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2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 MEETING OF THE SUBCOMMITTEE ON
6 THERMAL-HYDRAULIC PHENOMENA

7 + + + + +

8 WEDNESDAY,

9 MARCH 19, 2003

10 + + + + +

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

15 PRESENT:

16 GRAHAM B. WALLIS Chairman
17 SANJOY BANERJEE ACRS Consultant
18 THOMAS S. KRESS ACRS
19 DANA A. POWERS ACRS
20 VICTOR H. RANSOM ACRS Member
21 JOHN D. SIEBER ACRS
22 MICHAEL R. SNODDERLY ACRS Staff

A-G-E-N-D-A

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Introduction

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

8:34 a.m.

CHAIRMAN WALLIS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, Subcommittee on Thermal-Hydraulic Phenomena. I am Graham Wallis, Chairman of the Subcommittee. Subcommittee members in attendance are Tom Kress, Victor Ransom, and Jack Sieber, as well as our contractor Sanjoy Banerjee.

The purpose of this meeting is to discuss thermal-hydraulic issues associated with design certification of the AP1000 reactor design. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full committee. Medhat El-Zeftway is the designated federal official and Mike 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 motives of this meeting previously published in the Federal Register on March 5, 2003. A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice.

It is requested that speakers first

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1 identify themselves and speak with sufficient clarity
2 and volume so that they can be readily heard. We have
3 received no other written comments or request for time
4 to make oral statements from members of the public
5 regarding today's meeting.

6 This is the second in a series of meetings
7 to support a future full committee meeting on the
8 staff's draft safety evaluation report on the AP1000.
9 The first meeting was to review the AP1000 PRA.

10 Before we get started, I would like to
11 state that what I hope to see happen at this meeting
12 is the focus on technical issues which may need
13 resolution and understanding. Not a lot of other
14 material.

15 In particular, I would like to see how the
16 various formerly correlations and so on that have been
17 pulled out of the literature and applied to this
18 system, what the evidence is that they actually apply
19 because we all know in two phase flow you can pull
20 something from one area and try to use it in another
21 and it may be that the geometry and the conditions are
22 so different that you have to validate it very
23 carefully and that's what I would like to see happen.

24 We will now proceed with the meeting. I
25 call upon Mr. John Segala of the Office for Nuclear

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1 Reactor Regulation to begin.

2 DR. SEGALA: Thank you. Can you all hear
3 me okay?

4 CHAIRMAN WALLIS: I think it's most
5 important that the transcriber hear you.

6 DR. SEGALA: I'm John Segala. I'm a new
7 project manager for the AP1000 design certification
8 review. Larry Burkhart, who was the previous PM, has
9 left NRC to go work for the State Department. We now
10 have a team of project managers to handle the design
11 certification review to get our draft safety
12 evaluation report out.

13 I'm going to discuss a little bit about
14 the background. You are all probably very familiar
15 with that, as well as a summary of the preapplication
16 review. I'll talk about -- give a brief overview of
17 what transpired during that review. A discussion or
18 summary of where we are in the design certification
19 review.

20 I'll talk a little bit about the status of
21 the application issues that were identified during the
22 preapplication review. And discuss a little bit about
23 some follow-on issues. The way I define follow-on
24 issues are issues that weren't identified during the
25 preapplication review that could possibly be an open

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1 item in the DSCR report, the Draft Safety Evaluation
2 Report.

3 As you are aware, the AP600 was certified
4 in December of '99. Westinghouse expressed interest
5 in applying for the AP1000 design certification using
6 much of the AP600 design. Westinghouse and NRC agreed
7 on a three-phased approach. The first two phases were
8 during the preapplication review. The preapplication
9 review is completed.

10 Phase I is the scoping review where we
11 identified key review issues. Phase II we focused on
12 four issues, acceptability of the DACR, design
13 acceptance criteria, the acceptability of certain
14 exemptions, and the applicability of the AP600
15 analysis codes and test program to the AP1000.
16 We are currently in Phase III which is the design
17 certification review and I'll discuss a little bit of
18 that.

19 In terms of an overview of the
20 preapplication review, I just wanted to highlight some
21 key meetings that we had. We briefed the ACRS on
22 Phase II. There was a joint future plant design in
23 the Thermal-Hydraulic Phenomena Subcommittee in
24 February.

25 We had a full committee meeting the

1 beginning of March. Based on the full committee
2 meeting the ACRS issued a letter to the NRC on March
3 14th and they agreed in general with the staff's
4 conclusions regarding the preapplication review.

5 Following that the NRC issued a letter to
6 Westinghouse on March 25th where we reviewed the
7 analysis codes and test programs for the AP600 and
8 determined in general that they applied to the AP1000.
9 However, we identified some exceptions to that which
10 was the six issues that were brought out in that
11 letter. I'll briefly discuss the status of those
12 issues in a couple more slides.

13 Before I get to that, I just wanted to go
14 over the summary of design certification.
15 Westinghouse submitted their design certification
16 application in March of 2002. The NRC staff reviewed
17 and issued 714 RAIs. Westinghouse responded to the
18 RAIs by December 2nd.

19 In the 714 we issued recently -- that
20 includes the five additional ones we issued just
21 recently. NRC staff reviewed the Westinghouse
22 responses and we provided comments to Westinghouse.

23 CHAIRMAN WALLIS: I have a comment on
24 these RAIs. We got hundreds of RAIs. If you look
25 through them, some of them look very minor and some

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1 look very serious. It would be useful if you had
2 green RAIs and white and red and orange or something,
3 or some classification so we could say these ones are
4 important and these ones really are very minor. Other
5 ones you have to resolve. Otherwise, there is some
6 real safety issue.

7 DR. SEGALA: I think those would be the
8 ones that would be open in the Draft Safety Evaluation
9 Report but that doesn't necessarily help you doing
10 your review. I have a slide coming up that gives you
11 an overview of the RAIs, not necessarily the thermal-
12 hydraulic but the whole picture.

13 Following the conference calls and
14 meetings, Westinghouse issued revised responses and as
15 of February 28th we sent a letter to Westinghouse
16 identifying 188 unresolved RAIs which we are working
17 with Westinghouse to try to provide our comments on
18 those so Westinghouse can provide responses.

19 I just wanted to point out that the staff
20 has not finished their review and are still in the
21 process of doing reviews so we haven't made any final
22 conclusions yet on the acceptability of the AP1000
23 design certification.

24 This is the overview slide. Some key
25 things is you could look at reactor systems as 187

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1 RAIs and PRA has 99 RAIs. You focus in on where was
2 the staff asking most of their questions. In the
3 reactor systems arena we had 48 that were dealt with
4 the analysis codes and test program and about 48 that
5 dealt with the Chapter 15 analysis.

6 Getting back to the preapplication issues
7 that were identified, and I'm just going to give you
8 a little status of those issues. We had the liquid
9 entrainment in the upper plenum or hot leg during ADS-
10 4 actuation. This is one of our more significant
11 issues.

12 Following the preapplication review
13 Westinghouse submitted WCAP 15833. The staff reviewed
14 that and we issued 48 RAIs on that. Fourteen of those
15 came from NRR and 34 came from research. A lot of
16 discussions and conference calls and RAI responses.

17 We have about 6 RAIs that are unresolved
18 in the sense that they may become open items in the
19 DSER. We just issued yesterday a letter to
20 Westinghouse requesting new test data to support
21 justification of the modeling of the entrainment
22 process during a small break loca.

23 CHAIRMAN WALLIS: Does this include the
24 level swell?

25 DR. SEGALA: I think so, yeah.

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1 CHAIRMAN WALLIS: Because these are all
2 contributors to carrying liquid out of the vessel.

3 DR. SEGALA: Yes.

4 CHAIRMAN WALLIS: And you have to get the
5 level swell right as well as the entrainment
6 presumably. They affect each other. It swells more
7 it gets into the hot leg and can be entrained.

8 DR. SEGALA: Tomorrow we're going to have
9 Steve Bajorek from research. He's going to go into
10 this issue in a lot of detail.

11 CHAIRMAN WALLIS: We're not going to
12 discuss this one today?

13 DR. SEGALA: No.

14 MR. CORLETTI: This is Mike Corletti from
15 Westinghouse. Our presentation this afternoon will be
16 dealing with the entrainment issue.

17 CHAIRMAN WALLIS: So you will be doing it?

18 MR. CORLETTI: Yes, this afternoon. I
19 think Dr. Bajorek will be speaking to it tomorrow.
20 It's the major focus of this meeting, I think.

21 DR. SEGALA: The next issue, potential
22 steam voids in the RCS following main steamline break.
23 Initially in the preapplication phase Westinghouse
24 didn't provide a main steamline break analysis.

25 They provided that in the DCD or their

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1 design certification document. The staff issued an
2 RAI on the ability of LOFTRAN to evaluate steam voids.
3 Westinghouse provided a response to that and the
4 analysis showed that there were no steam voids. Walt
5 Jensen is going to discuss this issue this afternoon.

6 The nonconservative boiling heat transfer
7 correlation and NOTRUMP at high heat fluxes in the
8 passive RHR heat exchanger. The staff issued an RAI
9 on this. Westinghouse provided a response taking a 50
10 percent reduction in the passive RHR heat exchange or
11 heat transfer area. Based on that, this issue is also
12 considered resolved and Walt Jensen will discuss this
13 in more detail as well.

14 The potential boron precipitation in the
15 vessel during long term cooling. The staff issued an
16 RAI on this. Westinghouse provided a response and the
17 staff needed more additional information. I believe
18 that Westinghouse has responded to this item. The
19 staff has not had a chance to review that yet due to
20 the timing.

21 Concern for core uncovering during small-
22 break LOCA and performing complete break spectrum.
23 The staff issued an RAI on this. Westinghouse
24 responded and additional break sizes were analyzed and
25 no core uncovering was -- it was shown that no core

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1 uncovery had happened. This one is considered
2 resolved.

3 Except for the first one all the way down
4 to this one are going to be discussed by Walt Jensen
5 this afternoon.

6 MEMBER RANSOM: Can I ask a quick
7 question? Why is boron deposition in the vessel of
8 concern?

9 DR. SEGALA: I think --

10 DR. LOIS: This is Lambrose Lois of the
11 Apple Systems Branch. There is so much water in the
12 vessel. When the long term cooling phase initiates,
13 the potential is that only steam can exit the ADS-4
14 so, therefore, the boron keeps concentrating. If you
15 assume that the water is cycled only once, then you
16 have enormous amount of concentration which will
17 solidify and block the circulation of water.

18 MEMBER RANSOM: It seems like if you have
19 solid boron in the core, it must mean you have a
20 saturated mixture.

21 DR. LOIS: You do. The theoretical
22 maximum is about 60,000 ppm in the water and 35,000 is
23 the precipitation limit for those temperatures.

24 MEMBER RANSOM: At maximum concentration
25 why would it matter? I'm not sure I understand why

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1 this is so significant.

2 DR. LOIS: Because when it exceeds 35,000
3 ppm the remaining will precipitate.

4 MEMBER RANSOM: Yeah, but to me that would
5 say you still have the maximum concentration in the
6 liquid and so the --

7 DR. LOIS: But the amount that
8 precipitates will block the circulation.

9 CHAIRMAN WALLIS: It will block
10 circulation of the circuit. That's what we're worried
11 about.

12 MEMBER RANSOM: Oh, that's what you're
13 worried about. I see.

14 DR. SEGALA: The last item, use of the
15 approved WGOthic containment evaluation model to
16 address large scale test shortcomings. We didn't
17 issue any RAIs on this. This was addressed in the
18 design certification document. Westinghouse developed
19 a conservative model and the staff finds this
20 acceptable. Ed Throm is going to discuss this this
21 afternoon.

22 CHAIRMAN WALLIS: Is Westinghouse going to
23 discuss that?

24 DR. SEGALA: I think so, yes. The follow-
25 on issues, again, are those issues that weren't

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1 identified during the preapplication phase. We issued
2 about 48 RAIs related to Chapter 15 analysis, both
3 LOCA and non-LOCA. This is just a sampling of items.
4 Westinghouse responded satisfactorily to all except
5 for these few.

6 The feedwater line break analysis to
7 identify limiting case. Is the double-ended rupture
8 a limiting break for the feedwater line break event.
9 Tech spec required flow to support adequate flow
10 mixing in the RCS. The safety analysis assumes RCS
11 dilution, volume, well mixed during the boron delusion
12 event, and is the tech spec minimum flow adequate for
13 the well mixing assumption.

14 The ATWS analysis to identify the limiting
15 case Westinghouse needs to perform analysis of all
16 applicable non-LOCA transients to identify the
17 limiting ATWS case.

18 All these issues the staff feels that when
19 they review Westinghouse's responses, they think that
20 these will probably be acceptable and won't be open
21 items. We just wanted to give you a feel for some
22 other areas that we were looking at beyond the
23 preapplication phase.

24 CHAIRMAN WALLIS: The last one could be
25 important, the last bullet. What happened was that

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1 Westinghouse did some ATWS analysis and it was not
2 extensive enough. Is that it?

3 DR. SEGALA: I think so. Summer?

4 DR. SUN: This is Summer Sun and I'm a
5 reactor system grange. ATWS analysis as presented in
6 DCDs based on a limited case which is loss of normal
7 feedwater. The basis for selecting limited cases is
8 based on AP600 sensitivity study and, based on that,
9 identify that loss of normal feedwater.

10 The staff asked them to extend their
11 sensitivity study for AP1000 and it confirmed that the
12 loss of normal feedwater is still limited and we are
13 still waiting for the Westinghouse response on this
14 RAI.

15 CHAIRMAN WALLIS: Thank you.

16 DR. SEGALA: Okay. That concludes my
17 discussion this morning. The last slide I'm going to
18 discuss tomorrow afternoon. That will be sort of the
19 concluding summary remarks of where we plan to go in
20 the future.

21 CHAIRMAN WALLIS: Thank you very much.

22 Mike, it looks as if you're on next.

23 MR. CORLETTI: Yes.

24 CHAIRMAN WALLIS: You're keeping the best
25 for last? You're not going to talk about liquid

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1 entrainment?

2 MR. CORLETTI: We are keeping the best for
3 last, or else we would probably never get through the
4 easy ones, I think.

5 CHAIRMAN WALLIS: That's a photograph of
6 a real AP1000?

7 MEMBER SIEBER: Yes.

8 MR. CORLETTI: Good morning. It's a
9 pleasure to be here today. We're going to be talking
10 -- seeing John's presentation there's a lot of
11 similarities in the slides that I've prepared. I will
12 go through them but I think maybe I'll just try to put
13 where we see the issue.

14 CHAIRMAN WALLIS: Move right into the
15 tentacle issues.

16 MR. CORLETTI: I think these objectives
17 are pretty much in mind with what you're looking for.
18 If you will, just let me go over where we see our
19 scheduled objectives. We have provided our DCD
20 application and we've gone back and forth on these
21 RAIs.

22 We are now going through our RAI responses
23 that the staff found they would like additional
24 information. We're in that process of trying to
25 revise our RAIs and provide supplemental information.

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1 We are trying to do that this month time
2 frame to support the staff doing the -- issuing the
3 DSER in June. Our goal is really to address all the
4 open items in this DSER to the extent that we can and
5 to have as few of those going out of the DSER as we
6 can.

7 CHAIRMAN WALLIS: That looks a little
8 tight to me. I mean, if NRC is going to issue this on
9 6/16, and they will probably be late, then we have to
10 read it and analyze it and then beginning of July we
11 have to write a letter. Is this realistic?

12 DR. SEGALA: This is John Segala with NRC.
13 I think we believe this is an aggressive schedule but
14 we are putting as much resources towards it to try to
15 achieve that.

16 CHAIRMAN WALLIS: If you could do it in
17 5/16, or even 6/1. Give us some time to study this.
18 We want to avoid having to study it a week before we
19 have to make a decision.

20 DR. SEGALA: I think the draft sections
21 can be made available to the ACRS at an earlier time.

22 CHAIRMAN WALLIS: Some of us have
23 vacations in June.

24 MEMBER SIEBER: We don't have a meeting in
25 August.

1 CHAIRMAN WALLIS: Maybe that's all planned
2 ahead of time. If there isn't enough time, then we
3 won't be able to write the letter until August.

4 MEMBER SIEBER: There is no meeting in
5 August.

6 CHAIRMAN WALLIS: There is no meeting in
7 August. It would be September.

8 MEMBER KRESS: Or probably July.

9 CHAIRMAN WALLIS: It says July here but if
10 they don't give us time, if the DSER comes too late,
11 we won't be ready to write a letter in June. That's
12 what I'm saying.

13 MEMBER KRESS: I see.

14 MR. CORLETTI: I think it's a good point
15 and we'll see what we can do to facilitate that.

16 Okay. This was useful then putting up
17 this schedule slide I think.

18 CHAIRMAN WALLIS: Yes.

19 MR. CORLETTI: Some of the future
20 meetings, as we said, we had a PRA Subcommittee. This
21 is the Thermal-Hydraulic Subcommittee. We're talking
22 about an AP1000 subcommittee meeting or meetings. I
23 guess we are still working on that.

