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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

ESBWR SUBCOMMITTEE

+ + + + +

WEDNESDAY, APRIL 9, 2008

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ROCKVILLE, MARYLAND

The Subcommittee met at the Nuclear
Regulatory Commission, One White Flint North, Room 0-1
G16, 11555 Rockville Pike, at 8:30 a.m., Michael
Corradini, Chairman, presiding.

SUBCOMMITTEE MEMBERS:

MICHAEL CORRADINI	Chairman
SAID ABDEL-KHALIK	Member
J. SAM ARMIJO	Member
SANJOY BANERJEE	Member
DENNIS C. BLEY	Member
OTTO L. MAYNARD	Member
WILLIAM J. SHACK	Member
JOHN D. SIEBER	Member
JOHN W. STETKAR	Member

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CONSULTANTS PRESENT:

MARIO V. BONACA

THOMAS S. KRESS

GRAHAM B. WALLIS

DESIGNATED FEDERAL OFFICER:

DAVID E. BESSETTE

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P R O C E E D I N G S

Time: 8:30 a.m.

CHAIRMAN CORRADINI: The meeting will come to order. This is a meeting of the Advisory Committee on Reactor Safeguards, ESBWR Subcommittee.

My name is Mike Corradini, Chairman of the Subcommittee. Subcommittee members in attendance or soon to be in attendance are: Sam Armijo, Sanjoy Banerjee, Said Abdel-Khalik, Bill Shack, John Stetkar, Dennis Bley, Jack Sieber, and Otto Maynard, with consultants Tom Kress and, soon to be, Graham Wallis - and I'm sorry, and Mario Bonaca. I'm sorry. You weren't on the list, and I'm trying to make sure I get everybody. I apologize.

Dave Bessette is the Designated Federal Officer for this meeting.

The purpose of today's meeting is to review portions of the ESBWR Safety Analysis Report. In particular, we will discuss accident analyses -- that is, Chapters 4, 6, 15 and 21 -- and human factors, Chapter 18.

We will hear presentations from the staff and from GE Hitachi Nuclear Energy Americas. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and

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1 actions as appropriate for deliberation by the full
2 Committee.

3 The rules for participation in today's
4 meeting have been announced as part of the notice of
5 this meeting previously published in the Federal
6 Register, and portions of today's meeting will be
7 closed for the discussion of proprietary information.

8 We have received no written comments or
9 requests for time to make oral statements from members
10 of the public regarding today's meeting.

11 A transcript of the meeting is being kept
12 and will be made available, as stated in the Federal
13 Register notice.

14 We request that participants in this
15 meeting use one of the available microphones, hidden
16 somewhere in the room, when addressing the
17 Subcommittee. The speakers should first identify
18 themselves and speak with sufficient clarity and
19 volume so they can be readily heard.

20 I think we will start off with General
21 Electric and Mr. Kinsey. Where did he go? Jim, do
22 you want to kick us off?

23 MR. KINSEY: Sure. Just a few opening
24 remarks. My name is Jim Kinsey from GE Hitachi. We
25 appreciate the Committee's attendance today.

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1 The purpose again, as Dr. Corradini
2 mentioned, is to go through some follow-on questions
3 or go through some follow-on clarifications that were
4 based on our previous discussions around DCD Chapters
5 4, 6, 15 and 21. We are going to focus on thermal-
6 hydraulics and containment performance in this
7 morning's session.

8 Again, as Dr. Corradini mentioned, we
9 currently plan some Closed activity, probably after
10 lunch, but we will work through that on the agenda.
11 Then at the end of the day, the last portion of
12 today's session is for us to present and for the NRC
13 staff to present information related to DCD Chapter 18
14 and the human factors arena.

15 So that is how we have the day laid out,
16 again with some interaction or input from the NRC
17 staff.

18 With that, I would like to turn it over to
19 Chester Cheung, who is our first presenter. I think
20 we distributed some slides for the first portion of
21 today's session. Thank you.

22 MR. CHEUNG: Good morning. My name is
23 Chester Cheung from GEH. The first topic of this
24 presentation is the overview of containment response
25 during a LOCA.

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1 There are many questions related to non-
2 condensable gas in the ESBWR containment and where
3 they are coming from, where they are going, and how
4 they go and what fraction of it go from drywell and
5 wetwell, and then questions go on. We apply the PCC
6 wind fan. How does it work, and what are the impacts
7 on drywell pressure, and what causes the drywell
8 pressure to go down.

9 All of these non-containable gas interact
10 with the rest of the system, and the system interacts
11 one system to the next.

12 This presentation is to try to address
13 many of those questions, and I structured the
14 presentation in such a way that -- and first, we are
15 going to talk about overall the ESBWR passive safety
16 system and going to describe the PCCS operational
17 modes, how they work and in what time frame and how
18 they work from one time frame to the next.

19 Then we are going to go into the detail of
20 a main steam line break, and this is from zero to 72
21 hours, and the first calculation is for the first
22 three days with no vent fan.

23 After the discussion of this calculation,
24 then we go on to describe the vent fan, which is what
25 we call a drywell gas recirculation system. After

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1 that, we are going to present the next set of
2 calculations, which is from three days to seven days,
3 which is a continuation from the first set. In this
4 calculation, we --

5 MR. WALLIS: Can I ask you a question?

6 MR. CHEUNG: Yes.

7 MR. WALLIS: Are you going to describe how
8 you analyze the wetwell gas space?

9 MR. CHEUNG: Yes.

10 MR. WALLIS: In detail?

11 MR. CHEUNG: Well, I could. Thank you.

12 And for the vent fan calculation, we are
13 going to present two cases. One is six vent fans.
14 The other one is only four vent fans.

15 After this discussion of seven-day
16 calculation, then we will go on to describe the
17 sensitivity on the bypass leakage flow area and the
18 impact of this flow area on the drywell pressure, and
19 at such time we can discuss a little bit about how we
20 established the test acceptance on the bypass leakage
21 flow area and how we established the licensing base
22 leakage flow area.

23 Next slide, please.

24 Now this chart has been so many times
25 described at the ESBWR as passive safety system, and

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1 the key point I want to make is at this time we could
2 have -- Later on, we could describe the --

3 MR. WALLIS: We have seen this figure many
4 times, but I was unable to find any detail about what
5 the walls of the wetwell look like, when you have a
6 picture there of a downcomer to the vent, which I
7 understand is a pipe. Right? So it is a pipe in a
8 wall, but this picture doesn't give any indication of
9 how it fits in that wall, how thick the wall is or
10 anything.

11 Now do you have plans that detailed yet?

12 MR. CHEUNG: Yes. It is a plan layout
13 drawing in Chapter 6, one of those figures.

14 MR. WALLIS: So there is a detailed
15 drawing of all those things and the thickness of the
16 concrete and --

17 MR. CHEUNG: Yes.

18 MR. WALLIS: -- how the GDCS pool fits on
19 top of the wetwell? All that kind of stuff is in
20 detail somewhere?

21 MR. CHEUNG: Yes.

22 MR. WALLIS: Because I haven't been able
23 to find it.

24 MR. CHEUNG: Okay, thank you. Since we
25 are on this topic --

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1 CHAIRMAN CORRADINI: Could we just take an
2 action item and get to that specific question on the
3 side, and just refer us to the right document. Go
4 ahead.

5 MR. CHEUNG: But since we are on this
6 topic, let me describe a little bit. We have about 12
7 of these vertical pipes, which we call main vent, and
8 total flow area of detail. Vertical pipes is about 14
9 meters square.

10 CHAIRMAN CORRADINI: Point that out again.

11 MR. CHEUNG: The vertical pipe which is
12 called main vent, and 12 of them. The total flow area
13 is about 14 square meters, and we --

14 MR. WALLIS: They are in a concrete wall?

15 MR. CHEUNG: In the center of the concrete
16 wall.

17 MR. WALLIS: And that concrete wall has a
18 uniform thickness all the way around?

19 MR. CHEUNG: All the way around.

20 MR. WALLIS: How thick is it?

21 MR. CHEUNG: As I recall, somewhere around
22 maybe two or three meters.

23 MR. WALLIS: Maybe two or three meters.
24 It makes a big difference whether it is two or three
25 meters, doesn't it, in terms of transient heat

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1 transfer?

2 MR. CHEUNG: We have performed parametric
3 cases that the heat transfer area there is not
4 sensitive, have no significant impact on the end
5 pressure, and later on I am going to describe what end
6 pressure depends on.

7 MR. WALLIS: Well, that area is the area
8 by which the suppression pool, if it is going to be
9 heated by the drywell, is heated. If the heat comes
10 in through the wall --

11 MR. CHEUNG: Yes, we modeled the heat
12 coming through --

13 MR. WALLIS: -- with some source of
14 raising the pressure in the wetwell, we have to know
15 how to calculate it.

16 MR. CHEUNG: We modeled that heat transfer
17 area.

18 MR. WALLIS: Okay. And you have to model
19 the transient in the wall.

20 MR. CHEUNG: Yes.

21 MR. WALLIS: Okay.

22 MR. CHEUNG: It is a concrete wall.

23 MR. WALLIS: Yes, and it's got a lot of
24 rebar in it. Do you provide the properties of that
25 wall, activity and all that stuff?

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1 MR. CHEUNG: Yes, we provide the
2 properties.

3 MR. WALLIS: Could you put that down as an
4 action item, too?

5 MR. CHEUNG: Okay.

6 MR. WALLIS: Thank you.

7 MR. CHEUNG: Now I am going to say that we
8 have about 14 square meter of flow area in the
9 vertical pipe. We have six of these PCC vent pipe,
10 the total flow area of vent pipe is .3 square meter.
11 So it's a large ratio, and the vertical pipe main vent
12 is very effective way to condense steam for any extra
13 steam in the drywell.

14 MR. WALLIS: Okay. Excuse me. Now you
15 have these leaking vacuum breakers --

16 MR. CHEUNG: Yes.

17 MR. WALLIS: -- which, I understand, are
18 in the ceiling of this area here?

19 MR. CHEUNG: Yes.

20 MR. WALLIS: Somewhere between where it
21 says GDCS pool and this downcomer to the vents?

22 MR. CHEUNG: The next slide will show the
23 location of vacuum breaker. It is somewhere around
24 there, yes.

25 Next slide, please.

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1 This slide is trying to describe the
2 operational mode of a PCCS. Let me first go on to the
3 diagram on the righthand -- on the top righthand
4 corner.

5 The vertical scale is at this point -- at
6 this corner is a drywell. The vertical scale is the
7 delta pressure or the delta P between the drywell
8 pressure reference to the wetwell pressure. Let's
9 take a point --

10 MR. WALLIS: Are there units on this
11 graph?

12 MR. CHEUNG: There's no unit.

13 MR. WALLIS: Well, you need to have units,
14 if it means anything.

15 MR. CHEUNG: That's the reference point.
16 Okay, the vertical seal -- You can see the middle of
17 the seal. That means the drywell pressure equals the
18 wetwell pressure at this line, and you move on all the
19 way -- I mean, at this condition the water or the
20 submergence of the vent pipe, a PPC vent pipe -- The
21 water will go into the vent pipe and sitting at a
22 level equalized to the suppression pool water level.

23 MR. WALLIS: So I see you have these
24 things on the righthand side. When you say top vent
25 opens, does that mean that the water level reaches the

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1 top of the pipe, the very top of the pipe, or what,
2 because it's a big pipe?

3 MR. CHEUNG: The PCC vent pipe?

4 MR. WALLIS: Where it says top horizontal
5 vent open.

6 CHAIRMAN CORRADINI: Your upper line.

7 MR. WALLIS: Does it mean that the water
8 level reaches the top of that pipe? It looks like it
9 in curve 5 here. So the instant the water level
10 reaches the top of the vent, it opens?

11 MR. CHEUNG: Let me describe it this way.
12 If the delta P is zero, that means the water level in
13 the main vent pipe -- they are all sitting equalized,
14 equal to the suppression pool water level.

15 Now if the delta P is equal to the
16 submergence of the PCC vent next to almost the curve
17 number 2, then the PCC vent will be almost clear to
18 the end of it, the exit -- equal to delta P. Okay?

19 Now to go on, if the delta P increase all
20 the way to, say, equal to the top horizontal vent
21 submergence, then the main vent water level will be
22 just barely touching the top of the horizontal vent.

23 MR. WALLIS: So curve 2 is after the
24 initial blowdown and the vent clearing and all that
25 sort of thing?

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1 MR. CHEUNG: No. Curve 1 is a typical
2 operation after that.

3 MR. WALLIS: After that?

4 MR. CHEUNG: Yes.

5 MR. WALLIS: Okay. Curve 1?

6 MR. CHEUNG: Yes. I will describe those
7 curves.

8 MR. WALLIS: You want curve 2 a short
9 term, 10 minutes. Right?

10 MR. CHEUNG: Yes. And if the delta P
11 increased further, which is larger than the top
12 horizontal vent submergence, under this condition then
13 the water level in the main vent will go down to
14 uncover the first horizontal vent or maybe even the
15 second or the third one, and --

16 MR. WALLIS: So this is very sensitive to
17 your ability to calculate the pressure drop through
18 the PCC with condensation and in the presence of non-
19 condensable gas?

20 MR. CHEUNG: Yes and no, and the next
21 slide will tell you that it is not sensitive to all
22 these things.

23 MR. WALLIS: Okay.

24 MR. CHEUNG: Let's move on to say on the
25 other side of the scale that, if the delta P in the

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1 drywell is negative in such a way that it is below the
2 wetwell pressure, but there is a limit that how much
3 that can go. It goes all the way to the vacuum
4 breaker setpoint. Once that happens, the vacuum
5 breaker opens. That is nearby the end of curve Number
6 4. The vacuum breaker opens, then allows the non-
7 condensable gas or gas mixture from the wetwell back
8 to the drywell.

9 Now let's specifically talk about curve
10 number 6, which is on the lefthand corner, upper
11 corner. This is during the first blowdown period of
12 say from zero to -- of around 10 minutes or so. A lot
13 of steam blowing into the drywell. The drywell
14 pressurized such that the submergence are higher than
15 the submergence of the top horizontal vent, and during
16 these periods that both the top vent will be
17 uncovered, and the PCC vent would be uncovered.

18 Now you look at curve number 6 that moves
19 from the left to the right. That describes the
20 pressure drop from the drywell to the PCC inlet and
21 the PCC outlet and all the way to the PCC vent line
22 exit, that this curve number 6 is saying that there is
23 a parallel flow.

24 MR. WALLIS: So I notice here, there seems
25 to be no pressure drop across the PCC. Is that right?

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1 MR. CHEUNG: Well, it is just a cartoon.
2 There is some pressure drop, and just trying to
3 demonstrate the pressure drop from the drywell all the
4 way to the PCC vent exit. At the vent exit, it is
5 clear, the water and the mixture, gas mixture, will go
6 from drywell all the way to the suppression pool.

7 MR. WALLIS: So this pressure drop I see
8 at the top of the curve here is from the drywell to
9 the PCC Hx inlet.

10 MR. CHEUNG: Yes.

11 MR. WALLIS: That is through a valve or a
12 pipe or something?

13 MR. CHEUNG: It is PCC pipe exit.

14 MR. WALLIS: Pipe -- That's through a
15 pipe?

16 MR. CHEUNG: Yes.

17 MR. WALLIS: Okay.

18 MR. CHEUNG: Now you can see that in the
19 cartoon that it's showing that the horizontal vent
20 opens, and then some steam-gas mixture going out in
21 the suppression pool.

22 MR. WALLIS: So that pressure drop depends
23 on what the steam flow rate is.

24 MR. CHEUNG: Yes.

25 MR. WALLIS: Which has to be calculated

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1 somehow.

2 MR. CHEUNG: Yes.

3 MR. WALLIS: Through the condenser --
4 knowing how the condenser performs. Right?

5 MR. CHEUNG: Yes.

6 MR. WALLIS: And when you turn on the fans
7 later on -- Well, we'll talk about that -- this
8 influences that pressure drop, doesn't it?

9 MR. CHEUNG: When we turn on the vent fan,
10 the pressure drop of these vertical vents and the
11 horizontal main vent and the PCC vent is not going to
12 do anything, because they are all covered. We will
13 get that possibly in slide number 13 or 14.

14 MEMBER BANERJEE: What is the flow in the
15 line that the vent fan is drawing from? What is the
16 fluid that is flowing down the PCC vent line and the
17 vent fan is drawing from? Is that single phase or is
18 there some liquid in there?

19 MR. CHEUNG: In this page we have no vent
20 fan.

21 MEMBER BANERJEE: Well, I mean in this
22 picture that you have, the previous slide.

23 MR. CHEUNG: The previous slide.

24 MEMBER BANERJEE: Is there a vent fan or
25 not?

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1 MR. CHEUNG: There is a vent fan, but for
2 the discussion of how PCC works, we left out the vent
3 fan. We are going to discuss that later on, the vent
4 fan, how they work.

5 MEMBER BANERJEE: Yes, I just want to
6 understand. Is there a vent fan or is there not a
7 vent fan?

8 MR. CHEUNG: For the first three days, we
9 do not credit the vent fan.

10 MEMBER BANERJEE: Okay. But if the vent
11 fan comes on there after three days, what is the fluid
12 that is drawn by the vent fan?

13 MR. CHEUNG: Okay. If the vent fan comes
14 on, the vent fan draws mixture, gas mixture.

15 MEMBER BANERJEE: Of what?

16 MR. CHEUNG: From the PCC vent line and --

17 MEMBER BANERJEE: Is there any liquid in
18 it or is it just a pure gas?

19 MR. CHEUNG: The PCC vent line has no
20 liquid.

21 MEMBER BANERJEE: No liquid at all?

22 MR. CHEUNG: No liquid at all.

23 MR. WALLIS: If the separation works
24 properly in the PCC.

25 MEMBER BANERJEE: So the PCC separates out

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1 the liquid from the gas?

2 MR. CHEUNG: Yes. The next couple of
3 slides, we are going to discuss that.

4 MEMBER BANERJEE: Okay.

5 MR. WALLIS: So we will get to the vent
6 fan later?

7 MEMBER BANERJEE: And the separator in the
8 PCC. Right?

9 MR. CHEUNG: Yes.

10 MR. WALLIS: And the little shelf into
11 which they discharge? We'll get to that, too? Okay.

12 MEMBER ABDEL-KHALIK: Let's just compare
13 curve 6 and curve 5.

14 MR. CHEUNG: Yes.

15 MEMBER ABDEL-KHALIK: The overall driving
16 pressure difference for flow through the PCCS in curve
17 6 is higher than the overall driving pressure
18 difference in curve 5?

19 MR. CHEUNG: That is correct.

20 MEMBER ABDEL-KHALIK: Okay. So you would
21 expect that the heat removal capability during the
22 period covered in curve 6, the PCCS heat exchanger, to
23 be higher than that during period 5. Is that correct?

24 MR. CHEUNG: That's correct.

25 MEMBER ABDEL-KHALIK: And yet you are

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1 saying that during period 6, which extends up to 10
2 minutes, which means decay heat is probably-- at 10
3 minutes is, what, three percent?

4 MR. WALLIS: Fifty megawatts or something
5 like that?

6 MEMBER ABDEL-KHALIK: Yet the PCCS cannot
7 handle decay heat at that point.

8 MR. CHEUNG: That's correct.

9 MEMBER ABDEL-KHALIK: What is the maximum
10 capacity of the PCCS heat exchanger?

11 MR. CHEUNG: The PCC heat exchanger at
12 rate of condition total is about 60 megawatt. So it
13 takes a couple of hours that the PCC will take care of
14 the decay heat or the steam generated by decay heat
15 completely. It takes a couple of hours. Before that,
16 which is curve number 5 --

17 MEMBER ABDEL-KHALIK: It has to drop to
18 about one and a half percent decay heat.

19 MR. CHEUNG: Yes.

20 MR. WALLIS: And there is a sparger at the
21 bottom of that line. It's not just a pipe. Right?

22 MR. CHEUNG: Yes. Let me continue with
23 curve number 6. That means during this time period
24 that the major heat sink is a suppression pool. The
25 steam goes through the main vent and continue in the

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1 suppression pool, and part of the steam and gas
2 mixture will go through the PCC vent and clear it and
3 then de-charge the energy unit suppression pool that
4 the non-condensable gas going up in the wetwell.

5 CHAIRMAN CORRADINI: Just to make sure
6 that I am understanding, for the -- Your numbering
7 got me backwards. So 6 is the first phase.

