try to increase the accumulator  
21 size or numbers, or whatever directly to a place where  
22 we can say we have 1 out of 2.

23 And here we deliberately chose after  
24 discussions that we can (inaudible) 2 out of 2 success  
25 criteria. Both are needed. Both accumulative are

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1 needed.

2 And what that does to us as you can see  
3 here is that get a condition probability of 1 times 10  
4 to the minus 2 about.

5 CHAIRMAN APOSTOLAKIS: You see that there?  
6 That confused me, because when it says AC both --

7 MR. SAMCALTAR: Right, you need both.

8 CHAIRMAN APOSTOLAKIS: Well, this is an  
9 event, and so going down means failures.

10 MR. SAMCALTAR: Right.

11 CHAIRMAN APOSTOLAKIS: And so I thought it  
12 meant both accumulators fail.

13 MR. SAMCALTAR: Okay.

14 CHAIRMAN APOSTOLAKIS: You are saying that  
15 is not what it means?

16 MR. SAMCALTAR: Right.

17 MEMBER RANSOM: He says that's right, that  
18 both accumulators fail? Is that right?

19 CHAIRMAN APOSTOLAKIS: No, he says that  
20 both are needed, so that if one fails, you have  
21 failure.

22 MR. SAMCALTAR: Right.

23 MEMBER SIEBER: That's right.

24 MEMBER RANSOM: Really?

25 CHAIRMAN APOSTOLAKIS: Whereas, if I look

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1 at this without talking to Selim, I would assume that  
2 both had failed.

3 MR. SAMCALTAR: And that's why you need  
4 people to interpret it.

5 CHAIRMAN APOSTOLAKIS: We need humans.  
6 There is no question about it.

7 MR. SAMCALTAR: Okay. Basically, this  
8 mode is defined. Accumulators inject, and as I  
9 mentioned, you need four accumulators to inject. If  
10 one doesn't inject, then we declare it a failure.

11 Well, in the AP-600, it was not a failure.  
12 So the probability here is that you consider about 10  
13 to the minus -- 1 times 10 to the minus 2. This  
14 gives us the worst sequence, and almost determines the  
15 whole --

16 CHAIRMAN APOSTOLAKIS: Wait a minute.  
17 Wait a minute. The large LOCA frequency is 5 times 10  
18 to the minus 6. So if I divide 4.26, 10 to the minus  
19 8 by that, I should get the condition of failure  
20 probability of the accumulators?

21 MR. SAMCALTAR: Right, 1 times 10 to the  
22 minus 2.

23 CHAIRMAN APOSTOLAKIS: I get 8 times 10 to  
24 the minus 3. Can I divide? You said 1 times 10 to  
25 the minus 2. We are close enough.

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1 MEMBER ROSEN: Now, the initiating event  
2 frequency, 5 times 10 to the minus 6 includes the  
3 spurious actuation?

4 MR. SAMCALTAR: No. We have in AP-600 --

5 MEMBER ROSEN: Spurious actuation of ADS  
6 4.

7 MR. SAMCALTAR: Right. Now, in AP-600,  
8 they are together in one category. Here we separated  
9 them, and there is another category specifically for  
10 spurious actuation of the ADS 4.

11 MEMBER ROSEN: So for the total CDF, I  
12 have to add some --

13 MR. SAMCALTAR: For the ADS 4.

14 MEMBER ROSEN: For the ADS 4, plus a whole  
15 lot of other things.

16 MR. SAMCALTAR: Yes.

17 MEMBER SHACK: Now, what is different  
18 about that event tree? Can you handle that one with  
19 one accumulator? Why did you separate that one out?

20 MR. SAMCALTAR: Oh, yes, good question.  
21 This large LOCA basically assumes the worst kind of  
22 LOCA; whereas, we know exactly where the spurious ADS  
23 actuation is. So we can handle it with one  
24 accumulator.

25 So we don't have to punish ourselves for

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1 the sins of some other limited failure for ADS  
2 actuation.

3 MEMBER SHACK: Now, it is curious to me,  
4 and the staff had an RAI on this, too; that even when  
5 you take that one out, your large break LOCA frequency  
6 is about a factor of 10 lower than it was for the AP-  
7 600.

8 MR. SAMCALTAR: Right. Absolutely.

9 MEMBER SHACK: And you say industry data.

10 MR. SAMCALTAR: Yes.

11 MEMBER SHACK: There is not a whole lot of  
12 industry data on that.

13 MR. SAMCALTAR: Yes, I can tell you  
14 exactly where that came from.

15 CHAIRMAN APOSTOLAKIS: That is a 5750,  
16 right?

17 MR. SAMCALTAR: First of all, that number  
18 came from one of the recent (inaudible) from the NRC,  
19 and when I say recent, we are talking about 1999 time  
20 frame, and you know which one.

21 And we also know I'm sure, or if you don't  
22 know, I am telling you, the recalculations for that  
23 number being done. Somebody in Germany is doing  
24 something, et cetera, et cetera, et cetera. That  
25 number is so big, and we are well aware of that.

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1                   And where it falls out, we will suffer the  
2 consequences as they come out. But the point when we  
3 were doing this PRA, which we had started about a few  
4 years ago, is what to do with the initiating  
5 (inaudible) frequencies.

6                   I mean, there are various options, you  
7 know. We can totally redo the initiating events  
8 analysis. We can just say we are going to keep  
9 exactly the  
10 AP-600 assumptions.

11                   And we said that we will look at the  
12 important changes. Like we really didn't worry too  
13 much about the frenzy of the initiating event  
14 frequencies, because things in general are getting  
15 better, and what they use is a slightly on the  
16 conservative side, very slightly.

17                   It doesn't gain anything, and your  
18 insights are not affected, but if you look for things  
19 that might have changed, either the industry is  
20 looking at things differently, or something else  
21 happened, and so we try to look for those.

22                   And we are initiating our frequency for a  
23 large LOCA. You know, it is a fictitious number,  
24 whatever you say is true. We all support a number,  
25 and I shouldn't say a fictitious number, but a number

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1 well supported.

2 So from the Rasumssen time, there are  
3 people using 1 times 10 to the minus 4, and then  
4 people started saying, yes, 1 times 10 or 20 percent,  
5 and some distribution, and play with it, and somebody  
6 is 5 times 10 to the minus 4.

7 The point is that whatever you do, it was  
8 an expert opinion, and that is the kind of number that  
9 we used before, and (inaudible) it is something that  
10 we can refer to that is presumed, and those by the NRC  
11 since it is a NUREG.

12 So I have no basis to tell them that they  
13 should retain a design requirement if a large LOCA is  
14 not seen as a limiting event of the frequency space.  
15 So that is the best advice that we could find.

16 And next year the new efforts might have  
17 a considerably different number that we might have to  
18 revisit our assumptions, and I am not shy to do that.

19 CHAIRMAN APOSTOLAKIS: Now, this is  
20 actually a factor of 20 lower than what you used in  
21 AP-600.

22 MEMBER SHACK: Yes, but half of that is  
23 the DVI and the spurious actuation is separated out.

24 MR. SAMCALTAR: Right. Yes. And 5 times  
25 10 to the minus 5, is 5.4 times to the minus 5 is a

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1 spurious ADS actuation, which was lumped in with a  
2 large LOCA before, because the success rate was the  
3 same. So 1 out of 2 accumulators.

4 So what we are saying here is that if you  
5 look at just the pipe breaks, the random pipe breaks,  
6 which are really not seen as a threat much anymore as  
7 they used to be, you don't have to set your design  
8 against them anymore as was done in the past.

9 MEMBER ROSEN: The difference is that  
10 pipes are designed not to fail. The relief valves are  
11 designed to open with high reliability, which if you  
12 do that when you don't want them to is a failure.

13 MR. SAMCALTAR: Certainly.

14 MEMBER ROSEN: So there is a very big  
15 difference.

16 MR. SAMCALTAR: Certainly, and we are  
17 focusing on that. I mean, the ADS portion is  
18 separated out, and we are focusing on it, and we also  
19 have a larger -- an order of magnitude larger  
20 initiating event frequency for that, compared to past  
21 pipe breaks.

22 MEMBER ROSEN: I think that is a good  
23 move.

24 CHAIRMAN APOSTOLAKIS: Now this is your  
25 number two dominant sequence isn't it for a large

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1 LOCA?

2 MR. SAMCALTAR: Yes.

3 CHAIRMAN APOSTOLAKIS: To a CDF.

4 MR. SAMCALTAR: Yes.

5 CHAIRMAN APOSTOLAKIS: So it is about 40  
6 percent.

7 MR. SAMCALTAR: Yes.

8 CHAIRMAN APOSTOLAKIS: So the NRC or the  
9 people who are reevaluating the frequency of a large  
10 LOCA, increase this, I doubt it will go back to the  
11 original numbers.

12 MR. SAMCALTAR: Currently the contribution  
13 of large LOCA is 4.5 to the minus 8.

14 CHAIRMAN APOSTOLAKIS: Yes.

15 MR. SAMCALTAR: And if later on people  
16 come in here and say it is not 5 times to the minus 6.  
17 It is now 5 times minus 5. This is going to go up by  
18 a factor of 10, to 4.5 to the minus 7, which will be  
19 almost a 130 percent increase in our estimate of core  
20 damage.

21 CHAIRMAN APOSTOLAKIS: Right. So you will  
22 start approaching 10 to the minus 6 then in our  
23 estimate of core damage frequency?

24 MR. SAMCALTAR: Right. Yes.

25 CHAIRMAN APOSTOLAKIS: How conservative is

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1 this assumption that you need both accumulators?

2 MR. SAMCALTAR: Well, at this point, I  
3 would like to pass the baton to Terry or Jim.

4 MR. SCHULZ: This is Terry Schulz. Now  
5 the large pipe breaks are obviously made up of cold  
6 leg breaks and hot leg breaks. This assumption is  
7 extremely conservative for hot leg breaks. Hot leg  
8 breaks probably should be lumped in with the spurious  
9 ADS success criteria of one accumulator.

10 But the cold leg breaks, I explained to  
11 you that we did an analysis for the PRA and filled the  
12 containment isolation with off-site power being  
13 available for 10 seconds, or 12 seconds, and we got  
14 like 1800 degrees fahrenheit.

15 That is with two accumulators. Now the  
16 question is if you had one accumulator, and that is  
17 also with uncertainty, and so that is a conservative  
18 DCD-type number, there is about 200 and something  
19 degrees -- 250 degrees uncertainty in that number. So  
20 the best estimate number is that much lower.

21 On a best estimate basis, I think we would  
22 be okay with one accumulator. With conservative  
23 basis, we would probably be very close to the 2200  
24 degrees. I don't know. We might be under it, and we  
25 might be over it.

1                   So hot leg breaks, which are probably a  
2 large portion of that number probability-wise, are  
3 overly conservative. We could split those out and use  
4 1 out of 2 success rates area. Cold leg breaks, it is  
5 -- we are not sure if we really could or not.

6                   CHAIRMAN APOSTOLAKIS: Thank you. Now, do  
7 you know why this number is being reevaluated? Were  
8 there any objections to it?

9                   MR. SAMCALTAR: The basis, and if you look  
10 at the NUREG --

11                   CHAIRMAN APOSTOLAKIS: Yes, I did.

12                   MR. SAMCALTAR: It says Appendix J or  
13 something like that discusses it, the argument is  
14 rather limited. I mean, there isn't a database and  
15 one point that is remotely related to a large LOCA,  
16 and you can extend from that into an estimate.

17                   And I think that it was reflecting was --  
18 and it is still -- this how do you form this large  
19 LOCA really, or what is a large LOCA. And people were  
20 relaxing a little bit for the last few years that  
21 large LOCA is not really the limiting event, and even  
22 redefine the basis, and maybe design basis can be  
23 redefined and so on.

24                   And you know about these activities. So  
25 there is a better perception and how people are more

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1 relaxed about how bad it is.

2 CHAIRMAN APOSTOLAKIS: But are you saying  
3 then that the reevaluation will lead to a lower number  
4 because --

5 MR. SAMCALTAR: I don't know honestly.  
6 The reason why --

7 CHAIRMAN APOSTOLAKIS: You talked about  
8 the numerator, and you said that they had one point --

9 MR. SAMCALTAR: Well, let me answer that  
10 by saying this. I think one of the reasons that  
11 people are reevaluating it is that there are some  
12 cracks and so on in some domestic plants, and so that  
13 kind of started to bother people a little bit about  
14 what can happen, and that's why they are reevaluating  
15 it, I think.

16 I am not an expert on the subject, and I  
17 am telling you my opinion.

18 CHAIRMAN APOSTOLAKIS: But it seems to me  
19 that they lump all the reactor years together and they  
20 came up with a number like 500.

21 MR. SAMCALTAR: Yes, but they are looking  
22 for a reason.

23 CHAIRMAN APOSTOLAKIS: Why are we looking  
24 at plant to plant variability kinds of things, which  
25 weakens the evidence and pushes the number up? Maybe

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1 we will review the NUREG at some point. I don't know.

2 MR. SAMCALTAR: You don't usually  
3 reevaluate unless it is going in a bad direction, and  
4 so I don't think we were reevaluate if things go down.

5 CHAIRMAN APOSTOLAKIS: Well, 3900 reactor  
6 years is pretty strong evidence.

7 MR. SAMCALTAR: It is.

8 CHAIRMAN APOSTOLAKIS: And actually that  
9 assumes all pipe sets everywhere in the world that are  
10 identical, and that may not be the case.

11 MEMBER ROSEN: You know that's not.

12 MR. SAMCALTAR: So you can see that we are  
13 struggling with this, and we are going to find a fine  
14 line between what is the latest perception, and how  
15 fast should we push it, and how much we should depend  
16 on it.

17 And you see here that by doing this that  
18 we are trying, depending on that this number is not  
19 going to be 5 times 10 to the minus 4 after people  
20 have finished with it, which I don't think so. I  
21 doubt it based on a lack of otherwise.

22 But can it go to 5 times 10 to the minus  
23 5? Just because of calculations again or  
24 reevaluation, and not because of an event. Yes, and  
25 then we will just bite the bullet at that time. So

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1 that is possible risk assessment, and I don't have a  
2 problem with that.