24 These are some of the additional issues
25 that have been identified. I think we should come

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1 back to this at the end of the two days here to see
2 are there additional items that we want to -- that
3 comes out of this committee that we would want to
4 discuss in these future meetings.

5 CHAIRMAN WALLIS: The last one is
6 interesting, the man-machine interface. I'm not sure
7 how we'll resolve it.

8 MR. CORLETTI: For design certification
9 essentially it's really not resolved under design
10 certification. AP1000 similar to AP600 in the other
11 certified designs approved this as a future design
12 acceptance criteria.

13 CHAIRMAN WALLIS: Are you using fewer
14 operators than the existing reactor?

15 MEMBER KRESS: I think that was one of our
16 major issues, was how many operators that you're
17 talking about.

18 MR. CORLETTI: We are not using fewer
19 operators than what is allowed by the regulations,
20 although we have goals. We design it with those sort
21 of objectives. As far as our licensing commitments,
22 it is not.

23 MEMBER KRESS: That wouldn't be an issue
24 then in that case.

25 DR. CUMMINS: This is Ed Cummins. The

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1 utility requirements document for passive plants said
2 that the passive plants should be able to be operated
3 by a single operator and a single supervisor. We
4 support that what is in the design certification is a
5 process to determine the required number of operators,
6 not a determination of the number of operators. It's
7 really a deferral of a process to the COL stage.

8 MR. CORLETTI: Okay. John went over this.
9 I think the part I would add will be that in this
10 phased approach for license, the emphasis of the
11 precertification review really was the applicability
12 of the tests that were performed for AP600 to AP1000.
13 Were those tests suitable for scaling purposes to be
14 sufficient for AP1000 licensing.

15 Following that, were the safety analysis
16 codes that were validated to those tests also
17 applicable to AP1000 design certification. We wanted
18 to address that early because we see that as a -- it
19 can be a significant issue and can delay the overall
20 schedule so we wanted to have some certainty going
21 into licensing AP1000 that we were on solid foundation
22 there.

23 I think the results of that generally were
24 yes, the tests were applicable. We did significant
25 scaling studies. We're going to talk a little bit

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1 more about those this afternoon. We did scaling
2 studies of the AP600 test and showed how they were
3 applicable, or not, to AP1000. Identified that most
4 of them were applicable. The one issue that did come
5 out of that was the liquid entrainment issue.

6 MEMBER KRESS: Are you going to do any
7 more on supporting the range of pie groups that
8 designates applicability?

9 MR. CORLETTI: We at Westinghouse have not
10 done anything more on that. I think that was
11 identified in the --

12 MEMBER KRESS: It was a comment to the
13 staff.

14 MR. CORLETTI: Yeah, from the ACRS letter
15 on the pre-cert, the pre-certification review. I
16 think it was a comment really not for AP1000.

17 MEMBER KRESS: It was for the staff to get
18 ready for all future scaling type events. You're
19 right. I remember.

20 CHAIRMAN WALLIS: The assumption seemed to
21 be that if the pipe group was within a factor of 2
22 everything was fine. This seemed to be an article of
23 faith that a factor of 2 is okay but there is no real
24 evidence that 2 is better than --

25 MR. CORLETTI: Or 200. Right. What was

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1 the right number. It was the accepted practice and we
2 continue to use it on 600.

3 CHAIRMAN WALLIS: It was not rebuffed. I
4 don't know if it's accepted practice. You made the
5 argument, I think, and then it wasn't challenged.
6 Isn't that more description than to say it was
7 accepted practice?

8 MR. CORLETTI: Maybe.

9 DR. CUMMINS: Ed Cummins. In the
10 certification I believe the NRC and their consultants
11 used a factor of 3 and we got certification so we sort
12 of felt that there was some informal acceptance of a
13 factor of 2. Though I think we understand your
14 comments that the justification of that was not really
15 provided.

16 CHAIRMAN WALLIS: I'd be in real trouble
17 if I were evaluating the flight of a golf ball and I
18 said the Reynolds number was six times 10 to the fifth
19 and it actually turned out to be 12 time 10 to the
20 fifth, I would have a complete different answer for
21 sure.

22 MEMBER KRESS: Different phenomenon.

23 CHAIRMAN WALLIS: Different phenomenon.
24 That's a simple case. Golf presumably is a simple
25 thing.

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1 MR. CORLETTI: You've never seen me hit a
2 golf ball.

3 MEMBER RANSOM: Well, it seems to me there
4 are two issues actually and the similarity argument
5 that you don't often hear but one is qualitative
6 similarity meaning the same phenomenon are basically
7 there. That generally is this rule from, say, a half
8 to two. You are relatively assured that the same
9 phenomenon are governing.

10 Then the other aspect is quantitative
11 similarity which means you must have some measure of
12 just how close it really is. It seems like the
13 argument here is stuck back on the qualitative
14 similarity. I don't know that they have really
15 answered this question of how quantitatively similar
16 are the events.

17 MEMBER KRESS: The other issue is a lot of
18 times the phenomena is not governed by a single pie
19 group. It may be the composite of them and each one
20 of them -- if each one of them is on the low side
21 you're not sure how to add them up, how each
22 contributes to the phenomenon.

23 MR. CORLETTI: The key factor in the
24 integral system performance, he had all these
25 competing phenomena and you try to design your

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1 facility that every one of them to be one. It's
2 impossible to get them all at one.

3 DR. BANERJEE: Are you going to visit this
4 issue of pie groups at all in this presentation?

5 MR. CORLETTI: No, not really.

6 DR. BANERJEE: So we're going to take it
7 as a given that this sort of analysis was okay?

8 MR. CORLETTI: Yeah. I think this
9 committee reviewed that analysis as did the NRC under
10 the precertification review. We had not planned on
11 reopening that issue of the scaling. We are going to
12 focus it on the entrainment. We will talk about some
13 scaling aspects of entrainment.

14 MEMBER KRESS: Sanjoy, our thinking on
15 that was that the ECCS provisions in AP1000 are so
16 robust that you almost always keep the core covered.
17 The calculation for that using the codes does depend
18 on this pie groups. But the experiments that they
19 relied on also showed that you almost always kept it
20 covered. There's just no way to uncover the core. We
21 intuitively thought that the process was acceptable
22 based on that.

23 CHAIRMAN WALLIS: What was the pie group
24 you used for enjoy intuition?

25 DR. BANERJEE: There will be some pie

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1 groups then that will come up in the entrainment
2 studies. Right?

3 MR. CORLETTI: Yes.

4 DR. BANERJEE: So we can discuss it at
5 that point because I guess that is the most critical
6 issue on core level.

7 MR. CORLETTI: Not really the most
8 critical issue on core level but it is the last
9 remaining issue that we're discussing. I think
10 there's -- we feel that it's not the most critical
11 issue.

12 DR. BANERJEE: If I remember the AP600
13 top-down scaling, it really ended up being a group
14 which dominated that determined outflow from the ADS-4
15 system and the friction in the line leading in. There
16 was sort of a balance. If you didn't get enough, or
17 got too much outflow, you couldn't get the flow in
18 because of the friction in the line. I'm just
19 thinking back now. This was like five or six years
20 ago.

21 MR. CORLETTI: I think we're going to have
22 a very detailed discussion of the phenomena involved
23 in the IRWST injection phase and the ADS-4 phase. I
24 think we're going to be able to adequately
25 address --

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1 CHAIRMAN WALLIS: We'll ask these
2 questions when you get to that point.

3 MR. SNODDERLY: Chairman Wallace, if I
4 could make a suggestion. This is Mike Snodderly. I
5 would like to -- maybe we could ask John Segala and
6 the staff if tomorrow maybe if Steve Bajorek could
7 give us an update of how the staff plans to respond to
8 the ACRS's letter because we did ask specifically how
9 they were going to consider modeling of pie groups in
10 the future and maybe they can give us the status of
11 that and that may be the more appropriate time if
12 Steve Bajorek briefs us tomorrow morning. John, would
13 that be possible? You can get back to us later on
14 that.

15 DR. BAJOREK: Yeah. Dr. Kress, what I'm
16 planning to do, yes, in tomorrow's meeting where we
17 have the point where RES is going to talk about its
18 future actions, I have a few overheads where I would
19 like to talk about the scaling and how we want to try
20 to address this issue of .5 to 2.0. I'm not sure it's
21 going to resolve the issue but I want to present out
22 thoughts on it and some of the things that we might
23 want to do in that area.

24 MEMBER KRESS: Thank you.

25 MR. CORLETTI: Okay. This slide is just

1 really telling you what was included in our
2 application. Our DCD application includes what
3 traditionally is called the Final Safety Analysis
4 Report for an Operating Plan, or Standard Safety
5 Analysis Report.

6 Also included the complete PRA, the plant
7 specific PRA for AP1000 including the technical
8 specifications for the plant. I have 20 topical
9 reports. I think our number's above that. I didn't
10 update that. You have probably been seeing the flow
11 of topical reports across your desk.

12 CHAIRMAN WALLIS: Are you giving the staff
13 your codes to run?

14 MR. CORLETTI: In the pre-certification
15 review we had this issue and we have agreed that the
16 codes that were approved for AP600 and AP1000, we
17 didn't see the need to do that at that time. We did
18 say that additional codes that we would develop --

19 CHAIRMAN WALLIS: I thought there was a
20 new negotiation which occurred between you and the
21 NRC.

22 MR. CORLETTI: That is right. What we
23 said is new codes that we developed for AP1000, new
24 applications, we would make those available.

25 CHAIRMAN WALLIS: Do you get on the source

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1 code?

2 MR. CORLETTI: Yes. We have not done it
3 under this review, Dr. Wallis, but Westinghouse would
4 make it available.

5 CHAIRMAN WALLIS: You're going through
6 here sort of the things that you've done and given the
7 staff so I just wanted to know --

8 MR. CORLETTI: The things we didn't do?
9 Yes.

10 CHAIRMAN WALLIS: How much in the way of
11 codes you gave the staff or intend to give the staff.
12 Ideally I think our position is you should make
13 everything open and they should be able to run your
14 codes. Have you reached that point yet?

15 MR. CORLETTI: I think fundamentally we
16 don't have a problem with that.

17 CHAIRMAN WALLIS: You don't?

18 MR. CORLETTI: I think the issue really
19 was --

20 CHAIRMAN WALLIS: It's just that the legal
21 people have a problem with it?

22 MR. CORLETTI: No. No. I think so. I
23 think the issue is that under this review we had
24 already approved the codes so we weren't reopening
25 that code review and we had completed that under the

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1 precertification review. Any new codes that we would
2 develop for this application we would share with the
3 staff and for them to run that. I think that is
4 consistent with what other vendors were doing as well.

5 CHAIRMAN WALLIS: I guess what I'm getting
6 at is sort of the issue of public confidences
7 reinforce tremendously if they can run your codes and
8 get the same answers that you get.

9 MR. CORLETTI: Yes. Public confidence is
10 also instilled when they can get the same answers with
11 very independent codes.

12 CHAIRMAN WALLIS: That is also true.

13 MR. CORLETTI: Which they have done as
14 part of this review. I think --

15 CHAIRMAN WALLIS: I guess we will ask the
16 staff about that when we get to them.

17 MR. CORLETTI: There is also an ACRS
18 letter on the pre-certification review. I think in
19 general you endorse the findings in the
20 precertification review from the staff in
21 Westinghouse's contention.

22 This just really summarizes our position
23 on the codes in coming out of the pre-certification
24 review. Basically we agreed the AP1000 introduces no
25 new phenomena compared to AP600. The separate effects

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1 and integral test were acceptably scaled.

2 The issue of upper-plenum entrainment, and
3 we're going to talk a lot more about this today, we do
4 believe that while it was interesting, we believe that
5 it was a local effect that was somewhat self-limiting
6 but I think we're going to talk in detail further
7 about that.

8 We believe that additional code
9 validation, or additional testing, was not required.
10 We thought we would be able to resolve this issue by
11 sensitivity calculations and analysis and we're going
12 to be talking about that.

13 MEMBER KRESS: Does this apply to WGOthic
14 also?

15 MR. CORLETTI: No. This was really the
16 COBRA/TRAC, Westinghouse COBRA/TRAC sensitivity
17 studies that we did.

18 DR. CARUSO: Dr. Wallis, this is Ralph
19 Caruso from the staff. I would like to correct maybe
20 misimpression that may have been left by the previous
21 discussion about staff access to the Westinghouse
22 computer codes. The staff does not have any
23 Westinghouse computer codes in house at this point.
24 None of them. And has not as far as I'm aware.

25 MEMBER KRESS: Have you requested them?

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1 DR. CARUSO: They have been requested and
2 they have not been provided to us. There is currently
3 under negotiation an agreement with Westinghouse for
4 them to provide the codes to us but that agreement has
5 not yet been finalized.

6 CHAIRMAN WALLIS: So they will not be
7 available by the time you're making the decisions.

8 MR. CORLETTI: Dr. Wallis, Ralph, forgive
9 me for interrupting. They were not requested as part
10 of the AP1000 design certification review by the
11 staff.

12 DR. CARUSO: I would disagree, Dr.
13 Corletti, because they were requested.

14 MR. CORLETTI: Mr. Corletti.

15 DR. CARUSO: Mr. Corletti. Excuse me.
16 They were requested by the staff but because of
17 management decisions, that request was not followed
18 through on.

19 MEMBER KRESS: There was no official
20 request then.

21 DR. CARUSO: There was a request made but
22 it was not followed through.

23 MEMBER KRESS: Okay.

24 CHAIRMAN WALLIS: There was a letter sent?

25 MR. CORLETTI: This is during the

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1 precertification review we discussed this and that was
2 the request.

3 CHAIRMAN WALLIS: I knew that for some
4 time there's been misnegotiation going on. I thought
5 it had been resolved. It's still being done?

6 MR. CORLETTI: I believe it has been
7 signed by RCEO. I thought we had actually signed it.

8 DR. CARUSO: The agreement has not been
9 finalized

10 CHAIRMAN WALLIS: Okay.

11 DR. CUMMINS: This is Ed Cummins. In the
12 verification review we thought the codes were already
13 approved in AP600 and we believe that position was
14 endorsed. In the circumstance where the codes are
15 already approved, then we argued that it was not
16 necessary for the staff to re-review or reapprove the
17 codes for application of AP1000.

18 CHAIRMAN WALLIS: It's not necessary for
19 you to hide your codes. There should be no reason why
20 it can't be open. That's the thing. I mean, the fact
21 that you can argue that you have enough basis is no
22 reason to -- there must be some other reason involved
23 in order to not supply code. Presumably the only
24 argument you have there is some kind of commercial
25 value to the code.

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1 DR. CUMMINS: Right. I think the
2 Westinghouse company and the staff are coming to
3 agreement on that.

4 CHAIRMAN WALLIS: There is no safety issue
5 which is helped by your not providing the code. It
6 can only do good to provide the code to the staff in
7 terms of public safety. There's no way I can see that
8 public safety is enhanced by you not providing a code.
9 If you have a good argument, then please make it, but
10 I don't think there's anyway the public safety is
11 enhanced. It has to be commercial safety or
12 Westinghouse or something that's at stake.

13 DR. CUMMINS: -- Westinghouse is being
14 resolved independently of this review by Westinghouse
15 and the staff. I think it is essentially resolved.
16 In the public management sense Westinghouse paid for
17 the review and we don't think --

18 CHAIRMAN WALLIS: Okay. Should we move on
19 now?

20 MEMBER KRESS: We didn't view our request
21 as a new review of these codes. It was a new use of
22 them actually where we were that staff could actually
23 exercise them and look at them. We didn't intend for
24 it to be a full review and reapproval.

25 CHAIRMAN WALLIS: Well, the rescue phase -

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1 - we've got to move out of this, but when you do
2 supply the codes, then the staff does run them. If
3 something gets revealed then, then it might come back
4 to haunt you.

5 MR. CORLETTI: It was not an issue of --

6 CHAIRMAN WALLIS: Okay.

7 MR. CORLETTI: This was from the letter,
8 and I think we talked about this quite a bit. This
9 was from the NRC's letter on the pre-certification
10 review. Really talking that the separate effects
11 interval test programs are appropriate for use in
12 support of the analysis. The analysis codes validated
13 for the design could be extended to that of the
14 AP1000. This is from the staff letter from the pre-
15 certification review.

16 The plant response during ADS-4 operation
17 was raised. This is essentially the issue on the
18 treatment of upper plenum and hot leg entrainment.
19 That issue needed to be dealt with during the design
20 certification.

21 MEMBER KRESS: There was a question about
22 the NOTRUMP momentum model or non-momentum model and
23 how you dealt with that.

24 MR. CORLETTI: Right. We are going to
25 have -- I have a slide on that, but also in our

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1 NOTRUMP presentation later this morning we are going
2 to address that as well.

3 MEMBER RANSOM: Maybe you could give me an
4 answer to a quick question.

5 MR. CORLETTI: Sure.

6 MEMBER RANSOM: I wonder why do you have
7 to have this NOTRUMP code when you've got Westinghouse
8 COBRA/TRAC which is presumably more sophisticated. It
9 seems like it just makes issues.