8 MR. CHEUNG: Yes.

9 CHAIRMAN CORRADINI: So that's Phase 1.

10 MR. CHEUNG: Yes.

11 CHAIRMAN CORRADINI: All right. So at
12 phase 1 somewhere in the drywell is the high pressure
13 on the left, and I have parallel paths. I am flowing
14 down through the vent simultaneously through the PCC.

15 MR. CHEUNG: Yes.

16 CHAIRMAN CORRADINI: Okay. And when you
17 said 60 megawatts, that's all units or one unit?

18 MR. CHEUNG: All units.

19 CHAIRMAN CORRADINI: Thank you.

20 MR. CHEUNG: That's a rated condition.
21 When the pressure is higher, then the condensation
22 capacity would be higher -- somewhat higher.

23 Now as time go on --

24 MEMBER BANERJEE: Just to understand, do
25 you have somewhere a quantitative idea of where the

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1 heat is going, or maybe you can tell us, in these
2 various phases? So in the first phase, clearly, your
3 suppression pool is picking up most of the heat.
4 Right?

5 MR. CHEUNG: Yes.

6 MEMBER BANERJEE: But there is heat going
7 to other places as well, into the PCC pool and so on.
8 Is any going into the GDCS pool?

9 MR. CHEUNG: I'll get to that.

10 MEMBER BANERJEE: Do you have any sort of
11 a cartoon in each of these phases which tells us where
12 the heat and the non-condensables are going?

13 MR. CHEUNG: Page number 7, 8 or 9. We
14 will get to that.

15 CHAIRMAN CORRADINI: We are coming to it.

16 MEMBER BANERJEE: Okay. All right, I'll
17 wait then.

18 MR. WALLIS: I have another question. I
19 mean, this is going to get fairly complicated, it
20 appears, with all the questions.

21 Do you have a written reply to our
22 questions as well as this verbal presentation?

23 MR. CHEUNG: We have not yet prepared a
24 written --

25 MR. WALLIS: Because I want to check a lot

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1 of numbers, which you are not going to present.

2 MR. CHEUNG: I have some numbers, but not
3 all.

4 MR. WALLIS: I would like to have a
5 written response, not just a verbal response that says
6 everything is okay.

7 MS. CUBBAGE: Amy Cubbage, the Project
8 Manager for ESBWR.

9 Hitachi is responding to some RAIs. We
10 would be happy to provide those.

11 As far as some of the dimensions you were
12 talking about earlier, they are in the DCD. There are
13 detailed --

14 MR. WALLIS: If you can find them.

15 MS. CUBBAGE: I can help you find them.
16 But as far as whether you need a written reply to what
17 you have asked us, I don't think that is the process
18 we are in.

19 CHAIRMAN CORRADINI: They will provide us
20 all the responses to the RAIs.

21 MR. WALLIS: These are going to be real
22 technical responses, not some of the usual responses,
23 which simply say everything is okay?

24 MR. KINSEY: Jim Kinsey from GEH. We will
25 continue to respond to the staff's interrogatories.

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1 MR. WALLIS: This gets very frustrating
2 for ACRS. We have to go through the staff and the RAI
3 process, and then it looks as if the answers are not
4 sufficient. Then we have to go through the staff
5 again. This takes months and months.

6 MR. KINSEY: We are working to provide
7 detailed responses --

8 MR. WALLIS: You don't want us to hold up
9 GE's application.

10 MS. CUBBAGE: I guess this gets back to
11 some of the discussion we had at previous meetings
12 about early interaction and involvement with the
13 Committee. This is an RAI -- GE did provide an RAI
14 response just a few days ago on this topic. It is an
15 ongoing evolving issue and, when we come with a final
16 SER, all the issues will be resolved at that time.

17 So it's a matter of whether the Committee
18 wants to be involved early or not, and I think this is
19 the opportunity.

20 MR. WALLIS: Well, I think it's up to you,
21 and if we get involved late and we still have
22 significant questions, then you may have a problem.

23 MS. CUBBAGE: And that is why we are here.

24 MR. SNODDERLY: Graham, this is Mike
25 Snodderly from the Containment Systems Branch, NRO.

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1 I want you to be aware that we were aware
2 of your questions and all the Committee's questions,
3 and GE and the staff has spent a lot of time on these
4 -- preparing for this presentation.

5 So what I would like to suggest is let us
6 go through the presentation. Let us try to attempt to
7 answer your questions. I think we can, and then at
8 the end of the day let's see where we are and what
9 actions are needed. But again we are aware of those
10 questions, and please give us an opportunity to try to
11 address them.

12 MEMBER ABDEL-KHALIK: Let me just try to
13 anchor this graph into numbers so that we would be
14 able to follow what you are talking about.

15 MR. CHEUNG: Okay.

16 MEMBER ABDEL-KHALIK: At 60 megawatts you
17 essentially need to condense 200,000 pounds per hour
18 of steam. What is the delta P required to push that
19 much steam through the PCCS?

20 MR. CHEUNG: Now to condense that much of
21 steam is not the PCC capacity can handle through the
22 main vent and during the first blowdown period the
23 delta P from the drywell to the wetwell is way over 20
24 psi.

25 MEMBER ABDEL-KHALIK: So when you refer to

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1 60 megawatts, what are you referring to, the PCCS
2 condenser capacity or the PCCS plus whatever sparger
3 you have in the wetwell?

4 MR. CHEUNG: The PCCS condenser -- the PCCS
5 tube capacity.

6 MEMBER ABDEL-KHALIK: So if that is the
7 case, then you have to condense 200,000 pounds per
8 hour to give you 60 megawatts. So how much delta P do
9 you need to push 200,000 pounds per hour of steam
10 through the PCCS tubes?

11 MR. CHEUNG: The delta P is curve number 5
12 that --

13 MEMBER ABDEL-KHALIK: I really would like
14 a number.

15 MR. WALLIS: Maybe that should be an
16 action item.

17 MEMBER BANERJEE: I think these cartoons
18 are not very useful. If a graduate student presented
19 this at his PhD oral, he would fail. You don't even
20 have in the different phases the flow rates for the
21 various components, the pressure losses across them,
22 how much heat is being dumped where, where the non-
23 condensables are going.

24 You can just take this thing, put some
25 numbers on it, and show what the pressures are in

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1 different phases. You could have six of these, so
2 that we have the pressure drops, the temperatures, the
3 heat dump, the non-condensable concentrations. Then
4 we would have some concrete numbers to look at.

5 This is just all qualitative stuff and --

6 MR. MARQUINO: This is Wayne Marquino from
7 GE. We can provide numerical values for these curves
8 to the staff.

9 MEMBER BANERJEE: Well, it would be nice
10 if it was put on a chart like this so at different
11 phases we could see where everything is.

12 CHAIRMAN CORRADINI: So let me just take a
13 step back for a minute. So the purpose of this graph
14 was to give us a qualitative or quantitative feeling
15 on how the phases are?

16 MR. CHEUNG: It's qualitative.

17 CHAIRMAN CORRADINI: Okay. So are you
18 going to get quantitative soon or else I'm going to
19 lose my whole committee, and they will string me up
20 after they do? I think that's what they are dying to
21 see. They are dying to see some numbers on how this
22 evolves.

23 MR. CHEUNG: Let's --

24 CHAIRMAN CORRADINI: Move on.

25 MR. CHEUNG: Okay.

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1 MR. WALLIS: So we are still on number 6,
2 are we?

3 MR. CHEUNG: Okay, let's move on to curve
4 number 1, which is next page.

5 MR. WALLIS: Wait a minute. Five follows
6 6, doesn't it? No, no, 2 follows 6. It's really
7 strange here.

8 CHAIRMAN CORRADINI: Six to 2 to 4 to 5 to
9 one.

10 MR. WALLIS: Well, the thing that I want
11 to get on is you either show the top vent open or
12 closed. Some of the time, it's probably open. How do
13 you calculate that? I can look it up, but it's
14 something like .70 centimeters or something. It's a
15 big vent.

16 As the water level changes, the flow rate
17 changes a lot, and there are waves and things that go
18 through this vent. How do you figure out what
19 happens?

20 MR. CHEUNG: Actually, let me present the
21 next slide and then come back.

22 MR. WALLIS: So that's somewhere between
23 curve 6 and curve 5. It's partially open, right?
24 There is a question of how does a partially open vent
25 get modeled?

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1 MR. CHEUNG: Let's move on to the next
2 one, and then come back.

3 MR. WALLIS: Okay.

4 MR. CHEUNG: During most of the time --
5 this is curve number 1 -- the PCC work like this way.

6 The PCC is so regulated, when the steam and gas
7 mixture are coming in, the steam condenses. The gas
8 mixture, the non-condensable gas, collects or
9 accumulates in the bottom of the tube such that the
10 bottom half of the tube, for that argument, and all
11 the way to the PCC vent, they all significant or high
12 percentage of --

13 MR. WALLIS: There has to be enough
14 pressure drop to drive out the non-condensables.

15 MR. CHEUNG: Yes.

16 MR. WALLIS: Cannot be driven just be
17 condensation.

18 MR. CHEUNG: It's not.

19 MR. WALLIS: It will fill up with non-
20 condensables unless there is enough pressure drop from
21 the drywell to the wetwell to blow out the non-
22 condensables.

23 MR. CHEUNG: Yes. I agree with you.

24 MR. WALLIS: Okay. So it's not just
25 driven by condensation. You've got enough pressure

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1 drop to make it happen.

2 MR. CHEUNG: It is so regulated. That
3 means the pressure is controlled by other PCC action.

4 MR. WALLIS: But it's not true that it is
5 driven by condensation. There must be a pressure drop
6 to push the stuff through that pipe.

7 MR. CHEUNG: Yes. Let's move on to the
8 upper half corner of the curve. For argument, say
9 that the bottom half of the tube is filled with non-
10 condensables to shut off all the condensation.

11 MR. WALLIS: So in curve 2 the pressure is
12 not enough to drive it through the -- to push it
13 through? I don't understand.

14 MR. CHEUNG: We are on page number 5.

15 MR. WALLIS: It seems to me the pressure
16 drop through this pipe, number 6 there, the first
17 stage is the same when you are condensing the same
18 amount of steam, no matter which stage you are in. So
19 if you are condensing 50 megawatts of steam, you have
20 the same pressure drop through that pipe, whether it
21 is driven by condensation or anything else.

22 How does it get to be so low in 2, because
23 you are condensing so very much less?

24 MR. CHEUNG: In 2, that means the bottom
25 half -- the PCC vent pipe is sealed off by the water

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1 submergence.

2 MR. WALLIS: Well, I don't understand why
3 curve 2 is below -- What's the pressure necessary to
4 overcome the submersion?

5 MR. CHEUNG: Pardon me?

6 MR. WALLIS: There has to be a pressure
7 drop to overcome the submergence. Right?

8 MR. CHEUNG: Yes.

9 MR. WALLIS: And how much is that? I
10 don't see it on this figure. Is that the dashed line
11 which says PCC vent exit submergence? So how does 2
12 get to be below that? Maybe there is a simple
13 explanation. I'm just trying to figure it out.

14 MR. CHEUNG: It's sucking up.

15 MR. WALLIS: It's sucking it up?

16 MR. CHEUNG: Now the tube in the very
17 beginning has .75 meters submerging.

18 MR. WALLIS: How does the non-condensables
19 get out, if there isn't enough pressure drop to
20 overcome the submergence of the vent pipe?

21 MR. CHEUNG: Let's discuss page number 5
22 first, and then we'll come back.

23 MR. WALLIS: Are you going to come back to
24 that?

25 MR. CHEUNG: Yes.

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1 CHAIRMAN CORRADINI: So I think we should
2 let them go forward and present. Otherwise, we are
3 going to -- we are really going to get fouled up.

4 I want to ask, just to push this: So
5 Slide 4 is qualitative. The numbering at least lost
6 me, but that's aside.

7 Five is what phase? Slide 5 is what phase
8 in time?

9 MR. CHEUNG: Slide 5 represents most of
10 the time that is curve number 1.

11 CHAIRMAN CORRADINI: Okay.

12 MEMBER BANERJEE: Okay. Six to 72 hours?

13 CHAIRMAN CORRADINI: So this is when the
14 PCC is performing its functions solely.

15 MR. CHEUNG: Yes.

16 CHAIRMAN CORRADINI: And there is no
17 bypass parallel flow via an open vent into the
18 suppression pool?

19 MR. CHEUNG: There is no bypass, no
20 breaker open of how the non-condensables get moved
21 from one well -- from drywell to the wetwell.

22 CHAIRMAN CORRADINI: So let me just
23 phrase it this way. Before that time, there's too
24 much decay heat, and there's parallel paths.

25 MR. CHEUNG: Yes.

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1 CHAIRMAN CORRADINI: After that time, at
2 72 hours now you are into this issue of whether or not
3 you are going to provide an added means. So this is
4 the dominant thing from 6 to 72 hours?

5 MR. CHEUNG: Yes.

6 CHAIRMAN CORRADINI: Okay. So at least, I
7 think, you want to address quantitatively what
8 Professor Wallis is asking relative to the flows,
9 etcetera, in this.

10 MR. WALLIS: Well, I got to ask another
11 question again. Above curve 2, third line, third
12 bullet, it says no PCC vent flow, which is why curve 2
13 is below the critical thing to bubble into the pool.

14 MR. CHEUNG: Yes.

15 MR. WALLIS: What happens to the non-
16 condensables then? Are there absolutely no non-
17 condensables? It had to be vented somehow.

18 MR. CHEUNG: Let's move on to number 5 and
19 come back.

20 MR. WALLIS: You can't just put in non-
21 condensables into the PCC and not get them out of
22 there. You cannot do that.

23 MEMBER BANERJEE: I guess your strategy is
24 going to be to address first the one. Then they are
25 going to come back and address the curves which are --

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1 MR. WALLIS: Okay. So we are going to get
2 to all that stuff.

3 MR. CHEUNG: Yes. Because a lot of those
4 questions probably is answered in slide number 5.

5 CHAIRMAN CORRADINI: Okay. So we are
6 looking at essentially the behavior of curve 1 on
7 slide 5?

8 MR. CHEUNG: Yes.

9 CHAIRMAN CORRADINI: Okay.

10 MR. CHEUNG: Now during this time the
11 steam and gas mixture go into the PCC tube, and steam
12 condenses and non-condensable gas got moved through --
13 accumulate in the bottom of the tube, and all the way
14 to the PCC vent line.

15 Now when the column of non-condensable
16 gets about half of the tube, that means that will
17 reveal the heat transfer area, reveal the PCC
18 condensation power. Now if you look at the table side
19 by side to the tube, and the first column is a non-
20 condensable column that's the height of the non-
21 condensable gas. That's plus or minus.

22 Plus-- that means if the column increased
23 the length, then what are the impacts. The impact
24 reveals the PCC condensation power.

25 Move on to the next one is: when the PCC

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1 condensation is reduced, that means the steam
2 inventory in the drywell going to increase, because
3 less condensed.

4 MR. WALLIS: I'm sorry. On the righthand
5 side, the picture there, it says non-condensable gas
6 flow to wetwell, zero. Does that mean there is none?
7 What does that mean, that righthand upper picture
8 there. There's a plus and then a zero, but what does
9 that mean?

10 MR. CHEUNG: Well, I'll get to that.

11 CHAIRMAN CORRADINI: So let's just take
12 the first column where you've gotten to it.

13 MR. CHEUNG: The first column --

14 CHAIRMAN CORRADINI: Just stay with me for
15 a minute. So you've got NC Gas Column, plus/minus.
16 Does the plus/minus mean the pink and the blue? I'm
17 still a bit puzzled.

18 MEMBER BANERJEE: Plus means it's building
19 up.

20 CHAIRMAN CORRADINI: Okay.

21 MR. CHEUNG: The blue is the column, and
22 then the plus, that means the blue line is going to
23 increase the height.

24 CHAIRMAN CORRADINI: Thank you.

25 MR. CHEUNG: Minus is going to reveal the

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1 height.

2 MR. WALLIS: Well, t his is misleading,
3 because you can't get non-condensable gases out
4 without getting some steam out as well. There's
5 always some mixing.

6 MR. CHEUNG: Yes, there's some steam,
7 water with a leftover steam in the vent line.

8 MR. WALLIS: Well, there is always some
9 steam left.

10 MEMBER BANERJEE: So let's go on.

11 MR. CHEUNG: Then because the condensation
12 power is down, the drywell -- the steam inventory is
13 up, and then the consequence of that is drywell
14 pressures go up. Drywell pressure goes up, that means
15 the PCC pressure go up.

16 MR. WALLIS: The only reason the drywell
17 pressure goes up is because the wetwell pressure goes
18 up. The only reason it goes up.

19 MR. CHEUNG: No, let's say.

20 MR. WALLIS: Because you've got to supply
21 the delta P through the PCC.

22 CHAIRMAN CORRADINI: No, I think, Graham,
23 they are saying here that as they -- Unless I
24 misunderstand what you are saying, you are building up
25 non-condensables. So you are now degrading the

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1 performance. You wait. Pressure rises. You push it
2 out, and you come back. So you have --

3 MR. WALLIS: It's self-controlling.

4 CHAIRMAN CORRADINI: Yes. That's why he
5 said that.

6 MR. WALLIS: Well, we know it's self-
7 controlling.

8 CHAIRMAN CORRADINI: But I think that's
9 his point. Is that your point?

10 MR. CHEUNG: Yes, that is my point.

11 MR. WALLIS: The pressure in the whole
12 system is determined by the wetwell aspects.

13 MR. CHEUNG: Yes.

14 MR. WALLIS: That decides everything.

15 MR. CHEUNG: But this column -- or this
16 table is trying to describe how it is self-regulated.

17 MR. WALLIS: If you were venting the
18 wetwell and lowering its pressure, you would just suck
19 more non-condensable gases through the PCC. You would
20 condense more, and the drywell pressure would go
21 down.

22 MR. CHEUNG: Yes.

23 MR. WALLIS: Everything is determined by
24 this rise of pressure in the wetwell, which is the big
25 mystery of the whole story. Okay.

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1 So I don't understand your picture on the
2 right. Are you just saying that it is self-
3 controlling? Is that what it says?

4 MR. CHEUNG: Yes.

5 MR. WALLIS: Well, that's self-evident.

6 MR. MARQUINO: This is Wayne Marquino from
7 GE. In the long term, the wetwell pressure is -- and
8 non-condensable gas pressure in the wetwell dominates
9 the container pressure. I think what Dr. Cheung is
10 trying to show here is that variations of the drywell
11 temperature control venting of the PCC and the non-
12 condensable gas flow out of the PCC through the vent
13 line.

14 So as the PCC power drops below decay
15 power, drywell pressure builds up. The level in the
16 vent line goes down, and the PCC vents. And that is
17 how its self-regulation works.

18 MR. CHEUNG: Let me go on to this first
19 row --

20 MEMBER BANERJEE: Let me ask you a few
21 questions about this. I think I get the picture. But
22 now can you set our minds at rest that this really
23 happens? Give us a brief review of the experiments
24 that have been done to actually validate this
25 mechanism.

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1 MR. CHEUNG: I don't -- I did not dream up
2 these pictures.

3 MEMBER BANERJEE: Well, you don't have --
4 Just give it qualitatively. What experiments have
5 been done to support this mechanism?

6 MR. CHEUNG: PANDA testing saw that.

7 MEMBER BANERJEE: So PANDA has been done,
8 and it showed this. And did you do some full scale
9 experiment as well, or not?

10 MR. CHEUNG: PANDA is --

11 MEMBER BANERJEE: Was it full scale?

12 MR. CHEUNG: PANDA is full scale.

13 MEMBER BANERJEE: Full height, but it
14 wasn't full scale. Didn't you do some other
15 experiments somewhere else or was it only PANDA?

16 MR. MARQUINO: This is Wayne Marquino. We
17 also did the PANTHERS, which is a full height, full
18 volume representation of one PCC unit with two
19 headers.

20 MEMBER BANERJEE: Okay. I was trying to
21 get to that. And did you then have some sort of a
22 code or an analysis or a simulation done to compare
23 the calculations with these experiments?

24 MR. CHEUNG: Yes. We have performed a
25 whole series to check these the qualification against

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1 the PANDA the test, PANTHER test.

2 MEMBER BANERJEE: I suppose TRACG had a
3 condensable field added to it or it was already there,
4 and you then simulated these experiments using TRACG.