3 I mean, it constantly should be  
4 reevaluated. We shouldn't just tack a number on.

5 CHAIRMAN APOSTOLAKIS: What was the core  
6 damage frequency for AP-600? Do you remember?

7 MR. SAMCALTAR: Yes, AP-600 is 1.7, 10 to  
8 the minus 7. This one total is 2.4, 10 to the minus  
9 7. So the significant figure there is 2.4, and 1.7.  
10 It went up.

11 CHAIRMAN APOSTOLAKIS: It went up.

12 MR. SAMCALTAR: Yes.

13 MEMBER SHACK: It will go up a lot more if  
14 you use the same pipe breaks.

15 CHAIRMAN APOSTOLAKIS: If you use the same  
16 pipe breaks, yes.

17 MR. SAMCALTAR: Right, there is no doubt  
18 about it.

19 CHAIRMAN APOSTOLAKIS: This number was  
20 used in AP-600?

21 MEMBER SHACK: AP-600 is a --

22 CHAIRMAN APOSTOLAKIS: Yes, and so why  
23 would it go up for the AP-600?

24 MEMBER SHACK: it wouldn't go up as much.

25 CHAIRMAN APOSTOLAKIS: I don't think

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1 (inaudible) if you use the wrong number.

2 MR. SAMCALTAR: It would go up like this.

3 CHAIRMAN APOSTOLAKIS: Yes. So you may  
4 end up with almost an order of magnitude difference in  
5 the core damage frequency.

6 MR. SAMCALTAR: Yes. If I believe that  
7 within a reasonable time frame, for the next 5 years  
8 or 10 years, that this would have gone back to 5 times  
9 10 to the minus 4, I would have strongly advised them  
10 to go and push this to add a little bit more water and  
11 whatever it takes to go with the uncertainly.

12 MEMBER SHACK: But what they are arguing,  
13 George, is that if you used the same frequency in the  
14 AP-600 than this one, you will end up probably in the  
15 same place.

16 CHAIRMAN APOSTOLAKIS: But how can --

17 MEMBER SHACK: You know, if you use -

18 CHAIRMAN APOSTOLAKIS: The AP-600 used the  
19 old number.

20 MR. SAMCALTAR: Yes, that's right.

21 CHAIRMAN APOSTOLAKIS: So the only number  
22 that will go up is this.

23 MR. SAMCALTAR: You are correct.

24 CHAIRMAN APOSTOLAKIS: The only thing that  
25 struck me about this is that it is a significant

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1 impact on the CDF, and it doesn't come about because  
2 you did something to the design. It is because  
3 somebody did some calculation and reduced the number.

4 MEMBER ROSEN: But that is the Bayesian  
5 update.

6 CHAIRMAN APOSTOLAKIS: It wasn't Bayesian.

7 MEMBER ROSEN: You can think of it as an  
8 update of the knowledge base.

9 CHAIRMAN APOSTOLAKIS: Not all updates are  
10 Bayesian.

11 MR. SAMCALTAR: This is not.

12 CHAIRMAN APOSTOLAKIS: This is not,  
13 especially lumping all the reactor years together as  
14 one.

15 MR. CUMMINS: I happen to think that the  
16 order came from the NRC though, the data that we used.

17 MEMBER ROSEN: We are part of the NRC, but  
18 we did not generate that data.

19 CHAIRMAN APOSTOLAKIS: I don't even recall  
20 it, but unless somebody tells me that I did. Okay.  
21 Good. That was very clear what is happening.

22 MR. SAMCALTAR: This number personally  
23 doesn't bother me. I think is a fair number to  
24 represent this. If it goes up because people have  
25 concerns, then it goes up and what can I do. I mean,

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1 I can't change it.

2 But I don't believe this is a reckless  
3 number to use at this point, and we have recognized  
4 the potential impact and I think we can more or less -  
5 - and we don't believe that this is going to change  
6 drastically. The order of magnitude would still be an  
7 absolute change, but I don't think that it is going to  
8 go back to an order of magnitude.

9 MEMBER ROSEN: What it says is that large  
10 breaks in these plants are very unlikely, and that is  
11 what our experience is telling us.

12 MR. SAMCALTAR: And we should not force  
13 the designers to do extra things because of that.  
14 Besides that, as Terry mentioned, really we are almost  
15 there with the success rate. It could be 1 out of 2,  
16 but then we would have all kinds of difficulties with  
17 the uncertainty business and success criteria.

18 So actually they are taking one step back  
19 and covering that angle.

20 CHAIRMAN APOSTOLAKIS: So the frequency  
21 then, if it was 1 out of 2, the condition operability  
22 would affect the core damage another two orders of  
23 magnitude, right?

24 MR. SAMCALTAR: Maybe an order of  
25 magnitude. So this would be like 9, minus 9.

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1 CHAIRMAN APOSTOLAKIS: Yes.

2 MR. SAMCALTAR: Now that was interesting,  
3 and now just a little something that will be different  
4 and also gives you a glimpse of what we are struggling  
5 with and what we are thinking, and how we are  
6 approaching it.

7 And just to touch base on the subject of  
8 a spurious ADS. It just -- well, now this is tricky.  
9 Just since you touched upon them and that interests  
10 you also, the part that we talked about, the spurious  
11 ADS, the issuing event is 5.4 minus 5, an order of  
12 magnitude higher.

13 And here we can live with one out of two  
14 success criteria. So I just wanted to --

15 MEMBER ROSEN: Because this is a 14 inch  
16 break, rather than a bigger break for the --

17 MR. SAMCALTAR: It is a hot leg.

18 MEMBER ROSEN: A hot leg break.

19 MR. SAMCALTAR: The site of this location  
20 is also favorable, as opposed to cold leg.

21 MEMBER KRESS: But they cancel each other  
22 out.

23 MEMBER ROSEN: They cancel each other out,  
24 yes, but it ends up being 12 percent.

25 MR. SAMCALTAR: Right, it still is not

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1 trivial. It is kind of compensated, You lose around  
2 90 degrees here, and you gain approximately an order  
3 of magnitude here. So there is no loss.

4 CHAIRMAN APOSTOLAKIS: Okay.

5 MEMBER ROSEN: And that 12 percent, we  
6 will talk a whole lot more about that.

7 MR. SAMCALTAR: Okay.

8 MEMBER ROSEN: Because we will talk about  
9 the details of the valve and all the stuff like that,  
10 at a later time.

11 MR. SAMCALTAR: Okay.

12 MR. CORLETTI: Selim, did you want to talk  
13 about the probability basis for the spurious ADS, as  
14 far as what we have done?

15 MR. SAMCALTAR: Let me proceed as much as  
16 possible, and then see how we work that out.

17 MEMBER ROSEN: But my point as I  
18 understand it, even though we are boring in on the  
19 details of that ADS 4 valve, we are boring in on 12  
20 percent of the risk. That is how it is calculated.

21 CHAIRMAN APOSTOLAKIS: On the large LOCA?

22 MEMBER ROSEN: Of the ADS.

23 CHAIRMAN APOSTOLAKIS: Of the total? A  
24 large LOCA is about 19 percent.

25 MEMBER ROSEN: No, I am talking about

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1 spurious actuation.

2 CHAIRMAN APOSTOLAKIS: Oh, spurious  
3 actuation.

4 MEMBER ROSEN: 12.28 for the significant  
5 large LOCA. I am very impressed (inaudible).

6 MR. SAMCALTAR: When I started in the PRA  
7 business 20 some years ago, I looked at the tables  
8 they had created, and they had four significant  
9 figures. I said, come on. I mean, we have a hard  
10 time defining one significant figure, and how can you  
11 write four significant figures.

12 So I said let's round them off to two  
13 significant figures at least. We did that for a  
14 while, and what happened is that we have chop notes  
15 and people come and people come and review them  
16 afterwards. It is calculation notes on QA business  
17 and so on.

18 And these people are very, very strict.  
19 You round something up or down for a perfectly  
20 justifiable reason, and they come and said that this  
21 number is not the same as that number. They look at  
22 the computer output and it is 3.217 and you round it  
23 off to 3.2, they jump at you.

24 Sometimes we have different or that is one  
25 reason. Another reason is that we have different

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1 versions of calculations, and sometimes instead of  
2 specific figures, we round them off, and we lose track  
3 of which -- when we look at the pile, we lose track of  
4 where it came from, you know, for practical every day  
5 usage, because it is rounded off and we can't tell the  
6 difference.

7           So there is so much minute headaches, and  
8 so we decided that the criticism of reporting a four  
9 significant figure is less than the headaches that you  
10 get if you don't round it off. So that's why we don't  
11 round them off. But I certainly agree with you, and  
12 I hope there is no problems with those.

13           CHAIRMAN APOSTOLAKIS: The most honest PRA  
14 analyst that I have seen or heard. Let's talk about  
15 this. We don't have to talk specifically about that,  
16 but common cause failures. How can you do a common  
17 cause failure analysis for a plant that has not been  
18 built?

19           I mean, if I look at what the NRC, and  
20 EPRI, and everybody else has produced -- as you know,  
21 there was a common effort the last several years, and  
22 their main advice is that they can develop a common  
23 cause failure database, and they are saying that for  
24 your own plant that you should go down the list of the  
25 incidents that we have identified, and make a judgment

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1 if they apply or not apply, or partially apply to your  
2 plant, and then calculate the multiple Greek letter  
3 parameters.

4 Now, you are doing it here in a generic  
5 way, and I don't understand how you can do that.

6 MR. SAMCALTAR: Well, what else are we  
7 going to do?

8 CHAIRMAN APOSTOLAKIS: Well, I mean,  
9 something may have to be done later when actually  
10 somebody decides to built it.

11 MR. SAMCALTAR: That is-- I can't argue.  
12 I mean, I am not going to object to that statement.

13 CHAIRMAN APOSTOLAKIS: But if you get the  
14 certification, and maybe the staff can help me here,  
15 and then you get the combined basis later. Can they  
16 claim that, boy, this was certified and approved, and  
17 you shouldn't ask us to do a common cause failure  
18 analysis (inaudible)?

19 MR. SNODDERLY: You would have to make it  
20 part of an ITAAC, or help me out, Mike. Would it be  
21 an ITAAC?

22 MR. CORLETTI: Certain ITAACs say you have  
23 to do a common cause failure. There is a requirement  
24 to do a plant specific PRA after the plant is built to  
25 verify that the PRA that you used for design

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1 certification is still applicable.

2 CHAIRMAN APOSTOLAKIS: Because the same  
3 observation may apply to human reliability.

4 MR. SAMCALTAR: Although one step further,  
5 and I will tell you that in my opinion the same  
6 consideration applies to failure rates and others.

7 CHAIRMAN APOSTOLAKIS: Not so much. Not  
8 so much.

9 MR. SAMCALTAR: You cannot say that a PRA  
10 might today necessarily will have the same prospective  
11 of a PRA to be done in 10 years, or 5 years, or 29  
12 years.

13 CHAIRMAN APOSTOLAKIS: Well, certainly,  
14 yes, but some are more important.

15 MR. CORLETTI: With AP-1000, like AP-600  
16 and the other certified designs, there is a list of  
17 COL items that the COL applicant must perform, and one  
18 of them is plant specific.

19 CHAIRMAN APOSTOLAKIS: But does it single  
20 out common cause failure.

21 MR. CORLETTI: It doesn't specify, but I  
22 would assume that we would do it to the same level  
23 that we did the PRA for the design certification. It  
24 does not specify common cause failure.

25 CHAIRMAN APOSTOLAKIS: But still though --

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1 I mean, if the fundamental premise of this effort that  
2 the NRC sponsored in EPRI is that you will go down the  
3 list of incidents and decide what applies. What do  
4 you do? Do you use all of them?

5 How did you get these numbers? You are  
6 using betas and gamas.

7 MR. SAMCALTAR: They are numbers that  
8 basically are picking up from the URB, the EPRI  
9 requirements document.

10 CHAIRMAN APOSTOLAKIS: And that  
11 requirements document has been approved by the NRC?

12 MR. CORLETTI: Yes, and reviewed by the  
13 committee. But to answer your question, George, I  
14 think that unless it specifically identified as an  
15 ITAAC, or as a DAC, what the certification is  
16 approved, you would not go back and reopen common  
17 cause failure unless it is identified now.

18 CHAIRMAN APOSTOLAKIS: Well, let's make a  
19 note of it. Maybe we will want to think about it.

20 MEMBER KRESS: We looked at the utility  
21 requirements document, and there was no basis or no  
22 reason for us to approve. There is no approval --

23 CHAIRMAN APOSTOLAKIS: And also the  
24 requirements document as I remember it, and it has  
25 been a few years since I read it, said to do it this

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1 way, and these are your goals. You never said beta is  
2 .10 and gamma is .02.

3 We looked at the numbers for guidance, but  
4 in fact we had a measured debate here with the NRC  
5 staff one day when they presented generic numbers, and  
6 we told them that generic numbers in this particular  
7 case don't mean much. And they agreed finally as I  
8 recall.

9 So this is something that probably has to  
10 be singled out for something that needs to be done  
11 specifically for the --

12 MEMBER KRESS: I thought the idea was in  
13 the utility requirements document that these are  
14 numbers for common cause failure that you would like  
15 to have and are going to shoot for, and you take your  
16 design and make it such that you think you can arrive  
17 at those.

18 MR. CUMMINS: This is Ed Cummins. I  
19 believe at the time of the utility requirements  
20 document various vendors were beating each other by a  
21 factor of 10 in the PRA by just changing things like  
22 the common cause failures, and they wanted a uniform  
23 comparison basis and therefore we would have been  
24 criticized by them if we -- certainly if we used any  
25 number that was better than what was in their tables.

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1           Maybe you could have used numbers that  
2 were worse than what were in their tables, and so they  
3 specified a common basis for all the new plants to  
4 use.

5           CHAIRMAN APOSTOLAKIS: Right, but again  
6 this was never really approved by the NRC.

7           MR, BURKHARDT: This is Larry Burkhardt  
8 from the NRC staff. We don't use it as a review  
9 standard. This is an interesting subject, and my  
10 input on it is that if we don't have PRA requirements  
11 for operational plants, we go far in Part 52 as we  
12 should requiring a plant specific PRA.

13           Mike said that there is an ITAAC, and once  
14 that would transition into a COL application, I would  
15 say ideally that it would be nice if we had -- and  
16 this is just my opinion, but some sort of PRA  
17 regulation, and maybe, and maybe not.