10 MR. CORLETTI: The NOTRUMP code is our
11 license to approve small-break LOCA. The COBRA/TRAC
12 code that we applied, the supplemental calculation of
13 a COBRA/TRAC code really was a focused calculation at
14 the lower pressure phase of ADR-4 IRWST injection.
15 The COBRA/TRAC code has not been validated over that
16 entire range of the condition for small break.

17 This is a summary of the WCAP 15833 which
18 was our attempt at resolving the entrainment issue.
19 We are going to have about two hours of presentation
20 this afternoon. I believe that's the one you have
21 there.

22 CHAIRMAN WALLIS: That's this one here?

23 MR. CORLETTI: Yes, sir.

24 CHAIRMAN WALLIS: That seems to me to be
25 a lot of -- what I was saying when I started this

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1 meeting, a lot of stuff brought out of the literature,
2 but I didn't see much in the way of validation of
3 anything. I didn't see comparisons with data in here.

4 MR. CORLETTI: There actually is a section
5 where we compared the predictions of the COBRA/TRAC
6 calculation to the tests performed.

7 CHAIRMAN WALLIS: Maybe you could point
8 those out later on today or tomorrow.

9 MR. CORLETTI: Okay. And we did a series
10 of sensitivity studies really aimed at trying to range
11 the -- see the effects on increasing the magnitude of
12 entrainment, both hot leg and upper plenum
13 entrainment. Really what we're trying to see can we
14 see a sensitivity to the overall plant performance?
15 I think in our conclusions we were not able to see
16 appreciable difference in overall plant performance.

17 CHAIRMAN WALLIS: So what you're going to
18 do is show us that even if you don't have a very good
19 model, let's take some extremes of a lot of
20 entrainment or not much and it doesn't make much
21 difference because the level drops to some point and
22 doesn't go any further. Is that what you're going to
23 show us?

24 MR. CORLETTI: Essentially. I think
25 another aspects of that is the models in COBRA/TRAC

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1 have very high -- already COBRA/TRAC had very high
2 entrainment rates with the correlations that they
3 have. We're going to talk about the basis for those
4 models in COBRA/TRAC that we use and the analytical
5 basis for that this afternoon.

6 CHAIRMAN WALLIS: If I recall, you did a
7 sensitivity around the Kataoka-Ishii model. Right?

8 MR. CORLETTI: Yes.

9 CHAIRMAN WALLIS: And you're going to talk
10 about how well that model applies?

11 MR. CORLETTI: Yes. We're going to talk
12 about that model and the models that are actually in
13 COBRA/TRAC and compare them.

14 CHAIRMAN WALLIS: And you have some
15 comparisons with data to show those models are
16 applicable?

17 MR. CORLETTI: We have some comparisons
18 with data. The staff has not found those comparisons,
19 I believe, to be sufficient. We will discuss --

20 CHAIRMAN WALLIS: Just comparing
21 COBRA/TRAC to Kataoka-Ishii is not the same thing as
22 validating it against data.

23 MR. CORLETTI: Yes.

24 DR. BANERJEE: Also, there was a concern,
25 if I recall, with the AP600 that the OSU facility was

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1 probably the least well-scaled, particularly with
2 regard to poor height. At least in the top-down
3 scaling study that was done, there was concern about
4 that. Have you compared this data, say, something
5 like Rosa 4?

6 MR. CORLETTI: I don't think we agree that
7 it was the least scaled facility. I think for high
8 pressure phase of the transient the SPES facility in
9 Italy was the best scaled probably. The lower
10 pressure phase of the transient OSU was probably the
11 best scale. We did in the pre-certification review in
12 our scaling report we showed comparisons to SPES, OSU,
13 and Rosa as well.

14 DR. BANERJEE: I was involved with Idaho
15 study and our conclusion -- this is memory, which
16 might be wrong, was that SPES had a problem with heat
17 loss and it was, we thought, not all that typical.
18 APEX and the OSU facility there was this problem with
19 height that we were concerned about. The facility
20 that was closest to being well scaled was the Rosa
21 facility.

22 MR. CORLETTI: Was this a public NUREG
23 that you did or was this something that you did for
24 the --

25 DR. BANERJEE: I think so.

1 MR. CORLETTI: Okay.

2 DR. BAJOREK: No. This was a NUREG that
3 you had done for the AP600.

4 DR. BANERJEE: AP600. Yes.

5 DR. BAJOREK: I think our conclusions when
6 we did the independent scaling for AP1000 were more or
7 less consistent with that. We think that SPES was
8 okay for the high pressure periods leading up to ADS-
9 4, venting. APEX was good for the long-term cooling
10 in the period following that. Rosa may have been the
11 best overall, but SPES was a little bit better for the
12 early periods, APEX for the late periods.

13 DR. BANERJEE: I agree, Steve, but the
14 issue of the lowest core level when that was reached,
15 Rosa was the best scaled. That also was published as
16 a paper in Nuclear Engineering and Design and given as
17 a keynote paper at Nuretz which was held at Kyoto so
18 it's public information.

19 MR. CORLETTI: In our scaling report that
20 we did for AP1000 we did compare, I believe, some of
21 the key pie groups of Rosa to AP1000 as well from the
22 Rosa facility. We had independent scaling done by
23 actually INEL. They had done the scaling before for
24 AP600.

25 They went and did the scaling for AP1000

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1 and provided that in our scaling report. I think it
2 showed Rosa was adequately scaled for AP1000 when you
3 look at the pie groups. So what we confirmed is that
4 the confirmatory conclusions that the staff was able
5 to get from Rosa could also be applied to AP1000.

6 DR. BANERJEE: Well, I think it's okay if
7 you show us comparisons with data about whatever
8 correlation you are using.

9 CHAIRMAN WALLIS: This is going to happen
10 tomorrow?

11 MR. CORLETTI: Tomorrow we're going to
12 talk about the scaling of --

13 CHAIRMAN WALLIS: And we are going to
14 resolve it tomorrow?

15 MR. CORLETTI: That's a good objective for
16 this meeting.

17 DR. BANERJEE: The core height has
18 changed. Right?

19 MR. CORLETTI: Yes, it has.

20 DR. BANERJEE: So one of the concerns was
21 the core height scale and that was what as the
22 problem, I think, with OSU.

23 CHAIRMAN WALLIS: OSU is actually going to
24 be here tomorrow.

25 MR. CORLETTI: Yes, they are.

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1 DR. BAJOREK: I don't think we would use
2 anything in APEX for what goes on in the core.

3 MR. CORLETTI: Right.

4 DR. BAJOREK: It wasn't scale for that.
5 It's too short. In particular, I think they use like
6 1-inch diameter rods --

7 DR. BANERJEE: It was not the best
8 scaling. Absolutely. That issue of what you are
9 using to validate this quote needs to be resolved.

10 MR. CORLETTI: Okay. I think John spoke to
11 this. I think Walt is going to speak to this as well
12 so I don't need to belabor this issue. There was an
13 issue with the LOFTRAN. I think it really wasn't --
14 I mean, the issue was and I think the staff concern
15 was we know LOFTRAN is the transient analysis code.

16 You've been using it for a very long time.
17 We know it is generally a single-phase code that
18 allows two phases in the pressurizer and allows two
19 phases in the upper head but it's typically not a two-
20 phase code. The worry was the large steam generators
21 that we were going to with the AP1000.

22 On the main steamline break would the
23 depressurization be so significant that you would lose
24 subcooling and then have questions about whether the
25 code was adequate for that.

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1 We did not provide the final analysis
2 during the pre-certification review. We did provide
3 that as part of the DCB analysis. I believe the item
4 is resolved. I think we've provided those results to
5 the staff.

6 There were several issues in the pre-cert
7 review on the NOTRUMP. One was the heat transfer
8 model. We have a fairly detailed presentation of that
9 showing comparison plots of the heat transfer model in
10 NOTRUMP compared to the heat transfer correlation we
11 developed for AP600 and AP1000 based on the test.

12 This was another issue from the pre-cert
13 which the staff had really not reviewed keyed-up
14 methodology under AP600 for core uncovering cases
15 because we didn't really have core uncovering. The
16 issue was if you have significant core uncovering we
17 would want to revisit this issue, if we had sufficient
18 core uncovering for AP1000.

19 Our results for AP1000 are very similar.
20 Any Gagnon is going to be presenting that this
21 afternoon. There was one case that we didn't really
22 have uncovering but we had very, very high voids which
23 in our analysis we did a conservative -- assumed above
24 a certain level, I believe it was over 90 percent, we
25 would assume it would be uncovered and we did a very

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1 conservative adiabatic heat-up of the fuel rod to show
2 that even in that case the PCT is well under the
3 limits.

4 CHAIRMAN WALLIS: It has to stop. If you
5 have a heat-up, something has to turn it around. What
6 turns it around? The refilling of the --

7 MR. CORLETTI: Yes. It was a blow-down
8 uncovering so it was a very short blow-down uncovering.

9 CHAIRMAN WALLIS: Instead of having that
10 sort of V where the level goes down and comes up
11 again, it actually goes down, uncovers, and then
12 covers up again.

13 MR. CORLETTI: Yes, sir. Yes, sir.

14 The momentum flux model in NOTRUMP was
15 also an issue. The issue there was the methodology
16 that was employed for AP600 acceptable. I think the
17 staff found that it would be. Westinghouse committed
18 to do a supplemental calculation with WCOBRA/TRAC
19 which is a more sophisticated computer code to show a
20 relative comparison to assess the impact of our
21 methodology. That is also in that WCAP 15833. We are
22 going to talk about that later.

23 With regards to GOTHIC, I think here for
24 AP1000 as we reviewed in the pre-cert review, the
25 approved methodology for AP600 was found to be

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1 acceptable provided once we did the final analysis the
2 important scaling numbers were still within the range.

3 We had done preliminary analysis during
4 the pre-cert review and showed that we were in the key
5 range of the important Rayleigh numbers and Grashof
6 numbers. Rick Wright is going to be speaking to that.
7 Generally we showed that with our final DCD analysis
8 we were still within our scaling basis for --

9 CHAIRMAN WALLIS: Didn't you also do
10 analysis of CFD type?

11 MR. CORLETTI: Yes, we did. Under the
12 pre-cert review we showed the mixing characteristics
13 with CFD analysis.

14 MEMBER RANSOM: Was WGOthic coupled with
15 the COBRA/TRAC code or NOTRUMP?

16 MR. CORLETTI: Manually coupled but it's
17 not linked. We do not have them linked. We do take
18 the mass of energies either from COBRA/TRAC or other
19 calculations and feed them into the GOTHIC containment
20 model.

21 MEMBER RANSOM: As the calculation
22 proceeds?

23 MR. CORLETTI: No, they are not linked.
24 It's not a link.

25 MEMBER RANSOM: Independent calculation?

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1 MR. CORLETTI: Yes.

2 MEMBER RANSOM: How can you do that then
3 because I thought the source of energy --

4 MR. CORLETTI: Reiterate. We do them a
5 couple of times essentially. You're right, it's not
6 a link.

7 This issues was also -- I think Lambrose
8 is going to speak to this. This really wasn't a code
9 issue per se for the pre-cert. It was really a safety
10 analysis results issue. As John mentioned, in PWRs,
11 and especially for cold-leg breaks in PWRs the long-
12 term boiling in the core, it's postulated that this
13 goes on for a very, very long that boron could
14 precipitate in the vessel and could impact core
15 cooling if it finds a blockage of the core cooling.

16 We did a series of calculations and
17 analysis where we actually calculate the long-term
18 boron concentration in the sump and in the core. We
19 take the output from our COBRA/TRAC LOCA analysis to
20 get the steam qualities in that calculation. What we
21 showed for our base case was peak boron concentration
22 of 5,500 ppm in the core. The boron solubility limit,
23 as Lambrose said, is about 3,500 PPM at that
24 temperature so we are very far away from that.

25 We also do sensitivity studies to see what

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1 could the quality -- we range the quality and see the
2 sensitivity. The RAI response asked us to do a
3 different COBRA/TRAC analysis that was maybe select
4 the way the assumptions that you made to minimize
5 entrainment. We did that with a calculation
6 COBRA/TRAC with a very high containment back pressure.
7 All of the valves opened to minimize the velocities to
8 see if that could have an impact on that.

9 I think John had this as unresolved, I
10 think, yesterday or the day before. We are hopeful
11 that our additional RAI response will resolve the
12 issue. I think Lambrose hasn't seen that.

13 CHAIRMAN WALLIS: What are your sources of
14 water? Your IRWST and your CMTs, do they all have the
15 same boron concentration?

16 MR. CORLETTI: No, they don't. The IRWST
17 is borated to about 2,500 ppm. It's refueling water.
18 The CMTs and the accumulators are at the higher boron
19 concentration. This is the system arrangement that
20 you have long-term core cooling in the AP1000. You'll
21 see that you're steaming out the ADS-4 and you're
22 recirculation flow back through the containment recirc
23 lines. Your team is concentrating. Your steam is
24 condensing on the containment shell.

25 CHAIRMAN WALLIS: As long as it all

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1 recirculates there can't be a problem.

2 MR. CORLETTI: That's right.

3 CHAIRMAN WALLIS: Where else would it go?
4 You would have to have a leak in the containment or
5 something.

6 MR. CORLETTI: Yes. The worry is -- I
7 mean, there are worries that --

8 CHAIRMAN WALLIS: Holding up in parts of
9 the structure or something?

10 MR. CORLETTI: Are you deluding in the
11 sump. Are you concentrating in the core. You can do
12 these -- we do these transfer kind of calculations to
13 track long-term with the range of the concentrations.
14 Operating plants do this as well. They do these sorts
15 of calculations.

16 In an operating plant they actually have
17 procedures that in 24 hours they switch connections
18 from the RA jar pumps to back flush water through the
19 core. I think a lot of them are going away from that
20 because in the PRA risk significant it's hard to show
21 this is a real issue.

22 CHAIRMAN WALLIS: Now, you have this
23 recirculation screen. I think we visited that with
24 AP600 but this has become a big issue with PWRs and
25 debris.

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1 MR. CORLETTI: Yes. The staff has asked
2 us questions on that. We have answered those.
3 Essentially with our passive plant we have very, very
4 low velocities to the screen. In addition, we have
5 taken out all fibrous insulation that contributes to
6 this sump blockage.

7 We have metal reflective insulation. We
8 are very robust in that area in regards to our sump
9 performance. I'm waiting for the staff to tell us.
10 These were late RAIs so we haven't really discussed
11 them but we think our answers are --

12 CHAIRMAN WALLIS: Didn't you put something
13 above the screen?

14 MR. CORLETTI: Yes, a plate above the
15 screen to prevent things from falling on the screen
16 and blocking the screen.

17 MEMBER KRESS: Your ADS-4 valves that aim
18 into the containment, have you aimed those in a way
19 that --

20 MR. CORLETTI: Yes, away from anything
21 that could damage. They are actually in the loop
22 compartment or the steam generator compartment.

23 MEMBER KRESS: Not a lot of stuff in
24 there.

25 MR. CORLETTI: That's right. Because we

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1 are designed to flood, we have to be very careful
2 about where we put our safety related instrumentation
3 and things that are located below the flood level have
4 to be designed to be able to flood.

5 MEMBER RANSOM: Mike, could you explain
6 for me again how the containment basically deborates
7 water and it comes back into the IRWST and then drains
8 back into the core. How do you prevent deborating
9 core?

10 MR. CORLETTI: That's another issue. You
11 have to do your calculation with everything skewed the
12 other way. I think that is the mechanism that occurs.
13 I think when you do the calculations you don't see
14 that it -- because of all the born that we start with,
15 you --

16 MEMBER RANSOM: How does boron get mixed
17 back with this deborated water?

18 MEMBER KRESS: I would say it works the
19 other way, Vic. At relatively high pressures when you
20 blow off the steam you're enriching the water in boron
21 and the steam is less rich in boron. It will carry
22 some with it. Then when it condenses the boron may
23 get left behind but it would take a long time at
24 relatively high pressures. At low pressures you might
25 be able to have a problem where the steam would carry

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1 more boron with it.

2 MEMBER RANSOM: I'm worried the other way
3 around. The steam basically condensing on the
4 containment deborates the water.

5 CHAIRMAN WALLIS: But then where is the
6 boron? It's probably in the core.

7 MR. CORLETTI: That's right.

8 MEMBER RANSOM: How does it get back?

9 MEMBER KRESS: The steam leaves. That's
10 only at relatively high pressures. As the pressure
11 gets lower and lower you will take out more boron with
12 the steam. If you're at low pressure and long-term
13 cooling, there is a possibility of you carrying a
14 significant amount of boron with the steam and then it
15 ending up on the containment wall. I think that is
16 the issue you worry about. It would have to be
17 relatively low pressures for that to happen.

18 MEMBER RANSOM: Also it seems like the
19 boron could wind up in that pool of water surrounding
20 the reactor but not draining back into the reactor
21 director.

22 MEMBER KRESS: That may be. That's a
23 question of distribution.

24 MR. CORLETTI: But have we discussed it
25 enough, or have we answered your question?

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1 MEMBER RANSOM: You've done calculations
2 to assure that you do not get a boron pollution?