5 MR. CHEUNG: Yes.

6 MEMBER BANERJEE: What did you find?

7 MR. CHEUNG: We find that the PCC is self-
8 regulated by --

9 MEMBER BANERJEE: What did you find in the
10 comparison between TRAC and the experimental data?

11 MR. CHEUNG: In a simple sentence, that it
12 is well qualified and compare data real well.

13 MEMBER BANERJEE: And this was made
14 available to all of us to look at, these relations?
15 Okay.

16 The issue then with regard to the
17 separation at the bottom there of the liquid from the
18 non-condensables -- how did TRACG handle that?

19 MR. CHEUNG: We simulated by a T
20 component, and the SI branch simulated the drain line
21 as higher than the bottom line of which -- went line.

22 So the water will come down to the drain line and --

23 MEMBER BANERJEE: So just gravity
24 separation?

25 MR. CHEUNG: Yes.

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1 MR. WALLIS: Do you have another
2 presentation besides this one?

3 MR. CHEUNG: No.

4 MR. WALLIS: Because this is curve 2.
5 Right? The key thing that's happening here is --

6 MEMBER BANERJEE: This is curve 1.

7 MR. WALLIS: This is curve 1? This is
8 curve one, right. Now the key thing that you have to
9 figure out is what is the pressure in the wetwell, and
10 the pressure rises because the temperature rises. If
11 you look at your curves, the reason the pressure rises
12 in the wetwell is because the temperature of the gas
13 base rises.

14 So you have to present a very careful
15 analysis of what controls the temperature in the
16 wetwell. I don't see it anywhere here, and the
17 leakage of steam through the vacuum breaker is a very
18 important actor in this. Now I want to know where it
19 goes. Does it slide along the roof and condense?
20 Does it mix?

21 The walls are very key actors. If they
22 are two or three meters thick, then they cool the gas.

23 They don't heat it. They are still cold. And yet
24 when I see a MELCOR calculation, it appears that they
25 are heating the gas.

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1 So there are a huge number of questions
2 about what controls the temperature and pressure in
3 the wetwell, and I don't think, looking through your
4 slides, you are going to get to that.

5 MEMBER BANERJEE: In fact, that was the
6 discussion that was going on at the last meeting.

7 MR. WALLIS: Right.

8 MEMBER BANERJEE: Sorry. That was the
9 discussion -- That was part of the many things that
10 were discussed at the last meeting, precisely the
11 question that Graham raised.

12 MR. CHEUNG: Let me finish slide number 5,
13 and then tell you why --

14 MR. WALLIS: There is nothing about the
15 energy in the wetwell you are going to talk about here
16 this morning?

17 MR. CHEUNG: I am going to touch base on
18 that.

19 MR. WALLIS: You are going to touch base?
20 You are going to analyze it?

21 MR. CHEUNG: We have analyzed it.

22 MR. WALLIS: You are going to tell us how
23 you analyzed it?

24 MR. CHEUNG: We used TRACG, and I'm going
25 to tell you the delta or the impact of the leakage

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1 hitting on the wetwell.

2 MR. WALLIS: Okay.

3 MR. CHEUNG: And I can show you the
4 Hancock ratio in slide number --

5 MR. WALLIS: Well, I'll tell you what I
6 think happens is that the steam oozes through the vent
7 valve at the vacuum breaker and condenses on the
8 ceiling. I don't know if that is what you predict.

9 MR. CHEUNG: In the calculation, because
10 of conservative, we do not assume any condensation in
11 the top vent line.

12 MR. WALLIS: Then you are in real trouble,
13 if there is no condensation.

14 MR. CHEUNG: There is no condensation, and
15 on top of it, the vacuum breaker -- well, actually,
16 the water leakage on the top of the wetwell, they stay
17 at the top and do not mix --

18 MR. WALLIS: Don't mix with the gas.

19 MR. CHEUNG: -- with the gas in --

20 MR. WALLIS: So it stays at 260 degrees or
21 something? Does it cool down?

22 MR. CHEUNG: It cools down on the side
23 wall, only on the side.

24 MR. WALLIS: It cools down without
25 condensing?

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1 MR. CHEUNG: Well --

2 MR. WALLIS: Okay. Okay.

3 MEMBER BANERJEE: I am still a little
4 troubled by the drain line. so let me ask you the
5 question in a way that maybe I understand.

6 Imagine that the operation is sort of
7 sporadic as the pressure rises and that non-
8 condensables are driven out and then condensation
9 stops, and so on. Is there any possibility of non-
10 condensables getting into the drain line during this
11 operation and getting trapped?

12 MR. CHEUNG: No, because the drain line
13 has a U-tube at the end of it, and it takes the
14 gravity to move the liquid out, and the gas will tend
15 to go back up, any gas in the drain line.

16 MEMBER BANERJEE: Maybe if you could
17 clarify why it doesn't get -- So your pressure is
18 rising, right, because you've built up non-
19 condensables. Now when it rises enough, it drives the
20 non-condensables through, and it starts to condense
21 steam again. Right?

22 In this period, what happens to the
23 liquids that are -- or what is the detailed geometry
24 of the drain line which ensures that no gas gets into
25 that?

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1 MR. CHEUNG: Let me comment on that. If a
2 gas going back to the treated pool, it is not going to
3 affect anything.

4 MEMBER BANERJEE: No, no. I am not
5 worried about that. I am worried about it getting
6 trapped in the drain line and stopping the flow.

7 MR. CHEUNG: There is no -- The design of
8 the drain line is such that there is that U-tube at
9 the end, and only water can go through it. The gas
10 will go -- If anything, on the inside it would go back
11 up to the lower drum of the PCC.

12 MEMBER BANERJEE: Are there any horizontal
13 or near-horizontal runs?

14 MR. CHEUNG: If any near-horizontal runs,
15 they are going to slope.

16 MEMBER BANERJEE: So that any gas which
17 gets trapped is going to get vented?

18 MR. CHEUNG: Yes.

19 MEMBER BANERJEE: In some way.

20 MR. CHEUNG: Go back to the -- one way or
21 the other.

22 MR. WALLIS: This cartoon, I don't think,
23 is complete. I mean, sometime during Stage 1, curve
24 1, the GDCS drains. I think you have a separate
25 pocket there into which the drain line goes, which is

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1 still filled with water, and I think you also have a
2 loop in there. You have a loop in it --

3 MR. CHEUNG: I did not show the loop.

4 MR. WALLIS: -- like the loop you have
5 below your sink to prevent liquid gas getting sucked
6 up. This isn't a complete figure. I think you have a
7 -- what do they call the thing?

8 MR. CHEUNG: Seal loop.

9 MR. WALLIS: Loop seal. You have that,
10 don't you?

11 MR. CHEUNG: I did not draw the loop seal.

12 MR. WALLIS: And you also have a pocket as
13 shown in the earlier slides. In slide 3 there is a
14 pocket shown on the side of the GDCS pool into which
15 things go. Right? All these data are important.

16 MEMBER BANERJEE: Well, we just want to be
17 sure that all this is sort of an oscillatory operation
18 where you are pushing in and out, that there is no
19 likelihood that gas will get trapped and, therefore,
20 block the drain line or reduce the flow to the drain
21 line.

22 If now the flow through the drainline is
23 reduced, you will build up the drain level, and you
24 might be able to get water into the vent line
25 eventually, starting to make a mess.

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1 MR. CHEUNG: That is not happening by
2 design, because the elevation difference and the water
3 is --

4 MEMBER BANERJEE: I realize it doesn't
5 happen unless the flow through the drain line is
6 severely reduced, and it could be -- The thing is in
7 these systems you've got all this gravity vents
8 driving the flow. So if you manage to get a pocket of
9 air in, something which didn't clear, you could reduce
10 the flow quite a bit.

11 MR. WALLIS: Well, that is why you have to
12 have this loop at the bottom. When the GDCS drains,
13 you've to keep the bottom of the drain line covered.

14 MEMBER BANERJEE: Well, that is one end,
15 the water going in. The issue is can stuff get in
16 from the other end.

17 MR. WALLIS: Yes.

18 MEMBER BANERJEE: If you aren't condensing
19 much steam and you have some flow of non-condensables,
20 then eventually the drain line will drain out. Right?
21 Because there is no water coming there, and yet you
22 are pushing non-condensables. So some non-
23 condensables could get into the drain line at that
24 point.

25 MR. MARQUINO: This is Wayne Marquino from

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1 GE. I would like to address the concern about vapor
2 blocking the drain line.

3 MEMBER BANERJEE: Non-condensables; not
4 vapor.

5 MR. MARQUINO: The drain line will have
6 gas or vapor in it. It could be steam or a non-
7 condensable, but the condensate will drain through the
8 gas and reach the bottom of the drain line. When the
9 loop seal fills up to the design elevation, any
10 further condensate will overflow into the GDCS pool.

11 MR. WALLIS: So the loop seal has to be
12 big enough, have enough hydrostatic head to overcome
13 the sort of transient behavior that my colleague,
14 Professor Banerjee, is talking about. So how you
15 design this loop seal might be important.

16 These things are important. I think this
17 looks like a very nice design, but there are three or
18 four key elements that need to be designed and
19 analyzed properly.

20 MEMBER MAYNARD: I think also the drain
21 line -- the actual geometry and specifications would
22 be nice to know, because the current plants are
23 finding some problems with horizontal runs of pipe
24 that are supposed to have a slope and, due to
25 construction tolerances and long pipe, you find some

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1 areas that actually turn out higher and can trap.

2 So I think that is one of the concerns, is
3 what is the real geometry of this, and is it for sure
4 that it is always sloped to where the water will be
5 draining the condensation through the gas as opposed
6 to a trap being there.

7 MR. WALLIS: What is also very confusing
8 is that we see all these cartoons. I have a whole
9 stack of them at home, and they are all different.
10 Sometimes there is a horizontal line. Sometimes there
11 is a line with a loop in it. Sometimes there is a
12 slope, and sometimes there is a pipe that goes down
13 and up again. These vary, depending on which cartoon
14 you look at.

15 This is very confusing. You ought to have
16 a consistent picture of what is there.

17 MEMBER MAYNARD: What you are asking for
18 is architectural drawings?

19 MR. WALLIS: Well, have the cartoons
20 represent reality.

21 MEMBER BANERJEE: Or a safety measure
22 which would vent the drain line if anything got in
23 there.

24 MEMBER SIEBER: These cartoons -- They
25 won't show all the details. I think to answer these

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1 questions, you would need architectural drawings, and
2 I'm not sure GE has those.

3 MR. MARQUINO: This is Wayne Marquino of
4 GE. We have isometric drawings of the piping that we
5 are prepared to show you. I believe they are
6 proprietary information, but we can go over and
7 provide them to the staff for your review.

8 MEMBER BANERJEE: I guess, to go back to -
9 - sorry -- this question: We have come up against
10 these gas bubbles often in the past. It would be nice
11 to know that, if by some means that we can't imagine
12 today gas bubbles got in, you would be able to take
13 care of that problem without having the drain line
14 have a very reduced flow through it. But if that
15 happens, then you would build up condensate, and
16 eventually it will start to go into the vent line.
17 There is no other place for it to go.

18 MR. CHEUNG: The drain line is designed
19 such that there is no possibility for the gas to stop
20 somewhere and hide somewhere.

21 MEMBER BANERJEE: We've heard that about
22 many lines. That is a problem.

23 MR. WALLIS: Well, what you need to supply
24 us with is not some architectural drawings, which are
25 so complicated no one can figure them out, but enough

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1 detail to justify the analysis that was performed.
2 That's all we need.

3 MEMBER BANERJEE: Well, we have voiced a
4 concern.

5 MR. CHEUNG: Let me try to make a point.

6 MEMBER BANERJEE: I'm sure you can handle
7 it.

8 MR. CHEUNG: This slide is trying to say
9 that the PCC is self-regulated.

10 MR. WALLIS: We know that.

11 MR. CHEUNG: Okay.

12 MR. WALLIS: That is not the problem.

13 MR. CHEUNG: There were questions about
14 seal on one of these. The column is negative or
15 reveals an other way that the water in the suppression
16 pool go back into the PCC vent line, and then stop. I
17 mean, the gas is not going anywhere under this
18 condition. So whatever that non-condensable coming in
19 is going to fill up the non-condensable gas column.

20 MR. WALLIS: So another question. When
21 you turn on these fans you are going to show us later,
22 do they suck water up through the drain line?

23 MR. CHEUNG: No.

24 MR. WALLIS: Well, you can explain all
25 that, too.

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1 MR. CHEUNG: Because the line is so long,
2 and if there is any --

3 MR. WALLIS: Unless they are filled with
4 water.

5 CHAIRMAN CORRADINI: You are going to have
6 to make a decision. You have qualitatively taken us
7 down a path, but I -- at least for me, I want to see
8 the main steam line very quantitatively. Are we at a
9 point where we can quantitatively talk about
10 something?

11 MR. CHEUNG: Okay. Let's move on, number
12 six. The main steam line break is -- For the first
13 three days, we have bypass leakage one square
14 centimeter. The bypass leakage rate is leaking this
15 drywell energy in the wetwell, top of the wetwell, and
16 in this calculation no credit for PAR, and in these
17 calculations, the next couple of slides, there is no
18 vent fan and no other systems.

19 CHAIRMAN CORRADINI: So let's stop here
20 for a minute, because I want to understand the -- I
21 want to go back to some questions Graham is asking to
22 get clear.

23 In the DBA calculation, can you assume
24 condensation on cold walls or do you -- are you
25 prescribed to assume essentially an adiabatic

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1 boundary? I want to understand some boundary
2 conditions.

3 MR. CHEUNG: The wall has condensation.
4 The inner wall of the drywell and outer wall of the
5 wetwell, they have condensation.

6 CHAIRMAN CORRADINI: And you are modeling
7 condensate?

8 MR. CHEUNG: We model the heat straps.

9 MR. WALLIS: All on the ceiling?

10 MR. CHEUNG: Not on the ceiling.

11 MR. WALLIS: The ceiling is the most
12 important thing.

13 MR. CHEUNG: Because -- Well, we are not
14 modeling that.

15 MR. WALLIS: That's where the steam is,
16 and that is where it will come down.

17 MR. CHEUNG: Yes. We are very
18 conservative, because the energy to trap in there is
19 not mixing.

20 CHAIRMAN CORRADINI: I am going to
21 interrupt you, Graham, for just a minute. But just to
22 back up: So in the DBA calculation you are partially
23 modeling condensation. It is not totally adiabatic.

24 MR. CHEUNG: No.

25 CHAIRMAN CORRADINI: But it is adiabatic

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1 on the ceiling. So that's question one.

2 Question two is the one square centimeter
3 bypass leakage. That's a big thing. You are going to
4 come later to that and look at a sensitivity.

5 MR. CHEUNG: Yes.

6 CHAIRMAN CORRADINI: Okay. Third
7 question: On your -- What do you mean by no credit
8 for PARs?

9 MR. CHEUNG: We have PARs, but we do not
10 take credit. PARs -- the first three, we are not
11 taking any credit.

12 CHAIRMAN CORRADINI: Okay.

13 MR. CHEUNG: The PARs, some, not gas.

14 MR. WALLIS: These are recombiners?

15 MR. CHEUNG: Yes. Passive recombiner.

16 MR. WALLIS: They are, what, catalytic?

17 MR. CHEUNG: Yes. Can I have slide number
18 seven?

19 MR. WALLIS: Number 7 is very interesting,
20 yes.

21 MR. CHEUNG: Now on the lefthand side is
22 showing the initial condition. Initially, the drywell
23 is full pretty much of a non-condensable gas, and in
24 the table below that is a time series showing all the
25 non-condensable gas mass.

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1 Initially, the drywell had about 8,000
2 kilograms, and the GDCS gas space is a very thin layer
3 initially, only 300, and so on. Now the interesting
4 thing is the PCC tubes is a very small one and only
5 holds 12 kilograms. That's the thing that we have to
6 see that -- or remember that. Very small amount of
7 non-condensable gas generated by radiolytic gas will
8 go into that and supply the cell recreation process in
9 the PCC.

10 CHAIRMAN CORRADINI: So may I ask you
11 about that, because that came up in the audit
12 calculations, and I wanted to understand.

13 This is a prescribed model?

14 MR. CHEUNG: Of that radiolytic gas?

15 CHAIRMAN CORRADINI: Yes.

16 MR. CHEUNG: Yes.

17 CHAIRMAN CORRADINI: Okay. Which is based
18 on Reg. Guides?

19 MR. CHEUNG: Yes.

20 CHAIRMAN CORRADINI: Which is essentially
21 required from a DB analysis standpoint?

22 MR. CHEUNG: Yes.

23 CHAIRMAN CORRADINI: Got it. Thank you.

24 MR. WALLIS: But then the MELCOR model
25 gives quite different answers, doesn't it, seems to

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1 me?

2 CHAIRMAN CORRADINI: I think we will get
3 to that.

4 MR. WALLIS: Okay.

5 CHAIRMAN CORRADINI: I just wanted to make
6 sure of the source of the radiolytic gas, so I made
7 sure I understood.

8 MR. WALLIS: So somebody said that
9 nitrogen can stay up in the drywell head, although it
10 is denser than the steam below it. Somebody said that
11 can happen?

12 MR. CHEUNG: Let's look at the drywell
13 head. You can see there is a very little, narrow or
14 small passage.

15 MR. WALLIS: Well, it doesn't matter. The
16 nitrogen is cold, and it is denser than the steam. So
17 the steam is going to push it out, isn't it?

18 MR. CHEUNG: The steam below in the DPV or
19 the main steamline will push anything above it trying
20 to get a way into the PCC inlet. So anything in the
21 way that it is trying to push it out, push it out into
22 the drywell head --

23 MR. WALLIS: So are you going to show us
24 the nodalization of this thing and how the mixing
25 between the various regions is modeled or is that

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1 something that --

2 CHAIRMAN CORRADINI: I think that is in
3 Chapter 6. I have Chapter 6 up of the DCD.

4 MR. CHEUNG: That is in Chapter 6,
5 Nodalization.

6 MR. WALLIS: But this is a very key
7 thing. Where are the non-condensables go and how they
8 get there and how they get conserved and everything is
9 very important.

10 MEMBER BANERJEE: Is there some
11 experimental data that shows you what happens in the
12 drywell and how this gets pushed into the PCC?

13 MR. CHEUNG: In the PANDA test we show
14 that, how the non-condensable gas push from the
15 drywell and the wetwell through the PCC and
16 accumulation of non-condensable gas in the bottom of
17 the PCC tube.

18 MEMBER BANERJEE: And was it sort of a
19 scaled representation of what you have in the real
20 situation?

21 MR. CHEUNG: The PANDA tests are full
22 scale -- full height. Not full scale -- full height.

23 MEMBER BANERJEE: Full height. And so you
24 have -- You simulated a main steam line break in
25 smaller scale?

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1 MR. CHEUNG: Yes.

2 MEMBER BANERJEE: You had a representative
3 drywell of some sort with some features of the
4 geometry that were there with regard to height, and
5 you pushed the non-condensables out in a
6 representative manner into the PCC. Is that correct?

7 MR. CHEUNG: Yes.

8 MEMBER BANERJEE: Did you validate your
9 codes against the PANDA experiments?

10 MR. CHEUNG: Yes.

11 MEMBER BANERJEE: And which was the code?

12 MR. CHEUNG: TRACG code.

13 MEMBER BANERJEE: And it showed that you
14 could push out these non-condensables. Right?

15 MR. CHEUNG: Yes.

16 MEMBER BANERJEE: Was it a mixing with the
17 steam and then the mixture went or was there like a
18 piston-like thing or what happened?

19 MR. CHEUNG: In the first period of the
20 blowdown or the -- that the steam was well mixed with
21 the non-condensable gas.

22 MEMBER BANERJEE: And then?

23 MR. CHEUNG: And then the mixture will go
24 into the PCC, steam condense, non-condensable gas
25 trying to find a way to push it into the wetwell

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1 sooner or later. But in the meantime, they just
2 collect in the bottom.

3 MEMBER BANERJEE: So the non-condensables
4 started to collect in the PCC, and then sort of
5 eventually the pressure built up, then again was
6 pushed through.

7 MR. CHEUNG: Yes.

8 MEMBER BANERJEE: But if you say early
9 stage, clearly, the PCC did not have the capacity to
10 condense all the steam that was being generated. So
11 did PANDA have a simulation also of other flow parts
12 and other condensation?

13 MR. CHEUNG: The PANDA start at one hour
14 after the LOCA.

15 MEMBER BANERJEE: So what happens in the
16 first hour?

17 MR. CHEUNG: The first hour, we more or
18 less simulated the curve number 5 or so that the PCC
19 cannot handle.

20 MEMBER BANERJEE: Do you have any
21 experimental validation of that period?

22 MR. CHEUNG: Yes.

23 MEMBER BANERJEE: Where did you do those
24 experiments?

25 MR. CHEUNG: The PANDA test.

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1 MEMBER BANERJEE: The PANDA starts one
2 hour after. Right? What about the first hour?