18           But I am not so sure that this isn't  
19 something that can be resolved at the design  
20 certification stage other than -- and it is a good  
21 subject to talk about, and it is not -- I haven't  
22 really thought about it, and I am not really sure how  
23 we would address this issue at the design  
24 certification stage.

25           CHAIRMAN APOSTOLAKIS: Well, the thing is

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1 that a major lesson that we learned from all the PRAs  
2 that the industry and the staff have done in the last  
3 25 years is that they are very plant specific.

4 So here, you know, we have a sort of  
5 generic PRA, and at this point it is of course  
6 appropriately to do it that way. But we should be  
7 aware of this fact, and say several things that would  
8 make it really plant specific have to be done when  
9 there is an actual plant, and not say it is certified  
10 now and you shouldn't CCF later and so on.

11 MR. BURKHARDT: Yes, I guess I would just  
12 have to think about it. I am just not certain how we  
13 would attack that issue and resolve it, which I guess  
14 we are starting right now in this kind of discussion.

15 MEMBER ROSEN: You know, you don't have to  
16 know the answer in regulatory space right now. But  
17 just from a 50,000 foot level point of view, we are  
18 comfortable we think with core damage frequencies in  
19 the 2 E to the minus 7 range. That is what they  
20 predict.

21 Now, in a plant specific case, something  
22 changes due to site specific characteristics, or  
23 common cause failure aspects that changes that result.  
24 Now we don't have 2 to the minus 7. We have 2 to the  
25 minus 6, or something like that. Then there has to be

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1 a way for us to register some degree of angst about  
2 that.

3 What we are saying now is when you get all  
4 done with the plant specific thing, it ought not to be  
5 very different than this, because this is the basis  
6 upon which we are proceeding.

7 CHAIRMAN APOSTOLAKIS: Yes, but he thing  
8 is that in order for it to change to become 2 to the  
9 minus 6, really have to be aware of things like that,  
10 and go back and do the calculations correctly.

11 MEMBER ROSEN: But I think that also  
12 implies the need for a confirmatory staff in the  
13 ITAAC.

14 MEMBER KRESS: And there lies the concept  
15 that the PRA plays essentially no role in the  
16 regulation. If they need to design based on design  
17 basis accidents, then they are okay, no matter what --

18 CHAIRMAN APOSTOLAKIS: Well, if there is  
19 a requirement to do a plant specific PRA --

20 MEMBER KRESS: Sure, but there is no  
21 requirement for it to be at a certain level.

22 MEMBER ROSEN: And there is no requirement  
23 for them to read it, or do anything with it. It is  
24 resolved.

25 MEMBER KRESS: That's right.

1 CHAIRMAN APOSTOLAKIS: So what does that  
2 mean?

3 MEMBER ROSEN: It's nonsense, is what it  
4 means.

5 MEMBER KRESS: Yes, that's basically it,  
6 you know.

7 MR. SAMCALTAR: When this plant is built,  
8 in 10 years, let'S say, I don't think that a utility  
9 can go to the NRC and say remember 10 years ago this  
10 PRA existed? This is my PRA. I don't think they can  
11 do that.

12 MEMBER KRESS: No, you're probably right.

13 MR. SAMCALTAR: I can't imagine that.

14 CHAIRMAN APOSTOLAKIS: It is in the books,  
15 they might say that.

16 MR. SAMCALTAR: They may try. That's why  
17 we have to look at them.

18 CHAIRMAN APOSTOLAKIS: And also there is  
19 this --

20 MR. CUMMINS: Just as a matter of general  
21 comment. The three past certified designs took  
22 exactly this approach, AP-600, and System 80 Plus, and  
23 ABWR.

24 CHAIRMAN APOSTOLAKIS: You are doing now  
25 exactly what I am afraid will happen in the future.

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1 You guys looked at it before, and so don't raise any  
2 concerns. Now, this -- I can't imagine that the  
3 requirements document from EPRI had a table with a  
4 simplification of the 2 KQT equations that you have  
5 here.

6 You must have taken it from some other  
7 report, and so you really went beyond what is in the  
8 utility requirements document and that was a fairly  
9 high level document.

10 MR. SAMCALTAR: No it's not.

11 CHAIRMAN APOSTOLAKIS: It's there?

12 MR. SAMCALTAR: I can show you pages from  
13 it. The Utility Requirements document has tables for  
14 initiating frequency which you don't have to use, but  
15 they have tables for random failures probabilities;  
16 and they have tables for common cause parameters.  
17 They will tackle it as multipliers for convenience,  
18 and so you can use them if you want to.

19 And then they also have appendices that  
20 show you where they got these from, and they are kind  
21 of outliners how they reached these numbers.

22 It is very, very clearly. I mean,  
23 explicitly, and I will be happy to fax you the pages,  
24 or I mean you can just get a copy of it, and look at  
25 it.

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1 MR. BURKHARDT: I have a copy in the  
2 library and I will bring one over. But again we don't  
3 use that as any sort of review standard.

4 MR. SAMCALTAR: The NRC has pushed us to  
5 the limit and beyond in cases where you use some of  
6 those numbers. They pushed us for justification  
7 wherever they thought that some of those numbers were  
8 not what they thought they should be.

9 And we had long, long discussions that are  
10 documented by RAIs and other things.

11 CHAIRMAN APOSTOLAKIS: Well, let's look at  
12 it a different way. That particular project cost the  
13 agency and EPRI a lot of money. Now if the major  
14 conclusion really is not used and we can say, well, we  
15 can have generic numbers that are on a table, I wonder  
16 why the NRC spent all this money.

17 The second issue where the same  
18 observation applies or a variation thereof is the  
19 human error analysis. You use that, which as you know  
20 -- what, 20 years, 25 years-- are 20 years old. And  
21 here we have the Agency spending all sorts of money  
22 developing ATHENA.

23 Now, if 30 is acceptable when we make real  
24 decisions like this one, why then are we developing  
25 ATHENA. I don't understand that. Because then of

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1 course if we certify and approve this, somebody can  
2 come back two years later and say, oh, I don't care  
3 what ATHENA says. I mean, you guys approved this.

4 So it is these kinds of things that maybe  
5 don't both you, but they bother me. Either we should  
6 say that 30 is good enough and go with it, or say it  
7 is not good enough and we still need some development.

8 Because ATHENA was a pretty expensive  
9 project, and it was not -- and they talked about error  
10 forcing context, and all this, and you guys go back to  
11 Swain (phonetic) and do a nice job.

12 So this is what bothers me, and I wonder  
13 again whether the human error analysis should also be  
14 one of the analyses that will have to be revisited  
15 when the plant specific PRA will be done, whenever it  
16 is done.

17 Because one of the things that you learn  
18 here is that you have to be careful what you approve.  
19 Okay. Let's go on. I think they did a fine job given  
20 the fact that you had to do it. If I had to do it  
21 myself, I don't know. I am not sure I would be using  
22 ATHENA because ATHENA doesn't give me any  
23 probabilities.

24 And you have to come up with some  
25 probabilities, but I hope you see my problem, too.

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1 That we are also reviewing the research efforts of the  
2 agency, and we are approving other things, and we had  
3 the same problem with power uprates.

4 If we were not using the latest in there,  
5 there is no way we could approve it.

6 MR. SAMCALTAR: We use what they used  
7 here, which is a different form that we used in AP-  
8 600. In fact, we have not touched anything if we don't  
9 have to.

10 CHAIRMAN APOSTOLAKIS: I understand.

11 MR. SAMCALTAR: I am just going to give  
12 you a couple of examples of some pieces of fault  
13 trees. We have like 400 to 500 pieces of fault trees  
14 for the various missions of the front line systems,  
15 and their support systems.

16 And then we have another 400 pieces for  
17 PMS only, and so these are just a few numbers that I  
18 just picked up. These are fault tree names, and I  
19 went to the PRT fault tree, whatever that is, and a  
20 certain mission of passive RHR under certain  
21 conditions.

22 There is just not reliability for a  
23 passive RHR. It depends upon what it is reacting to.  
24 So this is just one number, and I have another, but I  
25 don't know exactly what the success criteria is. But

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1 I want to give you some sense of what is coming out of  
2 it.

3 CHAIRMAN APOSTOLAKIS: So what is the  
4 message here, Selim?

5 MR. SAMCALTAR: The message is --

6 CHAIRMAN APOSTOLAKIS: When I look at the  
7 numbers, 10 to the minus 4 and 5, and 3, I think that  
8 it is within reason.

9 MR. SAMCALTAR: Yes, that is the point.

10 CHAIRMAN APOSTOLAKIS: So that is your  
11 message?

12 MR. SAMCALTAR: Right.

13 CHAIRMAN APOSTOLAKIS: So the 10 to the  
14 minus 7 and 6 there, I don't know.

15 MR. SAMCALTAR: I pulled them out on  
16 purpose, okay? I didn't have to put those because the  
17 system is like one train before a common cause and so  
18 on comes in. The important thing is that it is  
19 actually happening here with this.

20 CHAIRMAN APOSTOLAKIS: If you didn't have  
21 to put them there, then why did you? Maybe the stage  
22 was not crowded enough?

23 MR. SAMCALTAR: Well, I can be as funny as  
24 you. Remember that this is a table that we gave the  
25 NRC, okay? I am just repeating it.

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1                   CHAIRMAN APOSTOLAKIS: You don't want to  
2 give us that.

3                   MR. SAMCALTAR: It is perilous for me to  
4 show you this, because this is where the systems come  
5 in, but the only system here that is of importance  
6 here is passive containment coolant.

7                   And as Terry mentioned, we had to do  
8 something to it to push it to this level. It wasn't  
9 here before. It was down here if you look at AP-600,  
10 because it had --

11                  CHAIRMAN APOSTOLAKIS: I'm sorry, go  
12 ahead.

13                  MR. SAMCALTAR: These are just notes of  
14 it, and this is just a piece, and I said a module, and  
15 it is not a system. The systems you can see here.  
16 The higher system that you see here is passive  
17 containment coolant, and we are saying that, and we  
18 are on paper saying that this thing is reliable on  
19 demand to the level of 2 times 10 to the minus 6.

20                  It was not there in the AP-600. It was  
21 here in this range if you look at the corresponding  
22 table. And because the dominant theory there is  
23 common cause failure to error of operator (inaudible),  
24 they ought to open.

25                  And here we have it and we wanted to raise

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1 up the liability because we need it, this design. So  
2 we added one more line with a different MOV, and so it  
3 is comes out to an order of magnitude plus. It  
4 doesn't give us like (inaudible), but I think it is  
5 another order of magnitude, because it is still  
6 constrained by signals. When we do this, we use  
7 signals. So we are always constrained by signals at  
8 some level.

9 CHAIRMAN APOSTOLAKIS: So the difference  
10 between -- I mean, which is an important difference,  
11 between what you are presenting and what I would see  
12 in a PRA of an existing LWR, is that you had your  
13 numbers, you developed your numbers like the existing  
14 LWR would do, but then you actually did things to the  
15 design to eliminate some of the annoying numbers.

16 MR. SAMCALTAR: Right.

17 MEMBER ROSEN: George, of course the way  
18 to -- the later plants did that, too, the plants that  
19 were designed.

20 CHAIRMAN APOSTOLAKIS: Yes.

21 MEMBER ROSEN: There were features added  
22 to the plants that I am aware of based upon the PRA  
23 during the early construction and late design phase.

24 MR. SAMCALTAR: So I did this for my own  
25 satisfaction, because I wanted to see if there was

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1 something that was out of line, like when I look at  
2 the year increasing and decreasing this way, just to  
3 give myself a warm feeling that nothing jumped at me.

4 For example, hydrogen control is 90  
5 percent and its failure is 10 percent. That is pretty  
6 lousy for a system, but this is a manual system, and  
7 it is not safety and so on, and that is where it  
8 belongs, and we are making that, and it is not by  
9 accident.

10 If you wanted to make it more reliable, we  
11 would have made it more reliable by putting more  
12 redundancy and making it automatic, and so on.

13 CHAIRMAN APOSTOLAKIS: Well, that is where  
14 the advantage comes into it. So I want to give you a  
15 feeling and see if you see anything here that bugs  
16 you. If you look at it, these are the ones in my  
17 opinion of course.

18 We have like (inaudible) favorite ones,  
19 and we say that in this particular mission that there  
20 are like 16 or 17 of these for different missions.  
21 ADS here is one mission of it, and I don't know  
22 exactly what it is, but it is one of them, and it is  
23 like 9 times (sic) minus 5, and it is almost 1 times  
24 10 to the minus 4, including operator actions,  
25 critical operator actions.

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1                   So it is not like, oh, look at it, and I  
2 say okay. It doesn't look too bad to me. So when you  
3 take the critical operator action, I think this is  
4 when they initiate the CMT?

5                   MR. SAMCALTAR: Offhand, I am not sure.

6                   CHAIRMAN APOSTOLAKIS: How bad is the CMT?

7                   MR. SAMCALTAR: I don't know. I can make  
8 a table, but at this moment I don't know.

9                   CHAIRMAN APOSTOLAKIS: That's okay.

10                  MR. SAMCALTAR: Passive RHR, for example,  
11 is 2 times 10 to the minus 4, and range is 10 to the  
12 minus 4 range. This is actual --

13                  CHAIRMAN APOSTOLAKIS: Okay. Okay. Let's  
14 go to the next one. We will be here until midnight at  
15 this rate.

16                  MR. SAMCALTAR: Okay. Okay. This is the  
17 CDF, and the CDF from AP-1000, internal event set  
18 power, we calculated to be 2.4, 10 to the minus 7, and  
19 again just for comparison purposes, it was 1.7 for the  
20 AP-600.

21                  Here are the initiating events, and there  
22 are 26 of them. Are they the same? Almost. The  
23 difference I will point out to you. We have spurious  
24 ADS throughout, and so if you look at AP-600, you will  
25 see that numbers 2 and 3 combine into initiating

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1 event, and in the AP-600, we have removed one  
2 initiating event, which is intermediate LOCA.

3 It was something in between medium LOCA  
4 and small LOCA. We absorbed it in medium LOCA. And  
5 so this medium LOCA includes what was before two  
6 categories, medium and intermediate. So the number of  
7 initiating events categories is the same by accident.

8 Here the initiating event frequencies, and  
9 here are the ore damage frequencies, and this is the  
10 commission of CDF, which is CDF divided by initiating  
11 frequencies.