3 MR. CORLETTI: Or a boron -- that's right.
4 We look at it in both -- we have selected the
5 assumptions in both ways to show that either you do
6 not concentrate or if you do it the other way, you do
7 not dilute.

8 MEMBER RANSOM: Is NRR satisfied with
9 that?

10 MR. CORLETTI: I think Lambrose is going
11 to speak to that this afternoon, or this morning.

12 Lambrose?

13 DR. LOIS: This is Lambrose Lois again
14 from Reactor Systems. The deboration of the vessel is
15 accomplished by expelling water out of the vessel. In
16 the long-term cooling phase, of course, you have steam
17 going out as the steam takes some water out with it.
18 If that's the case, then there's no problem. If the
19 blast of the steam is so small, it will not be able to
20 carry water with it into the containment and then
21 there's a problem.

22 MEMBER RANSOM: The issue I was concerned
23 with is the deborated water is being returned to the
24 reactor.

25 DR. LOIS: Yes, it is, because it

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1 continuously circulates through the core for the
2 cooling.

3 MEMBER RANSOM: So it would seem like you
4 have a net loss of boron from the core.

5 DR. LOIS: Not unless you expel water from
6 the vessel.

7 MEMBER RANSOM: Right.

8 CHAIRMAN WALLIS: Are we going to address
9 that later on?

10 MR. CORLETTI: We are not planning on a
11 detailed presentation on this issue. We can arrange
12 for that in the future if you would like. We could
13 show you curves from our calculations where we did
14 that. That is essentially what we do. We look at
15 both the potential for delusion in the core and the
16 potential for --

17 CHAIRMAN WALLIS: I don't think the staff
18 has reviewed all this so we're going to have to stop.

19 MEMBER KRESS: The sorry about delusion is
20 whether the core can go critical again. I don't see
21 much potential for that.

22 MR. CORLETTI: That's right. If you've
23 thrown in so much more at the beginning of the event
24 that you really --

25 MEMBER KRESS: It would take a long time.

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1 MR. CORLETTI: You can't get there.

2 CHAIRMAN WALLIS: You're concentrating
3 boron really.

4 MEMBER SIEBER: Concentrating.

5 MEMBER KRESS: Except in the long-term
6 cooling when you've got the pressure down you are
7 deluding then. The steam will carry a significant
8 amount of boron.

9 CHAIRMAN WALLIS: But if you leave it
10 behind somewhere else.

11 MEMBER KRESS: And it will just stay on
12 the containment walls.

13 MR. CORLETTI: But in your containment --
14 but you remember we had 500,000 gallons of borated
15 water here which is in the sump now which is mixing
16 with the condensation that returns.

17 MEMBER KRESS: I haven't done the
18 calculations but my feeling is that it would take a
19 long time to get down to boron concentration you would
20 be worried about.

21 DR. BANERJEE: With regard to the
22 recirculation screens, we were shown some results that
23 even a very small amount of fiber causes a problem
24 because you get this effect of filtration which
25 catches the small particles. To handle that some

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1 rather clever screen designs have been --

2 MR. CORLETTI: Improved screen designs.
3 Right.

4 DR. BANERJEE: Have you looked at this
5 because this seemed like a real issue when we looked
6 at this problem.

7 MR. CORLETTI: We have looked at those
8 screen designs and we could the screen designs that
9 would significantly increase the surface area given
10 the same kind of footprint. It's not in our base
11 design but we could use that. I think the staff is
12 reviewing it.

13 When you look at the amount of fibrous
14 material we have in our AP1000 because of the
15 elimination of that sort of insulation, and you also
16 look at the very low velocities we have here, the
17 approach velocities to the screen, when you categorize
18 is this an issue or not for AP1000, it didn't appear
19 to us that it was. I think we wouldn't have a problem
20 going to implementing the advance -- the one that I've
21 seen, at least, which is --

22 DR. BANERJEE: What they do is they have
23 velocities parallel to the walls rather than normal to
24 them. They take care of the problem by design.

25 CHAIRMAN WALLIS: It has to go through

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1 eventually, though.

2 DR. BANERJEE: Well, also there was this
3 issue that could you separate -- at least have
4 redundancy in the screens having two which is
5 geometrically at different locations.

6 MR. CORLETTI: This is maybe an issue that
7 if we want to talk about this more in our next
8 meeting, we could show you drawings, the results of
9 our calculations that we've done. I think it is an
10 industry issue that's getting a lot of attention and
11 I think we can show you what we've done. I think
12 we've tried to address this with design.

13 DR. BANERJEE: You have an opportunity to
14 take care of the problem before it occurs.

15 MR. CORLETTI: Yes.

16 MEMBER KRESS: And I think our committee -
17 - I don't mean to speak for them but in one of the
18 letters we expressed the opinion that an increased
19 surface area screen is not a good fix if that's what
20 you're talking about because it takes so little of
21 this insulation to block even a large screen that we
22 thought it wasn't the best kind of fix anyway.

23 MR. CORLETTI: We thought eliminating the
24 fibrous insulation was the best thing.

25 MEMBER KRESS: That would be a good way to

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1 do it.

2 MR. CORLETTI: That was what we did.

3 CHAIRMAN WALLIS: I think our concern was
4 with the paint fragments all coming down and floating
5 around. They are sort of like leaves. That kind of
6 material is very bad for screens, too. It doesn't
7 take many sheets of thin stuff to block up a screen.

8 MR. CORLETTI: We have looked at the paint
9 that we do use, the paint where they would be
10 susceptible to blow-down forces. We've taken care to
11 make sure we have the safety related paint that is
12 required. I think these non-safety paints are an
13 issue. They assume they all fall off.

14 CHAIRMAN WALLIS: Unsafety paint.

15 MR. CORLETTI: Or non-safety painters.

16 CHAIRMAN WALLIS: Okay. We should perhaps
17 move on.

18 MR. CORLETTI: This is more of the same --

19 CHAIRMAN WALLIS: This is what you told us
20 already.

21 MR. CORLETTI: -- of what you heard from
22 John. We are trying to resolve the issues. I think
23 John said a couple of these might be open. We are
24 going to keep working hard to resolve as many of them
25 as we can. I think staff has been accepting our input

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1 there.

2 I thought this was useful. It is hard,
3 Dr. Wallis. To do a presentation of the RAIs is to
4 get a sense of what were the important ones and what
5 were the unimportant ones. I'll just touch on some of
6 the key ones that we had. If this committee is
7 interested, before I leave we can get you the numbers
8 and point you to the ones that talked about these
9 issues.

10 We did increased spectrum for the small-
11 break LOCA. We did more complete spectrum on what we
12 presented to the staff. We also did additional shut-
13 down accident analysis. We did a loss of cooling
14 accident initiated in a low power mode without the
15 accumulators to see the robustness of the design for
16 shutdown. Long-term operation of the passive RHR to
17 show it is capable of cooling the plant long term.

18 ATWS analysis. This plant has a very
19 robust design with regard to ATWS. One of the
20 measures of acceptance is unfavorable exposure time.
21 The amount of core light time where if you would have
22 an ATWS you would actually exceed the reactor cooling
23 system service level C pressure.

24 The acceptance criterias have that to be
25 a very low number. For AP1000 we were essentially

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1 zero, I think, before we submitted our last RAI. We
2 are not at zero at this time. We were 99 percent.

3 I think Summer Sun wanted us to do
4 additional analysis to show not only did we do the
5 worst case, but also can we meet the essentially zero
6 UET. We are preparing that response. The staff does
7 not have that but I believe our response will resolve
8 that issue.

9 We did significant amount of PRA success
10 criteria analysis. We discussed a lot of that at the
11 PRA subcommittee meeting. The staff had asked for a
12 multiple steam generator tube rupture analysis as well
13 and we provided that in our RAI response.

14 And, finally, the low-temperature over-
15 pressure analysis. This demonstrates that your cold
16 temperature, your Appendix G pressure limits on the
17 reactor vessel are not exceeded.

18 CHAIRMAN WALLIS: This multiple steam-
19 generated tube rupture, is this based on simply
20 assuming that several will break or is it talking
21 about the mechanisms whereby the next one?

22 MR. CORLETTI: It assumes that multiple
23 ones on an area break and then --

24 CHAIRMAN WALLIS: That just assumes so
25 many break. You don't discuss how they might break

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1 simultaneously.

2 MR. CORLETTI: No, we don't. We don't
3 postulate that. We didn't postulate that as far as to
4 that analysis. Well, that summarizes my presentation.

5 CHAIRMAN WALLIS: You are way ahead of
6 time here. I'm wondering if we could move up one of
7 the next -- do one of the presenters have a
8 presentation that might take half an hour?

9 MR. CORLETTI: The next presentation is
10 the large-break LOCA analysis.

11 CHAIRMAN WALLIS: Would that take half an
12 hour? We could then take a break after that.

13 MR. CORLETTI: I think that's fine.

14 CHAIRMAN WALLIS: Okay. Let's do that.

15 MR. CORLETTI: Okay. Very good. Thank
16 you.

17 CHAIRMAN WALLIS: Thank you very much.

18 DR. KEMPER: Can you hear me all right?

19 MEMBER KRESS: The question is how
20 advanced are you?

21 DR. KEMPER: Well, you may have your own
22 judgment on that coming up. Am I able to be heard by
23 everybody? Okay. I am Bob Kemper from the LOCA group
24 at Westinghouse and I wanted to go over somewhat
25 briefly with you the large-break LOCA analysis that

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1 we've done for AP1000.

2 For AP600 what we did was begin with the
3 approved large-break LOCA best estimate technology
4 using WCOBRA/TRAC. That had been approved for the
5 three and four loop Westinghouse operating plants.
6 Then reviewed that in the context of the AP600 design.

7 We concluded that basically it was
8 acceptable to use it. The main things that showed up
9 as different in a PIRT investigation were direct
10 vessel injection feature of the AP600, now AP1000
11 design. In the work that we did for AP600 we did some
12 simulations of a CCTF and a UPTF test to demonstrate
13 code capability for phenomena associated with direct
14 vessel injection during a large-break LOCA.

15 Ultimately, the AP600 methodology was
16 reviewed and approved for that purpose in the NUREG
17 shown. For AP1000 we are just building on that and
18 using the same methodology to analyze a plant which is
19 basically the same in design as AP600. As part of the
20 approval, the NRC identified some limitations on the
21 methodology which we followed during the AP1000
22 analysis.

23 A number of these are carryovers from the
24 three and four loop model approval concerning natures
25 of distributions and ranges and that sort of thing

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1 that are generic. There are a couple specific for the
2 advanced plant design including consideration of the
3 effect of core makeup tank or PRHR on the results
4 obtained during the large break analysis.

5 To accommodate that we did a case
6 eliminating the CMT which doesn't really play a factor
7 of much significance in large-break LOCA, and also
8 eliminating the PRHR from the model. In either case,
9 the results were actually less limiting.

10 Large break is really very similar in this
11 plant to the conventional plant. You have your
12 doubled-ended cold leg rupture and the accumulators
13 are the thing providing the inventory necessary to
14 refill the vessel and recover the core.

15 This is one of the transients that we did
16 during the large-break LOCA best estimate methodology.
17 It calls for doing a series of like 14 global model
18 cases in which we are varying parameters such as the
19 discharge coefficient of the break and the resistance
20 of the broken nozzle. There are some simplifications
21 that we placed into the advanced plan analysis.

22 CHAIRMAN WALLIS: Could you show where the
23 CMTs come in on this figure?

24 DR. KEMPER: The CMTs actually --

25 CHAIRMAN WALLIS: Or the accumulators.

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1 Just show some of the key events here.

2 DR. KEMPER: Okay. The CMTs come on when
3 you get an S signal which is maybe four seconds into
4 the event.

5 CHAIRMAN WALLIS: So they are pretty
6 early.

7 DR. KEMPER: They come on very early and
8 inject for several seconds of time. The
9 depressurization is so great that you then hit the
10 accumulator set point. Once the accumulators begin to
11 inject the CMTs shut off.

12 CHAIRMAN WALLIS: When are the
13 accumulators coming on here?

14 DR. KEMPER: It would be about 10 seconds.
15 Roughly 10 seconds.

16 CHAIRMAN WALLIS: So this heat up between
17 50 and 120, this is a an adiabatic heat-up?

18 DR. KEMPER: No, this is -- well, part of
19 the time.

20 CHAIRMAN WALLIS: It's an uncovered core.

21 DR. KEMPER: The core is in essentially
22 adiabatic heat-up --

23 CHAIRMAN WALLIS: Uncovered.

24 DR. KEMPER: -- until maybe 70 seconds or
25 so on this scale. Then we begin to -- you refill the

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1 lower plenum.

2 CHAIRMAN WALLIS: But it's still on that
3 track. It's pretty linear. There's about 70 seconds
4 of linear heat-up and then 100 seconds of linear cool
5 down. It looks like a very simple picture.

6 DR. KEMPER: This is actually more simple
7 than a lot of large break transients. You have the
8 big break, uncover the core. The AP1000 is equipped
9 with capability to drain the upper head liquid very
10 effectively into the upper plenum. A lot of
11 Westinghouse plants don't have wholes in the upper
12 support plate that permit this draining to occur.
13 That enables you to get a very good cooling from 1,600
14 odd degrees down to 1,200 or so.

15 CHAIRMAN WALLIS: This is lightly the
16 small-break LOCA in reverse. In one case you're
17 worried about uncovering the core as they're coming
18 down on some curve. Then you turn around and go up
19 again. It doesn't quite uncover.

20 Here you go up on some heat-up and
21 something has to turn it around. It's pretty key that
22 you predict that turnover right. If it went on for
23 another 30 seconds instead of turning around, you
24 would be up in the danger zone. It's pretty important
25 that you predict the turnaround right.

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1 DR. BANERJEE: what's the pressure when
2 the turnaround is occurring?

3 DR. KEMPER: Somewhere below 1,000 PSI.
4 It would be going into the time when the accumulators
5 are going to begin injecting.

6 CHAIRMAN WALLIS: So it's the accumulators
7 that turn around?

8 DR. KEMPER: No.

9 CHAIRMAN WALLIS: They have already come
10 on.

11 DR. KEMPER: The accumulators really turn
12 around the second peak there when they provided enough
13 water --

14 CHAIRMAN WALLIS: That's what I mean, the
15 second peak.

16 DR. KEMPER: -- to refill the vessel. The
17 initial blow-down heat-up is turned around by the
18 blow-down cooling.

19 CHAIRMAN WALLIS: That's the second one.
20 It's the accumulators. It's the balance of water
21 coming in from the accumulators that turns it around
22 at this elevation.

23 DR. KEMPER: That's correct.

24 CHAIRMAN WALLIS: Okay. So that's what it
25 is.

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1 DR. KEMPER: You essentially have to have
2 enough accumulator and water injected to fill the
3 downcomer and refill the core.

4 CHAIRMAN WALLIS: That is a pretty
5 predictable thing. You've got a valve accumulated
6 with pressure and you can predict with a lot of
7 confidence how rapidly that water comes out of that
8 accumulator.

9 It's not like some of these later events
10 where you're balancing hydrostatic terms here, there,
11 and everywhere and a little more uncertain about just
12 what the flows are going to be. The accumulator flow
13 is pretty certain.

14 DR. KEMPER: You've got to get the
15 pressure right.

16 CHAIRMAN WALLIS: Right. You've got to
17 get the pressure right.

18 DR. BANERJEE: That's why it would be
19 interesting to see what the pressure was like.

20 DR. KEMPER: Well, the pressure by 30
21 seconds is down to containment pressure.

22 CHAIRMAN WALLIS: So it's down to nothing
23 really and the accumulators are --

24 DR. BANERJEE: When do the accumulators
25 come on then?

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1 DR. KEMPER: Roughly about 10 seconds into
2 the transient when you hit 600, 700 PSIA set point.

3 DR. BANERJEE: So what's the pressure at
4 125 seconds or something when the turnaround occurs?
5 The second turnaround.

6 DR. KEMPER: The second turnaround.

7 CHAIRMAN WALLIS: It's containment.

8 DR. KEMPER: Containment plus pressure.

9 CHAIRMAN WALLIS: So is that the
10 accumulators turning it around or something else?

11 DR. KEMPER: It's the accumulators

12 CHAIRMAN WALLIS: Just filling up the
13 vessel. That's all it's doing. It would seem to be
14 a pretty predictable thing. You depressurize and the
15 water is squirting in and it's filling up and the
16 simple analysis will probably get you that one.

17 DR. BANERJEE: So it's taking 120 seconds
18 or something.

19 CHAIRMAN WALLIS: Just to fill up the
20 vessel.

21 DR. KEMPER: Fill the core high enough
22 that you get good enough cooling.

23 CHAIRMAN WALLIS: The physical things
24 happening are pretty simple. It's not as if it's
25 subject to a lot of uncertainties in the modeling. Do

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1 a hand calculation. Sanjoy could do it overnight and
2 get the same answer.