3 MR. CHEUNG: We have the suppression pool
4 blowdown test.

5 MEMBER BANERJEE: Right. But here you
6 have a combined effect. Some of the heat is going to
7 go to the PCC. Some goes into the suppression pool,
8 and this fraction is changing over time, and
9 eventually after some long period of time, the PCC is
10 doing all the condensation. Right?

11 MR. CHEUNG: Yes.

12 MEMBER BANERJEE: So how do you -- What
13 experimental validation do you have of this period
14 which starts immediately after the break and goes on
15 to the time when the PCC takes over and does all the
16 condensation? There is a complicated set of events
17 going on at this point. Right?

18 MR. MARQUINO: This is Marquino of GE. In
19 the initial blowdown period we have separate effects
20 heat transfer tests that allowed us to qualify the
21 code against heat transfer coefficients developed at
22 UC Berkeley, MIT. So we do have --

23 MEMBER BANERJEE: These are very small
24 scale experiments. Right?

25 MR. MARQUINO: Yes, those are. So for the

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1 blowdown into the suppression pool, as Dr. Cheung
2 mentioned, we have pressure suppression tests, and
3 during that period we have flow force through the PCC
4 by the large differential pressures, and we have heat
5 transfer tests that qualified the heat transfer
6 calculated by the code in that period.

7 MEMBER BANERJEE: In the PCC?

8 MR. CHEUNG: In the PCC, yes.

9 MR. MARQUINO: Yes.

10 MR. CHEUNG: The PANDA test done in Italy
11 is a full scale PCC, too.

12 CHAIRMAN CORRADINI: Say that again. I'm
13 sorry. Could you repeat that?

14 MR. CHEUNG: The PANDA test in Italy is
15 full scale.

16 MEMBER BANERJEE: And the PANDA test -- is
17 high fluoresce that we are getting?

18 MR. CHEUNG: The PANDA test in Switzerland
19 is a system testing, full height.

20 MEMBER BANERJEE: You got two separate
21 tests. Right? One is the PANDA, was the largest
22 test?

23 MR. CHEUNG: That one is done in Italy.

24 MEMBER BANERJEE: Yes. So in PANDA you
25 also measured the heat transfer coefficients in the

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1 PPC?

2 MR. CHEUNG: Yes.

3 MEMBER BANERJEE: But it was not a systems
4 test. It was just to test the PPC. Right?

5 MR. CHEUNG: This is -- We call it
6 component test.

7 MEMBER BANERJEE: Yes. Okay. So it's a
8 sort of a separate effects test?

9 MR. CHEUNG: Yes.

10 MEMBER BANERJEE: And the PANDA was like
11 a system test?

12 MR. CHEUNG: Yes.

13 MEMBER BANERJEE: The PANDA test did not
14 look at the early state -- Right? So they only looked
15 at the situation one hour later or whatever?

16 MR. CHEUNG: The system in action after
17 one hour.

18 MEMBER BANERJEE: So I'm really asking:
19 In this very complicated geometry where you've got,
20 you know, the PCC and the suppression pool and all
21 this and you are going from most of the heat transfer
22 being done in the suppression pool to most of the heat
23 transfer being done in the PCC. In this transition
24 period, what sort of experimental database and
25 validation do you have for your analysis tools?

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1 MR. CHEUNG: We have a coefficient test
2 report and then to lay out all this time period, in a
3 given time period, given testing, to qualify the
4 computer code.

5 MR. MARQUINO: Let me expand on that. In
6 the middle of TRACG for containment analysis of ESBWR
7 and ECCS analysis of the ESBWR, we started with a TAPD
8 report, test and analysis program description. That
9 laid out the phenomena and how we were going to
10 qualify our code to the phenomena and what tests we
11 considered had to be conducted.

12 Then we conducted those tests, and we
13 qualified the code to those tests. We submitted a
14 number of TRACG qualification reports to the staff,
15 and they have been reviewed. The specific report
16 number for the TAPD report is 33079.

17 CHAIRMAN CORRADINI: Yes, I've got it
18 here.

19 MR. MARQUINO: And then if you go to the
20 33083, which is a TRACG application methodology for
21 ESBWR, that references different qualification reports
22 for the code.

23 So you are asking valid questions here.
24 We have in the 33083 report a qualification matrix
25 where we lay out the phenomena and then the tests that

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1 included those phenomena, and the qualification of the
2 code in another matrix.

3 So we have documented the capability of
4 the code and the qualification of the code.

5 MEMBER BANERJEE: I guess my question is
6 much simpler. I mean, were you -- Do you have any
7 integral database for integral rather than separate
8 effects for the phase which is before PCC control of
9 condensation?

10 MR. MARQUINO: Let me --

11 MEMBER BANERJEE: Even on a small scale.

12 MR. MARQUINO: Let me answer that
13 directly.

14 MR. WALLIS: May I ask, Sanjoy, are you
15 asking about PANDA or are you asking about the
16 modeling of how the gas gets from the GDCS DW annulus
17 and all those different regions to the PCC? Are you
18 including that in your integral test question?

19 MEMBER BANERJEE: It is all that. Right?

20 MR. WALLIS: I think we can talk about
21 PANDA forever, but just is the PCC, and the key
22 question for me is how the GDCS is able to store so
23 much gas for so long and then suddenly get rid of it.

24 Things like that are my questions.

25 Doesn't make sense. I mean, it fills up

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1 in 15 hours. It gets more stuff in it, and then it
2 suddenly empties. I mean, all these things don't make
3 sense to me, and how the non-condensables get around
4 the various regions.

5 MR. MARQUINO: Let me try and --

6 MR. WALLIS: There is no test for that, is
7 there?

8 MEMBER BANERJEE: Well, we can divide this
9 into phases. Let's start with the early phase. Then
10 we will go on to the longer term. I guess everybody's
11 concern is about the non-condensables and where they
12 are going. This is really the issue, and we are
13 asking that.

14 MEMBER ABDEL-KHALIK: Can I just ask about
15 one number in this table?

16 MR. CHEUNG: Yes.

17 MEMBER ABDEL-KHALIK: 529, the second
18 column, at 15 hours.

19 MR. CHEUNG: Yes.

20 MEMBER ABDEL-KHALIK: So I'm trying to
21 compare the conditions, the GDCS gas phase in the
22 drywell. The drywell is mostly steam. Right?

23 MR. CHEUNG: The drywell, mostly steam.

24 MEMBER ABDEL-KHALIK: At that point, and
25 the GDCS has a lot more non-condensable gas.

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1 MR. WALLIS: the DCD says that the partial
2 pressure is 100 kilopascals. That is an atmosphere,
3 but it's half non-condensables in there. Doesn't make
4 sense.

5 MEMBER ABDEL-KHALIK: And yet these two
6 spaces are pretty much connected.

7 MR. WALLIS: Then it suddenly vents itself
8 for 30 hours.

9 MR. CHEUNG: I have curve to explain that.

10 CHAIRMAN CORRADINI: Well, can you try it
11 in words?

12 MR. CHEUNG: Okay. Now through the
13 blowdown period -- or after the blowdown period, the
14 GDCS injection stop. The GDCS pool drains. Then you
15 increase the volume, and at the same time there is
16 some amount of the non-condensable gas in the drywell,
17 because --

18 MR. WALLIS: Not much left.

19 MR. CHEUNG: Not much left, but in the
20 blowdown period they are trying to push away all the
21 way up, find any way to move it.

22 MR. WALLIS: Doesn't it force pretty much
23 all the non-condensables before two hours?

24 MR. CHEUNG: And this accumulation -- I
25 have a curve to show that this accumulation of non-

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1 condensable gas in the GSCS drain down volume
2 occurring in the very first period, time period.

3 MR. WALLIS: But it hasn't drained yet.
4 There is no volume for it to go to.

5 MR. CHEUNG: It drained at a couple
6 hundred seconds.

7 MR. WALLIS: The GDCS pool drains in a
8 couple hundred seconds?

9 MR. CHEUNG: Start draining in a couple
10 hundred seconds.

11 MR. WALLIS: So it sucks in a lot of non-
12 condensables.

13 MR. CHEUNG: Yes. Let's move on to curve
14 number 12 and show you --

15 MR. WALLIS: Then they suddenly get purged
16 between 15 and 30? The first 15 hours, they build up.

17 MR. CHEUNG: Yes.

18 MR. WALLIS: The next 15 hours they
19 miraculously disappear.

20 MR. CHEUNG: Not they are building up in
21 the first couple of -- 15 hours. Build up in the
22 first one hour and stay there, and at 18 hours there
23 is some phenomenon happening, and I am going to
24 explain it.

25 MEMBER BANERJEE: I still am stuck on the

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1 first hour.

2 CHAIRMAN CORRADINI: Yes. I think -- So
3 just to help us organize our thoughts, I think Sanjoy
4 is asking a question which you can defer to later, but
5 I think we want to understand, which is: You are
6 saying the PANDA tests were full height integral and
7 gave physical insight into code and phenomena
8 synchronization, normalization, whatever, from one
9 hour forward.

10 For the first hour, you have --
11 essentially, your are dominated by losses to the
12 suppression pool, but you have the parallel path of
13 PCC. So what Sanjoy is asking is: What testing or
14 calculations or combination of logic gives you good
15 confidence that that hour is properly characterized?
16 I think that is what --

17 MEMBER BANERJEE: Exactly. Because where
18 I am coming from eventually is I want to trace the
19 history of the non-condensables from time zero through
20 each of these phases.

21 So the first hour I want to know how well
22 you predict where the non-condensables are, how much
23 confidence you have in that. Then we will move on to
24 the next phase and the next phase, because the whole
25 story eventually is all --

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1 MR. WALLIS: And this will take the whole
2 day to explain.

3 CHAIRMAN CORRADINI: Well, we don't have
4 the whole day.

5 MR. WALLIS: No, but at least we've got
6 the questions.

7 MEMBER BANERJEE: I think the story about
8 the non-condensables and how you predict where they
9 are going and what confidence you have in that is the
10 crux of the matter here.

11 MR. WALLIS: And your cartoon shows the
12 GDCS half-full.

13 MR. CHEUNG: Yes.

14 MR. WALLIS: Doesn't it empty?

15 MR. CHEUNG: No, not for main steam line
16 break.

17 MR. WALLIS: For three days, it stays
18 half-full?

19 MR. CHEUNG: Yes. At equilibrium
20 elevation between the pool and DP elevation.

21 MR. WALLIS: Oh, it's halfway down.

22 MR. CHEUNG: Halfway down.

23 MR. WALLIS: So there is a very big cold
24 water surface to condense vapor in the wetwell, if
25 there is condensation through the ceiling, and if

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1 there isn't -- If there isn't conduction through the
2 ceiling, then the ceiling is already cold --

3 MR. CHEUNG: We are not taking that
4 credit. You are right. We are not taking that
5 credit.

6 MR. WALLIS: So, well, I mean I can't
7 understand why the ceiling, which is the biggest and
8 the coldest area and obviously plays the biggest role
9 in controlling the wetwell pressure, is ignored.

10 MR. CHEUNG: Yes.

11 MR. MARQUINO: This is Wayne Marquino. I
12 would like to take 60 seconds to try and answer Dr.
13 Banerjee's question.

14 At the onset of the ESBWR program we had
15 completed a large number of full pressure blowdown
16 tests into various types of pressure suppression
17 containments, Mark I, Mark II, Mark III, ABWR.

18 The vent configuration in ESBWR is very
19 similar to the ABWR configuration. So we did not
20 conduct a full pressure blowdown test for ESBWR. We
21 are informed by the ABWR data, and we are applying it.

22 MEMBER BANERJEE: When you say vent
23 configuration, it's like for the PCC line?

24 MR. MARQUINO: No. No, the main vents
25 between the drywell and the wetwell and the horizontal

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1 vents leading off the main vents.

2 CHAIRMAN CORRADINI: So can I just modify
3 his question, because I think it will help.

4 I think another way to ask Sanjoy's
5 question is: Now you've added a parallel flow path.
6 How much energy are you pulling from that that you are
7 going to have to either validate or ignore?

8 I mean, I'm waiting for you to tell me I
9 don't care about the PCC, but you haven't said it yet
10 -- in that first hour.

11 MEMBER BANERJEE: You may not care in the
12 beginning, but toward the end you start --

13 CHAIRMAN CORRADINI: I think that's his
14 point. He is looking for the energy split and the
15 flow split.

16 MR. MARQUINO: Okay.

17 CHAIRMAN CORRADINI: And your confidence
18 that you know what those are.

19 MR. MARQUINO: Let me try. So at the
20 onset of the SBWR, we understood we have to test these
21 passive cooling features, passive gravity drain
22 pooling. The tests were done starting from about 150
23 psi in the blowdown.

24 So that allowed us to save some costs in
25 the test facilities. They were not designed to full

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1 reactor pressure but 150 psi. So if you look at the
2 GIS gravity drain tests, the GIRAFFE gravity drain
3 tests, the PANDA containment tests, they are about 150
4 -- They start at 150 psi in the blowdown.

5 Now your question is: So how do we know
6 what happened in the first part of the blowdown? In
7 that part, we have a differential pressure between the
8 drywell and wetwell, and we have qualified our codes
9 very well to calculate that differential pressure.

10 So the PCC has a forcing function applied
11 to it, and we have tube data and PANTHER's data on the
12 PCC with various differential pressures and flows that
13 we qualify the code to.

14 So although we don't have an integral test
15 for that portion of the blowdown, we do know what is
16 going on in the PCC during that portion..

17 MEMBER BANERJEE: So what you are really
18 saying is that you have some separate effects tests on
19 the PCC which tell you what would happen there. You
20 have some tests about what happens in terms of flow
21 into the suppression pool and the heat transfer there.

22 The issue really then is you've probably -
23 - and I don't know, but you probably take the drywell
24 region as being well mixed and then, just calculating
25 the various pressure losses, you split the flow

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1 between the PCC and the suppression pool. Is that
2 correct -- or into the suppression pool?

3 MR. MARQUINO: Yes.

4 MEMBER BANERJEE: And then this is
5 approximation what you are doing?

6 MR. MARQUINO: Yes.

7 MEMBER SIEBER: You have ignored all the
8 other effects, because they are all conservative?

9 MR. MARQUINO: Yes. Dr. Cheung is talking
10 about some of the conservatives that we have included.

11 MEMBER BANERJEE: But you assume
12 everything is well mixed. Right? So there is no --
13 In this period, there is no stratification occurring
14 in the drywell or anything like that?

15 MR. MARQUINO: It is well mixed. You can
16 see in Chapter 6 we have a nodalization diagram. So
17 we have some nodes, and it is possible to have
18 different concentrations in the different nodes. But
19 that is not a major player in the blowdown portion,
20 because basically, the -- We are talking like -- what
21 was it, a half an hour for -- So out of 72 hours, we
22 have this half-hour period, and there is no non-
23 condensable gas accumulation in the PCC in that period
24 for sure, because it is completely flowing through the
25 vent.

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1 MR. ALAMGIR: This is M.D. Alamgir from
2 GEH. In the PCC, the range of non-condensable
3 fractions tested, in my opinion, cover what happens in
4 the ESBWR containment during the first hours leading
5 to the PCCS. That's my point number one. So it is
6 local, and then that confidence gives us to go global
7 in analysis. Local qualification of the USB-MIT test
8 and the correlations that come out of it.

9 MR. WALLIS: Well, let's go back. I mean,
10 I think you did a good job on the PCC. You did full
11 scale tests, height tests and so on. You probably
12 understand it.

13 It is only one of about six or seven
14 different systems here which are interacting, and you
15 don't have, it seems to me, experiments for the mixing
16 between the GDCS gas space and the drywell. You don't
17 have any experiments for what really happens in the
18 wetwell gas space where you have steam leaking in and
19 you have walls at different temperatures and you have
20 a cold floor and so on, and the mixing between how the
21 stuff gets in and out of the drywell head and the
22 drywell annulus is all just theoretical in some way.

23 So what is the basis for -- Those are very
24 important phenomena governing what happens.

25 MR. ALAMGIR: Professor Wallis, you have

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1 very good comments there. I do want to explain that
2 the stratification is also diffused to some extent by
3 the fact that there is condensation on the vertical
4 walls. There is some minimum diffusion. So it is not
5 really the light steam will be fully stratified --

6 MR. WALLIS: Do you somewhere explain
7 that? I couldn't understand your model for the
8 wetwell. Your model is the steam is all on the top
9 and the gases all underneath?

10 MR. ALAMGIR: It's well mixed.

11 MR. WALLIS: It's well mixed? The
12 wetwell?

13 MR. CHEUNG: No. Wetwell is not well
14 mixed. The drywell.

15 MR. WALLIS: Completely stratified
16 wetwell?

17 MR. CHEUNG: Pretty much.

18 MR. WALLIS: Pretty much. Now come on.

19 MR. CHEUNG: Yes.

20 MR. WALLIS: Is it or not?

21 MR. CHEUNG: Yes.

22 MR. WALLIS: It's completely stratified?

23 MR. CHEUNG: We force it to be stratified.

24 We have --

25 MR. WALLIS: And then you are going to

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1 tell us how you model the heat and mass transfer to
2 the walls? Do you know how to calculate what happens
3 in there? I mean, this is not a simple problem, is
4 it? The walls are different temperatures, undergoing
5 transients, and the steam coming in at one place and
6 going somewhere else. It's not a trivial problem.

7 So to make sure that you've done it
8 conservatively, we have to look at it carefully. Then
9 it may be -- I think your conservatism is probably way
10 beyond what is necessary.

11 MR. CHEUNG: Yes. We agree with that.

12 MR. WALLIS: I think it probably is, but I
13 haven't seen what it is yet.

14 MR. CHEUNG: We have curves. Later on, we
15 show that conservative --

16 MR. WALLIS; It's unreasonably
17 conservative, isn't it?

18 MR. CHEUNG: Yes. Because we cannot
19 arrange that, we -- a very good job in mixing --

20 MR. WALLIS: Well, it may be so
21 conservative that it misses some other phenomenon that
22 is important, because it misrepresents the transient.
23 But anyway, let's go on.

24 CHAIRMAN CORRADINI: Let me -- If I might
25 just help us along. So I know we are behind, but I

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1 want to make sure -- You are going to move on. So are
2 you done with this slide?

3 MR. CHEUNG: No, this slide I am going to
4 show that -- The table is going to show up in a couple
5 of other slides. This one, I am going to show that on
6 the righthand side, that the GDCS pool going to drain
7 down to a equilibrium level here that equalize to the
8 DPV elevation.

9 MR. WALLIS: Are you going to tell us what
10 this phenomenon is that suddenly gets the gas out of
11 the GDCS?

12 MR. CHEUNG: Yes.

13 MR. WALLIS: Okay.

14 MR. CHEUNG: Now the GDCS pool still have
15 about 1,000 cubic meter of water remaining in it, cold
16 water, and the PCC drain water is hot, to mix with the
17 pool water and heat up the pool water slowly and
18 slowly, and then the pool water going into the RPV
19 downcomer and mix with water in the downcomer.
20 Because the temperature of this pool water keep going
21 up at, at about 18 hour or so the water level in the
22 downcomer slowly change and get into the point that
23 overflows from the DPV in the drywell annulus and --

24 MEMBER BANERJEE: Can you show us what you
25 mean?

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1 CHAIRMAN CORRADINI: I think you are
2 trying to say the righthand blue and the blue inside
3 the vessel equalize, and then you get to the point of
4 the open pipe, and it spills out.

5 MR. CHEUNG: Yes, out of the RPV. Once it
6 overfills in the drywell --

7 MR. BANERJEE: I'm losing it.

8 CHAIRMAN CORRADINI: It is spilling out of
9 the vessel. The GDCS drains, drains, drains, until
10 the RPV fills, and then it gets to the open pipe and
11 spills out.

12 MR. WALLIS: When it comes out of the DPV,
13 where does it go? Does it just drain down the annulus
14 space?

15 MR. CHEUNG: It drains down the annulus
16 space.

17 MR. WALLIS: Does it fall into the wetwell
18 downcomer?

19 MR. CHEUNG: No. Accumulating in the
20 bottom of the drywell.

21 MR. WALLIS: You see, this cartoon is
22 misleading. Some of the other cartoons show the DPV
23 above the wetwell.

24 MR. CHEUNG: When that drain starts, the
25 cold water from the downcomer condenses steam in the

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1 drywell, create a sudden drop in the drywell pressure,
2 and the drywell pressure drops. The pressure in the
3 drywell head and the GDCS pool air space still
4 higher. Then force start initiate the process of
5 pushing whatever remaining gas mixture from this too
6 high a volume into the drywell.