12 CHAIRMAN APOSTOLAKIS: You have similar  
13 tables with LERF, or actually LRF?

14 MR. SAMCALTAR: Not with me unfortunately,  
15 but we have it in the RAI.

16 CHAIRMAN APOSTOLAKIS: Has the order  
17 changes significantly?

18 MR. SAMCALTAR: I don't remember offhand.

19 CHAIRMAN APOSTOLAKIS: The first two, for  
20 example. the (inaudible) line break and the large  
21 LOCA, these are different plant damage states, right?

22 MR. SAMCALTAR: Yes. And these are not  
23 just contributed to LERF, whereas, this will go up and  
24 so on. I don't have another table for it with me  
25 unfortunately.

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1 CHAIRMAN APOSTOLAKIS: Okay. Next.

2 MR. SAMCALTAR: Oh, by the way, the total  
3 number of initiating events and the way we are  
4 modeling it, it comes out to be about 2.4. So  
5 nowadays it is driven by transients, you know, and  
6 nowadays the plants are running like 1 to 2 transients  
7 per year. So this is a reasonable total.

8 MEMBER ROSEN: The total are what?

9 MR. SAMCALTAR: The number of initiating  
10 events.

11 CHAIRMAN APOSTOLAKIS: Per year.

12 MR. SAMCALTAR: Per year is 2.4.

13 CHAIRMAN APOSTOLAKIS: That you  
14 anticipate?

15 MR. SAMCALTAR: Yes. It is a sanity  
16 check, and it should not be .1. I mean, in some  
17 initiating frequencies, I get 10, 10 per year, and  
18 that is very conservative for today's --

19 CHAIRMAN APOSTOLAKIS: And that doesn't  
20 mean --

21 MR. SAMCALTAR: So .1 would also be  
22 unbelievable. So I am just pointing things out to  
23 you.

24 MEMBER ROSEN: One of the other sanity  
25 checks that makes a lot of sense to me if you go back,

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1 is to look at whether or not there is anything that  
2 sticks out, and the one that sticks out here is safety  
3 injection line break.

4 I would be more comfortable with -- that  
5 is 70 percent of the risk right there in the first  
6 three lines -- if it was more evenly balanced.

7 MR. SAMCALTAR: Certainly. If you could  
8 do anything about it that is like modually available,  
9 we would do it. I mean, we feel the same way, but it  
10 is not -- I mean, there is really no hard safe area,  
11 and here if you are feeling good, you distribute them  
12 evenly or close to.

13 CHAIRMAN APOSTOLAKIS: That is not in the  
14 EPRI utility requirements documents?

15 MR. SAMCALTAR: No.

16 CHAIRMAN APOSTOLAKIS: Feeling good is not  
17 there?

18 MR. SAMCALTAR: Feeling good is.

19 MEMBER ROSEN: Well, it says that if you  
20 get them about even, it says that you can't work on  
21 any one of them and make one -- you can't pick one to  
22 work on, because they are all about the same, and you  
23 basically stop at that point.

24 But this is not -- they have not quite  
25 achieved that here. The safety injection line break

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1 is in fact a standout here.

2 CHAIRMAN APOSTOLAKIS: Yes. Of course,  
3 you have to combine that argument with the absolute  
4 value, and --

5 MEMBER ROSEN: Anyway, I was asking if you  
6 thought that thought, and you said yes.

7 MR. SAMCALTAR: Yes, this is a plant  
8 specific, you know, initiating event basically. This  
9 is happening because of the way that things are  
10 arranged, and where this is happening is a design  
11 basis accident.

12 CHAIRMAN APOSTOLAKIS: Do we need this to  
13 talk about? We talked about it already.

14 MR. SAMCALTAR: Yes, comparisons.

15 CHAIRMAN APOSTOLAKIS: Yes.

16 MR. SAMCALTAR: These are some dominant  
17 CDF sequences, like the first one, and so you can see  
18 what kind of tables we are generating. This is for  
19 information, and like the first one is safety  
20 injection line break occurs, and CMT injection is  
21 successful, and full ADS occurs, but we are failing 1  
22 of 1 IRWST injection line.

23 You can see why we are getting what we are  
24 getting. I mean, this is it. This is the guide that  
25 is doing it for us.

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1 MEMBER ROSEN: You only have one  
2 injection.

3 MR. SAMCALTAR: Right. And we also have  
4 a worst break in the worst place with the worst wall.

5 MEMBER ROSEN: It creates the break and it  
6 takes out one of the injectors?

7 MR. SAMCALTAR: Yes. Here again the other  
8 culprit, we discussed this before, and so on, and here  
9 is spurious ADS showing up, and it is equal to this in  
10 some way, and so on.

11 CHAIRMAN APOSTOLAKIS: So these were the  
12 two that were lumped in AP-600?

13 MR. SAMCALTAR: Before, right. And there  
14 is more.

15 CHAIRMAN APOSTOLAKIS: Okay. Let's look  
16 at this.

17 MR. SAMCALTAR: And then we did a bunch of  
18 sensitivity analyses on various subjects, and one of  
19 the things that we did, and I didn't mention it, and  
20 I will show you the picture here.

21 The AP-600 was proven to our satisfaction  
22 that you don't have to have the passive containment  
23 cooling water actually coming down over the  
24 containment shell for the success of containment  
25 cooling. Air cooling is sufficient for long time

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1 periods with a good margin.

2 In this plant, when we started the PRA, it  
3 was not obvious that it will be successful or not. We  
4 weren't sure. So we said that we are going to collect  
5 these sequences where everything works, but water from  
6 the passive containment cooling does not come down and  
7 flow down over the surface of the containment.

8 MEMBER ROSEN: What happens then?

9 MR. SAMCALTAR: We don't know at that  
10 point whether it will be a success or core damage, or  
11 containment failure that leads to core damage. So we  
12 collected them, and these are these states that we  
13 named as LCF, late containment failure.

14 If the passive containment cooling fails,  
15 containment may not survive after the 24 hours, may or  
16 may not, and that is the initial question. We  
17 collected them just in case, and if we cannot prove  
18 it, then we will declare them core damage. If we  
19 prove it is okay, then they are no never minds.

20 Now, with that information, I can now go  
21 back to this first -- now, this first sensitivity  
22 display here says what happens if everything else is  
23 successful, and water doesn't come down, and I assume  
24 it is containment failure which leads to core damage.

25 MEMBER ROSEN: Wait a minute. I having a

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1 problem with this index. Containment failure leading  
2 to core damage. Usually core damage leads to  
3 containment failure.

4 MR. SAMCALTAR: Well, in this case,  
5 containment failure leads to core damage because the  
6 containment is for some reason that after 24 hours  
7 that it severely compromises, and something opens up  
8 and the water or the steam goes out, and so the water  
9 levels, the head of the passive systems, the flow gets  
10 lower, and lower, and lower.

11 MEMBER ROSEN: Okay. Now I understand.  
12 It actually proves an accident in which the core was  
13 not damaged.

14 MR. SAMCALTAR: Not damaged.

15 MEMBER ROSEN: And everything else is the  
16 same, and the only thing that happened was that you  
17 had a big pipe break, and it fills up the containment  
18 with steam, and everything was going along fine, and  
19 the core stayed covered. But the containment failed  
20 and then you lose the steam, and then it goes to core  
21 damage.

22 MR. SAMCALTAR: Right.

23 MEMBER ROSEN: Thank you.

24 MR. SAMCALTAR: If all these sequences  
25 also went to core damage, then the increase would be

1 a factor of 1.3, or 30 percent, or it would be 2.4  
2 times 1.3, whatever that number is.

3 Of course, we looked at initiating event  
4 importances, and sequence importances, and in-state  
5 importances, and these are listed here, and common  
6 cause failure importances.

7 CHAIRMAN APOSTOLAKIS: When you say  
8 initiating event importance, are you referring to --

9 MR. SAMCALTAR: Just to the two tables  
10 before when I listed them. Like the SI line break is  
11 --

12 CHAIRMAN APOSTOLAKIS: Oh, so you are just  
13 telling us again that 39 percent is good and you are  
14 not referring to the standard of importance measures?

15 MR. SAMCALTAR: No. And then from these,  
16 you can find out what happens if I --

17 CHAIRMAN APOSTOLAKIS: Did you use any of  
18 the standard importance measures?

19 MR. SAMCALTAR: Yes. We have tables for  
20 those.

21 CHAIRMAN APOSTOLAKIS: Are those a  
22 separate table?

23 MR. SAMCALTAR: Yes, that is where these  
24 come from, the components. All of these come from  
25 (inaudible) values. You have one of these tables

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1 reporting lows and (inaudible) for all the components,  
2 and human errors and common cause.

3 MEMBER SHACK: And the number is 60,000?

4 MR. SAMCALTAR: Yes. Maybe he forgot. We  
5 did some human error probability, and like we sent in  
6 all the human errors to one area, and we set them to  
7 zero, and then we set them to .1 just to see something  
8 in between.

9 CHAIRMAN APOSTOLAKIS: This includes  
10 errors as you say there to diagnose those things and  
11 everything?

12 MEMBER ROSEN: It's all the models of  
13 human actions.

14 CHAIRMAN APOSTOLAKIS: Everywhere where  
15 you have a human error probability (inaudible)?

16 MEMBER ROSEN: The human fails.

17 MR. SAMCALTAR: Right.

18 MEMBER ROSEN: So you say here it is 57,  
19 a factor of CDS --

20 MR. SAMCALTAR: A factor of 57. It says  
21 2.4 multiplied by a hundred, and you have to divide by  
22 two to make it good, and so it will go from 2.4 minus  
23 7, to 2.4 minus 5, divided by two; and 1.2 minus 5  
24 approximately. I am just roughly estimating. It is  
25 going to go up by a factor of 50, and multiple it by

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1 a hundred and divide by two.

2 There are a couple of ones here that we  
3 long discussions with the NRC about, the reliability  
4 of check valves, and I know we had long discussions  
5 about explosive valve reliability. So we did a few --  
6 we did some sensitivity analysis on this to see what  
7 happens if we increase --

8 MEMBER ROSEN: You see, this is very  
9 interesting to me, because we were talking about the  
10 spurious failure of the ADS 4, and now you are telling  
11 me that even if it turns out that all my fears are  
12 correct, failure of the ADS 4 will work when commanded  
13 is a factor of three on CDF.

14 MR. SAMCALTAR: Right, but let me qualify  
15 if so that there is no misunderstanding. I don't want  
16 to mislead you, you know. In that case, we are past  
17 the initiating frequency, and just responding to the  
18 initiating frequency.

19 MEMBER ROSEN: Right.

20 MR. SAMCALTAR: So the ADS spurious --

21 MEMBER ROSEN: No, this is when it is  
22 commanded, it doesn't work, and it is a factor of  
23 three?

24 MR. SAMCALTAR: Yes, because these were  
25 points that required a lot of back and forth with the

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1 NRC.

2 MEMBER ROSEN: Well, that is very helpful  
3 to me.

4 CHAIRMAN APOSTOLAKIS: Now the passive  
5 systems that were handled separately, you don't have  
6 any importance --

7 MR. SAMCALTAR: Oh, the system importance  
8 is coming up in the next one.

9 CHAIRMAN APOSTOLAKIS: Okay.

10 MEMBER ROSEN: And the reason that it is  
11 only a factor of three is because it is only 12  
12 percent to begin with.

13 MR. SAMCALTAR: Yes. It is not a major  
14 contributor. The RCP is -- oh, this is the reactor  
15 trip breakers, and it should be RCT. Those are the  
16 reactor trip breakers. and then the last one,  
17 sensitivity to standby non-safety systems.

18 This is when we turn off five systems at  
19 once, and these are truly standby systems. They just  
20 sit on safety standbys, as opposed to alternating  
21 systems. Like some systems are charging, and  
22 (inaudible) safety works every day. I mean, it is  
23 tested by just working.

24 These guys are sitting basically and doing  
25 nothing for long time periods, and they are non-

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1 safety, and so we said let's send them to failure and  
2 see what happens.

3 These are system importances. Here by the  
4 very next slide has a description of what these  
5 acronyms mean in case you wonder what the acronym is.  
6 So it is on the next slide.

7 CHAIRMAN APOSTOLAKIS: What does PMS stand  
8 for?

9 MEMBER KRESS: Post-menstrual syndrome.

10 MEMBER ROSEN: Protective safety margins.

11 MR. SAMCALTAR: So what I do is I had this  
12 table before, and I grouped them so we could focus on  
13 what this is really saying and took away the minute  
14 details to show you what it is really saying.

15 So if you look at the increase in CDF, and  
16 if you turn it off, the systems listed here increase  
17 the core damage less than a factor of two. So these  
18 are truly important, whichever way you look at them.

19 MEMBER ROSEN: Which is a level of not  
20 risk significant than option two.

21 MR. SAMCALTAR: As defined, yes.

22 MEMBER ROSEN: By option two, we were in  
23 that discussion of component importance, and we had a  
24 long discussion with the staff, and it became two on  
25 the risk achievement was the level at which you said

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1 it was not risk-significant.

2 MEMBER KRESS: Yes, but that was for a  
3 plant that had CDF like 10 to the minus 4.

4 MEMBER ROSEN: No, it was actually for a  
5 plant that had 10 to the minus 5.

6 MEMBER KRESS: 10 to the minus 5, and not  
7 10 to the minus 7.

8 MEMBER ROSEN: Right.

9 MEMBER KRESS: So I think we would change  
10 the two.

11 MEMBER ROSEN: It might be higher than two  
12 is what he is saying.

13 MEMBER KRESS: Well, yes.

14 CHAIRMAN APOSTOLAKIS: And that would be  
15 the second from the right.

16 MR. SAMCALTAR: I mean, it can be higher  
17 than two. Now, these breaks are not traditional,  
18 okay? I kind of look for places where they punched  
19 up, and these are forced upon me, and I did not choose  
20 them. So don't tell me why this is 50, but not  
21 hundred.

22 CHAIRMAN APOSTOLAKIS: That still doesn't  
23 get you off the hook. So why is it 50?

24 MR. SAMCALTAR: And then the next one was

25 --

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1 CHAIRMAN APOSTOLAKIS: That it was a  
2 natural break.