3 DR. BANERJEE: If I knew the answer.

4 DR. KEMPER: I would agree this is more
5 straightforward than some of the other events.

6 CHAIRMAN WALLIS: Right.

7 MEMBER KRESS: Is this COBRA/TRAC?

8 DR. KEMPER: This is COBRA/TRAC.

9 DR. BANERJEE: So it's not due to IRWST
10 water or anything like that?

11 DR. KEMPER: No. Accumulators are still
12 injecting.

13 CHAIRMAN WALLIS: The passive aspects have
14 nothing to do with this transient really. This is
15 just like the classical PWR.

16 DR. KEMPER: Only the ultimate classic
17 passive system, the accumulator.

18 CHAIRMAN WALLIS: But that was there
19 before.

20 DR. KEMPER: Yes. That's nothing new
21 here. The result of the calculation is --

22 CHAIRMAN WALLIS: This is so reassuring
23 that you have ADS-4 to create a large-break LOCA in
24 the other transients.

25 DR. KEMPER: That is true. I mean, LOCA

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1 will become a large break eventually.

2 CHAIRMAN WALLIS: This suggestion was
3 made, it seems to me, about 30 years ago that since we
4 no longer analyze large-break LOCAs, let's make
5 everything into a large-break LOCA. Now it's finally
6 going to happen.

7 DR. BANERJEE: The BWS followed that.

8 DR. KEMPER: I don't necessarily recall
9 that. I do recall it being considered blow a hole in
10 the hot leg to enable the venting.

11 CHAIRMAN WALLIS: This is a best estimate
12 calculation?

13 DR. KEMPER: This is a best estimate
14 calculation.

15 CHAIRMAN WALLIS: A realistic calculation.

16 DR. KEMPER: So then we proceed to
17 consider the uncertainties and identify peak cladding
18 temperature of the 50th percentile and at the 95th
19 percentile. We need to meet the 10 CFR 50.46
20 regulatory requirements here for PCT as well as the
21 cladding oxidation both local and core-wide. The 0.73
22 percent could also be called your core-wide oxidation
23 or hydrogen generation number.

24 CHAIRMAN WALLIS: That's the 95th
25 percentile as well?

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1 DR. KEMPER: That is done according to the
2 methodology that was approved for the three and four
3 loop plants. It's really based on a calculation that
4 exceeds a WCOBRA/TRAC transient whose cladding
5 temperatures exceed the 95th percentile PCT value.
6 Then there's a methodology that uses these elevated
7 temperatures to identify what the cladding oxidation
8 is.

9 MEMBER RANSOM: Were these results
10 generated using a nonparametric statistical approach?

11 DR. KEMPER: It uses a response surface
12 methodology.

13 MEMBER RANSOM: You then go back and
14 sample, I guess.

15 DR. KEMPER: No. It's done by generating
16 response surfaces from varying model parameters. Then
17 based on identified distributions identifying what the
18 50 percent values are.

19 CHAIRMAN WALLIS: Since you're just
20 filling a vessel from an accumulator, it would seem
21 the uncertainty should be pretty small. Is it the
22 uncertainty in the heat transfer coefficient that
23 gives you this number?

24 DR. KEMPER: Part of the methodology is to
25 look at things like ride internal pressure, heat

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1 transfer coefficient on the fuel rod, and things such
2 as this which would be --

3 CHAIRMAN WALLIS: In fact, the rods cool
4 before the level gets to them and you're going to pull
5 that in there so it's the whole reflood basis of
6 assumptions comes into play.

7 DR. KEMPER: That's right.

8 MEMBER SIEBER: Maybe you can help me
9 understand a little bit physically what's going on.
10 The clad temperature is a LOCA phenomenon.

11 DR. KEMPER: That's correct.

12 MEMBER SIEBER: You're looking for the hot
13 rod and the point on the hot rod where the power
14 history was the highest, which is assuming parabolic
15 would be somewhere in the middle. On the other hand,
16 during a reflood you have a level that's changing the
17 location of where that hot spot is. Do your codes
18 actually look at the fact that the hot spot physically
19 moves?

20 DR. KEMPER: In doing one of these
21 analysis we keep track along the length of the rod
22 where the highest or hottest point is at any
23 particular point in time.

24 MEMBER SIEBER: Okay. That will change
25 the effect of -- the shape of the curve that you

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1 showed on slide 26. That probably has greater effect
2 on what the slope and consistency of that curve is
3 than just how many gallons you're pumping in or
4 pushing in.

5 DR. KEMPER: That's also a function of the
6 paper shape that you're assuming. What we've
7 identified for this plant is a top skewed shape which
8 is the most limiting and that's what is analyzed here.
9 One simplification that we introduced for the advanced
10 plan analyses is to do some shape studies and use the
11 bounding shape. In our conventional plan analyses we
12 sample power distributions and consider a variety of
13 them and the uncertainty methodology.

14 CHAIRMAN WALLIS: Sample in an aleatory
15 way the time after refueling. The power profile
16 changes. Do you sample that in an aleatory way?

17 DR. KEMPER: Well, the sampling in the
18 three and four loop methodology is from a number of
19 shapes. It's not necessarily tied to a given burnup.
20 That methodology does assume maximum start energy so
21 it's early in life.

22 CHAIRMAN WALLIS: So if you change your
23 fuel management scheme for this right after you built
24 it, you would have to redo all the stuff?

25 DR. KEMPER: We would have to, I think,

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1 verify the shape that we looked at is bounded. That's
2 our intent here. That is another reason to go with
3 what we believe to be a bounding shape so that we're
4 not -- we don't have a distribution based on shapes
5 that ultimately might --

6 CHAIRMAN WALLIS: So there's an additional
7 conservatism in this then?

8 DR. KEMPER: Yes, definitely.

9 CHAIRMAN WALLIS: Besides this 95th
10 percentile is the fact that you've used some kind of
11 what you think is a bounded shape for the power
12 profile.

13 DR. KEMPER: Definitely.

14 MEMBER SIEBER: And there's other factors
15 there, too, because you have to make an allowance for
16 misaligned broads and tilts and things like that which
17 is also built into that calculation

18 DR. BANERJEE: How much volume do
19 accumulators have compared to the volume of the
20 vessel?

21 DR. KEMPER: Accumulators are 2000 cubic
22 foot tanks and the water level nominal level is 1,700
23 cubic feet. With two of them there's like 3,400 cubic
24 feet and that's certainly larger than the lower part
25 of the vessel and the core.

1 DR. BANERJEE: So that would cover the
2 core, 3,400 cubic feet?

3 DR. KEMPER: Yeah. I'm thinking maybe
4 there is 1,200 or 1,500 cubic feet to the hot leg
5 elevations in the reactor vessel.

6 DR. BANERJEE: And roughly how many cubic
7 feet do you lose out of a cold leg break?

8 DR. KEMPER: The initial part of the
9 transient while your accumulator is injecting and the
10 pressure is still high you do have bypass and lose
11 most all of the accumulator water at that point in
12 time. I would guess that it's less than 20 percent of
13 the total water in the accumulators for this plant
14 that would bypass during this point.

15 CHAIRMAN WALLIS: Well, this shouldn't be
16 an issue. This is an old PWR analysis and there's
17 nothing new about AP1000 presumably.

18 DR. KEMPER: Yeah. That's --

19 CHAIRMAN WALLIS: Except the CMTs don't
20 have a role.

21 DR. KEMPER: CMTs really come on the first
22 few seconds but then it's all accumulators and they
23 don't contribute.

24 So for AP1000 we have performed a large-
25 break LOCA analysis as we are required to according to

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1 the regulations and followed the restrictions that had
2 been identified by the staff both in terms of those
3 carried over from the methodology as a whole for
4 Westinghouse best estimate large-break LOCA. And also
5 the AP600 restrictions from the SER issued for that
6 plant design.

7 CHAIRMAN WALLIS: So you do this
8 calculated 95th percentile. Presumably there's some
9 PCTs you calculate which are higher than that. Is
10 that your disparities to get to a distribution and
11 then cut it off at the 95th percentile?

12 Or are you going to say the nonparametric
13 method is to say we'll calculate a lot of things and
14 make sure we've got a 95 percent confidence that we've
15 got at least something in 95th percentile and then we
16 use that value and it may be above or -- it may be way
17 up above the bound of the 95th percentile if you did
18 billions of calculations, but at least it's a number
19 you can use.

20 DR. KEMPER: Well, this methodology uses
21 response surfaces and sampling to identify that. I
22 believe some of my colleagues are going to be speaking
23 with you hopefully soon about the approach you're
24 indicating that we are aware one of our competitors
25 has adopted. That doesn't apply to AP1000.

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1 MEMBER KRESS: With the response surface
2 at 95 percentile means that 5 percent of the results
3 are above that number.

4 DR. KEMPER: Five percent are --

5 CHAIRMAN WALLIS: That's right. So you do
6 calculate some numbers higher than 2,124.

7 DR. KEMPER: Yes.

8 CHAIRMAN WALLIS: What's the highest one
9 you calculated then?

10 DR. KEMPER: Really our codes aren't set
11 up to necessarily identify them.

12 CHAIRMAN WALLIS: They have a loop that
13 says if it gets over 2,200 --

14 DR. KEMPER: No, no. They print out the
15 95th percentile value when you're doing your Monte
16 Carlo sampling. I'm not --

17 CHAIRMAN WALLIS: I guess someone else
18 might address that. It's a generic problem with these
19 codes and it's a problem with the realistic code
20 approach is what are you going to accept as being good
21 enough statistically.

22 MEMBER KRESS: I think it's already been
23 decided.

24 CHAIRMAN WALLIS: I think it's already
25 been decided so we can't do anything about it. I

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1 think this committee might want to revisit that in the
2 future generically for all reactors. It's all been
3 approved so we can't do anything about it.

4 DR. KEMPER: I won't argue with that.

5 MEMBER KRESS: The point is you want to
6 keep the core cool and this is a conservative number
7 anyway to keep the core cool.

8 DR. KEMPER: So in the way of RAIs our
9 initial presentation of this material was, I'll call
10 it, rather sparse consistent with some of what the
11 operating plants had been providing for their three
12 and four loop methodology. They wanted significantly
13 more information so we provided that.

14 Another request was to continue running
15 the large grade beyond the time at PCT out beyond the
16 point the accumulators are empty and you have the CMTs
17 now providing the injection. They are the source of
18 injection until such time that you reach the low level
19 in the CMT tank to permit IRWST to come on. We
20 performed that analysis and the injection is adequate
21 to maintain the core quenched.

22 CHAIRMAN WALLIS: Maybe this is a good
23 time to take a break before you move on to the next
24 topic.

25 DR. KEMPER: If you think so.

1 CHAIRMAN WALLIS: I think it is. We'll
2 take a break. We'll come back at 10:30 which will
3 bring us back to our original schedule. Okay. We'll
4 take a break until 10:30.

5 (Whereupon, at 10:14 a.m. off the record
6 until 10:33 a.m.)

7 CHAIRMAN WALLIS: Okay. Let's get started
8 again.

9 DR. KEMPER: Bob Kemper speaking again.

10 DR. CARUSO: Bob, before you start. Dr.
11 Wallis, I had one other piece of information to add to
12 my last comment about code availability. I determined
13 there is one Westinghouse code that the staff does
14 have in house. It's called the Map 5 code. It was
15 submitted by an operating reactor licensee to support
16 a change in containment licensing basis and we do have
17 a copy of the source code in-house. That's the only
18 one I'm aware of at this point.

19 CHAIRMAN WALLIS: This is not the code
20 that --

21 DR. CARUSO: I believe it's the Map 5
22 version of that code, yes.

23 CHAIRMAN WALLIS: The one that we had
24 considerable questions about?

25 DR. CARUSO: I believe so, yes.

1 CHAIRMAN WALLIS: In terms of the handling
2 of the mixing?

3 DR. CARUSO: Yes, I believe so.

4 CHAIRMAN WALLIS: And you never came back
5 to us with an improved explanation?

6 DR. CARUSO: I don't want to go there.

7 DR. THROM: Dr Wallis, Ed Throm with the
8 staff. I'm in the group Plant Systems that will be
9 looking at that Map 5.

10 CHAIRMAN WALLIS: We need to look at Map
11 5 again in this committee.

12 DR. THROM: Yeah, but we do have -- just
13 to address the issue of code availability, we do have
14 the code. We have the source term and we may exercise
15 it as necessary.

16 CHAIRMAN WALLIS: Okay. But presumably
17 this licensee is intending to use it.

18 DR. THROM: Yes, and we are still very
19 early in the stages of the review.

20 CHAIRMAN WALLIS: We need to see that code
21 again. I think our staff will follow up on that.

22 DR. THROM: Yes. Thank you.

23 CHAIRMAN WALLIS: Sorry to interrupt.

24 DR. KEMPER: All right. I'm going to
25 proceed to talk about long-term cooling analysis that

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1 we performed for AP1000. As a large break what we're
2 doing is applying a methodology that had been
3 developed and approved for use on AP600. This is
4 another analysis that uses our WCOBRA/TRAC code in a
5 very much less detailed nodalization and approached
6 than is used for the large-break LOCA event.

7 In the approval for AP600 the staff did
8 identify some limitations for the application. We
9 have adhered to those doing the AP1000 analysis.
10 Nodalization is the same as it was before so it is
11 still consistent with the validation calculations that
12 we did to support the application on AP600.

13 CHAIRMAN WALLIS: Did you do sensitivity
14 studies on nodalization? The idea that you could fix
15 a nodalization on OSU and then use it for this large
16 scale device is quite a step, if that's what you're
17 doing.

18 DR. KEMPER: That's indeed what was done
19 for AP600 that we are doing here. In doing OSU they
20 did investigate some things regarding to the code. I
21 honestly don't recall if they were noting sensitivity
22 studies as a part of that.

23 MEMBER RANSOM: You mean you have a longer
24 vessel. You didn't use any different nodalization in
25 the vessel than the AP600?

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1 DR. KEMPER: The vessel below the hot legs
2 is approximately the same length. The core is now 14
3 feet instead of 12 feet. No additional node was used
4 for that.

5 MEMBER RANSOM: I thought there was a
6 longer distance between the top of the core and the
7 bottom of the hot leg.

8 DR. KEMPER: I believe that dimension is
9 the same.

10 MEMBER RANSOM: That's the same?

11 DR. KEMPER: Yeah. I think that was the
12 only thing we wanted to definitely preserve for this.
13 We took some volume out of the lower plenum to
14 accommodate the additional two feet of active fuel
15 length.

16 MEMBER RANSOM: How many nodes are used
17 between the top of the core and the bottom of the hot
18 leg?

19 DR. KEMPER: This is a very coarse model
20 so there are two nodes within the core and one node
21 within the upper plenum range. These transients are
22 very long duration with slowly changing phenomena.
23 The idea here was to come up and validate a simple
24 model that we could use and make it feasible to do in
25 computer running time space.

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1 MEMBER KRESS: Refresh my memory on the
2 window mode. What you did was took a window in time
3 and looked at the transient and then extrapolated that
4 to some other window in time?

5 DR. KEMPER: Okay. Window mode was
6 another thing that was implemented, again, because
7 these transients are so long. The idea of the window
8 mode is to focus on the time of most interest or the
9 time of lowest capability of the system.

10 Typically that has been when the IRWST is
11 drained down to the point that sump injection or
12 containment recirculation of water begins. This can
13 be for some breaks well out there in time.

14 The window mode methodology is developed
15 and validated against OSU to look at that point of
16 time that you're interested in, specified boundary
17 conditions for the containment pressure, the levels in
18 the IRWST and/or sump, and temperatures associated
19 with the liquid present there.

20 Then start with those boundary conditions
21 and begin initializing the reactor vessel and primary
22 system with a set of identified initial conditions
23 that were deemed reasonable. Now, this is a boundary
24 value type of problem.

25 The way we've approached it is you run the

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1 code for a period of time just until it settles out to
2 its determine condition and overrides the initial
3 condition that you specified. Then you proceed to
4 analyze the transient.

5 CHAIRMAN WALLIS: This is long-term
6 cooling?

7 This is when you have already filled the sump?

8 DR. KEMPER: This is --

9 CHAIRMAN WALLIS: The picture we just saw
10 that Mike showed a picture of water everywhere around
11 the reactor. Is that what is meant by long-term
12 cooling?

13 DR. KEMPER: That would be during long-
14 term cooling.

15 CHAIRMAN WALLIS: So nothing exciting is
16 going to happen. Is it?

17 DR. KEMPER: Probably not if you have
18 your --

19 CHAIRMAN WALLIS: You've got water
20 everywhere and it's higher than the core and its got
21 access to the core. The question might be can you get
22 rid of the heat to the environment?

23 DR. KEMPER: It should be very benign
24 given that you have properly sized ADS stage 4 valves
25 pass the safety system.

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1 CHAIRMAN WALLIS: That's all over. Isn't
2 it?

3 DR. KEMPER: Still your ADS-4 --

4 CHAIRMAN WALLIS: Yeah, but it's open.
5 It's a huge opening.

6 DR. KEMPER: It's been open for an
7 extended period of time. You're draining water from
8 the IRWST and/or recirculating it from containment.

9 CHAIRMAN WALLIS: And the velocities at
10 that valve are relatively modest, aren't they, by
11 then? Or are we still dealing with fairly high flow
12 rates out of ADS-4?