7 Once this gets into the drywell and --

8 MR. WALLIS: I don't understand that at
9 all, because the volume is still constant in the gas
10 space in the GDCS. How can it be pushed out? The
11 only way it can be pushed --

12 MR. CHEUNG: Because the drywell pressure
13 is low due to --

14 MR. WALLIS: No. It doesn't make any
15 difference. The water level -- It can expand --

16 MR. CHEUNG: Suck up by the drywell low
17 pressure.

18 MR. WALLIS: So the water level in the
19 GDCS rises to the ceiling and pushes out the gas?

20 MR. CHEUNG: No, not the water level push
21 it out, but --

22 MR. WALLIS: Well, how can the gas get
23 out? It can expand, and some of it can come out.

24 MR. CHEUNG: Yes.

25 MR. WALLIS: But the rest of it stays

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1 there.

2 MR. CHEUNG: And because the water from
3 the GDCS drain water is hot --

4 MR. WALLIS: Yes. It's steam.

5 MR. CHEUNG: And steam trying to slowly
6 push it up.

7 MR. WALLIS: So it steams in there.

8 MR. CHEUNG: The water temperature or
9 water partial steam pressure in the GDCS pool lowering
10 going up.

11 MR. WALLIS: Steam is lighter than
12 nitrogen, isn't it?

13 MEMBER BANERJEE: I guess that's the
14 issue.

15 MR. WALLIS: Steam is lighter than
16 nitrogen, and to be conservative, as in the wetwell,
17 you should assume it goes to the top without mixing.

18 MEMBER BANERJEE: And, basically, you vent
19 the steam out, but you may still leave the non-
20 condensables in the GDCS.

21 MR. CHEUNG: I agree with you. In
22 reality, the non-condensable gas will hide in those,
23 but we cannot demonstrate how accurately we can
24 calculate it. We force it out, but --

25 MR. WALLIS: Well, how do you get it down

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1 to 1.26 kilogram at 30? That's a real mystery.

2 MEMBER BANERJEE: Basically, it's a
3 piston. The steam is pushing it out.

4 MR. WALLIS: But that's a nonconservative
5 assumption.

6 MEMBER BANERJEE: Well, I don't know if it
7 is conservative or not. It is probably an incorrect
8 assumption.

9 MR. CHEUNG: No, yet the -- gas stay
10 behind, not going in the wetwell. The end pressure
11 going to be lower. That, I know.

12 MR. WALLIS: Do you know -- Do you
13 understand how steam evolving from a pool pushes gas
14 out above it without -- because it is lighter. It is
15 hotter, and it's got a lower molecular weight. So the
16 steam will tend to come up in plumes or along the
17 walls or something.

18 MR. CHEUNG: Yes.

19 MEMBER SHACK: It is a conservative
20 calculation, not trying to be realistic.

21 MR. WALLIS: Well, I'm not sure what is
22 conservative, because what is conservative in one
23 stage may be unconservative in another.

24 MR. CHEUNG: The key measure here is the
25 drywell pressure, which trying to force the way into

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1 that maximum driver pressure going to be.

2 MR. WALLIS: Well, the key to the whole
3 thing is the wetwell gas space pressure.

4 MR. CHEUNG: Yes.

5 MR. WALLIS: The drywell pressure really
6 just follows it, with a little difference.

7 MR. CHEUNG: Yes.

8 CHAIRMAN CORRADINI: So I am going to do a
9 time check, since we are already 20 minutes behind.

10 MR. WALLIS: That's all?

11 CHAIRMAN CORRADINI: Yes. And so I am
12 going to turn to the committee and ask that we give
13 Dr. Cheung the time to go through his presentation,
14 because we want to hear the audit calculations from
15 Melcor, or else I will also be chastised about not
16 allowing that to occur.

17 So I would ask that we let you finish, and
18 we will clarify but allow you to proceed. Okay?

19 MR. CHEUNG: Okay.

20 MR. WALLIS: So we are not going to get in
21 a presentation of what happens in the wetwell gas
22 space?

23 MR. CHEUNG: We are going to touch base on
24 that.

25 MR. WALLIS: Which is the key to an awful

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1 lot of what happens.

2 MR. CHEUNG: Next slide, please.

3 So about 18 hours and the water is in the
4 downcomer overspill, and start decreasing the drywell
5 pressure and then start the process of sucking up the
6 non-condensable gas from the higher wall and back into
7 the drywell, and once it gets in the drywell and then
8 all the non-condensable gas will find a way and move
9 it to the PCC and get into the wetwell.

10 Now these two pictures show at 30 hour and
11 60 hour, and notice that the PCC pool water level
12 drops, and because the evaporation; and also notice
13 that the non-condensable gas column, as shown in this
14 cartoon, change to just what is needed to condense the
15 steam generator in the drywell or by the decay heat.
16 You can see that the effective heat transfer area
17 change over time.

18 MR. WALLIS: Would you show in this figure
19 next time you present it the level of the steam in the
20 wetwell gas space, because presumably your model says
21 steam is here, and gas is underneath it, and as the
22 steam leaks in through the vacuum breaker, that steam
23 gets bigger. Would you show that next time you
24 present this?

25 MR. CHEUNG: Yes.

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1 MR. WALLIS: There might well be a next
2 time, it seems to me.

3 MR. CHEUNG: Okay. Sure.

4 MR. WALLIS: That's a key thing. Right?
5 How much steam is in that wetwell, and where is it,
6 and what is its temperature and pressure.

7 MR. CHEUNG: We have the temperature, but
8 we will show it in a back-up. Okay.

9 Now the key thing is you can see that the
10 effective heat transfer area or the PCC capacity is
11 self-regulated and you can see that, from time to
12 time, that the actual -- the PCC tube will transfer
13 energy to the pool, which is water. It is reducing
14 such that to accommodate what is being generated in
15 the drywell.

16 MR. WALLIS: Well, that's the old story.
17 We understand that one.

18 MR. CHEUNG: Okay. Next page. Now this
19 going to end of the 72-hour, again showing the
20 interaction between the correction of non-condensable
21 gas in the bottom. The table, showing it again, you
22 can see that we force most of the non-condensable gas
23 in the drywell into the wetwell, and also whatever
24 that rate are that get generated can also get into the
25 wetwell, and at the end of it the wetwell collect

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1 about 15,000 kilograms.

2 MR. WALLIS: Okay. So let's see. Between
3 30 and 72, there is almost no addition of gas to the
4 wetwell. It's almost constant --

5 MR. CHEUNG: No. The radiolytic gas,
6 about 300.

7 MR. WALLIS: It's almost constant, though.

8 MR. CHEUNG: Almost constant. It's 300.

9 MR. WALLIS: Almost constant. It goes up
10 by one or two percent. Right?

11 MR. CHEUNG: Go up by two percent, to be
12 exact.

13 MR. WALLIS: So the temperature is what is
14 raising the pressure, is it? Of steam.

15 MR. CHEUNG: Let qualify that. The non-
16 condensable gas by the radiolytic gas would generate
17 from 30 hours to 72 hours is two percent.

18 MR. WALLIS: I'm saying the amount of gas
19 in the wetwell space, the 14736, rises to 15,000,
20 which is a very small, relatively small, change.

21 MR. CHEUNG: That's two percent.

22 MR. WALLIS: Right. That can't account
23 for the rise in pressure. Something else causes the
24 pressure to --

25 MR. CHEUNG: The other thing is the

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1 leakage. That increases the wetwell temperature by
2 six percent. So it is a total of about eight percent.

3 That's the wetwell pressure increase from 30 hours to
4 72 hours.

5 MR. WALLIS: So what heats up the wetwell
6 gas is only the steam coming in?

7 MR. CHEUNG: The steam through the
8 leakage, the energy through the leakage.

9 MR. WALLIS: The steam -- No. The steam
10 coming in through the leak is what heats up the gas.

11 MR. CHEUNG: Yes.

12 MR. WALLIS: All right. That's the only
13 thing heating it up?

14 MR. CHEUNG: Yes.

15 MR. WALLIS: And the walls are not cooling
16 it down?

17 MR. CHEUNG: The wall cooling it down, but
18 it is limited, because you look at it. You see almost
19 2 meter thick of concrete, and take only two hours.
20 So that the concrete --

21 MR. WALLIS: The Melcor report says that
22 the wall is very important, I thought. But anyway --

23 CHAIRMAN CORRADINI: We'll get to that, if
24 we allow him.

25 What is the vacuum breaker setpoint?

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1 MR. CHEUNG: I don't have the number.
2 It's about half a psi or so, when the drywell pressure
3 lower than the wetwell pressure by half --

4 CHAIRMAN CORRADINI: Can we get that
5 number exactly?

6 MR. CHEUNG: Yes.

7 CHAIRMAN CORRADINI: Then you are going to
8 move on. So I will just suggest something here,
9 because I think what your intent of this was, was
10 helpful. But I think it's got to be coordinated with
11 what you were trying to explain to us in the
12 qualitative part.

13 You made a big thing about the qualitative
14 part about time phasing, zero to one hour, one hour to
15 five hours, five hours -- whatever. All these aren't
16 matching up. So that is what's causing some of the
17 questions.

18 I would think it would be very educational
19 for me to understand how it changed from zero to one
20 hour in the non-condensable, because I think the non-
21 condensable is decreasing from one hour forward, and
22 the 15 hour just happens to be a slice in time.

23 So next time you do it, and you are going
24 to explain phasing qualitatively and phasing
25 quantitatively, all the graphs and all the cartoons

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1 ought to be at the same points in time. Otherwise, it
2 will cause some confusion. That's just a suggestion.

3 MR. WALLIS: And show the continuous
4 curves from the DCD about what the gas is doing.

5 CHAIRMAN CORRADINI: But I think I
6 understand your point of how you tried to do it. I
7 just wanted to compliment you on I understood what you
8 were after, but the lack of the one hour caused us to
9 be a bit confused.

10 MR. CHEUNG: Yes. We have the -- The next
11 couple of slides show the mass distribution.

12 MR. WALLIS: I would say we are not
13 confused. We are not informed.

14 MR. CHEUNG: Next slide. This shows the
15 drywell pressure and the wetwell pressure, and you can
16 see that from 30 hours to 72 hours is continuing
17 increase.

18 MR. WALLIS: So the key thing you should
19 focus on next time you come here is why the
20 temperature does what it does and how you calculate
21 that.

22 MR. CHEUNG: Okay.

23 MR. WALLIS: Why the pressure does, and
24 what the temperature is doing all this time, and the
25 temperature you should show on the same graph. And

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1 that's a very key thing, because the temperature rise
2 is what is driving the biggest force driving the
3 pressure rise.

4 MR. CHEUNG: Yes.

5 MR. WALLIS: Then the question is how does
6 the temperature rise so much? Okay.

7 MR. CHEUNG: Next slide, please.

8 Now this shows the PCC condensation power
9 versus the decay heat, and you can see that the first
10 two hours of that, there is a big dip in the PCC
11 power. Doesn't mean that the PCC is not doing
12 anything, but because of the GDCS water going into the
13 -- draining into the RPV and pick up all the decay
14 heat. So this big dip is due to the GDCS injection,
15 and after two hours or so, then the PCC start picking
16 up, and the difference between the direct curve and
17 the back curve in the first couple of hours is the
18 deficiency or the water that is left over is going
19 into the suppression pool through the PCC vent line,
20 and after a couple of hours or so, the PCC actually
21 pick up all the decay heat or all the steam generated
22 by decay heat.

23 Now after a couple of hours, so the
24 difference between these two curves is due to the
25 1,000 cubic meter of cold water in the GDCS pool is

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1 still cold and going into the RPV and pick up some of
2 this energy.

3 CHAIRMAN CORRADINI: So now this -- I
4 think it is important at this point to link back to
5 your question. In the first hour, the PCCS is just
6 going along for the ride, and that goes, I think -- at
7 least, that's my interpretation, is that you are
8 concerned about the parallel flow paths, which are
9 really crucial, but I think from an energy sucking
10 standpoint it is doing nothing -- well, almost
11 nothing, compared to what --

12 MEMBER BANERJEE: Well, sort of -- Why are
13 we getting this huge dip? This is what I don't
14 understand.

15 MR. CHEUNG: Because the GDCS cold water
16 going in the RPV, and the decay heat had to heat up
17 the cold water until generating steam.

18 CHAIRMAN CORRADINI: And that's what
19 causes in curves 2 through 3 to go below. Right? We
20 start at 6, 5, then we fall below because of the
21 cooldown effect, and now we come back up to this kind
22 of quasi-steady.

23 MR. WALLIS: Well, we didn't get back to
24 that question about how that green curve could ever be
25 below the --

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1 CHAIRMAN CORRADINI: And I am not going to
2 let you right now.

3 MR. WALLIS: Okay, but we don't know how
4 the non-condensables --

5 CHAIRMAN CORRADINI: It was my one shot at
6 you today. I only get one, but that was my one.

7 MR. WALLIS: But that's a question which
8 is not answered.

9 CHAIRMAN CORRADINI: But I think the
10 crucial thing is in that first hour you are
11 essentially dumping everything, and it is very cold,
12 and now I come back up and I start now cruising along
13 at this quasi-steady behavior.

14 MR. WALLIS: You can't do that, if you've
15 got non-condensables in there.

16 CHAIRMAN CORRADINI: We are talking in the
17 vessel. In the vessel. That's what their point was.
18 Their point was in that first hour you are dumping
19 the GDCS. You are cooling down, and now you have to
20 reestablish a quasi-steady state. And that is why you
21 are not pulling power out of the PCC.

22 MEMBER BANERJEE: Dumping it into the
23 drywell.

24 MR. WALLIS: Okay. That's very helpful.
25 So that would be good to show where the heat goes

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1 first.

2 MEMBER BANERJEE: Yes. I think that there
3 is -- What you really -- I wasn't aware that this
4 stuff would spill out into the drywell in some way.

5 MR. CHEUNG: At about 18 hour. So that
6 you can see the overspill. The cold water from the
7 downcomer in through the DPV into the drywell annulus.
8 The condensed steam is not going through the PCC but
9 rather by condensed by this overspill of cold water.

10 MEMBER BANERJEE: Why do you get these
11 little spikes?

12 MR. CHEUNG: Because this is a parallel
13 path. You can see that the GDCS pool is one. There
14 is a U-tube going to the downcomer and then when the
15 water is going out and then condensed to steam, and
16 then the U-tube effect, and the amount of the water
17 going condensed in drywell annulus as steam is -- This
18 is the U-tube process. It is not -- It takes long
19 time. It is not changing in over a couple of seconds.

20 MEMBER BANERJEE: It would be helpful to
21 have some markings on this red showing what events are
22 these spikes showing. Otherwise, they just look
23 strange.

24 MR. CHEUNG: Okay.

25 MEMBER ABDEL-KHALIK: When you say that

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1 the PCCS capacity is 60 megawatts, what are the
2 conditions corresponding to that capacity ?

3 MR. CHEUNG: i believe it is 300 -- 350
4 kilopascal at roughly about 45 psia at that test
5 condition. The steam at that test -- at that pressure
6 condition, the PCC will condense 100 percent steam at
7 60 megawatt.

8 MEMBER ABDEL-KHALIK: Okay. And that
9 pressure is never reached during this transient?

10 MR. CHEUNG: No, during this transient the
11 pressure is somewhat over the design pressure or the
12 rated condition.

13 MEMBER ABDEL-KHALIK: And the reason why
14 the PCCS heat removal capacity is less than its stated
15 60 megawatts is what? What is limiting the heat
16 removal capability here?

17 MR. CHEUNG: There are a couple of slides
18 before that. The PCC is self-regulated. After a
19 couple of hours or so, the PCC had over-capacity.
20 The PCC is trying to condense -- or trying to collect
21 non-condensables in the bottom of it to suck off the
22 surplus capacity.

23 CHAIRMAN CORRADINI: Can I try? I think
24 what he is wanting to tell you is I have parallel flow
25 paths. So I can't get to the flow through the PCC to

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1 demonstrate at 60 megawatts. It's dumping through the
2 vent line. Right?

3 MR. CHEUNG: Yes.

4 CHAIRMAN CORRADINI: Okay.

5 MEMBER BANERJEE: Well, also there is
6 another effect, that the 60 megawatts must be with all
7 steam. So if you block a part of it with non-
8 condensables --

9 CHAIRMAN CORRADINI: You degrade it.

10 MEMBER BANERJEE: -- you degrade it.

11 MR. WALLIS: Well, I disagree with you,
12 Mr. Chair. If there is enough pressure drop to open
13 the vents, that pressure drop is still applied to the
14 PCCS and drives steam into it. Must do. I mean, it
15 drives even more steam than when the vent is closed.

16 CHAIRMAN CORRADINI: But it's a
17 combination of the 60 megawatts -- unless I misheard -
18 - is pure steam.

19 MR. WALLIS: No, the pressure drop.
20 You've got a pressure drop, and you've got a pipe, and
21 that determines the flow rate into the PCCS. It has
22 to go somewhere. Has to be condensed or bubble out
23 the bottom.

24 CHAIRMAN CORRADINI: So just to be clear:

25 So the 60 megawatts is pure steam or --

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1 MR. CHEUNG: Pure steam.

2 CHAIRMAN CORRADINI: Okay.

3 MR. WALLIS: No, but you see what I mean.

4 CHAIRMAN CORRADINI: I understand.

5 MEMBER BANERJEE: I'm still having
6 problems with this. Maybe I'm not getting it, because
7 it needs to be sketched for me. But this big dip
8 right in the first hour -- You have steam flow through
9 this thing. Right? So why doesn't it remove --

10 MR. CHEUNG: It's the electrical power is
11 going to use to heat up the incoming cold water,
12 instead of generating steam. No steam going into the
13 drywell and, therefore, the PCC is not seeing any
14 drywell --

15 MEMBER BANERJEE: So in this there is no
16 flow. The pressures are not such that you are getting
17 any flow through here. Once you get flow, you have
18 heat transfer. Right?

19 MR. CHEUNG: Yes.

20 MEMBER BANERJEE: So the only way you
21 cannot have heat transfer is not to have any flow,
22 which means there can't be any pressure drop. So
23 there is no pressure drop. So there is no pressure
24 drop across this year.

25 CHAIRMAN CORRADINI: There is no steam.

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1 MR. WALLIS: There is no steam.

2 CHAIRMAN CORRADINI: They have dumped the
3 water.

4 MR. WALLIS: It has cooled everything
5 down.

6 CHAIRMAN CORRADINI: Education is a very
7 painful thing.

8 MR. WALLIS: No, it's a very good thing.
9 Those of us who believe in it think it's great.

10 CHAIRMAN CORRADINI: But it's painful.

11 MR. WALLIS: It's painful for the
12 instructor. I know that.

13 CHAIRMAN CORRADINI: Okay, next slide, 12.

14 MR. CHEUNG: Now this shows the
15 distribution of non-condensable gas in different
16 regions, and you can see that the red curve is the
17 drywell non-condensable gas, and during the blowdown
18 period it just all of a sudden --

19 MR. WALLIS: This is a very interesting
20 curve. If you look at the DCD, this is expressed in
21 terms of partial pressure, which gives a different
22 impression when you see the partial pressure in the
23 GDCS space is one atmosphere. That tells you a lot
24 about how much gas is there, and this number here
25 doesn't quite give that -- or tell you that.

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1 MR. CHEUNG: You have to calculate the
2 pressure together with the volume.

3 MR. WALLIS: Yes, but that tells you how
4 much of it is gas, which isn't evident from this
5 figure.

6 CHAIRMAN CORRADINI: And you can see that
7 the green curve --

8 MR. WALLIS: Then at 18 hours something
9 magical happens.

10 MR. CHEUNG: At 18 hours, that is because
11 of overspill of the cold water from the downcomer.

12 MR. WALLIS: I don't understand how that
13 works. So you have to tell me that someday, if we
14 ever get there.

15 MR. CHEUNG: And the thing is we've tried
16 to very conservatively move everything, every single
17 jot or molecule of non-condensable gas, from the
18 drywell into the wetwell, such that to maximize the
19 wetwell pressure and, therefore, the drywell pressure
20 will follow it.