3 MR. SAMCALTAR: So, again in putting this  
4 here, and I am looking back at it and saying that  
5 doesn't make sense, you know. Do I see anything that  
6 jumps at me. That is the reason why we are looking at  
7 it.

8 But if something jumps at me, because it  
9 is an insight, and it is telling me something, and it  
10 is wrong. And in both cases, we want to know. So if  
11 you look here now, non-1E diverse actuation system, AC  
12 power, which is a non-safety grade.

13 PLS is control system, and what we know as  
14 control system now in other plants. In the next  
15 range, CMT, accumulator (inaudible), these are the  
16 most important ones. PMS 1E-DC, IRWST recert mode,  
17 AVS, IWRST injection mode.

18 And the two most important ones are these,  
19 and they are related to each other, and this actually  
20 is a support system for this. They have an umbilical  
21 cord.

22 MEMBER SHACK: Supposed I looked at the  
23 squib valve by itself? Where would it --

24 MR. SAMCALTAR: Here is a table that has  
25 every basic event, and a single squib valve will not

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1 really show up, but squib valve common cause will show  
2 up.

3 MEMBER SHACK: Squib valve common cause?

4 MR. SAMCALTAR: Well, if you look at the  
5 top of the table, it is just populated by common  
6 (inaudible), and if you say what is the importance of  
7 one squib valve, it is nothing.

8 CHAIRMAN APOSTOLAKIS: But it makes the  
9 common cause failure --

10 MR. SAMCALTAR: Right.

11 CHAIRMAN APOSTOLAKIS: So that jumps out  
12 at me.

13 MEMBER ROSEN: What that says in layman's  
14 terms is that you don't want someone to mess up all of  
15 your squib valves.

16 MEMBER KRESS: At the same time for the  
17 same reason.

18 CHAIRMAN APOSTOLAKIS: Even without this,  
19 I wouldn't want that to happen, but that is exactly  
20 what it says.

21 MR. SAMCALTAR: And PMS and DC-1E power,  
22 because of its relation to the PMS basic weight, are  
23 the most important systems. They increase your core  
24 damage in orders of magnitude, 3 or 4 orders of  
25 magnitude.

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1                   And PMS is very variable, and Terry tried  
2                   to give you a taste of it this morning by telling its  
3                   basic design features and the thought that went behind  
4                   it.

5                   CHAIRMAN APOSTOLAKIS:     Well, let me  
6                   understand this a little bit.     Maybe I am missing  
7                   something.     30 percent of this table on slide 24 where  
8                   he said that there is a diverse system, DAS, right?

9                   MR. SAMCALTAR:     Right.

10                  CHAIRMAN APOSTOLAKIS:    So even with that,  
11                  we would get this kind of importance for PMS.

12                  MR. SAMCALTAR:     Right.     Remember, the  
13                  importance -- if you take the --

14                  MEMBER SHACK:     That is because the power  
15                  to the DAS goes out.

16                  MR. SAMCALTAR:     No.     The DAS is there.     It  
17                  works.     The change -- remember the orders of magnitude  
18                  that you go up when you (inaudible) a system?     If you  
19                  take the inverse of it, one over that, that is like  
20                  the general reliability.

21                  It is a measure of the general reliability  
22                  of that system in a formal sense.     Like if I go three  
23                  orders of magnitude in CDF and if I fail a system, and  
24                  system failure probability is approximately 10 to the  
25                  minus 3.     That's what it means roughly as an average.

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1 Can you relate to that? I don't know if you can  
2 visualize it that way.

3 MEMBER KRESS: That is some sort of  
4 contribution for that thing for sequences that  
5 dominate?

6 MR. SAMCALTAR: Yes. If you had an  
7 initiating event, one, and if PMS failure takes me to  
8  $1 \text{ times } 10 \text{ to the minus } 5$ , and then down failure, and  
9 then I have DAS failure,  $10 \text{ to the minus } 2$ . And then  
10 let's say control power is  $10 \text{ to the minus } 1$ . And  
11 then I get core melt, let's say, and I have lost  
12 everything now.

13 So it is going to be a magnification of  
14 those numbers. Now, if you have the sequence, and  
15 squib PMS, and maybe it is one, anything (inaudible)  
16  $10 \text{ to the minus}$  (inaudible) orders of magnitude.

17 And you can say, yes, this is a lot. Yes,  
18 it is a lot because it is a reliable system. Now we  
19 can say what can I do. There is nothing that you can  
20 do, except to make it less reliable, because if you  
21 increase the reliability of that, and again visualize  
22 what I have just told you.

23 Transient, PMS failure, and DAS failure,  
24  $10 \text{ to the minus } 2$ , let's say; and control power,  $10 \text{ to}$   
25  $\text{the minus } 1$ , and I go to core damage. So now I want

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1 to say I think it tends to make DAS more reliable, 10  
2 to the minus 3, and PMS will still go up five orders  
3 of magnitude, right?

4 MEMBER KRESS: Yes.

5 MR. SAMCALTAR: You can't change that.

6 CHAIRMAN APOSTOLAKIS: Yes, more or less.

7 MR. SAMCALTAR: So the higher the raw  
8 value is, it means more reliable that system is, you  
9 know, originally is. It is more reliable.

10 CHAIRMAN APOSTOLAKIS: Now, we really  
11 don't know, and there is no universally accepted for  
12 calculating the reliability of software.

13 MR. SAMCALTAR: You are absolutely right.

14 CHAIRMAN APOSTOLAKIS: Yet, you have a  
15 CCF.

16 MR. SAMCALTAR: Yes.

17 CHAIRMAN APOSTOLAKIS: Now, I don't recall  
18 the utility requirements document having anything to  
19 do with that?

20 MR. SAMCALTAR: No, they have nothing.

21 CHAIRMAN APOSTOLAKIS: And yet it is very  
22 important.

23 MR. SAMCALTAR: Yes.

24 CHAIRMAN APOSTOLAKIS: Can you remind us  
25 how you did that?

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1 MR. SAMCALTAR: Okay. We were in this  
2 room five years ago or so, and you were here, and you  
3 were here.

4 MEMBER ROSEN: No, I was running --

5 MR. SAMCALTAR: Okay. John Wiseman, our  
6 expert in PMS --

7 CHAIRMAN APOSTOLAKIS: You see, that is  
8 the problem. Now you are telling me that I approved  
9 something five years ago.

10 MR. SAMCALTAR: No, no, I am not going to  
11 say that. Absolutely not. Absolutely not. I am not  
12 a precedence man.

13 CHAIRMAN APOSTOLAKIS: You don't want to  
14 do it, but you did it anyway.

15 MR. SAMCALTAR: No, I want to tie it to  
16 something.

17 CHAIRMAN APOSTOLAKIS: Okay.

18 MR. SAMCALTAR: But I don't want to do an  
19 injustice to it. I have a totally different reason to  
20 tell you. Not a precedent, and I am not a precedence  
21 man if you didn't figure that out.

22 CHAIRMAN APOSTOLAKIS: Okay.

23 MR. SAMCALTAR: We had a meeting here and  
24 these are electrical engineers who relate to this and  
25 I am not, but I am going to tell you that in the third

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1 person thing.

2           There are certain things I know in the  
3 first person, second person, and third person. I am  
4 here as a third person in this subject. He was the  
5 first person, and he tried to explain all this stuff  
6 for about -- it took like 2 hours, and it was only for  
7 45 minutes, but it felt like it was two hours.

8           And it was back and forth, and the point  
9 is this. PMS is so reliable because of its  
10 redundancy. We superimpose on it various checkpoints  
11 by common cause. We insert common cause among  
12 (inaudible) at the level of 10 to the minus 5.

13           CHAIRMAN APOSTOLAKIS: But that is a  
14 judgment though, and is not based --

15           MR. SAMCALTAR: It is based on expert  
16 opinion, and it is based on some equation that was  
17 made years ago, and it is like a factor. You say what  
18 about this aspect of it, and it contributes this much,  
19 and you kind of find things out.

20           But the bottom line is it is an expert  
21 opinion, and you can get out of it 10 to the minus 3,  
22 and 10 to the minus 4, and 10 to the minus 5, or  
23 anything that you want. And people do.

24           And actually I remember one of your  
25 comments at the end of this discussion, and I hate to

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1 place it in your -- and I hate to misquote you, but  
2 you said then why did you put it there.

3 I mean, if this is such an expert opinion  
4 and so it is really damaging. It really hurts our  
5 reliability. But we put it in enough places that it  
6 makes physical sense.

7 I mean, later on it is in the model, and  
8 so you can say, hey, I limited my reliability in  
9 import cards, and I limited my reliability to output  
10 cards. I limited my reliability in sensors  
11 separately, and not with one box, but different boxes.

12 And so if later on somebody can go in  
13 there and say, oh, maybe I can do sensors better this  
14 time, you know. Now, if you have 10 to the minus 5,  
15 and if you say it is 10 to the minus 4, I cannot sit  
16 here and argue with you. I have no basis to argue.

17 CHAIRMAN APOSTOLAKIS: Now I remember that  
18 meeting, and I think at the end why the committee went  
19 along was that you did a sensitivity analysis I think,  
20 where you started setting things to the same state,  
21 and you still showed that the core damage frequency  
22 was very low. Is that correct?

23 MR. SAMCALTAR: It might be. I don't  
24 remember.

25 CHAIRMAN APOSTOLAKIS: I remember sitting

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1 over there to the right and saying that if they did  
2 that, then what else can you do.

3 MR. SAMCALTAR: Yes.

4 CHAIRMAN APOSTOLAKIS: I think that is  
5 what you did. It was a scientific analysis of safety.

6 MR. SAMCALTAR: But it was more than that.  
7 Not only was it (inaudible) among like objects, like  
8 the cards, and the sensors, and the cause again could  
9 be separately.

10 But we also put in a common cause of 1  
11 times 10 to the minus 6 between the PMS and PLS. So  
12 that we never can go beyond that barrier. Whatever we  
13 do, we will stop there.

14 Moreover, it was one more checkpoint. We  
15 put 1 times 10 to the minus 6, or like operators have  
16 no information coming into the room. Everything goes  
17 blind, whatever that means.

18 So that you can never multiple numbers and  
19 signals, and operator actions. You could never go  
20 beyond that barrier, and it stops you. We tried to  
21 limit those and these things showed themselves. So  
22 you can look at them separately, and say what does  
23 this mean.

24 Other than that, I don't know what else to  
25 do if --

1 CHAIRMAN APOSTOLAKIS: Well, PMS is very  
2 important.

3 MR. SAMCALTAR: Yes.

4 CHAIRMAN APOSTOLAKIS: You talk about a  
5 factor of 50,000.

6 MR. SAMCALTAR: Yes, at that range. If  
7 you take one over that, it is like 2 times 10 to the  
8 minus 5 and the reliability is variable and not as far  
9 as individual same systems. So, 2 times 10 to the  
10 minus 5.

11 CHAIRMAN APOSTOLAKIS: But we do a very  
12 gross bounding analysis, and say it is gone, you are  
13 still -- the core damage frequency is what?

14 MR. SAMCALTAR: If it is (inaudible), you  
15 go to 10 to the minus 3.

16 CHAIRMAN APOSTOLAKIS: So CDF is now 2  
17 times 10 to the minus 7.

18 MR. SAMCALTAR: Right. And 50,000 is a  
19 big number.

20 CHAIRMAN APOSTOLAKIS: And you go 10 to  
21 the minus 3 is only what I can think of. I thought  
22 you were going higher.

23 MR. SAMCALTAR: No, just 10 to the minus  
24 3, and also that 66,000 --

25 CHAIRMAN APOSTOLAKIS: Well, I think that

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1 is what happened with the AP-600.

2 MEMBER ROSEN: This is not unusual. You  
3 have very reliable systems, and in current day  
4 operating plants, like essential cooling water, or the  
5 7300 processor system, they have very high raws.

6 I agree that they are very reliable, and  
7 we rely on them to be very reliable.

8 CHAIRMAN APOSTOLAKIS: I agree, but what  
9 I am trying to do here is have an argument on why I  
10 don't have to worry about actually quantifying this,  
11 and if I do the worst case, like core damage frequency  
12 is still low, then as soon as the system is gone,  
13 which I know is extremely important.

14 And maybe you can argue about the CDF  
15 being 10 to the minus 5, or 4, or 3, but it is 4 to 1.  
16 But even if it is one, my CDF is too low. It is less  
17 than 10 to the minus 2, and that gives me --

18 MR. SAMCALTAR: The only way to do that is  
19 --

20 CHAIRMAN APOSTOLAKIS: It is not about  
21 hitting one, and you see that is what -- I mean, even  
22 people who are dead set against putting probabilities  
23 of software reliability in performance, I think that  
24 would be crazy to say that a probability failure is  
25 one, which automatically of course makes them put a

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1 probability number and so then they are crazy. But  
2 that is okay.

3 And I think that was the argument in AP-  
4 600. Now I remember that meeting. It was late in the  
5 day.

6 MR. SAMCALTAR: Yes, it was a long day.

7 CHAIRMAN APOSTOLAKIS: So why are you  
8 sitting down? Are you tired?

9 MR. SAMCALTAR: No. No, I'm not.

10 CHAIRMAN APOSTOLAKIS: Are you planning to  
11 finish before lunch?

12 MR. SAMCALTAR: I am at your service.

13 MEMBER ROSEN: What was lunch time?

14 CHAIRMAN APOSTOLAKIS: What was the plan?  
15 But the question is if we let you go to 12:20, you  
16 will be done with the whole PRA presentation?

17 MR. SAMCALTAR: I can go through them very  
18 fast, very slowly, according to what you want to see.

19 CHAIRMAN APOSTOLAKIS: Yes, because after  
20 that we start with the seismic criteria, right?

21 MR. SAMCALTAR: I can go very fast.

22 MEMBER ROSEN: Let him go.

23 CHAIRMAN APOSTOLAKIS: Okay.

24 MR. SAMCALTAR: Okay. I have this slide  
25 for uncertainly analysis. We did uncertainty analysis

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1 and it is a numerical exercise, and I don't have a lot  
2 of -- well, I don't get it at least, but we do it to  
3 make sure that it has been performed.

4 To me it is more meaningful to look at  
5 sensitivity analyses, and the importances, and so on,  
6 rather than a numerical uncertainty analysis.