13 DR. KEMPER: Well, the velocities at the
14 time of sump injection, which was the picture Mike
15 showed, depending on your assumptions regarding single
16 failure of the ADS-4 valve that we would need to
17 assume.

18 CHAIRMAN WALLIS: It can't be very high.
19 It would have a big pressure drop and then you
20 wouldn't get the water in so there must be a very low
21 pressure drop for that valve. Or is it a few feet of
22 water or something?

23 DR. KEMPER: No. It's a PSI or two. It's
24 not large.

25 CHAIRMAN WALLIS: A few feet of water?

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1 DR. KEMPER: Yeah.

2 DR. BANERJEE: Did the OSU tests show any
3 oscillations in the long term?

4 DR. KEMPER: There were some.

5 DR. BANERJEE: Could you explain those?

6 DR. KEMPER: Well, a lot of effort went
7 into explaining those. I was not part of that. I
8 don't think they were considered safety significant.
9 I know there was something that went on in the core
10 makeup tanks in one of the tests but I'm not really
11 familiar with all of what was determined from that.

12 MR. CORLETTI: Perhaps tomorrow Dr. Reyes
13 from Morgan State will be here as will some of the
14 other people that we have involved with the test
15 program and we could revisit some of that question as
16 far as the oscillatory behavior.

17 CHAIRMAN WALLIS: So do you think that
18 behavior was peculiar to that facility or would it be
19 expected?

20 MR. CORLETTI: Not necessarily. I think
21 it's characterized by flood of water and filling up
22 the system and then burping out of the ADS valves and
23 filling the system and burping out. It is an
24 oscillatory behavior that you can see. We even see
25 some of that in our calculations for the plant as

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1 well.

2 DR. BAJOREK: Bob, weren't those due to
3 condensation on the outside shell of the CMT in the
4 tests and it was condensation inside the CMT that was
5 stagnating the flow periodically and that was feeding
6 back on the oscillation.

7 MR. CORLETTI: I think that was associated
8 with one set of oscillations. I think there may have
9 been some other things going on, too. I never
10 personally looked into that to a great extent.

11 DR. BANERJEE: And your codes model this
12 for this calculation?

13 MR. CORLETTI: The codes will show
14 behavior of a slug of liquid enters the ADS stage 4
15 and then you pressurize the system. Once that passes
16 the pressure drops back. That type behavior is
17 observed in the code level.

18 CHAIRMAN WALLIS: Are you discussing this
19 now because this was some point of issue with the
20 staff?

21 MR. CORLETTI: No. Just basically that
22 we've --

23 DR. CUMMINS: This is Ed Cummins. Maybe
24 I could give a context to long-term cooling. The
25 safety issue or the safety significant question is

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1 that as the IRWST empties and transitions to injection
2 to the sump you have less driving head and is the
3 driving head sufficient at that stage to cool the core
4 with your ADS flow.

5 We had to prove that to the staff and we
6 used this analysis to prove it to the staff. The
7 sequence was modeled in the OSU test and we
8 benchmarked the codes against the OSU test and then
9 predicted the plant.

10 DR. BANERJEE: I guess the issue is
11 whether a bubble short of grows and there's liquid
12 held up in the hot leg in the ADS system which has to
13 be pushed out. Then this bottle sort of vents and
14 then starts that process again. Is there something
15 like that happening or is it just the CMT sucking?
16 There was that, too, wasn't there, that the CMT
17 motivated?

18 DR. KEMPER: Slugging of portions of
19 liquid flow through the ADS-4 valves were observed in
20 the tests but it was never to an extent that you were
21 doing anything significant to the water inventory.

22 CHAIRMAN WALLIS: I think your argument
23 has to be that if you get water into the ADS-4 line,
24 there must be water above the core and there is no
25 problem.

1 DR. KEMPER: Exactly.

2 DR. BANERJEE: Well, it could be a growing
3 steam bubble. You see, you've got stuff there in the
4 hot leg ADS and you could be growing this until it
5 breaks through and vents and then it starts again.
6 That's why I'm asking what is the phenomena? If the
7 phenomena was something different, that's fine, but
8 what was the basis of this phenomena? Did they see
9 oscillations in core temperature?

10 DR. KEMPER: No, I don't think so, not in
11 any of the -- nothing significant in my recollection
12 occurred in the way of inventory in the vessel during
13 anything that was causing these small fluctuations in
14 pressure.

15 DR. BANERJEE: Anyway, maybe tomorrow he
16 could just briefly address it.

17 MR. CORLETTI: Dr. Wallis, one question
18 you asked is when are we presenting this. This is one
19 of the safety analysis that is in the Chapter 15 of
20 our DCD and we were providing it.

21 CHAIRMAN WALLIS: But I thought we were
22 going to go over today the areas where there might be
23 some tentacle problems we had to think about.

24 MR. CORLETTI: The only issue that was
25 raised by the staff during the pre-cert review was in

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1 addition to this window mode that we talked about
2 where we looked at key windows, they had asked could
3 we do a continuous transient calculation from the
4 beginning of the transient and we did do that.

5 Some of the transients are so slow. We
6 can't run a 30-day transient that way but we did run
7 some that are -- we did run a limiting one in that way
8 and provided that also to the staff. That was, I
9 think, the one issue from the pre-cert review.

10 CHAIRMAN WALLIS: What you're predicting
11 is that you've got this sump full of water, water
12 flows into the core, there's a two-phase flow in the
13 core but what comes out into the ADS-4 line is steam.

14 MR. CORLETTI: It's a mixture, yes.

15 CHAIRMAN WALLIS: It is a mixture?

16 MR. CORLETTI: Yes.

17 CHAIRMAN WALLIS: So maybe you have to get
18 the two-phase flow right.

19 MR. CORLETTI: Yes, I believe you do.

20 DR. BANERJEE: It's not steady.

21 CHAIRMAN WALLIS: It's not steady.

22 MR. CORLETTI: In the oscillatory behavior
23 that you are referring to here on these tests was kind
24 of a filling and venting kind of a long-term
25 operation. The other oscillations about the core

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1 makeup tanks and condensing in the core makeup tanks,
2 that's a very early time. The core makeup tanks
3 before they start to inject --

4 CHAIRMAN WALLIS: If the core were to be
5 drying, you wouldn't get two-phase flow out the ADS-4
6 line. Would you?

7 MR. CORLETTI: That is correct. When we
8 do have water in the hot leg, we think this is a good
9 sign.

10 CHAIRMAN WALLIS: So if you analyzed that
11 case where you began to dry-out and showed that you
12 were okay then, maybe you wouldn't need to do all the
13 other work.

14 MR. CORLETTI: That would be a bounding
15 calculation. Yes, I agree with that.

16 CHAIRMAN WALLIS: I think that would be
17 more convincing to us if you could show a couple of
18 pictures about what's happening and say, "We make this
19 bounding calculation and it can't be worse than that
20 and everything is okay," we can believe it. But when
21 it's sort of just words like this, we don't quite know
22 what we're looking at.

23 MR. CORLETTI: Maybe, Bob, if you
24 continue.

25 MR. SNODDERLY: I'm sorry. Mike, before

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1 we continue, Dr. Wallis, when we developed the agenda
2 I thought it would be useful for Westinghouse to just
3 give you an overview of the large-break LOCA, small-
4 break LOCA and the containment analyses. What we
5 accomplished in bullet No. 3 was really what the major
6 open issues that were identified during the
7 preapplication process except for liquid entrainment
8 which we're going to do later and to try to give some
9 idea --

10 CHAIRMAN WALLIS: Four is just a review of
11 some of the major safety analysis results which were
12 not subject to RAIs.

13 MR. SNODDERLY: They were subject to RAIs
14 and there may be some open items that will be covered,
15 but I think what I wanted to try to do here was just
16 to provide you an overview of those analyses.

17 CHAIRMAN WALLIS: I think it would always
18 help this committee if instead of getting this
19 presentation which says, "We did this and everything
20 is fine," if you could sort of give a better picture
21 of, "We had to consider these phenomena and this is
22 what happened. The RAI analyses were secure," and so
23 on.

24 DR. BANERJEE: Well, in particular with
25 this the collapsed liquid level is six to eight feet

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1 or eight and a half. That's about 50 percent of the
2 core roughly. Oh, sorry. You were going to come to
3 that?

4 DR. KEMPER: Yeah. Well, we can come to
5 that.

6 CHAIRMAN WALLIS: Can you just keep going
7 until you get that picture?

8 MR. SNODDERLY: I'm sorry, Bob. Before we
9 move on, I hate to interrupt again, Graham, but could
10 we go back to assist me in my notes. Dr. Banerjee's
11 question, I don't know if we clearly answered that
12 when he asked can COBRA/TRAC model the oscillations
13 that were seen at the OSU test. It wasn't clear to me
14 whether they could or they were.

15 DR. KEMPER: Yeah, WCOBRA/TRAC models
16 oscillations are comparable to those that occurred in
17 the test with regard to ADS-4 liquid and steam flow.

18 MR. SNODDERLY: Thank you. Bob.

19 DR. BANERJEE: And that's documented in
20 some report?

21 DR. KEMPER: Yeah, there's a large inch-
22 thick WCAP about Oregon State University.

23 DR. BANERJEE: Do you know that number?

24 DR. KEMPER: 14776 Rev. 4. Okay. So the
25 one thing with condenses and the time since AP600 we

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1 did have the capability to run a DEDVI line break case
2 from the end of the NOTRUMP run onward out into the
3 sump injection phase and did not at this point have to
4 use window mode to do this. This is one of the
5 results from that run. As Dr. Banerjee noted, it's
6 core collapsed liquid level.

7 CHAIRMAN WALLIS: What is times zero on
8 this plot?

9 DR. KEMPER: Times zero on this would be
10 the end of the NOTRUMP run which would be 4,000 second
11 maybe.

12 MR. CORLETTI: After IRWST injection.

13 DR. KEMPER: Once the IRWST is on and has
14 established itself as a consistent source of input of
15 water to the vessel.

16 DR. BANERJEE: But this level is
17 calculated by COBRA/TRAC?

18 DR. KEMPER: Yes. This is COBRA/TRAC
19 result for collapsed liquid level.

20 DR. BANERJEE: It's a 3-D calculation?

21 DR. KEMPER: No, it's essentially a 1-D
22 calculation.

23 DR. BANERJEE: And this is with the two
24 nodes or something or more nodes?

25 DR. KEMPER: Two nodes in the core.

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1 DR. BANERJEE: If I remember, you have
2 some large bundle tests, right? Fourteen-foot bundle
3 tests and 12-foot bundle tests, G2, G1?

4 DR. KEMPER: There's blow-down heat
5 transfer.

6 DR. BANERJEE: No, I'm saying boil-up
7 collapse liquid level. When do you get dry-out? At
8 what sort of collapsed liquid levels?

9 DR. KEMPER: Dry-out was not observed
10 during this phase in any of the AP600 tests at OSU.

11 DR. BANERJEE: No, no. OSU is not the
12 same height. This is a 14-foot bundle. Do you have
13 tests showing first that you are getting the right
14 collapsed liquid levels and, second, getting about 50
15 percent there that you don't have dry-out? The
16 numbers are around 30 or 40 percent that you get dry-
17 out with collapsed liquid levels.

18 CHAIRMAN WALLIS: You're meaning the level
19 of the two-phase mixture which you're looking for.

20 DR. BANERJEE: Well, that's where it goes
21 to. If you have about 30 percent collapsed liquid
22 level, for sure you get dry-out. At about 40 percent
23 the jury is out. Maybe you do get dry-out.

24 CHAIRMAN WALLIS: You get two-phase swell
25 that you wet the top of the core.

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1 DR. BANERJEE: And that's a function of
2 the height of the core. Actually, it's quite easy to
3 show analytically.

4 CHAIRMAN WALLIS: There is a situation
5 here where if you had too little heat produced, you
6 might be worse off because you might actually not so
7 much swell so you might actually dry-out the top.

8 MEMBER KRESS: Is the 14-foot the top of
9 the active core?

10 DR. KEMPER: That's right.

11 MEMBER KRESS: So your two-node break line
12 is at the seven-foot level?

13 DR. KEMPER: That's right. This is the
14 overall collapse level which is at like 60 percent.

15 CHAIRMAN WALLIS: It's a pretty crude
16 model with two nodes and you're trying to predict this
17 level.

18 DR. BANERJEE: And also what's the
19 validation of this? If you get things a little bit
20 wrong in terms of flow resistance this could be
21 dropping so there's an issue of sensitivity as well.

22 DR. KEMPER: There were some sensitivities
23 looked at in the WCAP that I mentioned earlier
24 concerning the OSU predictions in terms of
25 implementation of this methodology.

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1 DR. BANERJEE: Remind me of the height of
2 the OSU core.

3 DR. KEMPER: It's three feet. Quarter
4 scale of 12-foot core so three feet.

5 DR. BANERJEE: Do you feel that those
6 experiments were really applicable to a 14-foot core?

7 DR. KEMPER: I would say no. Less so than
8 to a 12-foot core. You're still looking at a height-
9 scaled facility no matter.

10 DR. BANERJEE: You have experiments which
11 are with the 14-foot core and a 12-foot core, don't
12 you, with bundles?

13 DR. KEMPER: I'm not really familiar with
14 14-foot core.

15 DR. BANERJEE: Only 12-foot cores? One of
16 these big bundle experiments for level swell, how many
17 feet were they?

18 DR. KEMPER: They are all older
19 experiments. My recollection of the height would be
20 12-foot.

21 DR. BANERJEE: Okay. So let's say 12-
22 foot. That's closer than three-foot. How do the --
23 what did you find in these level swell experiments?
24 I mean, how much collapsed liquid level was required
25 to give no dry-out?

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1 DR. KEMPER: I don't really know the
2 answer to that.

3 CHAIRMAN WALLIS: But you're still having
4 two-phase flow-out the ADS-4.

5 DR. KEMPER: Yes.

6 CHAIRMAN WALLIS: So what you're
7 predicting is that this two-phase flow go all the way
8 through the core and above it and that's what cooling
9 it.

10 DR. KEMPER: Right. You have two-phase
11 flow.

12 CHAIRMAN WALLIS: The reason this level is
13 so low is because you're making a lot of steam in the
14 core.

15 DR. KEMPER: Yeah. You still have
16 significant decay heat.

17 DR. BANERJEE: Also whether it's steady is
18 important or not. I mean, in the long term. Do you
19 just have a steady boiling with flow out or are you
20 getting some sort of jogging phenomena which is going
21 back and forth?

22 If there is jogging, how much further down
23 is it going and what is the period? I think those are
24 things which your code can probably calculate but it
25 has to be validated against some database which is

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1 representative. A three-foot core maybe tells you
2 something but it's not the same as a 14-foot core.

3 CHAIRMAN WALLIS: Don't you have to get
4 the bubble rise velocity or the interfacial drag or
5 something right to do this? Isn't that the key thing
6 you have to get right to get the level swell?

7 DR. KEMPER: The interfacial drag would be
8 what you're looking at to get the level predictions
9 good in the vessel in the upper plenum, yes.

10 MEMBER RANSOM: Two analogies don't have
11 enough detail really, I would think. I was going to
12 ask you does the fuel also only have two axial nodes,
13 the core?

14 DR. KEMPER: That's right.

15 MEMBER RANSOM: So you have lumped the
16 upper region and the lower region into relatively low
17 power type situation whereas you're missing the point
18 of the highest power where you're more likely to get
19 dry-out.

20 MEMBER SIEBER: That's true.

21 MEMBER RANSOM: I really don't know that
22 you could look at these kind of calculations and draw
23 any conclusion about whether or not you have seen dry-
24 out.

25 CHAIRMAN WALLIS: The dry-out that we're

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1 talking about, I think, is not DMB type dry-out. It's
2 just simply the water doesn't get to the top of the
3 core. Is that what you're talking about?

4 MEMBER SIEBER: Right.

5 CHAIRMAN WALLIS: There isn't water at the
6 top level of the core so it's just steam cooling and
7 that might take off. I would think this is a simple
8 problem and the staff could do some of its own
9 checking calculations or something. Well, it has.
10 You want to ask the staff? Is this a problem here?
11 Are we spending too much time with it?

12 DR. BAJOREK: I think it's a valid
13 question. I do kind of question having only two axial
14 nodes in the core for this. Now, I think in answer to
15 the question, yeah, we have looked at this type of
16 phenomena.

17 Generally what you find by looking at
18 tests like Oakridge, the G2, which is a 14-foot
19 bundle, G1 and, I believe, Theta which I haven't
20 looked at, is that at lower-type pressures your level
21 swell, which can take like a ratio between your two-
22 phase level and your collapse level, is about a two
23 with some uncertainty.

24 That would say in these calculations you
25 would start expecting dry-out at the top if you got

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1 below about seven feet. Now, it appears that there's
2 enough level in this one that you're probably not
3 drying out.

4 Maybe not by a large amount but, there
5 again, the way that is nodalized you may be cheating
6 yourself of some liquid because you aren't getting a
7 good axial discretion in the void fraction. I mean,
8 this is saying that you're getting basically a 40
9 percent void fraction on average in the core.

10 My guess is without looking at the plots,
11 we're seeing something that's on the bottom cell of .1
12 void fraction with something fairly high. That is
13 going across too many flow patterns for COBRA/TRAC to
14 really do a good job on.