21 MR. WALLIS: Eventually, it all gets
22 there. Right.

23 MR. CHEUNG: Yes.

24 MR. WALLIS: All right. But whether it is
25 conservative to assume it all gets there in the first

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1 hour or doesn't all get there until after 18 hours, we
2 don't really know until we look at all the details.
3 I'm not sure what is conservative and what isn't.

4 MR. CHEUNG: Well, the endpoint is the
5 wetwell pressure at the end depends only on a few
6 things, the total amount of non-condensable gas.

7 MR. WALLIS: Yes.

8 MR. CHEUNG: That we have, and then the
9 temperature in the wetwell, we force it to be high,
10 because we do not allow the mixing. Then the
11 suppression pool surface temperature will supply about
12 10 percent of the partial steam pressure, and we force
13 it after a couple of hours, so the energy going into
14 the suppression pool through the PCC vent line stay
15 above the layer of water --

16 MR. WALLIS: So everything depends upon
17 getting the bypass leakage right.

18 MR. CHEUNG: Yes.

19 MR. WALLIS: Okay.

20 CHAIRMAN CORRADINI: Which we are going to
21 get to soon.

22 MEMBER BANERJEE: I mean, in a way,
23 putting all the non-condensables in the wetwell is
24 conservative, I guess, from the viewpoint of pressure.

25 CHAIRMAN CORRADINI: I would think so.

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1 MEMBER BANERJEE: But the real issue here
2 is removing the heat.

3 MR. WALLIS: Right.

4 MEMBER BANERJEE: And removing the heat
5 requires that your PCC system works. So if it somehow
6 gets blocked with non-condensables, then you are
7 really in trouble.

8 MR. WALLIS: So conservative for one thing
9 is not conservative for the other.

10 MEMBER BANERJEE: Right. But conservative
11 -- We could block the PCCS with non-condensables --

12 MR. CHEUNG: But non-condensable column in
13 the PCC tube is self-regulated. It takes only a small
14 amount of non-condensable gas to self-regulate.
15 Condense no more steam or no less steam than is --

16 MEMBER BANERJEE: I guess the behavior of
17 the PCC system is the crucial issue here. If it is
18 clearing itself and keeping removing the heat, we are
19 all happy.

20 MR. WALLIS: The non-condensable vent line
21 has valves in it, I see. Are these operator
22 controlled valves?

23 MR. CHEUNG: No. There is no valve.

24 MR. WALLIS: There are valves shown in the
25 figure, non-condensable vent line.

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1 MR. CHEUNG: That's for testing.

2 MR. WALLIS: Those are for testing?

3 MR. CHEUNG: Yes.

4 MR. WALLIS: What? On page 13, I see
5 valves. It would seem to me that closing one of those
6 valves would be in the PRA somehow. I mean, if you
7 close the vent line, do you prevent the PCCS working?

8 MR. CHEUNG: That's for the testing
9 purpose.

10 MR. WALLIS: Testing purpose? So they
11 can't be closed during operation?

12 MEMBER SHACK: This is a design basis
13 accident. They are not closed. In the PRA, there's a
14 chance.

15 MR. WALLIS: Well, the only thing that
16 really matters to the public is an accident that
17 happens, not a design basis accident.

18 MR. CHEUNG: Okay. This picture shows --

19 CHAIRMAN CORRADINI: I'm sorry. Let me
20 just take again a time check. So are we moving on to
21 the post-72 hour discussion?

22 MR. CHEUNG: Yes.

23 CHAIRMAN CORRADINI: Okay.

24 MR. CHEUNG: This is the PCC vent fan, and
25 this sketch shows that the PCC vent fan suck the gas

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1 mixture from the bottom of the PCC tube or the vent
2 line, and then discharge it into the GDCS pool and
3 then eventually bubble up to the GDCS gas space -- or
4 GDCS pool air space.

5 MR. WALLIS: So if there are no non-
6 condensables, what does it pump?

7 MR. CHEUNG: No. This condensable
8 accumulate in the bottom of the tube. We pump that
9 bottom of the tube to destroy that column.

10 MR. WALLIS: If the vent fan is too
11 strong, it will pump enough pressure drop that it will
12 be pumping steam, if there is very little non-
13 condensable. It will exceed the capacity of the PCCS,
14 and it will pump steam. Right?

15 MR. CHEUNG: It is very big fans, yes.

16 MR. WALLIS: So we need to know how much
17 it pumps and what the pressure drop is and all that
18 kind of thing, and what happens when there are no non-
19 condensables.

20 MR. CHEUNG: That won't happen.

21 MR. WALLIS: What do you mean, it won't
22 happen?

23 MR. CHEUNG: Because I can show you in a
24 couple of slides that it won't happen.

25 MR. WALLIS: Well, it depends on how well

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1 you can calculate where the non-condensables are.

2 MR. CHEUNG: because once the -- Let me go
3 back this way. Once the vent fan turn on, the column
4 of non-condensables destroyed, and then the PCC heat
5 capacity increase.

6 MR. WALLIS: That's right.

7 MR. CHEUNG: And then it's increased.
8 That means it condense the steam.

9 MR. WALLIS: That's right, and that's why
10 the pressure comes down in the drywell.

11 MR. CHEUNG: The drywell pressure drop
12 comes down.

13 MR. WALLIS: So what is that steam
14 fluorides? That steam fluoride correspond to 70
15 megawatts or 50 or 40 or what?

16 MR. CHEUNG: Whatever the steam in the
17 drywell condense, and then drywell pressure drop,
18 breaker open. Non-condensable gas from the wetwell
19 back into the drywell, and then non-condensable gas,
20 once it get into the drywell and eventually go back to
21 the PCC tube.

22 MR. WALLIS: You have a very good model
23 for how it mixes in the drywell. Right?

24 MR. CHEUNG: Yes.

25 MR. WALLIS: Yes? Okay.

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1 MR. CHEUNG: Once it go back to the PCC
2 tube and then the self-regulate, now I have a uniform
3 -- not say uniform. I do not have a column of non-
4 condensable gas, but rather I have an incoming mass,
5 say, at 15 -- or .15, and then the mass increasing as
6 it go on to the bottom of the tube, maybe increase
7 from 1.115 to .25.

8 MR. WALLIS: When the vent valve opens,
9 when the vacuum breaker opens, you have a column of
10 non-condensable gas coming out which, I presume, mixes
11 with all the steam somehow?

12 MR. CHEUNG: Before it opens.

13 MR. WALLIS: Things are pretty quiet,
14 aren't they, in the drywell now? Things are very
15 quiet? There's a quiet room, right ?

16 CHAIRMAN CORRADINI: In 72 hours.

17 MR. WALLIS: And you are oozing out
18 something through the floor, which is non-
19 condensables. Right? And you are going to tell me
20 that mixes with everything in there?

21 MR. CHEUNG: If not mixed --

22 MR. WALLIS: It's a plume of some sort?
23 Is it lighter or heavier? Does it flow along the
24 floor? It's heavier. It's nitrogen. It's heavier
25 than steam. And it's colder as it came from the

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1 wetwell. It just flows along the floor, doesn't it?

2 MR. CHEUNG: It flows on the floor,
3 though, even better, because then the PCC is going to
4 condense more steam.

5 MR. WALLIS: You are telling me it
6 doesn't.

7 CHAIRMAN CORRADINI: I don't think we are
8 allowing him even to answer the question --

9 MR. WALLIS: Okay. I'm sorry.

10 CHAIRMAN CORRADINI: -- before he gets to
11 the next question. That's not fair to him. So let me
12 ask this. You are now phasing into the post-72-hour
13 period where you are going to show your analysis. Is
14 that correct?

15 MR. CHEUNG: Yes.

16 CHAIRMAN CORRADINI: And then you are
17 going to go into your bypass uncertainty or bypass
18 sensitivity.

19 MR. CHEUNG: Yes.

20 CHAIRMAN CORRADINI: Okay. Let's take a
21 break, I would propose, for five or 10 minutes, and I
22 want to caucus with GE and the staff, because I want
23 to hear before -- soon the Melcor audit calculations
24 to compare to this. So can we take a break for 10
25 minutes, please. We will be back at 10:35.

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1 (Whereupon, the foregoing matter went off
2 the record at 10:26 and went back on the record at
3 10:40.

4 CHAIRMAN CORRADINI: Chester, you're up.
5 Consultants or no consultants, you're up. And just to
6 tell the Committee, I suggest to Chester that we go to
7 the bypass leakage analysis, and if we have questions
8 about post-72 hour, we bring it up, but first we
9 probably want to see bypass leakage first. Okay?

10 So we will kick off. Dr. Cheung, you're
11 up. Twenty-one, Chester?

12 MR. CHEUNG: Okay. Now bypass leakage is
13 one of these things that affect the wetwell
14 temperature, such that the wetwell temperature will
15 affect the wetwell pressure, and then bring down the
16 drywell pressure.

17 We have performed parametric case on a
18 bounding calculation from zero, one, two, 2.25, and
19 2.5 square centimeter, and on the blue line shows the
20 design pressure. And when we increased the bypass
21 leakage from zero all the way to 2.25 and then see
22 that the drywell pressure almost touching the design
23 pressure, and another point I am going to bring is
24 that these set of curve -- they behave nicely and are
25 not -- They behave as expected, increase the pressure

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1 as they increased the bypass leakage.

2 Next slide, please.

3 MEMBER ABDEL-KHALIK: I guess the
4 question, if I remember correctly, is: How realistic
5 is a limit of one square centimeter on the bypass
6 leakage area?

7 MR. CHEUNG: Let me comment on that. The
8 leakage is coming from the diaphragm floor. That
9 leakage coming from the diaphragm floor is way below
10 .5. Now the other possible leakage is through the
11 vacuum breaker, and currently we have isolation well
12 on vacuum breaker. So the vacuum breaker leakage is
13 almost -- once it is a detected leak with isolation
14 wall isolate. So the remaining possible way of
15 leakage is through the diaphragm floor, the
16 penetration, which is very small.

17 On top of it, at the current technology we
18 can test the leakage or leakage area. We have 95
19 percent confidence at .5 square centimeters.

20 MEMBER ABDEL-KHALIK: Why do you set the
21 acceptance level at 2 and the design calculations at
22 one?

23 MR. CHEUNG: Currently we turn it the
24 other way, that acceptance testing acceptance of 1 and
25 licensing at 2. That means that gives you a 50

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1 percent margin.

2 MEMBER SHACK: DCD goes the other way,
3 doesn't it, or did I read it wrong?

4 MR. CHEUNG: We are going to try to bring
5 it -- change it.

6 MR. MARQUINO: This is Wayne Marquino. We
7 are going to make a revision in 5, and we will show
8 the bounding result at 2 square centimeters bypass
9 leakage.

10 MR. WALLIS: This is 2 square centimeters
11 for all the vacuum breakers taken together?

12 MR. MARQUINO: Yes.

13 MR. WALLIS: Because if one presumably
14 stuck, the leakage would be many square centimeters,
15 wouldn't it?

16 MR. CHEUNG: We have isolation model to
17 limit it.

18 MR. WALLIS: One square centimeter is a
19 very small thing.

20 MEMBER BANERJEE: How many microns raising
21 will give you one centimeter?

22 CHAIRMAN CORRADINI: Well, just to remind
23 the Committee, we have their report where -- I've
24 forgotten, but I remember you've given to all of us,
25 which has the testing and the design, and we discussed

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1 the fact of this last time, if I remember.

2 MEMBER SHACK: He's going to have a tech
3 spec that they are going to test to meet this.

4 MR. MARQUINO: That's right.

5 MEMBER STETKAR: What closes the isolation
6 valves on the vacuum breakers -- signals?

7 MR. CHEUNG: The signal -- The temperature
8 measurement around the vacuum breaker in the drywell
9 temperature, the wetwell temperature and the cavity
10 which is inside the vacuum breaker -- the temperature.

11 So we measure all these temperatures and then
12 determine if there is a leak, and then we isolate it.

13 MEMBER STETKAR: Manually close?

14 MR. CHEUNG: No. Close by signal.

15 MEMBER STETKAR: Signal? Okay.

16 MEMBER BANERJEE: If you have some grit or
17 some particles getting in there during operations, how
18 much would that -- Remind me how much it would have to
19 rise in order to get one centimeter squared? Is it 10
20 microns? So a 10 micron particle could do that?

21 MR. WALLIS: Well, there is a seal,
22 presumably.

23 CHAIRMAN CORRADINI: So I guess I want to
24 ask GE to remind us, or we can pull out the PDF file,
25 what is the -- It seats at some diameter with some

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1 lip. Right? And it's a soft seal. So can you just
2 remind us briefly.

3 MR. MARQUINO: The vacuum breaker has both
4 a hard seat and a soft seat on it. Is that what your
5 question was?

6 CHAIRMAN CORRADINI: Yes.

7 MEMBER BANERJEE: In other words, can it
8 tolerate some dirt getting in there and still close?

9 MR. MARQUINO: Yes, it can tolerate dirt
10 during the test, they inject it, and it was forced to
11 ingest sandblasting grit, and the leakage was tested.

12 MEMBER BANERJEE: And what was the
13 leakage? Very low?

14 MR. MARQUINO: In that post test degraded
15 condition, it was less than one square centimeter.

16 MR. CHEUNG: No, less than point-some
17 square meter, .1 or .2.

18 MEMBER BANERJEE: Square centimeters?

19 MR. CHEUNG: Yes.

20 CHAIRMAN CORRADINI: We have the report.
21 I can -- Okay, fine.

22 MEMBER BANERJEE: So under most
23 circumstances that one can imagine in this mass that
24 will be there with all sorts of things floating
25 around, you feel that this vacuum breaker will close,

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1 even though there could be particles and debris and
2 everything in the air?

3 s MR. MARQUINO: Yes. There is a screen on
4 the vacuum breaker, and the vacuum breaker is
5 initially seated during the blowdown phase. So --

6 CHAIRMAN CORRADINI: Because of just those
7 dynamics. But during the blowdown phase -- I guess I
8 wanted to ask that. So we have the testing that we
9 can look at, but from the standpoint of its operation,
10 will it open during the early hours? I was trying to
11 think of this, because of the delta Ps or will it
12 always be seated from the moment I have the main steam
13 line break and remain seated?

14 MR. CHEUNG: Remain seated until the GDSC
15 injection.

16 CHAIRMAN CORRADINI: Until the GDSC
17 injection ?

18 MR. CHEUNG: Yes.

19 CHAIRMAN CORRADINI: So in that frame of
20 less than a couple hours, it will then open up? It
21 will open?

22 MR. CHEUNG: It will open. Yes.

23 CHAIRMAN CORRADINI: Okay. All right.

24 MR. WALLIS: So none of these spikes and
25 things that we see in the traces are due to the vacuum

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1 breakers opening early on? They remain seated until
2 it is eventually called upon after three days to open?

3 CHAIRMAN CORRADINI: The opposite, Graham.

4 It will open. Ten minutes to one hour is when it
5 would open, because we are in that curve --

6 MR. WALLIS: So it does open at the
7 beginning?

8 MR. CHEUNG: No. Only when the GDCS
9 inject.

10 MR. WALLIS: So it does open early on.

11 MEMBER SHACK: Depends on what you mean by
12 "the beginning."

13 MR. WALLIS: An hour or two. It does open
14 at the beginning. Right? It does some up and down
15 early on in the transient.

16 MR. CHEUNG: Not during the blowdown.

17 MR. WALLIS: No, but it does some early on
18 in the transient.

19 MR. CHEUNG: Yes.

20 MR. WALLIS: Before a day is up, it has
21 opened.

22 MR. CHEUNG: Before couple of hours, yes,
23 it's going to open in a couple of hours. Yes.

24 MR. WALLIS: So it does open. So it has a
25 chance to open and not quite close several times

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1 before it really is called upon to open.

2 MR. CHEUNG: The design is such that our
3 guaranty -- the warranty is not --

4 MR. WALLIS: But it is exercised a few
5 times early on in the transient.

6 MR. CHEUNG: Yes.

7 MR. WALLIS: So there is a chance that
8 something could happen. Right? It has to be
9 evaluated somehow.

10 MR. CHEUNG: There is a chance, but there
11 is also an isolation wall on top of it.

12 MEMBER ABDEL-KHALIK: Let's go back to the
13 question that was asked earlier by Mr. Stetkar as to
14 what signals are used by the operator to know that
15 these valves are in an erroneous position and,
16 therefore, must be isolated manually.

17 Does the operator really know at every
18 moment --

19 MR. CHEUNG: The isolation valve is not
20 operated by --

21 MEMBER ABDEL-KHALIK: The isolation valves
22 are operated how?

23 MR. CHEUNG: By signal, automated by
24 signals.

25 CHAIRMAN CORRADINI: Professor Abdel-

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1 Khalik and John -- John and Said are asking you what
2 is the logic that would tell the operator to hit the
3 button and --

4 MEMBER STETKAR: Operator.

5 CHAIRMAN CORRADINI: Oh, I'm sorry.

6 Excuse me.

7 MEMBER STETKAR: Operator doesn't hit the
8 button. The signal is automatically configured. The
9 question may still be relevant, but the operator is
10 not required.

11 CHAIRMAN CORRADINI: And the signals are
12 what?

13 MR. CHEUNG: The temperature around the
14 vacuum breaker and inside the vacuum breaker.

15 MEMBER ABDEL-KHALIK: And under all
16 conditions, measuring those two temperatures one can
17 come up with a logic that --

18 MR. CHEUNG: Yes.

19 MEMBER ABDEL-KHALIK: -- would tell him
20 whether or not these valves should be open or closed?

21 MR. CHEUNG: Yes, and on top of it there
22 is a proximity probe that sees, if the vacuum breaker
23 is not seating well, then also close it.

24 MEMBER BLEY: And there must be some time
25 delay or something.

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1 MR. CHEUNG: Some time delays.

2 MEMBER BANERJEE: So what are these
3 temperatures that are measured in the flows? If a
4 flow establishes through the vacuum breaker, what
5 happens to these temperatures?

6 MR. CHEUNG: No, if the vacuum breaker is
7 a very small leak, is not huge, then we measure the
8 drywell temperature. We measure the cavity
9 temperature inside the vacuum breaker. We measure the
10 wetwell temperature. So compare the delta P between
11 the cavity and the drywell and cavity and the wetwell.

12 If there is a leak at this temperature ratio, so it
13 is sort of indication that that's a leak. If there is
14 no leak, then the ratio is the other way around.

15 So we have established a logic.

16 MR. MARQUINO: So if you have a -- You
17 should have a flow from the wetwell to the drywell
18 through the vacuum breaker. The wetwell is a lower
19 temperature than the drywell.

20 if you have an indication that the
21 temperature in the vacuum breaker is high, that
22 indicates that you are getting flow from the drywell
23 into the vacuum breaker. It is not sealing as it
24 should, and that would initiate closure of the backup
25 valve.

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1 MR. WALLIS: I think your assumption is
2 that steam comes into the wetwell from the drywell,
3 very small pressure drop, leaking in. So it doesn't
4 change its temperature much, and there is no heat
5 transit. So it's still about 260 degrees Fahrenheit.

6 If that steam leaks out, it won't tell you
7 anything, because it's about the same conditions as
8 what is in the drywell. So are you are going to
9 suddenly invert it and put the gas through the vacuum
10 breaker? I don't understand your model for what
11 happens in the wetwell.

12 I think you said the steam is at the top,
13 and it hasn't been cooled down.

14 MR. MARQUINO: Well, I think you are
15 talking about our TRACG analysis versus the logic for
16 isolating the vacuum breaker.

17 MR. WALLIS: But when it comes to the
18 vacuum breaker, you assume that the gas coming out of
19 the wetwell is cold. When it comes to calculating the
20 pressure in the wetwell, you assume the steam is on
21 top, and it's hot.

22 MR. CHEUNG: That's conservative.

23 MR. WALLIS: So you are warping reality in
24 both cases, and I'm just wondering if that is the
25 right way to approach an accident, because you never

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1 quite know when you make what you think is a
2 conservative assumption that you might be making
3 something else happen which is unreal, which is bad.

4 MR. MARQUINO: In terms of isolating the
5 vacuum breaker, the concern is getting a high
6 temperature gas flowing in and steam from the drywell.

7 So we --

8 MR. WALLIS: I'm just wondering if
9 temperature is the right indicator. That's all.

10 MR. MARQUINO: Well, we chose temperature,
11 because it will be more sensitive than any kind of
12 differential or --

13 MR. WALLIS: Well, how do you know the
14 temperature of the gas layer at the top of the
15 wetwell, because steam has been leaking into there all
16 the time.