7 CHAIRMAN APOSTOLAKIS: But this  
8 uncertainty analysis though, we just said that the  
9 software reliability is highly uncertain. So how can  
10 you come up with another factor of six for core damage  
11 frequency? Shouldn't it be higher?

12 MR. SAMCALTAR: I will tell you what. Our  
13 basic assumption is that every data point in our  
14 database has a mean value, and that is very important.  
15 And whether you agree with it or not is a different  
16 story.

17 We use mean values, and that is the next  
18 simplest assumption we have is it is not normal. Now,  
19 we don't have to make that. Now we have very powerful  
20 software that you can do anything that you want.

21 And when you say I have a mean value,  
22 whenever a high error factor you have assigned, it  
23 came out normal. The mean is either 70 percent, or 75  
24 percent, 80, 90, but the mean is never at 5 percent or  
25 10 percent. With this normal distribution, it is not

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1 that flexible.

2 CHAIRMAN APOSTOLAKIS: So your assumption  
3 for their mean value is more to the left.

4 MR. SAMCALTAR: Right. So even if my  
5 range is 10,000, only a factor of 10 is here and the  
6 thousand is actually --

7 CHAIRMAN APOSTOLAKIS: But how an you say  
8 that about the highly uncertain common cause failure  
9 probability of software? Do you even assume the mean  
10 value there?

11 MR. SAMCALTAR: Right. I always do the  
12 mean value.

13 CHAIRMAN APOSTOLAKIS: Well, it is medium,  
14 and what do you mean what else can you do?

15 MR. SAMCALTAR: 1 times 10 to the minus 5  
16 is the mean, and that is my assumption, and I am  
17 telling you what it is.

18 CHAIRMAN APOSTOLAKIS: Okay. So the  
19 uncertainly is in that assumption then.

20 MR. SAMCALTAR: Yes. And it would  
21 certainly make a big difference if you said I have 1  
22 times 10 to the minus 5, and I have an error factor of  
23 a hundred, and it is a big difference.

24 CHAIRMAN APOSTOLAKIS: Because it is a  
25 skewed distribution.

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1 MR. SAMCALTAR: Right. Exactly.

2 CHAIRMAN APOSTOLAKIS: Well, that is  
3 pretty serious.

4 MR. SAMCALTAR: But you normally have that  
5 information from the previous sensitivity analyses and  
6 component importances. You already know what is  
7 important. So to me this is an exercise in  
8 calculation.

9 CHAIRMAN APOSTOLAKIS: Well, especially  
10 after what you just said.

11 MR. SAMCALTAR: With what I just said,  
12 yes. These are little details of it for individual  
13 sequences, and so they will just follow naturally.  
14 The crux of the matter, you got it. I told you the  
15 crux of the matter.

16 Shutdown. We did a quantitative shutdown  
17 risk evaluation, and notice we are saying evaluation.  
18 We did not go back and exercise the model to the nth  
19 degree. We just used the results on the AP-600, and  
20 looked for differences, real differences that were  
21 implemented.

22 And basically the bottom line of this is  
23 that we have an increase of 18 percent in the shutdown  
24 core damage frequency, and it is now standing at 1.2  
25 times 10 to the minus 7, which is about half the value

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1 for power.

2 And the 18 percent increase is basically  
3 due to the fact that we went from 24 months refueling  
4 to 18 months refueling, and the AP-600 had 24 months  
5 refueling and this plant has 8 months refueling.

6 So the initiating event frequencies went  
7 up because we exercised shutdown events moreover, and  
8 that is why it increased. I mean, it is not a worst  
9 plant or --

10 MEMBER ROSEN: Let me focus on another  
11 piece of this, and that is 1.2 compared to 2.4. These  
12 are additive. If you want to take the total risk for  
13 operations cycled risk, operation and shutdown, 1.2  
14 and 2.4, 3.6.

15 So then it says that shutdown risk is one-  
16 third of the total.

17 MR. SAMCALTAR: Yes, so far. Yes.

18 MEMBER ROSEN: Yes, so far. Now, let me  
19 tell you that my rule of thumb for plants that do mid-  
20 loop evolutions in shutdowns, is half the total. So  
21 why does this out come so low compared to my rule of  
22 thumb?

23 MR. SAMCALTAR: Okay. First of all, I  
24 will try to answer the question, but it is not that  
25 low, and do you have an answer for that?

1 MR. CORLETTI: I can't address it from a  
2 system point of view. The passive safety systems are  
3 actually designed to mitigate events that can occur  
4 during shutdown, and in fact our tech specs require  
5 them to be available during shutdown modes.

6 So we have taken shutdown in the design  
7 process, and we have tried to address as Terry pointed  
8 out the loss of RNS, and loss of normal residual heat  
9 removal at shutdown can be mitigated by the passive  
10 safety system. So they do or have contributed to we  
11 think a higher level of safety in shutdown.

12 MEMBER ROSEN: Okay. Go on. Let's hear  
13 some more of the story.

14 MR. SAMCALTAR: One thing that he said  
15 that I thought was very important is before going to  
16 plant shutdown that could lead to a mid-loop and so  
17 on, we require support systems to be available, and  
18 that nothing is out of service on purpose.

19 MR. CORLETTI: Yes.

20 MR. SAMCALTAR: Is that what you said?

21 MR. CORLETTI: Well, I was saying that we  
22 actually require passive safety systems.

23 MR. SAMCALTAR: But what about the others?

24 MR. CORLETTI: Yes, they are also, yes.

25 MR. SAMCALTAR: Now, we don't go into a

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1 plant shutdown with one diesel generator output, and  
2 I don't want to say anything wrong, okay? Is that  
3 correct?

4 MR. CORLETTI: Yes.

5 MR. SAMCALTAR: And one component cooling  
6 drain out, or one surface water drain out. There are  
7 precautions taken to address the mid-loop issue.

8 MEMBER ROSEN: But this does not explain  
9 it to me, because you are comparing two things, and  
10 the thing that you are comparing it to also takes  
11 those precautions.

12 MR. SAMCALTAR: Fair enough. Then his  
13 other point might be, a very important point, that  
14 mainly passive systems that are left operational on  
15 purpose to address this, because everybody knows it is  
16 important now, and so the design tries to address it  
17 as much as possible.

18 The three events dominating the CDF are  
19 loss of component cooling or service water during  
20 drain conditions. Loss of offsite power during drain  
21 conditions, and then loss of normal RHR during drain  
22 conditions. It is a comparison of CDF with AP-600  
23 shows that these two designs are not very different.

24 And 18 percent is basically due to what we  
25 call the frequency change. The 12 dominant accident

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1 sequences basically make up 77 percent of the level 1  
2 shutdown CDF.

3 And they contain the same culprits as I  
4 just mentioned namely sequence associated with loss of  
5 component cooling or surface water, and then much less  
6 is normal RHR and loss of off-site power, and all  
7 draining events, whatever that is.

8 Okay. That is all that I have for  
9 shutdown really, unless you have questions. Okay.  
10 Internal flooding, never mind. I mean, this plant is  
11 designed to predate and is not susceptible to internal  
12 flooding.

13 However, to me, the true internal flooding  
14 can only be done at a walkdown and so on when the  
15 plant is built. So this is a design exercise showing  
16 that it is not a big --

17 CHAIRMAN APOSTOLAKIS: And fire, too.

18 MR. SAMCALTAR: However this shows us that  
19 there is nothing that is obvious somewhere and that  
20 water won't accumulate there and go from room to room  
21 or something like that.

22 However, again, the bottom line is plant  
23 specific walkdown and so on. Otherwise, this is, no,  
24 never mind. Flooding, the same stuff. Now, fire and  
25 the PRA. Usually when we submitted the PRA the first

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1 time, the AP-1000, we didn't really have a fire PRA.  
2 We just had a discussion.

3 And the NRC said no, and so we actually  
4 went through the full exercise from scratch, and not  
5 really taking the AP-600 and looking at things, but  
6 truly looking at what is happening here.

7 Basically, my general impression is this.  
8 If you have a newer plant with Appendix R conditions  
9 already met, it is very, very difficult to really find  
10 things for fire PRA.

11 And it is true with this plant, and the  
12 most interesting thing here was this spurious hot-  
13 shorts that was called spurious ADS. That was the  
14 only thing that was really worth discussion.

15 Now, the design people did everything I  
16 think that can be done to minimize that, and the  
17 question is how do you quantify it. The problem has  
18 been defined from a long time ago, and we understand  
19 it, and we don't disagree with it.

20 The design people did something and how do  
21 you assign numbers to it, and that is always a  
22 controversy. We assigned what we thought was  
23 reasonable numbers, and they are still giving us --  
24 the bulk of this comes from LOCAs, spurious ADS  
25 openings or something that are induced by fire.

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1 Otherwise, there is nothing.

2 MEMBER SIEBER: Well, let me ask a  
3 question. It says that design features were  
4 incorporated to address hot-shorts. What were they?  
5 What did they do?

6 MR. SAMCALTAR: Well, let me see.

7 MR. CUMMINS: This is Ed Cummings. I  
8 think Terry got the essence of it with that arm and  
9 fire sequence. If you have an arm and fire sequence  
10 that are separate cables, then anyone -- fire can  
11 actuate one of the other of them, but not both of  
12 them.

13 So that helped us very much with the PRA  
14 part of it.

15 MR. CORLETTI: This is Mike Corletti. In  
16 the fire PRA that we submitted, in the back is  
17 Attachment 57D, where we go through about 10 pages of  
18 discussion of the design features in the plant that  
19 were aimed at addressing the issue of hot shorts.

20 I think you have the fire PRA and I am not  
21 sure whether you have seen -- if you made your way to  
22 this Attachment 57D.

23 MEMBER SIEBER: That is pretty far back.

24 MR. CORLETTI: Yes, it is pretty far back.  
25 But I have a copy of it here, and I would be glad to

1 make copies for you all.

2 MR. SAMCALTAR: So we really tried to look  
3 into all the interesting scenarios that can come up,  
4 including scenarios in the containment, which normally  
5 people will say, oh, inside containment and ignore it.  
6 That is less probable. So we looked at them in  
7 detail.

8 That brought us incredible difficulties,  
9 because by definition they are large fire zones, but  
10 not areas. If it was a fire area, then it was 3 hour  
11 or 5 hour boundary; and if it is a zone, it doesn't.

12 And we were arguing with the NRC that if  
13 you have a cable right here, and another cable, say,  
14 a hundred feet away, but they are in the same zone.  
15 They don't have a 3 hour barrier, and can you have a  
16 fire there, and somehow this will affect this.

17 And from a pure common sense or  
18 engineering or whatever you want to call it, you said  
19 come on, where is your limits. Where do you draw the  
20 line.

21 And yet unless you officially have a 3 hour barrier,  
22 somehow --

23 MEMBER ROSEN: There is another option now  
24 with NFDA05, and that is to do fire modeling.

25 MR. SAMCALTAR: Right. You have to go to

1 the next step, yes.

2 MEMBER ROSEN: And you can prove, and if  
3 your engineering intuition is correct, you can prove  
4 it with a fire model.

5 MR. SAMCALTAR: Yes.

6 CHAIRMAN APOSTOLAKIS: What does it mean,  
7 the last line, for internal events? You mean for  
8 power?

9 MEMBER ROSEN: No, fire that is induced by  
10 earthquakes.

11 MR. SAMCALTAR: Right.

12 CHAIRMAN APOSTOLAKIS: Or earthquakes  
13 induced by fires?

14 MEMBER ROSEN: No, no, no.

15 MR. SAMCALTAR: That's possible, too, I  
16 guess in some scenarios. I don't know.

17 MEMBER ROSEN: Well, I think this is  
18 important before you get to seismic. What this says  
19 is that you went back and looked at fire, and you did  
20 a fire PRA, and you improved the fire protection of  
21 the plant.

22 MR. SAMCALTAR: Yes, and we have tried to  
23 show it also by looking very carefully into different  
24 scenarios, and another interesting thing is there are  
25 almost no operator actions here that we had to take

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1 credit for. There were only two that we credited.

2 We didn't have to rely on operators to go  
3 and close doors, or do things, and press things, and  
4 so on, other than what they would normally do. There  
5 were no special things, except two.

6 CHAIRMAN APOSTOLAKIS: Does this plant  
7 have --

8 MR. SAMCALTAR: No.

9 MEMBER ROSEN: I didn't get to my bottom  
10 line yet. If you go back to this Slide 63. Now, you  
11 have done these things to improve, which is  
12 commendable, and where you end up is .5 E to the minus  
13 7, right?

14 MR. SAMCALTAR: Eight.

15 MEMBER ROSEN: .5.

16 MR. SAMCALTAR: Oh, I'm sorry, .5.

17 MEMBER ROSEN: I am doing something. .5  
18 E to the minus 7, which is included in the 2.4 or not?

19 MR. SAMCALTAR: No. It is additional,  
20 right.

21 MEMBER ROSEN: Okay. So now we are  
22 getting a picture here. We have got 2.4 for internal  
23 events at power, and we have got 1.2 for shutdown, and  
24 we have .5 for fire. Fire is 10, 12, 15, or 20  
25 percent, something in that range of the total?

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1 MR. SAMCALTAR: Yes. And it is driven by  
2 the assumptions in hot shorts. That's it.

3 MR. BURKHARDT: This is Larry Burkhardt,  
4 and I am sure that you will hear more about this  
5 later, but I think what we are trying to do now is  
6 looking at the RAI responses and some of the numbers  
7 you may not agree with, am I safe to say, and the  
8 issue that you brought up, Dr. Rosen, about the  
9 modeling, the fire modeling.

10 That you have not done, and that is one of  
11 the issues that we are talking about, too. The zone  
12 issue, the combustible material, et cetera and so  
13 those are some of the subjects of the RAIs. I don't  
14 know if you have had a chance to look at it.

15 At least right now we are in discussion  
16 with Westinghouse on trying to expand the RAI  
17 responses and completely resolve it. But there are  
18 some areas where we are not on exact agreement, and I  
19 am sure that you will hear about that this afternoon.

20 MEMBER ROSEN: But I am just getting the  
21 sense that -- I am just thinking in terms of is it  
22 reasonable. This is why our PRAs are disciplined, and  
23 so usually we get numbers, but then you sit back and  
24 use your intuition, and say is this reasonable, does  
25 it make sense, that fire should be 20 percent maybe of

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1 the total risk in a plant.