15 DR. BANERJEE: Just another question.
16 Does COBRA/TRAC have a drift flux model built in to
17 get the level swell or how does it do it?

18 DR. KEMPER: Well, this is in the COBRA
19 vessels where you have representations of interfacial
20 drag. It's not a drift flux model.

21 DR. BANERJEE: Two fluid?

22 DR. KEMPER: Two fluid.

23 DR. BANERJEE: Then how does it get the
24 level swell right? Two fluid models are notoriously
25 bad at getting level swell right as far as I know.

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1 How does it get the level right?

2 DR. KEMPER: Well, again, in the WCAP by
3 reference that shows that for this application that
4 was done right. The COBRA/TRAC expert will be here
5 this afternoon if you would like to pursue that
6 further.

7 DR. BANERJEE: Who is the expert?

8 DR. KEMPER: Dr. Ohkawa.

9 CHAIRMAN WALLIS: I think it would be good
10 if they could show more detail than just this curve.
11 This doesn't show us much.

12 DR. BANERJEE: Really what is the basis
13 for the belief in this?

14 MEMBER RANSOM: Well, it would be helpful
15 to see the void fraction profile, too. At least the
16 voids in the three different nodes that they have
17 above the core and the two core.

18 CHAIRMAN WALLIS: But they are very crude
19 models.

20 MEMBER RANSOM: Oh, extremely.

21 CHAIRMAN WALLIS: If you're worried about
22 whether it's six or seven or eight feet, I would think
23 the model is too crude to really distinguish that.

24 MEMBER RANSOM: Well, standard approach in
25 1-D codes use about a one-foot node, you know, so you

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1 would have like 12 to 14 nodes.

2 CHAIRMAN WALLIS: Doesn't your window do
3 that? Doesn't your window mode use more number nodes
4 or not?

5 DR. KEMPER: No.

6 CHAIRMAN WALLIS: It's so easy to do,
7 though. Just take a look at it at one point there and
8 calculate as it it were steady state. It should be
9 easy.

10 DR. BANERJEE: Well, the only thing I
11 don't know is whether, first of all, this is right.
12 Even if it is off by a little bit it doesn't really
13 matter. If it gets to six foot, for example, then you
14 are going to be drying out a significant part of the
15 top of the core if it's not eight but six.

16 CHAIRMAN WALLIS: It must depend on the
17 power level. If there's no power at the six-foot
18 level, it's dried out the rest of the core.

19 MEMBER SIEBER: It doesn't make any
20 difference.

21 CHAIRMAN WALLIS: If it's a very low power
22 level, then the bottom is just water and the top is
23 dry and heating up.

24 DR. KEMPER: Yeah.

25 CHAIRMAN WALLIS: It's primarily worse off

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1 than it was a long time in the future and you just
2 don't have enough power to keep the level of the swell
3 up there. It's all tied up to the ADS-4 flow rate,
4 pressure drop through that and how much that
5 depressures.

6 The whole picture isn't here at all.
7 Where do we go from here? I think someone has to look
8 into it in more detail because we're not getting
9 enough detailed answers here to be reassured. I don't
10 think we're going to get them right now.

11 MEMBER RANSOM: The other part that is
12 helpful is the heat transfer mode in each of these
13 nodes here.

14 DR. BANERJEE: This is almost a steady
15 state calculation. Right? Virtually. There's going
16 to be a calculation which is almost possible to do by
17 hand.

18 MEMBER KRESS: Hot water bottle with a
19 line feeding in.

20 DR. BANERJEE: As long as you know the
21 resistance.

22 MEMBER KRESS: Resistance coming in and
23 going out.

24 DR. BANERJEE: The only thing is if you do
25 get this oscillatory mode of chugging, that needs to

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1 be dealt with, too, to either explain it or something.

2 MEMBER KRESS: You would have to have
3 momentum equations so you couldn't do that by hand
4 very easy I don't think.

5 DR. BANERJEE: Very slow probably.

6 MEMBER KRESS: Yeah.

7 DR. BANERJEE: You might be able to do a
8 number of steady states.

9 MEMBER KRESS: You might.

10 CHAIRMAN WALLIS: Where do we go from
11 here? Are you guys going to come up with something
12 that is more convincing today or tomorrow or are we
13 going to ask the staff to look into this with more
14 detail? I don't see why you just don't do a 20-node
15 model. Stay the same would be trivial to do it.
16 There's not much going on. What's the problem?

17 DR. KEMPER: Well, the original problem
18 was computer resources for a very long transient.
19 That has changed over the years.

20 CHAIRMAN WALLIS: There's a big pool of
21 water and it's coming in through DVI line right into
22 a vessel and it's essentially sort of one dimensional
23 flow up through the vessel.

24 DR. BANERJEE: It may not be so one
25 dimensional.

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1 CHAIRMAN WALLIS: Is it wet at the top or
2 not?

3 MR. CORLETTI: Dr. Wallis, this is Mike
4 Corletti from Westinghouse. We'll be talking a lot
5 about WCOBRA/TRAC this afternoon and the models in the
6 code. Not on this code but in the other that we have
7 that we've done our supplemental calculation. I think
8 that maybe we can bring some questions there about how
9 this COBRA/TRAC really handled that. Then we can go
10 from there to see whether we need a future action
11 after we discuss that this afternoon.

12 CHAIRMAN WALLIS: I don't think looking at
13 the models in the code is going to help very much.
14 You have to look at what they are predicting in more
15 detail.

16 MR. CORLETTI: In our DCD we have quite a
17 bit more plots than this plot here. Also we can get
18 with Bob and see what is the best way to present that.

19 CHAIRMAN WALLIS: Maybe you could give Dr.
20 Ballenger a homework problem where you can tell him
21 some of these levels and the power level and the
22 resistance to the ADS-4 valve and he can come back
23 tomorrow and say it's okay or it's not.

24 MR. CORLETTI: I can give you the
25 resistances.

1 CHAIRMAN WALLIS: It's not a complicated
2 problem. That's why it's really puzzling me why you
3 are saying you are limited by computer resources. I
4 could do this overnight it seems to me with a PC.

5 DR. BANERJEE: You should get an
6 analytical solution.

7 CHAIRMAN WALLIS: Analytical solution.
8 Okay.

9 MEMBER RANSOM: Another question that I
10 think would be interesting to ask is when they resist
11 crude nodalization and one-dimensional in a multi-
12 dimensional code, do they use the same constitutive
13 package for the interface drag?

14 The floor regimes are quite different that
15 you must use from a 1-D representation versus a multi-
16 dimensional that uses the radio distribution across
17 the core. Is it the same constitutive package then
18 that is being used in COBRA/TRAC for both of these
19 calculations?

20 DR. KEMPER: Again, that would be a
21 question -- if you want to pursue it, I think you need
22 an expert.

23 CHAIRMAN WALLIS: Well, suppose we told
24 you we don't think a two-node model is good enough.
25 Show us something more detailed. Wouldn't that be a

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1 fair position for us to take? It doesn't have to be
2 transient. You have quasi-steady state at 2,000 and
3 8,000 second or something. So where's the details
4 with the quasi-steady state model? Should be able to
5 do it in a couple of days.

6 DR. CUMMINS: This is Ed Cummins. I think
7 the question is can you use another tool to predict
8 this result. It doesn't have to be COBRA/TRAC. It
9 can be Dr. Banerjee's or Westinghouse's hand
10 calculation. We can handle that kind of a question.

11 CHAIRMAN WALLIS: But not with two nodes.
12 Two nodes seem much too crude for this problem. Did
13 the staff let them get away with two nodes?

14 Steve, did you let these guys get away
15 with a two-node model for this thing?

16 DR. BAJOREK: Well, I want to hesitate
17 because I don't really feel I should be answering your
18 question, but I think the answer is no, you should not
19 be using a two-node core for something like this.

20 The reason being, and I think Katsu can
21 give you more explanation this afternoon, is that in
22 subroutine interfere where these interfacial drag
23 correlations are done, it will break up this core or
24 this process into several discrete flow patterns.
25 Embedded in those interfacial drag correlations are

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1 RAMS that go between delta alphas of about .2 to .4.

2 Now, I think just by doing a mental
3 calculation on the delta void, what the code has done
4 in this is it has jumped over a couple of these flow
5 patterns. You've gone from bubbly up to annular and
6 you've mushed out everything else in between. The
7 interfacial drag in those regimes are drastically
8 different. Much higher down on the bubbly and the
9 slug than it is up in the annular.

10 I think by not having the nodalization
11 there, you've missed several of the bubbly slug churn
12 pattern which would probably give you or retain a
13 higher froth and more liquid in the core. I think
14 that's what you would wind up seeing in a more
15 detailed calculation.

16 Secondly, I think maybe what you might
17 want to think about are, I think, some of the
18 simulations that were done with the G2 and I think G1
19 and Oakridge to kind of show that COBRA-TRAC does kind
20 of model level swell. I think there is a basis there
21 but I think you're going to have to pull that out.

22 DR. KEMPER: Yeah. Well, as Dr. Bajorek
23 mentioned, we have these simulations. Now, this is a
24 no core uncovering situation so it's a different
25 condition from some of these tests that were core

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1 uncover tests literally.

2 CHAIRMAN WALLIS: It seems to me we have
3 some new RAIs here and somehow or the other these 700
4 RAIs didn't pick up these matters that we're
5 discussing now.

6 DR. BAJOREK: I think 440 164 alludes to
7 that.

8 DR. KEMPER: Well, this is long-term
9 cooling as opposed to --

10 CHAIRMAN WALLIS: This is long-term
11 cooling. Did you discuss the long-term cooling issue
12 with the RAI's? Did you have this sort of discussion
13 with them that we're having now about the two nodes?

14 DR. BAJOREK: I guess you would have to
15 ask the NRR reviewer who was doing the long-term
16 cooling.

17 CHAIRMAN WALLIS: Apparently not.

18 DR. LOIS: This is Lambert Lois, Reactor
19 Systems. Within that question of the two-node
20 solution that they proposed, we do have some
21 outstanding questions regarding the model that they
22 used generally in the long-term cooling.

23 CHAIRMAN WALLIS: We just have two
24 samples. We have large-break LOCA and long-term
25 cooling that we've looked at a little bit today. One

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1 of them looks as if we have some important questions
2 about. From a sample of two, one of them we've got
3 important questions about. If we had a sample of 50,
4 I wonder how many we would have important questions
5 about.

6 DR. BANERJEE: Just as a matter of
7 information, what is the velocity of the steam and the
8 hot leg and through the ADS valves? This is almost
9 atmospheric pressure.

10 DR. KEMPER: Right. Now, the velocity
11 depends on how many valves you are presuming to have
12 open and what conditions. It would be on the order of
13 100 feet per second. For a single failure case you
14 could be maybe size 300 feet per second at some point
15 steering this transient.

16 CHAIRMAN WALLIS: This is in the hot leg?

17 DR. KEMPER: This is in the ADS-4 line.

18 DR. BANERJEE: And the hot leg?

19 DR. KEMPER: The hot leg would be lower
20 because of its significantly higher area.

21 CHAIRMAN WALLIS: It's a lot less. What's
22 the area ratio?

23 DR. KEMPER: Let's see. Maybe a factor --

24 DR. BANERJEE: Two to one. Let's say 50
25 to 100.

1 DR. KEMPER: Two and a quarter to one.

2 CHAIRMAN WALLIS: And what's the velocity
3 coming out of the core?

4 DR. BANERJEE: Top of the core.

5 CHAIRMAN WALLIS: Steam velocity coming
6 out of the core.

7 DR. KEMPER: There you have a wide area.

8 CHAIRMAN WALLIS: Is it one or 10 feet a
9 second? Twenty? .1?

10 DR. KEMPER: Order of 10 feet per second
11 I would say.

12 CHAIRMAN WALLIS: So it's reasonably
13 significant. It's above the bubble rise quite a bit.
14 It's probably carrying over liquid. If it's carrying
15 over liquid, then double the core is wet. It seems to
16 me all these answers ought to be there just like this
17 without having to dig for them.

18 DR. BANERJEE: But, as Graham says, if the
19 velocities are at 10, 15, 20 feet per second, you are
20 probably getting droplets coming out.

21 CHAIRMAN WALLIS: No problem at all. You
22 may have no problem. But you may have a problem at
23 2,000 seconds or something, or 20,000 seconds. When
24 the power level has gone down, you don't have enough
25 velocity to carry the liquid up. This long-term

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1 cooling may be a problem several days later. I don't
2 know. Did you pursue this out much longer in time?

3 DR. KEMPER: We've got a calculation that
4 was done at 28 days, 30 days.

5 CHAIRMAN WALLIS: Is this okay 100 days in
6 time?

7 DR. KEMPER: The 38-day calculation
8 assumes low levels as well within the containment so
9 it's a minimum driving head type of situation. That
10 case was adequate.

11 DR. BANERJEE: Why is it lower?

12 MR. CORLETTI: In 30 days we assumed that
13 there are passive leaks inside the containment and
14 that the water actually falls to a lower level. It's
15 what we call a wall-to-wall flooding case where we
16 assume that all the compartments flood to an even
17 level and that's a reduced level compared to the
18 design basis case earlier.

19 CHAIRMAN WALLIS: When I looked at this
20 figure, what concerned me right from the start is
21 you've got a collapsed level that starts out at
22 something like 7.5 and it slowly goes up to something
23 over 8. Then at around 8,000 seconds it starts to
24 wiggle more and come down. You wouldn't expect that,
25 would you?

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1 DR. KEMPER: That's when you have reached
2 the point of minimum driving head. The IRWST is
3 emptied to its level where you begin self-
4 recirculation. That's a low-driving head situation
5 and you begin to have warmer water come that's been
6 from the sump. Instead of the highly sump cool water
7 from the IRWST, you are now having warmer water being
8 injected into the sump.

9 CHAIRMAN WALLIS: So it makes more
10 bubbles, makes more steam, makes more voids.

11 DR. KEMPER: You have a little more
12 voiding in the core.

13 CHAIRMAN WALLIS: This curve really should
14 be continued out until the level is 14.

15 MR. CORLETTI: In the 30-day case, the
16 wall-to-wall flooding case actually shows collapsed
17 level of about 14 feet.

18 CHAIRMAN WALLIS: Thirty days?

19 MR. CORLETTI: Yes. We do this window
20 mode for some time periods in between so this shows
21 that we're --

22 CHAIRMAN WALLIS: And it never goes --
23 does it steadily go up from eight to 14 or does it go
24 down part of the time?

25 MR. CORLETTI: This is the window modes

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1 that we're doing. I believe if you look at the
2 windows that we did --

3 Bob, do you have an answer to that trend?
4 Is that the trend? Or did we do enough windows in
5 that trend?

6 DR. KEMPER: I would expect that to be the
7 trend but there's no specific calculation done for
8 AP1000 under that.

9 CHAIRMAN WALLIS: To be reassured about
10 the safety of this thing, I would like sort of more
11 positive answers.

12 MR. CORLETTI: Yes. I understand.

13 CHAIRMAN WALLIS: I thought you guys had
14 it all sewed up.

15 MR. CORLETTI: This methodology is the
16 methodology we did use on AP600 and that we reviewed
17 during the pre-cert.

18 CHAIRMAN WALLIS: I don't really care
19 about methodology. I just care about convincing
20 arguments that this thing isn't going to have any
21 problems.

22 MR. CORLETTI: Okay. I understand.

23 CHAIRMAN WALLIS: That's all I care about.
24 I only care about approved methodology and all that
25 stuff.

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1 MR. CORLETTI: I misunderstood your
2 question. I think --

3 CHAIRMAN WALLIS: You can always take
4 refuge in approved methodology. If I'm not convinced
5 that it's going to work, it doesn't help me.

6 DR. BANERJEE: But what is approved for a
7 12-foot core at a lower par density and different
8 floor regimes may not be approved for this.

9 CHAIRMAN WALLIS: Okay. So this is going
10 to be resolved before you come before the full
11 committee? Maybe we have to have another subcommittee
12 meeting. Maybe there is something we're just missing
13 here.

14 MR. SNODDERLY: Graham, I think the
15 meaning is objective in the sense that we want to try
16 to identify issues so that in the summer when we write
17 this letter on this draft SER the staff will have
18 identified certain open items.

19 We would confirm and say that they have
20 identified the proper open items or issues or they
21 haven't. This may be an example of an area where the
22 staff is inadequately -- not the staff but the models
23 used for long-term cooling are inadequate. Maybe we
24 should use more than two nodes.

25 These types of comments I would see going

1 in to the letter where the staff would either have to
2 come back and say, "No, we don't think that rises to
3 the level of an open item," and they will have to
4 convince us.

5 CHAIRMAN WALLIS: What concerns me is that
6 we were supposed to focus on sort of the tentacle
7 issues that the staff had problems with with the RAIs
8 and all of that. We weren't supposed to discuss this
9 at all but I understand that Mike said, "Why don't you
10 go and review some of these other things." By this
11 sort of randomly picking this, we seem to have run
12 into some major problems already. We wouldn't have
13 seen it at all unless you happened to present it.