17 MR. MARQUINO: We will be measuring it.

18 MR. WALLIS: You will be measuring the
19 temperature at the top of the wetwell.

20 MR. CHEUNG: That's separate. In the
21 model, we assume there is a leak.

22 MR. WALLIS: Ah. So when you actually
23 build one of these things -- Well, I guess -- so we
24 won't know whether any of these assumptions make any
25 sense until there is an event.

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1 MR. CHEUNG: And even with the
2 conservative model, there is still a large
3 significant delta P between the drywell and the
4 wetwell.

5 MR. WALLIS: Well, calculating the
6 temperature in the wetwell and the pressure, we assume
7 the steam is on the top, and it doesn't cool down very
8 well. When it comes to figuring out the temperature,
9 when it goes through the vacuum breaker so we can
10 figure out whether to close off the valve or not, we
11 assume something else about the temperature in the
12 wetwell.

13 MR. CHEUNG: Even in that calculation, the
14 temperature in the wetwell, top of the wetwell, is
15 still significantly below the drywell. So we can
16 establish the --

17 MR. WALLIS: Is it 100 degrees lower or
18 what?

19 MR. CHEUNG: It's 80 degrees Celsius
20 lower sometimes.

21 MEMBER BANERJEE: Does it matter to you --
22 You are measuring the temperatures. Right? Just
23 outside, and then within the chamber? What you are
24 really seeking is to see whether if there is a flow,
25 then you would get the cavity temperature becoming

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1 equal to the --

2 MR. CHEUNG: Close to the drywell.

3 MEMBER BANERJEE: Close to the drywell
4 temperature. So it's a direct measurement.

5 MR. WALLIS: But what has been coming in
6 through the leakage is close to the drywell
7 temperature, which reminds me of TMI where they had a
8 leak, because the temperature was up all the time and
9 they didn't fix anything. When there was an accident,
10 the fact that the temperature went up didn't tell them
11 anything, because it didn't really go up, because it
12 had been leaking already.

13 So the temperature is not a good
14 indication, if there is a leak the other direction.

15 MEMBER BANERJEE: Well, if there was
16 always a leak.

17 MR. WALLIS: So if your one square
18 centimeter is aimed at your thermometer, it's going to
19 heat up, isn't it?

20 MR. MARQUINO: We have proximity probes on
21 the vacuum breakers which are very sensitive, and we
22 have drywell pressure -- drywell-wetwell differential
23 pressure measurements.

24 MEMBER STETKAR: Those I've found. I
25 haven't found any mention in Chapter 7 of the DCD that

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1 talks about signals and actuations. The temperatures
2 were the first -- Today was the first time I had ever
3 heard of that.

4 MR. MARQUINO: That is new, and it is in
5 an RAI response. Yes.

6 MEMBER STETKAR: So it would be
7 interesting to see what those temperatures really are.

8 MR. MARQUINO: Maybe we should wait until
9 you have had time to read the RAI response.

10 MEMBER ABDEL-KHALIK: But let me just ask
11 you a simple question. Let's just say that you are
12 just right on the borderline, and you have one
13 centimeter squared of leakage area. How big are these
14 vacuum valves -- vacuum ports -- Manhole cover, right?

15 One square centimeter is a tiny tilt in
16 that valve. Right? And if you are going to try to
17 detect a leak through one square centimeter leak area
18 from something that big, how well do you have to
19 instrument this thing to measure the variations of
20 temperature along the entire perimeter of this valve?

21 MR. CHEUNG: Again, we have a design --

22 MEMBER ABDEL-KHALIK: Is it at all
23 reasonable to use temperature measurements? I don't
24 know how many temperature probes you would have to
25 have to be able to detect a one square centimeter

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1 leakage area in something that big by measuring
2 temperature variations.

3 MR. CHEUNG: Currently, we have four set -
4 - or four probes at different angles and different
5 locations for the drywell temperature, cavity
6 temperature, and the wetwell temperature. It's been
7 designed and tested and even threw sand, blasting
8 sand, into it, and it still satisfied the design
9 requirement of less than one square centimeter, and
10 actually, the leakage is less than .1 or somewhere
11 around .1, .2 square centimeter.

12 MEMBER ABDEL-KHALIK: That is not the
13 point. The point is whether or not you would be able
14 to detect a one square centimeter leakage area by
15 temperature measurement.

16 MR. MARQUINO: The concern is that we have
17 a high temperature flow going -- leaking through the
18 vacuum breaker and entering the wetwell. So by these
19 differential temperature measurements, we are
20 detecting the symptom that we have a high temperature
21 in the wetwell side of the vacuum breaker, and that's
22 what we have chosen to trigger the isolation.

23 MEMBER MAYNARD: I'm just a little bit
24 confused. Let me go back over it. My understanding:
25 Basically, the vacuum breaker is a check valve, and

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1 it doesn't really require electricity or anything to
2 move it. It's basically done on differential
3 pressure.

4 It's the isolation valve that requires
5 some type of signal. When it detects that the valve
6 is supposed to be closed and didn't close, well,
7 that's when the isolation valve is then closed by -- I
8 think it's a DC solenoid valve or something.

9 So you're saying you're using a
10 combination of temperature and the proximity probes to
11 trigger that isolation valve?

12 MR. MARQUINO: No, only the temperature.

13 CHAIRMAN CORRADINI: I didn't mean to
14 interrupt you. So let me just ask a couple of
15 questions, not about detecting anything, but I want to
16 understand timing again.

17 These are new vacuum breakers. They are
18 not on the ABWR. Okay. So there is no past history
19 of performance in the field.

20 Why do you even care about the vacuum
21 breakers after 10 or 15 hours into the accident? Why
22 don't you just isolate them and be done with it? What
23 the hell. Why even have them even there? You've told
24 me that I'm going to have a positive pressure. Why
25 don't I just simply isolate them to 12 or 24 hours

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1 into the accident and be done with it?

2 MR. CHEUNG: After a couple of days --

3 CHAIRMAN CORRADINI: Well, they just told
4 me they have an electrical system. They got
5 batteries. They hit the button or it closes on
6 temperature, and you isolate.

7 MR. MARQUINO: Two reasons. The one is
8 the basic function of the vacuum breaker is, if there
9 is a rapid drop in the drywell pressure, the vacuum
10 breaker opens, lose non-condensable gas in the drywell
11 . it prevents the drywell from going sub-atmospheric
12 or having too large a differential or too large a
13 liner differential.

14 CHAIRMAN CORRADINI: But what I guess I'm
15 asking is: So since this is a stylized accident and
16 there are possibilities a day or two days into the
17 accident that you actually would have a negative
18 pressure, you had to equalize?

19 MR. CHEUNG: When we turn on the active
20 system, like FAPCCS or like a vent fan --

21 CHAIRMAN CORRADINI: We are just trying to
22 understand -- I'm just trying to understand actuation
23 of isolation, you said, is automatic. I, somehow in
24 my head, thought it was manual. But actuation of
25 isolation is automatic, and it is based on some sort

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1 of measurement.

2 MR. CHEUNG: Yes.

3 CHAIRMAN CORRADINI: So take for the
4 moment the measurement is perfect. I'm trying to
5 understand the automatic isolation versus manual
6 isolation, if you have battery power to isolate.

7 Under some scenarios, do you even need it?
8 I mean, by this scenario you don't need it. It's
9 sitting there above pressure, and you don't want them
10 to leak.

11 MR. MARQUINO: Well, we don't want them to
12 leak, and we don't expect them to leak.

13 CHAIRMAN CORRADINI: Nor do you even need
14 their function task, according to the stylized
15 accident.

16 MR. MARQUINO: I think we do need their
17 function. All pressure suppression containments have
18 drywell-wetwell vacuum breakers for the reason I just
19 stated, to allow non-condensable gas to move back into
20 the drywell after a blowdown, if you have a cold water
21 injection into the drywell.

22 Granted, that is more of an issue in the
23 forced EECS plants where they do inject a lot of cold
24 water into the vessel and drywell post LOCA.

25 The other reason we like the vacuum

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1 breaker is when we recover the FAPCCS systems in this
2 postulated accident and we can pump cold water into
3 the vessel. We can cool down the drywell, and then
4 when the vacuum breaker opens, the non-condensable gas
5 moves and we decompress the wetwell, and we drop the
6 containment pressure.

7 CHAIRMAN CORRADINI: Let's move on. This
8 graph shows the sensitivity of the --

9 MR. WALLIS: I have a question. I'm
10 sorry.

11 MR. CHEUNG: Okay.

12 MR. WALLIS: Are you going to discuss
13 pages 13 and 14, because I have questions about those.

14 CHAIRMAN CORRADINI: We have to make a
15 choice. I want to -- I've made the decision that I
16 want to hear from the staff and their audit
17 calculations.

18 MR. WALLIS: So we are not able to talk
19 about the vent fan?

20 CHAIRMAN CORRADINI: No. We had too much
21 fun with the first few graphs.

22 MR. WALLIS: I don't think it's fun. I
23 think it's professional activity.

24 CHAIRMAN CORRADINI: I know, but I meant
25 we spent enough time on the first few graphs, that we

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1 have to get to the audit calculations.

2 MR. WALLIS: Well, I just want to indicate
3 that I have some questions which, I guess, we have to
4 make another time for, on pages 13 and 14.

5 CHAIRMAN CORRADINI: This is the post-72
6 hours? Yes. If we have time later today, we can, but
7 I want to hear the staff.

8 MR. WALLIS: I agree.

9 MR. CHEUNG: On the vertical side of this
10 chart is the margin, the containment pressure margin.
11 That is relative to 45 psig. On the horizontal side
12 is bypass leakage flow area. The blue line is the
13 bounding calculation, and the red line is nominal
14 calculation.

15 Bounding -- that is, we use the bounding
16 initial condition, bounding plain condition like one
17 or two percent power, and initially we want to stop as
18 much nitrogen gas in the drywell as much as we could
19 in the initial condition, and so on. And also in the
20 blue curve we assume that the gas that the hot energy
21 leak from the drywell into the wetwell through the
22 leakage stay at the top of the wetwell. We also
23 assume that the energy going into the suppression pool
24 via the vent line stay at the top of the layer of the
25 water.

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1 The blue curve -- So that at about 2.25
2 square centimeter then, the margin becomes approaching
3 the seal, and 2.5 become negative margin.

4 The red line -- so the nominal
5 calculation, which is typical operating conditions and
6 also the nominal model parameter -- Well, with the
7 restriction on mixing, on the wetwell, top layer and
8 the suppression pool top layer, and the nominal
9 calculation show that the margin decreased with the
10 increasing leakage flow area, bypass leakage flow
11 area, but the point at the seal, margin is about 4
12 square centimeter.

13 Now at 1 square centimeter, you can see
14 that there's two big triangles there. This is a
15 parametric case. The lower one is the one we are
16 allowing some mixing in the wetwell gas. You can see
17 that. Once we allow that, the margin increase about
18 three or four percent.

19 The top triangle, light blue, is the one
20 that we allowed the top layer of suppression pool
21 water to be mixed, some of it, with the rest of the
22 pool. You can see that with that model turnoff -- the
23 certification model turnoff, the margin increase about
24 seven percent.

25 Now the combine of these two model

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1 turnoff, we are expecting or we have some rough
2 calculation, we are expecting nine percent margin
3 increase.

4 Now this is a very conservative model. We
5 turn it off. We can see that there is a margin there
6 8 or 9 percent, and if we slide off all the way to 2
7 square centimeter, we expect similar margin
8 improvement without that conservative assumption, and
9 on top of it --

10 MR. WALLIS: I don't know. It is only
11 conservative if you can really talk about a few
12 microns being realistic. The difference between -- If
13 it is fully open, you've got, what, a few centimeters
14 of gap or something; orders of magnitude difference if
15 one of these things sticks open.

16 MR. CHEUNG: For this discussion, we are
17 assuming less stick. The vacuum breaker is the
18 testing well, and we can go to the test report, and we
19 have the isolation wall to prevent, if anything
20 happened in the vacuum breaker, we isolate it.

21 MR. WALLIS: Let's say if the vacuum
22 breaker sticks fully open, one vacuum breaker sticks
23 fully open. How long does it take to discharge what
24 is in the wetwell? I mean, that's the kind of thing
25 that is got to be calculated somewhere. If it sticks

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1 fully open, what happens? Is that in the PRA?

2 MR. CHEUNG: Sticking open, that takes a
3 couple hours for the pressure to increase all the way
4 to the design --

5 MR. WALLIS: You've got that calculation
6 somewhere?

7 MEMBER ABDEL-KHALIK: And the other
8 extreme, of course -- I don't know if you have
9 demonstrated clearly and have actually designed both
10 the sensors and the logic that would allow you to
11 detect a one square centimeter leakage area and show
12 that you can actually isolate these bounds.

13 MR. CHEUNG: The logic and the highway
14 design are being in process for the isolation wall.

15 MEMBER ARMIJO: Does GE have any operating
16 experience they could refer to that demonstrates that
17 vacuum breakers of this size instrumented with
18 temperature sensors -- that it is capable of detecting
19 small leakages, let's say one square centimeter or
20 less, in a reasonable time? Is there any operating
21 experience that you can point to, in addition to
22 whatever testing you have done?

23 Do you understand my question?

24 MR. CHEUNG: Yes, I understand your
25 question. Wayne, you want to comment on that?

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1 MR. MARQUINO: We -- As I said, we have a
2 new vacuum breaker for ESBWR, and we don't have
3 specific operating experience of instrumenting the
4 vacuum breaker for this back-up isolation function.

5 MEMBER ARMIJO: Let's say for the ABWR.
6 Did you have any temperature sensors on the vacuum
7 breakers in those systems or any others?

8 MR. MARQUINO: No. Those vacuum breakers
9 have position indication on them, and it wouldn't be
10 applicable to this temperature isolation feature.

11 MEMBER ARMIJO: My last question, and
12 that's with regard to the position indicator. My
13 personal opinion is that they would probably be more
14 sensitive than the temperature sensors, but that's
15 just my bias. Do you have data on the sensitivity of
16 these position indicators on leakage of other vacuum
17 breakers that are actually in operation?

18 MR. MARQUINO: I believe there is
19 information in the test report on the position
20 indication for the ESBWR vacuum breaker, and it is
21 very sensitive. I think it can detect down to less
22 than one square centimeter, and there was some
23 discussion about like how much offset, how many
24 millimeters of offset would correspond to that to the
25 leakage.

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1 The soft seat provides the ability to pick
2 up some offset in the valve seat, but we have chosen
3 to go with this temperature differential isolation,
4 because it removes the question of are there ways to
5 get leakage besides the valve being open or slightly
6 open. So that if you had some degradation of the
7 seat, this detection would still work. Whereas, if
8 you are just looking at the fixed position of the
9 seat, you could postulate things that wouldn't be
10 picked up.

11 MEMBER BANERJEE: Why did you -- Excuse
12 me. Why did you go to a new set of vacuum breakers
13 compared to the previous ones?

14 MR. MARQUINO: We wanted these to be more
15 leak-tight than the available --

16 MEMBER SHACK: It's only got two square
17 centimeters.

18 MEMBER BANERJEE: And the other vacuum
19 breakers leaked? They did?

20 MR. MARQUINO: Well, in the operating
21 plants, they have problems with the vacuum breakers
22 not showing full closed indication. So that was
23 another reason that we wanted to go to the new design
24 for the passive plant.

25 MEMBER BANERJEE: So this becomes a more

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1 crucial component than in the other plants?

2 MR. MARQUINO: That's right. It's
3 important that these vacuum breakers are leak-tight
4 and work.

5 MEMBER BANERJEE: So what is the physical
6 reason why these become more important?

7 MR. MARQUINO: Because of the drywell-
8 wetwell leakage, which causes energy to bypass the
9 PCC, so that we don't have full decay heat removal
10 mechanism.

11 MEMBER BANERJEE: So if one vacuum breaker
12 was stuck open and was not isolated, what would it do
13 to the PCCs then?

14 MR. MARQUINO: Well, you can -- We are
15 providing some curves with -- We don't have the full
16 vacuum breaker area shown on that.

17 MEMBER SHACK: Fourteen centimeters
18 squared to get to the failure pressure of the
19 containment. Right?

20 MR. MARQUINO: Right, and that is in the
21 full area of a vacuum breaker.

22 MEMBER SHACK: A vacuum breaker would
23 normally be closed during operation.

24 MR. MARQUINO: Right.

25 MEMBER BANERJEE: So coming back to this

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1 question: Let's say whatever that number is, 14
2 square centimeters or whatever. At that point, your
3 PCC system would not be able to remove the decay heat?

4 MR. MARQUINO: Yes. Now before we scare
5 anybody, remember that these are like manhole covers
6 that are held closed by gravity. So they tend to be
7 seated. In order to open them, you have to have a
8 differential pressure.

9 So the chance of the vacuum breaker
10 staying open is very, very unlikely. I think what we
11 are talking about is, even though it has some ability
12 to ingest grit and not leak, we are providing the
13 capability that, if it is leaking, we are able to
14 isolate it.

15 MEMBER BANERJEE: How many vacuum breakers
16 are there?

17 MR. MARQUINO: Three.

18 CHAIRMAN CORRADINI: Other questions?

19 MR. CHEUNG: Okay, let's move on. The
20 next slide.

21 MEMBER BLEY: Just a quick question. I'm
22 sorry. How many need to work?

23 MR. CHEUNG: One.

24 MEMBER BLEY: Just one.

25 MR. CHEUNG: On the righthand side of the

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1 curve showing the leakage area and a margin, and in
2 the bottom is zero, and one square centimeter is in
3 the bottom of the curve. From zero to one, that's
4 been identified as operation or plant operation
5 margin.

6 MR. WALLIS: I think you said that one of
7 them fully open was 14 centimeters square?

8 MR. CHEUNG: No. That's what needed to
9 fail the --

10 MR. WALLIS: Well, how much is one of them
11 fully open?

12 MR. CHEUNG: Two square feet.

13 MR. WALLIS: Two square feet?

14 MR. CHEUNG: When it is fully open.

15 MR. WALLIS: What is that in square
16 centimeters?

17 MR. CHEUNG: About .3.

18 MR. WALLIS: 2,000 square.

19 MR. CHEUNG: About .3 square meter.

20 MR. WALLIS: So you don't want it fully
21 open?

22 MR. CHEUNG: It is not happening by
23 design.

24 MR. WALLIS: Well, sometimes these things,
25 if they are going to stick, stick in the fully open

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1 position. They can bang up there, and they stick.

2 CHAIRMAN CORRADINI: But their argument
3 there is then any sort of proximity or temperature is
4 going to isolate. I think that is their argument.

5 MEMBER BANERJEE; Is what?

6 CHAIRMAN CORRADINI: Anything that severe
7 will be caught and isolated downstream. Isolation
8 valve would close. You would have to have three
9 sticking like that.

10 MR. CHEUNG: Let's go on to describe that
11 one centimeter -- We chose it as a test of acceptable
12 limit. Then the plant operator can have a margin
13 between zero and one, and the current technology we
14 can test it with 95 -- 95 percent confidence that
15 certify the acceptable limit of one square centimeter.

16 MR. WALLIS: So that's good enough? I
17 mean, if it only works 95 percent of the time?

18 MR. CHEUNG: Even over that, that we still
19 below -- somewhere around one, but 95 percent of the
20 time is less than .1 square centimeter.

21 MR. WALLIS: Is that good enough? Why 95?
22 I mean, if it doesn't work five percent of the time,
23 is that acceptable?

24 MR. CHEUNG: It is not -- The test showing
25 that, if it is not acceptable, then the plant operator

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1 had to do something to make it acceptable.

2 MEMBER ABDEL-KHALIK: And what would that
3 be?

4 MEMBER SHACK: Well, five percent of the
5 time he may exceed the one percent. Some fraction of
6 that he may see the design pressure. Some even
7 smaller fraction of that, he is going to fail the
8 containment. So it's not as though at 95 percent of
9 the time it is going to work and five percent of the
10 time it is going to fail.

11 MR. WALLIS: So he has to test these
12 things periodically, and he can detect these very
13 small leakage rates?

14 MR. MARQUINO: This is Wayne Marquino. So
15 there will be periodic interval containment leakage
16 tests that measure the drywell, wetwell leakage and
17 we'll be conducting those tests with instrument
18 accuracy sufficient to provide 95-95 measurement of
19 the one square centimeter acceptance criteria.

20 So this is a statistical accuracy basis on
21 the test. It is not that five percent of the time the
22 vacuum breaker is going to be open and we don't know
23 about it. It is five percent of the time the leakage
24 might be a little higher than one square centimeter.