2 And it sounds to me like it ought to be  
3 higher, or I mean lower, but then I realize that the  
4 overall total is very low. So this piece, which tends  
5 to be resistant to being lower than even more, tends  
6 to stick up more and more, because you have lowered  
7 the internal events so low that this piece, in a  
8 modern PWR, you would expect it to be quite a bit  
9 lower.

10 But not in a PWR, and not in any future  
11 PWR, like AP-1000, if you have substantial internal  
12 events CDF. Whereas, here you have lowered the  
13 internal events CDF so much that this tends to stick  
14 out a little bit. Also, it is reasonable, and when  
15 you get down with all that rationale, it seems  
16 reasonable.

17 MR. SAMCALTAR: Well I can say this. It  
18 is not unreasonable. Moreover, it is driven by a  
19 single issue. What is really the probability of hot  
20 shorts, you know. A single hot short cannot do  
21 anything to this plant, and even probably multiples  
22 will happen before it can actuate anything.

23 So the whole question is what are the  
24 assumptions, modeling assumptions and probabilities  
25 assigned to this issue about hot shorts. And I

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1 believe that what we did is reasonable under the  
2 conservative side. I would think that if we were a  
3 little bit more pushy that we would have probably used  
4 more realistic values, but it would make us further  
5 apart, and it would only make things even last longer,  
6 you know, the discussions.

7 So I would say in reality that it is  
8 probably a little bit less percentage wise, but we  
9 weren't uncomfortable with settling at this number,  
10 because it is one of those things that is expert  
11 opinion driven on what you should do.

12 But engineering wise, we recognize it. I  
13 mean, it is recognized, and it has been addressed  
14 engineering wise. We are comfortable with that.

15 Seismic margins. Previously, we did  
16 seismic margins on this plant, and we just evaluated  
17 it and we looked at it, and we were looking for our  
18 magic number, which is .5 g HCLPF.

19 CHAIRMAN APOSTOLAKIS: Even with the tank  
20 on top of the container?

21 MR. SAMCALTAR: Excuse me?

22 CHAIRMAN APOSTOLAKIS: Even with the tank?

23 MR. SAMCALTAR: Oh, with that tank, there  
24 has been a lot of fun. Yes, the tank is always there.  
25 It should be somewhere in here. This is tank failure.

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1 It used to be .58 g, and we made it larger, and it  
2 slipped down to .51.

3 And so it is at the border. So these are  
4 the guys who were the major culprits, you know, and it  
5 is there. Whether it is down here or up there, there  
6 isn't a big difference. But these are the major  
7 contributors.

8 Not the first one. The first one is there  
9 for completeness sake. It doesn't really do any harm.  
10 But the new few are at the border and I put this as a  
11 comparison to see if there is a new actor coming in.

12 Steam generators are larger and so I guess  
13 that is why it went down a little bit here. There is  
14 not really anything new here. We had previously a set  
15 of actors, and they didn't really change, and this  
16 kind of summarizes this story.

17 There were no frequencies calculated or  
18 anything. We are good for .50 and that is the bottom  
19 line. The rest is the normal stuff; no credit for  
20 operator actions, and assumes a loss of offsite power  
21 for all sequences, and there is nothing new there.

22 MEMBER ROSEN: But you make a good point  
23 that at a future meeting that we get into some detail  
24 about the structural side and analysis of the seismic  
25 response of that structure.

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1 MR. SAMCALTAR: Yes, absolutely.

2 MEMBER ROSEN: But not on the PRA conduct.

3 MR. SAMCALTAR: Not on the PRA side.

4 Comparison of AP-600 and AP-1000 PRA results. We  
5 quantified the PDF at 1.7; and quantified yes at 2.4;  
6 LERF, 1.8; and here it is also quantified.

7 CHAIRMAN APOSTOLAKIS: Why did you use  
8 that E? You said LERF. Why? What are you proving  
9 here that the --

10 MR. SAMCALTAR: Why was it LERF?

11 CHAIRMAN APOSTOLAKIS: To make it  
12 pronounceable. Please identify yourself and speak  
13 with sufficient clarify and volume.

14 MR. SCOBEL: Yes, sir, this is Jim Scobel  
15 from Westinghouse. Because actually we just lump all  
16 the large release into one number. There isn't a  
17 whole lot of late release. Everything is early. So  
18 we just kind of call it LRF, large relief frequency,  
19 and it includes everything.

20 CHAIRMAN APOSTOLAKIS: Late release, can  
21 you tell us why?

22 MR. SCOBEL: Well, the containment, long  
23 term is so good with containment cooling and all the  
24 real severe challenges to the containment are early  
25 during the core melt process.

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1                   So your challenges from high energy events  
2 are really the contributors to large release.  
3 Otherwise, the containment stays intact, or else you  
4 have a containment bypass.

5                   CHAIRMAN APOSTOLAKIS: Okay.

6                   MR. SAMCALTAR: And forgive me if I say  
7 LERF, you know, and I might say LERF out of habit. We  
8 are talking about any large release. So it is a  
9 quantified yes.

10                  CHAIRMAN APOSTOLAKIS: Is there any  
11 particular interest on the part of the committee on  
12 this comparison?

13                  CHAIRMAN APOSTOLAKIS: The first part was  
14 interesting, but let's move on.

15                  MEMBER SHACK: Well, the fire, is that  
16 because you don't have the two-stage ADS squib valve  
17 in the AP-600?

18                  MR. SAMCALTAR: For fire?

19                  MEMBER SHACK: Yes.

20                  MR. SAMCALTAR: That is a totally  
21 different thing. For AP-600, we really didn't do a  
22 fire analysis for best estimates PRA model. We did it  
23 with a focus PRA, where all of the non-safety systems  
24 were already taken out.

25                  So these two numbers are not comparable

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1 really.

2 MEMBER SHACK: Okay.

3 MR. SAMCALTAR: And that's it.

4 CHAIRMAN APOSTOLAKIS: Any questions from  
5 the members? Okay. Thank you very much, Selim.

6 MR. SAMCALTAR: Thank you.

7 CHAIRMAN APOSTOLAKIS: We are recessing  
8 until 1:35.

9 (Whereupon, at 12:27 p.m., a luncheon  
10 recess was taken.)

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

(1:37 p.m.)

1  
2  
3 CHAIRMAN APOSTOLAKIS: We are back in  
4 session. The next title is the PRA Level 1 Success  
5 Criteria, and Mr. Schulz will have the floor once  
6 again.

7 MR. SCHULZ: Thank you. What I am going  
8 to try to cover is talk a little bit about what the  
9 success criteria is, in terms of the number of  
10 components and I think I am going to use ADS as the  
11 talking point, and some changes versus AP-600.

12 And then the bulk of the time for my talk,  
13 we will talk about the justification of that success  
14 criteria, in terms of the T&H analysis done, including  
15 some T&H uncertainty evaluations, which are part  
16 probability and part T&H.

17 So the success criteria ends up being very  
18 similar to AP-600, and the reasons of course are that  
19 the designs, the configuration, in terms of the number  
20 of valves, components, is the same. The capabilities  
21 are very similar. Not exactly in all cases.

22 We talked about the large LOCA and  
23 accumulator, and that is kind of an exception in most  
24 other cases. The capacities are equivalent so that we  
25 need the same number of components. The verification

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1 approach is the same as AP-600, where we have  
2 conservative DCD analysis that applies to the  
3 accident, and the components that we are using. We of  
4 course use that, because that is a very detailed  
5 analysis, and conservative analysis. For example,  
6 passive RHR being successful in the case of loss of  
7 power, and loss of feedwater, and steam generator tube  
8 ruptures.

9 Those accidents are all analyzed in the  
10 DCD and so we don't reanalyze them for the PRA.

11 MEMBER ROSEN: Remind me if you will what  
12 the DCD acronym is?

13 CHAIRMAN APOSTOLAKIS: Design control  
14 document. I have learned my acronyms.

15 MR. SCHULZ: It is equivalent to the SSAR,  
16 in this context anyways.

17 CHAIRMAN APOSTOLAKIS: I just looked it  
18 up. That's why.

19 MR. SCHULZ: Where we performed special  
20 analysis is typically where we are taking more than a  
21 single failure, which of course we do consider in the  
22 PRA, but what we don't consider in the design basis or  
23 DCD type analysis.

24 So when we start talking about failing  
25 both core makeup tanks, and one accumulator in a small

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1 LOCA, that is well beyond the single failure, and  
2 something that we don't analyze in the DCD.

3 So we in that case perform special  
4 analysis for the PRA. In some cases the AP-1000  
5 success rate criteria is in fact more conservative or  
6 robust than AP-600.

7 I mentioned the ASD Stage 4, and in AP-  
8 600, it was 2 out of 4; and for AP-1000, it is 3 out  
9 of 4 valves have to work. And the reason for that is  
10 not due to the fact that there is less margin in Stage  
11 4. It is just that we are being more conservative.

12 And that reduces the T&H uncertainty that  
13 we have to deal with ultimately. When we look at  
14 success criteria, we consider the key safety functions  
15 that typically we consider. It is not that we don't  
16 know that, and I didn't remember to write it down when  
17 I was making the slide.

18 The containment service level C pressure,  
19 the design pressure is 59 psi, and the service level  
20 C pressure is I think 91 psi; and that gives you a  
21 very low probability of failure, maybe one percent or  
22 something.

23 A 50-50 percent chance of failure pressure  
24 is more like 150 psi. So that gives you a feeling for  
25 what kind of containment pressures that we looked at.

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1 CHAIRMAN APOSTOLAKIS: What do you mean by  
2 less than emergency stress limits?

3 MR. SCHULZ: Well, the service level C  
4 deals with stress levels, and in that case this would  
5 be 91 psi. We do consider in some cases going above  
6 emergency stress limits up to rupture points, and then  
7 you will start talking about probabilities of failure  
8 that are significant.

9 This is the full -- we call it full ADS.  
10 This is sufficient ADS to get you down to gravity  
11 injection. You need a lot less ADS valves to get you  
12 to RCS pump injection, and there is a matrix here  
13 based on what equipment is available, versus the  
14 accidents.

15 We do require ADS for large LOCAs. This  
16 was not required in AP-600, and so this is again where  
17 we are being more conservative. This relates to long  
18 term cooling needs. So in long term recirculation,  
19 and you really don't need it in the short term because  
20 the break is big enough to get your IRWST injection.

21 But as the containment floods up, in the  
22 long term your pressures go down, and we still need  
23 ADS.

24 You see that when the core makeup tank is on or  
25 available, then ADS tends to be automatic.

1                   When the core makeup tank is assumed not  
2 available and an accumulator is available, then ADS of  
3 course has to be manual, and that is again because of  
4 automatic signals come from the CMT level.

5                   But basically we need 3 out of 4 ADS stage  
6 4s throughout this. Now, this details some of the  
7 changes that we actually made in that success  
8 criteria, and I think I talked about 3 out of 4.  
9 Partial ADS, we went up from one stage, 2 or 3, on top  
10 of the pressurizers, to two, and that strictly had to  
11 do with that we did not increase the size of those  
12 valves, but we did increase the pressure power of the  
13 reactor, and so this is a power related thing.

14                   The difference in reliability is not very  
15 much between 1 out of 4 and 2 out of 4, and so we just  
16 used the 2 out of 4 in the probability calculations.  
17 This was an interesting thing. For medium LOCAs, when  
18 we first started analyzing AP-1000, we did it just  
19 like AP-600, which means that we did not require  
20 passive RHR to be available.

21                   AP-600 did not require it to be available.  
22 However, we had difficulty allowing or providing 20  
23 minutes for the operator to take action, which is what  
24 we did end up justifying in AP-600.

25                   And the issue has to do with the higher

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1 power level versus the volume of the reactor coolant  
2 system being similar to AP-600, but the power being  
3 higher.

4 CHAIRMAN APOSTOLAKIS: Speaking of the 20  
5 minutes, and since we made such a big deal on the  
6 utility requirements, I remember vaguely that one of  
7 the requirements or goals was that in the new plants  
8 that the operators wouldn't have to do anything for  
9 what, 24 hours?

10 MR. SCHULZ: Ye.

11 CHAIRMAN APOSTOLAKIS: So here we have 20  
12 minutes?

13 MR. SCHULZ: That statement applies to  
14 design basis accidents.

15 CHAIRMAN APOSTOLAKIS: Only?

16 MR. SCHULZ: Only, yes. And here we can  
17 meet that, okay?

18 CHAIRMAN APOSTOLAKIS: Okay.

19 MR. SCHULZ: We only get into trouble when  
20 you start having multiple failures. And in this case,  
21 this is a medium LOCA with no core makeup tanks, which  
22 if it is a hot leg/cold leg break, that is four  
23 failures, because each core makeup tank has two  
24 valves.

25 If it is a DVI line break, then it is two

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1 failures. So it is still beyond design basis to get  
2 into this situation.

3 CHAIRMAN APOSTOLAKIS: Well, for the  
4 current fleet, if I look at the LOCA as a design basis  
5 accident, I require action within 30 minutes? I  
6 thought it was only in severe accident --

7 MEMBER ROSEN: No, for the current fleet,  
8 10 minutes.

9 CHAIRMAN APOSTOLAKIS: For design basis?

10 MEMBER SIEBER: Right.

11 MEMBER ROSEN: You have to be able to not  
12 do anything for 10 minutes.

13 MR. SCHULZ: And typically in our current  
14 plan, if you start talking about two or more failures,  
15 with some accidents, you are out of luck.

16 MEMBER ROSEN: And real accidents, as one  
17 of our consultants has said, have little respect for  
18 the single failure criteria.

19 MR. SCHULZ: That is one of the reasons  
20 why you look at PRAs, right?

21 MEMBER ROSEN: Right.

22 MR. SCHULZ: Another thing that we did is  
23 as Selim showed you in the large break LOCA event  
24 tree, we have put in containment isolation and passive  
25 containment cooling, into the level one entries. The

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1 AP-600 did not have either of those in level one.  
2 They were in level two only.

3 And one of the things that we did is that  
4 required more containment recirculation flow paths to  
5 be available if containment isolation fails, and that  
6 is a recognition that containment isolation fails, and  
7 the containment pressure is going to be lower, which  
8 is making the LOCA performance more difficult from a  
9 T&H point of view.

10 And you also lose some inventory from the  
11 leak before you stop the leak with the passive  
12 containment coolant system. So the water level will  
13 be a little bit lower, and I will show you some  
14 analysis of that.