14 MR. SNODDERLY: What I would like to
15 suggest is with the time we have we could spend a half
16 an hour on the small-break LOCA analysis and then a
17 half hour on the containment analysis.

18 CHAIRMAN WALLIS: I think we should move
19 onto something else having identified this as a
20 problem. Let's move on and see what we get on the
21 next one. But we're not reviewing everything by any
22 means. This is just a few things. Maybe we should
23 look at the next presentation and see what comes up
24 with that. Are you ready for another one?

25 DR. GAGNON: Good morning. Can you hear

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1 me fine? My name is Andre Gagnon and I'm here to talk
2 about the AP1000 small-break LOCA analyses and
3 NOTRUMP.

4 First of all, we're going to look at some
5 of the open items from the pre-certification review.
6 Not all of these were specifically identified by the
7 NRC but were issues that the ACRS also had related to
8 NOTRUMP. The first one is the ADS-4 momentum flux
9 issue. The second issue is the existence of upper
10 plenum and hot leg entrainment.

11 The third issue is the passive RHR heat
12 transfer model, what we are doing to account for
13 nonconservatism in the nuclear boiling correlation.
14 Next is the noncondensable -- treatment of
15 noncondensable gases in the modeling for the
16 simulations. The last issue is the treatment of core
17 uncovering.

18 ADS-4 momentum flux. The NOTRUMP model
19 itself does not contain the detailed momentum flux
20 model. It does not -- it has the standard evaluation
21 model package which does not deal with changes in area
22 and density. For most instances for small-break LOCA
23 the velocities are low enough --

24 CHAIRMAN WALLIS: This can't be true in
25 the break. The break is all momentum flux so it must

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1 be only in the pipe that you do it. In the valve it's
2 all momentum flux.

3 DR. GAGNON: And that's treated as
4 critical flow models.

5 CHAIRMAN WALLIS: So your concern is that
6 the valve is big enough compared with the pipe that
7 the flow velocity in the pipe is big enough that there
8 is momentum flux in the pipe which needs to be
9 considered in comparison with the other pressure drop
10 terms.

11 DR. GAGNON: And of the paths where this
12 is an issue, ADS-4 was shown to be the biggest issue.
13 ADS-1 to 3 was shown to have a relatively minor effect
14 but ADS-4 was shown to have a relatively large effect.
15 Now, to deal with this --

16 CHAIRMAN WALLIS: I'm really puzzled. For
17 40 years or something we've been neglecting these
18 momentum flux terms or something, and now all of a
19 sudden we have to worry about them. It seems to be so
20 easy to get them right the first time.

21 DR. GAGNON: Anyway, continuing. To
22 address the ADS-4 issue in the AP600 program, what was
23 done was to utilize an IRWST level penalty. That was
24 a penalty based on scaling arguments and --

25 CHAIRMAN WALLIS: That's a very round

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1 about way to do it.

2 DR. GAGNON: Yes, it was.

3 CHAIRMAN WALLIS: Because momentum flux is
4 wrong in the pipe so you change the level in the tank?

5 MEMBER KRESS: Gave you a bigger driving
6 edge.

7 DR. GAGNON: That's what was done
8 originally for AP600. What was done as part of the
9 latter ACRS reviews, if you remember, Dr. Kress, was
10 that we developed the stand-alone momentum flux model
11 to model the ADS-4 flow path from the hot leg to
12 determine the effect.

13 We then compared that to the IRWST level
14 penalty to show that they were comparable. But what
15 we are doing in terms of AP1000 is to utilize that
16 same methodology which is the detailed ADS-4 momentum
17 flux model to generate a resistance adjustment for the
18 ADS-4 flow to more directly attack the problem which
19 is ADS-4 pressure

20 CHAIRMAN WALLIS: Is this a problem in the
21 long-term cooling or is this a problem in earlier part
22 of the transient?

23 DR. GAGNON: This is a problem
24 particularly from the transition from sonic to
25 subsonic.

1 CHAIRMAN WALLIS: So it's an earlier part
2 of the transient.

3 DR. GAGNON: Yes.

4 CHAIRMAN WALLIS: Through the ADS-4
5 valves?

6 DR. GAGNON: Yes.

7 DR. BANERJEE: And is that based on steam
8 flow or two-phase flow?

9 CHAIRMAN WALLIS: Two-phase flow.

10 DR. BANERJEE: Two-phase flow? High
11 quality?

12 DR. GAGNON: We actually have run the
13 model from low quality to high quality and then do a
14 regression to get a fit and an adjustment factor. The
15 adjustment factor that we came up for AP1000 was
16 approximately 70 percent increase.

17 CHAIRMAN WALLIS: I'm not quite sure. The
18 way that people often argue about momentum flux is,
19 "If I get it wrong, it doesn't matter because the
20 momentum flux that comes out of one node goes into the
21 next one. If I get too little here, I pick it up in
22 the next one." It also works out in the end. If you
23 model momentum flux in the pressure drop in one node
24 and you take that momentum flux to the next one, you
25 can get that momentum flux back.

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1 DR. GAGNON: But what this is is there's
2 a single flow link with fluid node that represents the
3 ADS-4 pipe and then we model the squib valve which is
4 a break link so there's nothing downstream.

5 CHAIRMAN WALLIS: But the momentum flux
6 that you have in the pipe, the pressure drop in the
7 pipe, you can pick up again in the valve if you take
8 the incoming random flux into the valve as part of the
9 momentum balance for the valve.

10 DR. BANERJEE: It depends how they do the
11 critical flow calculations.

12 CHAIRMAN WALLIS: Take the incoming
13 momentum flux --

14 DR. GAGNON: -- based on stagnation
15 empathy.

16 CHAIRMAN WALLIS: Stagnation empathy?
17 It's not stagnate, though. Is it?

18 MEMBER RANSOM: Well, is NOTRUMP like a
19 tube and tank type of model in which the flow from
20 node to node is really a quasi-study phenomena? You
21 know, ignore inertia and momentum flux and just
22 consider resistance type formula?

23 DR. GAGNON: Yes. I believe that's true.

24 MEMBER RANSOM: So you don't even have the
25 acceleration effects in this kind of model, let alone

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1 the momentum flux part.

2 CHAIRMAN WALLIS: I'm not sure I want to
3 see another momentum equation.

4 DR. BANERJEE: But this is a drift flux
5 model.

6 CHAIRMAN WALLIS: It's a drift flux model?

7 DR. GAGNON: Yes.

8 CHAIRMAN WALLIS: For EDS pipe at high
9 velocity?

10 DR. BANERJEE: No, no. You are modeling
11 that separately. Right?

12 MEMBER RANSOM: This is modeling the slip
13 between the phases with drift flux model.

14 CHAIRMAN WALLIS: The drift flux model
15 doesn't apply to this sort of situation.

16 DR. GAGNON: Not at the valve, no.

17 CHAIRMAN WALLIS: Not even in the pipe.

18 DR. BANERJEE: At the core it does.

19 CHAIRMAN WALLIS: Yeah, in the core it
20 might but pipe? This is the pressure drop in the ADS-
21 4 pipeline you're talking about?

22 DR. GAGNON: Yes.

23 DR. BANERJEE: They have a separate model.

24 CHAIRMAN WALLIS: They have a drift flux
25 model for that?

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1 DR. BANERJEE: They have a separate model.

2 CHAIRMAN WALLIS: This is all, I suppose,
3 old stuff. This is what you did for AP600?

4 DR. GAGNON: Yes. What is in the DCD for
5 AP600 is the IRWST level penalty cases. We also ran
6 the ADS-4 resistance change cases to show that they
7 were comparable. But for AP1000 we went with directly
8 attacking the problem rather than changing something -
9 -

10 CHAIRMAN WALLIS: This is all written up
11 in some document somewhere?

12 DR. GAGNON: They are in RAIs.

13 CHAIRMAN WALLIS: This is all in the RAIs?
14 What is the actual number?

15 DR. GAGNON: This is an AP600 RAI which is
16 RAI 447.

17 CHAIRMAN WALLIS: Does that give equations
18 and things or is it just talk?

19 DR. GAGNON: Yes.

20 CHAIRMAN WALLIS: It gives equations.
21 Okay. The staff accepted these? Did the staff accept
22 these?

23 DR. JENSEN: Yes, the staff has accepted
24 this.

25 CHAIRMAN WALLIS: Okay. So if I looked at

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1 these momentum equations I would accept them, too?

2 DR. JENSEN: I think so. It's back out
3 from the momentum equation what an equivalent
4 resistance would be.

5 DR. GAGNON: This was developed by Mike
6 Young in the AP600 and was reviewed by the ACRS.

7 CHAIRMAN WALLIS: We can't review
8 everything in detail, though.

9 DR. GAGNON: I don't remember for sure but
10 I believe Dr. Schrock --

11 CHAIRMAN WALLIS: So momentum flux is
12 treated as an equivalent resistance in some way.

13 DR. BANERJEE: I guess you're integrating
14 over the whole pipe. Right?

15 DR. GAGNON: Yes. The detailed momentum
16 flux model has approximately 440 cells simulating the
17 entire piping down through the squid valves.

18 DR. BANERJEE: Dr. Watson fatal. That's
19 not good. And so that adjustment would change
20 depending on the length of the pipe and so on.

21 DR. GAGNON: Yes. Yes. And this is
22 specifically for AP1000.

23 CHAIRMAN WALLIS: Is this just a
24 theoretical calculation or is it related in some way
25 to evidence or data?

1 DR. GAGNON: It was compared to data for
2 OSU.

3 DR. BANERJEE: I thought they got
4 slugging.

5 DR. GAGNON: Well, we're talking early
6 phase.

7 CHAIRMAN WALLIS: Okay. So there's a
8 comparison and it shows that your new model is better
9 than the old model?

10 DR. GAGNON: Yes.

11 MEMBER RANSOM: This could have been
12 accepted by NRR and have been benchmarked against some
13 of the scales, some of the classical blow-down
14 experiments and basically accepted as a licensing
15 tool?

16 DR. JENSEN: Yes. The code was compared
17 to experimental data primarily in the AP600 review.
18 It was benchmarked against a wide range of data, SPES,
19 OSU, and the staff accepted the code. Then we looked
20 at the application of the code to AP1000 and had some
21 additional questions. Yes, we believe the code has
22 been appropriately benchmarked against experimental
23 data with the exception of the entrainment coming off
24 the ADS-4.

25 CHAIRMAN WALLIS: This code that was

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1 benchmarked had no momentum flux terms in it?

2 DR. JENSEN: No. At one time it did have
3 momentum flux long ago and Westinghouse for some
4 reason took the momentum flux terms out for the
5 purpose of reviewing the advanced plants probably
6 because of low-pressure problems.

7 CHAIRMAN WALLIS: What's been benchmarked,
8 this one with the momentum flux terms put back in
9 again?

10 DR. JENSEN: The one that was benchmarked
11 against SPES and OSU is the same code that is used for
12 AP1000. It does not have momentum flux.

13 CHAIRMAN WALLIS: So what assurance do we
14 have that these momentum flux calculations or
15 corrections are valid?

16 MR. CORLETTI: I think if we go over the
17 presentation it will answer that.

18 CHAIRMAN WALLIS: You'll get to that?
19 Okay. You don't see comparisons with data in here,
20 though. I'm just leafing through the slides.

21 DR. KEMPER: For the ADS-4 momentum flux?

22 CHAIRMAN WALLIS: Going back to AP600 we
23 had a lot of questions about the code and the more we
24 looked at the code, the more we said gee whiz. But
25 then what eventually convinced the bulk of the

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1 committee was the evidence, the comparison with SPES
2 and so on, saying that, yes, there's all these hocus
3 pocus in the theory but it works. That's what you
4 need to do here, too.

5 MR. CORLETTI: Our overall approach was we
6 were going to also benchmark this NOTRUMP against
7 COBRA/TRAC and show COBRA/TRAC to the test, which I
8 think Andy is going to get to next.

9 CHAIRMAN WALLIS: Those figures show very
10 different protections by the two codes.

11 MR. CORLETTI: That's where were are next.

12 DR. BANERJEE: So there was a point made
13 that the momentum flux terms were taken out because
14 you had problems at low pressure?

15 DR. GAGNON: I don't believe that's the
16 case. I believe at one time -- this is all from
17 memory so don't take this as gospel. Where the code
18 used to run was on the CDC when you had small core
19 memory, large core memory and it was a space issue.
20 At that time the momentum flux models weren't being
21 used. They took them out and they have never been
22 reintroduced.

23 DR. BANERJEE: But with low pressure
24 there's a large change in volume going from water to
25 steam. Acceleration has to be somewhat important more

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1 at low pressure than at high pressure so what is the
2 logic of taking it out at low pressure when it was in
3 at high pressure?

4 DR. GAGNON: It's been out for a year.

5 MR. CORLETTI: That predates --

6 DR. GAGNON: It's not a recent removal.

7 CHAIRMAN WALLIS: Sometimes it gives yo
8 problems. Momentum flux sometimes gives you
9 nonphysical oscillations.

10 DR. BANERJEE: It's a nonlinear term.

11 DR. GAGNON: Anyway, in order to support
12 the missing pieces of NOTRUMP, which is basically the
13 ADS-4 momentum flux, or to supplement what we're doing
14 with NOTRUMP which is using that detailed ADS-4
15 momentum flux model to calculate a resistance, we
16 proposed to perform supplementary calculations with
17 the COBRA/TRAC code for the ADS-4 and IRWST initiation
18 phase.

19 That code does contain the momentum flux
20 terms in the momentum equation. It also contains
21 upper plenum and hot leg entrainment models which
22 NOTRUMP does not. It also contains horizontal flow
23 models, flow regime.

24 DR. BANERJEE: Was this a 3-D model you
25 used it with or not for the core in the upper plenum?

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1 DR. GAGNON: Yeah. I believe the core
2 upper plenum is 3-D, yes.

3 DR. BANERJEE: Or is it the three-node
4 model that we talked about before?

5 DR. BANERJEE: No, no, no. This is in the
6 ADS-4 IRWST phase. Right?

7 DR. GAGNON: Right.

8 DR. BANERJEE: So you had a detailed model
9 in COBRA/TRAC for this?

10 DR. GAGNON: I'll let Dr. Kemper answer
11 that question.

12 CHAIRMAN WALLIS: So NOTRUMP has no hot
13 leg entrainment models. It just assumes that whatever
14 quality goes in comes out or something like that?

15 DR. GAGNON: What is modeled in NOTRUMP is
16 the pipe diameter that is attached to the hot leg is
17 extended into the hot leg by that pipe diameter so
18 it's rather arbitrary.

19 CHAIRMAN WALLIS: There's no change in
20 quality or anything. Whatever comes along hot leg
21 goes out there.

22 DR. GAGNON: Whatever comes along. It's
23 a circular contact so whatever mixture is in there
24 will determine what the flow quality will be as a
25 function of level.

1 CHAIRMAN WALLIS: Now you think you have
2 a more physical model than WCOBRA/TRAC?

3 DR. GAGNON: That's correct. We will be
4 discussing that more in detail.

5 DR. BANERJEE: You're going to tell us the
6 model in COBRA/TRAC later?

7 DR. GAGNON: That will be this afternoon,
8 yes.

9 DR. BANERJEE: So how many nodes did you
10 have for the core in rough terms?

11 MEMBER RANSOM: In the COBRA/TRAC model
12 for this ADS-4 initiation phase there are four nodes
13 in the core for this application.

14 DR. BANERJEE: And then the upper plenum?

15 DR. JENSEN: The upper plenum we actually
16 looked at sensitivity to having one node there and
17 three nodes there. The sensitivity studies we
18 performed have three nodes in the upper plenum region.

19 DR. BANERJEE: Okay. And was this all 1-D
20 or did you do some 3-D?

21 DR. JENSEN: There's no radial
22 representation in here.

23 CHAIRMAN WALLIS: Okay. Please go on.

24 DR. GAGNON: The idea with the
25 supplementary COBRA/TRAC calculation was to

1 demonstrate that the adjusted NOTRUMP model provides
2 a conservative prediction of the IRWST injection
3 phase. As part of, I believe -- is that WCAP 15883?
4 Is that the entrainment?

5 COBRA/TRAC comparisons to the NOTRUMP
6 models or NOTRUMP simulations were performed for the
7 DEDVI line break inadvertent ADS case. What was shown
8 was that COBRA/TRAC predicts a much higher entrainment
9 rate through the ADS-4 flow pass than is predicted by
10 NOTRUMP. We have some curves that will be
11 demonstrated here shortly.

12 COBRA/TRAC also depressurizes much more
13 rapidly basically because of NOTRUMP's break flow
14 blending model that restricts flow as it approaches
15 subsign.

16 CHAIRMAN WALLIS: How does it predict much
17 greater entrainment? I thought that NOTRUMP sort of
18 assumed what goes in comes out so there's no mechanism
19 for de-entrainment.

20 DR. GAGNON: Only when it gets into
21 contact with the pipe elevation. As the mixture level
22 stays below, the contact elevation --

23 CHAIRMAN WALLIS: Gives no entrainment at
24 all. Okay. Until you take this pipe and stick it in
25 a little bit further.