15 So in order to provide some more margin in  
16 the design, we are requiring more flow paths to be  
17 available to get water back from the containment back  
18 into the reactor in the case where containment  
19 isolation fails. I talked about the last point in the  
20 previous slide.

21 This is just over the different size LOCAs  
22 and how we divided up the LOCA spectrum I should say  
23 in the PRA. And there is nothing magic about it. It  
24 really -- we did it to relate to the success criteria,  
25 and when we needed more or less equipment.

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1                   So we have found through our analysis that  
2 up through about 9 inches, we don't need two  
3 accumulators, cold leg breaks. Above 9 inches, we  
4 start to need accumulators for cold leg breaks.

5                   For spurious ADS and all the way up  
6 through 4 ADS valves opening simultaneously, which is  
7 almost incredible, but we analyzed that as a limiting  
8 spurious stage four, one accumulator is sufficient for  
9 that. And one CMT together.

10                   And when you get down to medium LOCAs and  
11 smaller, then we only need one accumulator, or one  
12 CMT. And that helps us with redundancy and diversity  
13 in these systems.

14                   When you get RCS leaks, the pump CDS make  
15 up the deficient. Obviously passive systems also work  
16 down there. And the difference between small and  
17 medium, a medium LOCA is big enough to get you below  
18 the stage 4 pressure interlock, and a small LOCA is  
19 not big enough to get you below 1300 psi, and you need  
20 something else, like passive RHR, will drag you down  
21 below that, or a stage 1, 2, or 3. Any one of those.

22                   CHAIRMAN APOSTOLAKIS:     What is the  
23 diameter of the largest spike?

24                   MR. SCHULZ:     In the RCS?

25                   CHAIRMAN APOSTOLAKIS:     Yes.

1 MR. SCHULZ: The hot leg is 32 inches, or  
2 31 inches. That is a hot leg break, and the cold legs  
3 are 22. There is obviously two cold and one hot.  
4 This is a summary of the different classes of  
5 accidents.

6 CHAIRMAN APOSTOLAKIS: I was wondering,  
7 you know, and I don't know if you follow the  
8 developments here about risk informing 5046  
9 (inaudible). Would your numbers justify in removing  
10 the large LOCA from the design basis accident? Have  
11 you thought about it? If you haven't that's fine.

12 MR. SCHULZ: I haven't. We have in AP-  
13 1000 generally not wanted to take on challenging  
14 licensing.

15 CHAIRMAN APOSTOLAKIS: Yes, I understand.  
16 I am not saying that you should do it, but I am  
17 wondering whether the numbers justify it.

18 MR. SCHULZ: I don't know.

19 CHAIRMAN APOSTOLAKIS: Okay.

20 MR. SCHULZ: You see here a list of  
21 different accidents, and the primary protection. So  
22 transients are being protected by passive RHR, and DCD  
23 analysis, with lock train analysis. So this analysis  
24 is -- we didn't do anything for the PRA.

25 The same thing for the tube rupture. For

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1 the rest of them, we did special PRA analysis, T&H  
2 analysis. The success criteria for the small breaks,  
3 up through medium LOCAs, was based on MAAP, many,  
4 many, many MAAP runs.

5 And for the large break, MAAP is not  
6 adequate for that, and so we used WCOBRA-TRAC, and for  
7 -- well, for both of these, and then for ATWS, we also  
8 did some specific PRA analysis, using LOFTRAN.

9 I will also talk about T&H uncertainty,  
10 where we bounded like 98 percent or so of the success  
11 -- of the risk, using conservative T&H analysis, with  
12 using design basis codes.

13 There has been a lot of discussion about  
14 the use of MAAP and the adequacy of MAAP. Our  
15 approach in AP-600 is --- on AP-1000, is the same as  
16 AP-600. We use it for defining success criteria where  
17 we have multiple failures in LOCAs, and feed and bleed  
18 cooling sequences starting from transients and  
19 failures of passive RHR, and start up feed water.

20 And it provides us an integrated reactor  
21 coolant system containment response. It runs very  
22 fast and very reliably, which is important when you  
23 are making hundreds of runs, as opposed to 10 runs  
24 like you make for maybe the DCD.

25 We have to make so many runs because we

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1 are looking at a spectrum of break sizes, and  
2 locations, and compounding that many different kinds  
3 of failures that we don't have to look at in design  
4 basis analysis.

5 MAAP 4 was benchmarked against NOTRUMP for  
6 AP-600, and NOTRUMP has been shown to be application  
7 to AP-1000. I know that there is some issue on  
8 entrainment that is still being discussed, and if  
9 something happens there that throws or requires a  
10 modification to NOTRUMP, then that may upset this  
11 logic.

12 But right now we are assuming that they  
13 end up being successful. So NOTRUMP being applicable  
14 to AP-1000, and MAAP being benchmarked against that,  
15 we think that provides a reasonable assurance that  
16 MAAP 4 can do the success criteria.

17 In addition, as I mentioned just  
18 previously, we have this separate T&H analysis, where  
19 we take the low margin risk importance sequences, and  
20 then analyze them with the DCD codes.

21 CHAIRMAN APOSTOLAKIS: What do you mean by  
22 low margin?

23 MR. SCHULZ: Low margins are basically  
24 sequence where we get core uncovering.

25 CHAIRMAN APOSTOLAKIS: So there are risk

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1 importance sequences?

2 MR. SCHULZ: Well, that doesn't make them  
3 risk important by themselves. Risk important is where  
4 it is an important fraction of the total core melt  
5 frequency.

6 CHAIRMAN APOSTOLAKIS: Okay. So they can  
7 be below margin, but extremely unlikely?

8 MR. SCHULZ: Yes. Yes. And we do both  
9 the probability and the margin part to try to pick a  
10 case as we eventually analyze this way. We have  
11 gained something in this whole process by making the  
12 success criteria at least in some cases a little more  
13 conservative.

14 Okay. I am headed toward showing you some  
15 of the success criteria results now, and I am going to  
16 concentrate on the LOCA feed and bleed type cooling  
17 analysis, which ADS and the injection systems are key  
18 factors in that.

19 We had a large number of different  
20 initiating events and timings to look at between LOCAs  
21 and the different sized LOCAs, and the feed and bleed  
22 cooling sequences, and the available equipment.

23 Because AP-600 and AP-1000 are still very  
24 similar plants, we used our experience with AP-600 in  
25 this area to reduce the large number of cases that we

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1 had to look at.

2 CHAIRMAN APOSTOLAKIS: So this is not a  
3 small LOCA?

4 MR. SCHULZ: What I am going to show you  
5 is a spectrum from zero up to about 9 inches, and is  
6 the different sized LOCAs.

7 CHAIRMAN APOSTOLAKIS: And for that size  
8 you can bleed and feed?

9 MR. SCHULZ: Oh, bleed and feed starts  
10 from a transient with no LOCA, and the feed and bleed  
11 type cooling is where you use start up feed water and  
12 main feed water, and in our case, passive RHR.

13 CHAIRMAN APOSTOLAKIS: You're right.  
14 You're right.

15 MR. SCHULZ: And you have a steam  
16 generator inventory, and you eventually -- and then we  
17 go to ADS and some kind of makeup; accumulators, C&Ps,  
18 and that kind thing. So that is what I am talking  
19 about here. So for feed and bleed there is no LOCA  
20 starting.

21 And there is four kind of groups of  
22 analysis that we look at. The first two are automatic  
23 ADS, and one with gravity injection, and both with  
24 core makeup tanks that provide you the automatic ADS.

25 The first one is with a full ADS and IRWST

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1 gravity injection, and the second one is what we call  
2 partial ADS, and pumped injection. So we look at both  
3 of those.

4 And then separately we look at the manual  
5 ADS, with just an accumulator, just one accumulator in  
6 this case, and either IRWST gravity injection, or RNS  
7 pump injection.

8 Now, I am going to touch upon those four  
9 groups of analysis. So the first one is automatic ADS  
10 with IRWST injection. We looked at the limiting  
11 success criteria. So it is the worst combination, and  
12 it is no ADS Stage 1, 2, or 3; and three stage 4s, and  
13 that is pretty well outlined here.

14 And one core makeup tank, and no  
15 accumulators, and one valve and one path from the  
16 IWRST injection line. Now, for the very small breaks,  
17 we do need something else to get us down to the 1300  
18 psi. So that is included.

19 And in addition containment isolation  
20 fails, and so the containment back pressure is always  
21 atmospheric pressure in these analyses. So we looked  
22 at with those conditions a spectrum of half-inch  
23 breaks up to almost nine inch.

24 We looked at what the core uncovering,  
25 depth, and duration was sequence by sequence, and

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1 generally what we see is that the performance is  
2 better in AP-600.

3 And this is related to especially ADS 4  
4 capacity, and IRWST injection capacity helps us here.  
5 So our conclusion is that that success criteria was  
6 verified. Now, I am going to show you a little bit  
7 more about why we think that.

8 This is sort of a summary chart which  
9 looks at depth of core uncovering, and this above here  
10 is no core uncovering, is a function of break size. And  
11 the solid line is the minimum level before ADS goes  
12 off, and the dotted line is the minimum level that  
13 occurs after ADS.

14 So what you see here is that before ADS  
15 goes off, you get no core uncovering in these sequences,  
16 with one core makeup tank and no accumulator. You do  
17 see some core uncovering, not very deep, in the smaller  
18 break sizes after ADS goes off.

19 And what is happening here is that  
20 normally in a design basis accident the accumulator  
21 will help going to ADS blow down to keep the reactor  
22 full of water.

23 But here you don't have an accumulator.  
24 You only have one core makeup tank. So sometimes you  
25 will run a little shy in terms of injection during the

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1 ADS blow down. Now, what I would also like to show  
2 you is one particular case, and which is a two inch -  
3 -

4 MEMBER ROSEN: If you could just go back  
5 to that prior one for just a second. Give me a feel  
6 for how long your core is uncovered for 4 feet? Well,  
7 4 feet is kind of little.

8 MR. SCHULZ: I was going to show you this  
9 2 inch break case in the next slide.

10 MEMBER ROSEN: Okay.

11 MR. SCHULZ: So see if it answers your  
12 question. So here you see several of the interesting  
13 plots for a 2 inch break case, which from the previous  
14 slide is like one of the worst ones.

15 And you see compared here AP-600 in the  
16 solid line against AP-1000 in the dotted line. And  
17 the key is the core uncovering, and the core uncovering  
18 depth is a little bit less for AP-1000, and  
19 considerably shorter.

20 So in this case, it is 300 seconds or  
21 something like that for duration of uncovering.

22 MEMBER SIEBER: Yes.

23 MR. SCHULZ: And you can see the core  
24 makeup tank injection behavior, and ultimately the  
25 IRWST injection. The IRWST injection is what provides

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1 the recovery.

2 MEMBER ROSEN: And during that 300 seconds  
3 what sort of fuel events do you get?

4 MR. SCHULZ: I don't -- you get some heat  
5 up in this case, but not very much. We don't  
6 typically calculate peak clad temperatures for MAAP.  
7 Well, it outputs some temperatures, but for this kind  
8 of a thing, it is going to be -- there is a T&H  
9 uncertainty case, which is one of the last ones that  
10 I show, which has a longer and deeper uncover, and  
11 you get to maybe 1500 degrees. So I think that this  
12 would be less than that.

13 MEMBER ROSEN: So how much core damage do  
14 you get?

15 MR. SCHULZ: None.

16 MEMBER RANSOM: One thing. You mentioned  
17 uncertainty associated with the use of these codes on  
18 the thermal hydraulic analysis. Does that include  
19 like the epistemic uncertainty inherent in the codes  
20 themselves, and did you evaluate that in some way?

21 MR. SCHULZ: The MAAP analysis is done on  
22 a pretty much best estimate basis. Decayed heat is  
23 ANS-79, plus no SIGMA. We do typically use  
24 conservative line resistances, and normal plant  
25 parameters. So that is what this is based on.

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1 MEMBER RANSOM: So when you determine  
2 uncertainty, you mean in terms of the inputs?

3 MR. SCHULZ: Well, no. Let me finish,  
4 okay? When we look at the T&H uncertainty analysis,  
5 we take the design basis codes that we use in the DCD,  
6 and so for a small break LOCA, that would be NOTRUMP,  
7 one in an Appendix K fashion.

8 So it is extremely conservative decayed  
9 heat, and every plant input parameter is conservative,  
10 and the code models are conservative.

11 CHAIRMAN APOSTOLAKIS: Is it a correct  
12 understanding that the way that you handle at some  
13 kind of level the thermal hydraulic uncertainties is  
14 by going to more conservative success criteria, and  
15 see if you are still successful?

16 MR. SCHULZ: No. But what we look at in  
17 qualitative words, we try to take -- if you look at  
18 the success criteria, and in all the failures that we  
19 can tolerate, if you calculate and use all of those  
20 worst, worst, worst failures, the probability of that  
21 sequence is incredibly small.

22 CHAIRMAN APOSTOLAKIS: Right.

23 MR. SCHULZ: It is meaningless in terms of  
24 our core melt frequency, okay? So what we did is --  
25 and I will show you, is that we expanded the event

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1 trees, and instead of just looking at zero core makeup  
2 tanks, or one core makeup tank, we also looked at two,  
3 in culmination with zero to two accumulators, and  
4 calculated all the intermediate probabilities, and  
5 then put the results into low margin-high margin  
6 success paths.

7 And low margin being core uncoveries. And  
8 we looked at those low margin success paths and  
9 figured out what is the most probable of those.

10 CHAIRMAN APOSTOLAKIS: So you have to do  
11 core makeup times, right, in the plant?

12 MR. SCHULZ: Yes, we do.

13 MR. CUMMINS: If I could say something  
14 here. This is Ed Cummins. I think there is a little  
15 bit of a definition confusion on what we mean by  
16 thermal hydraulic uncertainty, and if I could try to  
17 help that.

18 What happened in the AP-600 was there was  
19 considerably consternation from the NRC staff  
20 regarding the reliability of MAAP to predict passive  
21 plants, and so they were saying that we would like you  
22 to verify that the MAAP results are the same as your  
23 DCD analysis results with NOTRUMP, and with COBRA-  
24 TRAC, and we titled this whole issue thermal hydraulic  
25 uncertainty.

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