25 MR. WALLIS: So the person who owns this

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1 plant is going to be a little careful, isn't he? He
2 may find that he buys this thing, and after two years
3 he gets a lot of trouble with vacuum breaker tests.

4 MR. MARQUINO: We have some
5 representatives from Entergy here today, and they are
6 aware of this concern, and they are helping us get
7 through the licensing with a leakage area that they
8 are confident can be met when the plant is ready to
9 load fuel and we have the initial tests, and also
10 continues through the 60 year life of the plant.

11 MEMBER BANERJEE; How easy is it to
12 repair?

13 MR. MARQUINO: They are accessible. They
14 are on the drywell floor.

15 MEMBER MAYNARD: Well, like any other
16 component, if you end up being a maintenance or
17 testing nightmare, you end up redesigning it at some
18 point.

19 My question would be more along the lines
20 of the frequency of the testing here. If it is only
21 done as part of the overall integrated leak rate
22 testing, that is not a real frequent test.

23 MR. MARQUINO: Yes. We are going to test
24 -- The individual vacuum breakers will be tested on a
25 higher frequency than the integrated drywell-wetwell

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1 test.

2 CHAIRMAN CORRADINI: You will do that -- I
3 thought you explained that last time we were going to
4 put like a little cover over it and then pressurize
5 and look at them individually. Is that not correct?

6 MR. MARQUINO: Yes.

7 CHAIRMAN CORRADINI: So are we at the end?

8 MEMBER ABDEL-KHALIK: So would some of
9 these tests be done during operation or are they
10 always done during refueling outages?

11 MR. MARQUINO: During outages.

12 MEMBER ABDEL-KHALIK: So there is really
13 no consequence to this, if you find out that a valve
14 fails the leak test?

15 MEMBER MAYNARD: There are consequences.
16 You find something that has been inoperable, there are
17 consequences.

18 CHAIRMAN CORRADINI: Like the ox-feed one,
19 there is consequences.

20 MR. WALLIS: So is it tested at the
21 temperatures that you would get in a LOCA or is it
22 tested at the temperatures you get in normal
23 operation? Presumably, you put a cap on it, and you
24 put in steam at several atmospheres.

25 MR. MARQUINO: It will be tested at the

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1 normal refueling temperatures.

2 MR. WALLIS: It won't be tested at the
3 LOCA temperatures?

4 MR. MARQUINO: No, only --

5 MR. WALLIS: It still might behave
6 differently?

7 MR. MARQUINO: That's why we do equipment
8 qualifications, so that we can consider the LOCA
9 environment as well.

10 MR. KRESS: I can't imagine you would use
11 steam. Wouldn't you use a gas to do that leak
12 testing?

13 CHAIRMAN CORRADINI: Just to ask a
14 question, wouldn't you want to use it with a non-
15 condensable gas? Isn't that more of a difficult test
16 at cold conditions than steam condensing into cold
17 gas?

18 MR. WALLIS: I don't know how the seal
19 performs at elevated temperature.

20 CHAIRMAN CORRADINI: I guess I was
21 thinking this was a harder test to pass, similar to
22 the containment leak rate test.

23 MR. WALLIS: No. We are asking about
24 integrity of the seal. Heat it up to the maximum
25 temperature obtained in a LOCA after three days, it

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1 may behave differently from the way it behaves under
2 normal temperature conditions. I would think you want
3 to test it under the most severe conditions expected
4 in the operation during a LOCA.

5 MEMBER MAYNARD: And typically, you are
6 going to set acceptance criteria that give you quite a
7 bit of margin there. I don't know if there is some
8 initial qualification. Most of these components have
9 to be qualified initially for the environment, the
10 worst case environment.

11 MR. WALLIS: You don't the seal to melt
12 when it gets hot.

13 MEMBER MAYNARD: Right. So they are going
14 to have some type of equipment qualification testing
15 and certification for the materials that are being
16 purchased.

17 MR. WALLIS: But then if you are going to
18 test it heating it up and cooling it down, there's a
19 question of fatigue failure of this whatever it is,
20 rubber type compound that is a seal, soft seal.

21 MEMBER MAYNARD: I would imagine a test on
22 this would probably either be pressurizing one side
23 and a vacuum on the other and then measuring the decay
24 rate or the leakage that way.

25 MEMBER BANERJEE: Are you allowed to tell

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1 us in an open session what the seal material is? Can
2 you tell us in a closed session?

3 CHAIRMAN CORRADINI: Afternoon.

4 MR. WALLIS: See, most soft seals in use
5 after a while get sticky and perish, and they change
6 their chemical surface. So you have to worry a lot
7 about the aging of this seal material, presumably.

8 MEMBER MAYNARD: And I am sure they are
9 going to fall under the equipment qualification
10 requirements, which does address life and cycles and
11 worst case harsh environments, and I'm sure that is
12 being applied to the design.

13 CHAIRMAN CORRADINI: So are you at the
14 end, with the proviso that we cut out a center section
15 to try to allow staff to come in with their audit
16 calculation.

17 MR. CHEUNG: Okay. Now let me summarize
18 it. At the very beginning, I tried to demonstrate
19 that the PCC operation is self-regulated, and such
20 that the accumulating non-condensable gas in the
21 bottom of the tube self-regulated.

22 We have not had a chance to discuss the
23 vent fan, but I can tell you that, once the vent fan
24 turn on, the vent fan destroy that non-condensable gas
25 column, and then the vent fan going to redistribute

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1 the mass, the non-condensable gas mass, from the
2 wetwell back into the drywell, and the drywell
3 pressure increases because of this mass distribution
4 and not because you enhance the heat transfer in the
5 tube due to the vent fan.

6 We established -- The first time we
7 discussed this with you, we established the licensing
8 basis with 2 square centimeter. This licensing basis
9 is supported by calculation and a lot of calculations
10 so that it is conservative modeling and plant
11 conditions.

12 We established a test acceptance limit for
13 the bypass leakage at 1 square centimeter, and
14 realistically the leakage flow area is through the
15 diaphragm floor, which is much less than 1 square
16 centimeter, and there is still 50 percent margin to
17 the licensing basis.

18 On top of it, there is a large margin,
19 safety margin, to the containment ultimate capacity,
20 and even before the containment fails, there is
21 another structural margin on the previous slide we
22 saw.

23 MEMBER BANERJEE: Can I ask you a question
24 about the vent fan?

25 MR. CHEUNG: How much time do we have?

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1 CHAIRMAN CORRADINI: Two minutes.

2 MEMBER BANERJEE: What are the velocities
3 in the tubes of the PCC when there is a vent -- when
4 you operate the vent fan?

5 MR. CHEUNG: I do not have that number in
6 my mind, but the vent fan -- what it does is, when --

7 MEMBER BANERJEE: What is the -- The
8 reason I am asking this is, if you have a mixture of
9 steam and non-condensables, you will get some
10 condensation, and I am wondering whether the
11 velocities are high enough to entrain the water and
12 bring it into the vent fans.

13 MR. CHEUNG: We will find out the
14 velocity.

15 MEMBER BANERJEE: Or will the water
16 separate or will it be entrained? That's really what
17 I want to know.

18 MR. CHEUNG: The water -- We will separate
19 it in a lower drum, on the lower header.

20 MEMBER BANERJEE: But it's a matter of
21 velocity whether it separates or not.

22 MR. CHEUNG: Yes. And I can tell you the
23 consequence is not important, because it will be going
24 back to the other side of the GDCS pool, still going
25 back to the GDCS pool and with the water and with the

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1 gas and everything else.

2 MEMBER BANERJEE: But not if you have a
3 fan which is pumping a multi-phase mixture --

4 CHAIRMAN CORRADINI: He is worried about
5 the equipment operability, I think.

6 MR. CHEUNG: Yes. The equipment going to
7 be quantified or qualified for that operation.

8 MEMBER BANERJEE: With water going through
9 it?

10 MR. CHEUNG: Has to be, in case of the
11 water coming in. And during the vent fan operation,
12 actually, the PCC vent is all -- all full of water.
13 There is no flow going to the PCC vent.

14 MR. WALLIS: Could I have 10 seconds? You
15 have a summary. I have a summary. My summary is most
16 of my technical questions remain, and I've found some
17 new ones.

18 MS. CUBBAGE: Ready for the staff now?

19 CHAIRMAN CORRADINI: I'm ready for the
20 staff.

21 MS. CUBBAGE: All right. In the interest
22 of time, we are going to skip -- The NRO had a few
23 introductory slides. We are going to go straight to
24 the Office of Research. Allen Notafrancesco will be
25 beginning and bringing up some of his colleagues and

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1 contractors.

2 CHAIRMAN CORRADINI: To remind the
3 Committee, we had a CD with the audit calculations,
4 and also, I think, the boron dilution calculations
5 were on it, on the CD that was sent to us.

6 MR. WALLIS: I'm not sure I had the CD,
7 but I may have lost something along the way, but I'm
8 not sure I saw this.

9 MS. BANERJEE: I don't remember a CD.

10 MEMBER SHACK: There's so many of them.

11 MR. WALLIS: Yes, I saw the Melcor.
12 That's what you mean. I thought you were referring
13 to something else.

14 CHAIRMAN CORRADINI: No, no, no. I meant
15 the CD that has --

16 MR. WALLIS: That's clear enough.

17 MR. NOTAFRANCESCO: Okay, I'll start. I
18 am Al Notafrancesco, Office of Research.

19 The RES research had a mandate to provide
20 NRO with audit calculations: Technical monitor. We
21 sponsored this effort with Sandia National Laboratory.
22 Jack Tills is a subcontractor to Sandia, and he will
23 get up next.

24 We also did some scoping calculations in
25 the past six months, and Hossein Esmaili will discuss

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1 that in a few minutes.

2 The code we selected for this application
3 was the MELCOR Code for several reasons. It is robust
4 in running long term. It uses state of the art
5 computational approach.

6 MR. WALLIS: I think it has one node for
7 the containment volume. The drywell has one node.

8 MR. NOTAFRANCESCO: It has more than one
9 node, but we will get to it. I'm giving you the
10 overview.

11 MR. WALLIS: I thought it had one node for
12 the drywell.

13 MR. NOTAFRANCESCO: Most of the drywell is
14 one node except the GDCS pools. We'll get to that.

15 MR. WALLIS; Yes. Yes, thank you.

16 MR. NOTAFRANCESCO: The key issue I wanted
17 to make here was that usually MELCOR is associated
18 with severe accidents. In selecting it for design
19 basis application, we went back and did target
20 assessments to make sure that MELCOR is ready to look
21 at design basis accidents.

22 The next slide: And as part of the
23 technical review of the audit calculation, we did
24 provide RAIs and we did try to understand the TRACG
25 modeling to a certain extent.

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1 Next slide.

2 MEMBER BANERJEE: Does TRACG use only one
3 node in the drywell?

4 MR. NOTAFRANCESCO: No. Jack will have a
5 --

6 MEMBER BANERJEE; It was a comparison of
7 the nodalization?

8 MR. NOTAFRANCESCO: We have back-up
9 slides. It's in the DCD of the TRAC, and we will show
10 you the node from MELCOR.

11 Basically, we are focusing on the limiting
12 containment pressure break, which is the main steam
13 line break with a failure of 1 DPV. Jack will
14 describe what he did in the first three days, and
15 that's the report the Committee was sent about a year
16 ago, and then any scoping calculations. But again,
17 Jack was based on the DCD Rev. 3-Rev. 4 TRACG results.

18 The beyond three days has not been documented, but
19 these are scoping calculations, and Hussein will get
20 into that.

21 So Jack will describe our MELCOR analysis.

22 MEMBER BANERJEE: Let me ask a question
23 which is sort of general. Does TRACE have the same
24 capability as TRACG to do these things?

25 MR. NOTAFRANCESCO: TRACE right now is

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1 limited to look at reactive vessel water level. So
2 the interest is more short term. Whether it could run
3 out to three days to seven days is questionable at
4 this time.

5 MEMBER BANERJEE: For what reason? What
6 is the reason it can't?

7 MR. NOTAFRANCESCO: I can't speak for
8 that, specifically for the code. All I know, it's
9 not coming through in that area.

10 MEMBER BANERJEE: The reason I ask this
11 question is that, if GE can have an integrated code
12 which can handle the inside and the outside, and TRACE
13 is supposed to be a distant spirit -- it will do the
14 same thing -- why do we choose this sort of diversity
15 of codes to try and do confirmatory calculations?

16 MR. NOTAFRANCESCO: Well, first of all,
17 it's a good idea to have diversity and independence
18 from TRACE and TRACG here.

19 MEMBER BANERJEE: But TRACE is not TRACG.
20 It's a separate code.

21 MR. NOTAFRANCESCO: Well, I understand.
22 Originally, three, four years ago, our strategy was to
23 use TRACE-CONTAIN and then develop TRACE enough to
24 have the CONTAIN modeling wither away and TRACE to be
25 the unified code.

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1 For whatever reason, that did not happen.

2 So in the meantime, we were involved with MELCOR
3 analysis within the guise of the severe accident
4 assessments. Then we got to a point where we say,
5 well, we need to get long term calculations with
6 results, and that's what I am trying to do.

7 MEMBER BANERJEE: So does MELCOR have the
8 multi-field capabilities that TRACE and TRACG have?

9 MR. NOTAFRANCESCO: No. And this is one -
10 - But this is relevant to the short term, and it turns
11 out it won't make much of a difference in these
12 blowdown cases -- that is, not compromise our
13 calculations at all.

14 MEMBER BANERJEE: So you handle formation
15 of liquid films and things like this in some explicit
16 way in the code?

17 MR. NOTAFRANCESCO: The liquid films are
18 going to be related to the condensation on the heat
19 transfer, for example.

20 MEMBER BANERJEE: So you feed it in as
21 sort of a boundary calculation here?

22 MR. NOTAFRANCESCO: Well, no. We model
23 the RPV as a simple configuration, probably much more
24 than TRACE or TRAC. It is basically a blowdown feed,
25 feeding the containment. Our main interest is feed

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1 containment pressure, not water level.

2 So if we are sloppy with the water level,
3 as long as we are getting the integrated amount in the
4 short term, we're fine, and we will show you.

5 MEMBER BANERJEE: This is a very complex
6 situation where you are getting non-condensables going
7 here and there, splitting and accumulating in various
8 things. Do you feel that MELCOR can handle this type
9 of stuff?

10 MR. NOTAFRANCESCO: No, and that's why we
11 are doing what we are doing and lumping the volumes,
12 because we are not pretending we are going to model
13 the mixing of non-condensables. So we have taken a
14 conservative approach about --

15 MEMBER BANERJEE: Perhaps you would
16 explain what the objectives of this are. What are you
17 trying to actually predict, and what is the bottom
18 line in terms of --

19 MR. NOTAFRANCESCO: Well, our main goal
20 here is to look at 6.2 in the DCD on peak containment
21 pressure analysis, and we are doing counterpart
22 calculations to the sequence to those TRACG
23 calculations.

24 MEMBER BANERJEE: So you are trying to see
25 whether the peak pressures that your code predicts are

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1 in the same ballpark as TRACG. But these peak
2 pressures depend very much on where the non-
3 condensables go. So if you are not confident that you
4 can calculate where the non-condensables go, how can
5 you be confident in the peak pressures that you
6 predict?

7 MR. NOTAFRANCESCO: Well, when we are not
8 confident where the non-condensables are in the
9 drywell, we make sure they are expedited to the
10 wetwell.

11 MR. WALLIS: So you make the same
12 assumptions that GE does, which is why you get about
13 the same answer.

14 MS. CUBBAGE: I would like to propose that
15 Jack proceed with the presentation, because he
16 explains what he -- how he treats the different
17 parameters and why.

18 MEMBER BANERJEE: Start with the
19 objectives, please, so we know where we are going.

20 MR. TILLS: My name is Jack Tills. Sandia
21 has me on contract to provide containment support for
22 the Office of Research.

23 We started doing the type of analysis that
24 is characterized by this plant in the mid-Nineties
25 with the small SBWR, and we began with the CONTAIN

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1 code which is a lump parameter code, and then as SBWR
2 went away and then ESBWR came on board, we moved over
3 to MELCOR because we realized we needed more coupling
4 between the RPV and what was going on in the
5 containment.

6 So we stayed with a code that was lump
7 parameter and a containment code that had the pedigree
8 of a containment code.

9 Now issues of non-condensable gases
10 certainly wouldn't be solved by TRAC or TRACE in terms
11 of validation. So what we looked at in terms of the
12 MELCOR code was to try and provide --

13 MEMBER BANERJEE: Excuse me. I was just
14 told that TRACG modeled PANDA.

15 MR. TILLS: That's right, and we've
16 modeled PANDA also and got just the same results as
17 they did. PANDA is a one-dimensional type of a
18 facility. We purged gases out of trapped areas, just
19 as PANDA did.

20 The areas that we are interested is what
21 controls this facility, and what controls this
22 facility is what you have already heard, which is the
23 wetwell. The migration of non-condensables into the
24 wetwell is an issue, but we know what is the bounding
25 issue, is if you get all of it going into the wetwell,

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1 you get the highest pressure.

2 Now that's been confirmed clearly for
3 blowdowns, and that's been our licensing procedure for
4 blowdowns for many years, to force a vendor to use a
5 single cell for the drywell, to force the maximum
6 pressure during blowdown.

7 There is a little bit of a difference here
8 now with this PCCS, because if you trap too much gas
9 in the wetwell and it bleeds out later and degrades
10 the PCC performance, you could get a long term
11 increase in pressure as a result of not accounting for
12 trapping.

13 Now that would hold if the PCCS was
14 designed with very low capacity and you were right at
15 the limit. But this plant is designed with a PCCS
16 system that is over-designed, significantly over-
17 designed, after a few out.

18 Therefore, you can do a hand calculation
19 and calculate how much retained trapping you would
20 need to degrade the PCCS before you just begin to pass
21 steam into the suppression pool. It's a simple hand
22 calculation.

23 When you do that, you find that you have
24 to pass gas -- you know, this may be a couple of
25 thousand to three thousand kilograms of gas which is

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1 the amount of gas that is just in the annulus in the
2 wetwell area -- or in the annulus and in the lower
3 drywell. You have to pass that within an hour or less
4 in order to degrade the condenser before you pass
5 steam.

6 That is why you don't see any major blips
7 in pressures when, even in the TRAC case, they bleed
8 out this gas. The reason you don't see it is because
9 the condensers are keeping up, and the gas is just
10 bleeding out into the wetwell.

11 So because of that, it became clear to us
12 that using a single cell for the drywell was really a
13 bounding calculation for this plant.

14 Now in the case of the TRAC calculation,
15 TRAC code is not qualified for blowdown containment
16 analysis, and when you look at the early -- this goes
17 to the question of what you are looking at in this
18 containment deal -- you look at short term, blowdown
19 peak for a BWR, and you look at long term.

20 Now in the TRAC calculation, they have
21 many, many nodes, and you've seen that in the DCD.
22 Early on, they trap about 2,000 to 3,000 kilograms.
23 That is all of the nitrogen in the lower DL. That
24 depresses the short term peak down to about 250. It
25 should be, in terms of licensing, about 330 to 350.

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1 So that is the issue for short term. However, that is
2 well below the margin for the design pressure.

3 If you look at, going back now to delay
4 time, now you look at the PCCS performance. Our
5 interest in doing the MELCOR calculation was to, first
6 of all, understand the facility, and we did that by
7 looking and qualifying MELCOR in a variety of tests
8 similar to what GE has done.

9 MR. WALLIS: I have a question for you
10 about non-condensables. In your report, you said that
11 radiolytic gas keeps the passive cooling condensers
12 bound up.

13 MR. TILLS: That's right.

14 MR. WALLIS: Such that the pressure drop
15 from drywell to wetwell is maintained relatively
16 constant. The nitrogen is swept out very quickly in
17 the first hour. The ones that are obtained through
18 radiolytic formation do have a significant effect on
19 the PCC.

20 MR. TILLS: That's correct. But the rest
21 of the time in the calculation with the single cell is
22 almost nil. If you look at what the resident time and
23 how much gas is retained in the drywell, it is very,
24 very small. Most of it is passed on through the PCCS.
25 That's why they accumulate.

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1 In the early calculations when GE was
2 doing calculations -- and this is kind of debatable --
3 I don't think they had radiolytic gases in there, and
4 certainly in SBWR they weren't accounted for, and so
5 really you had a design that was pressure controlled.

6 Somewhere along the line, probably a year
7 or two ago, radiolytic gases came into vogue, and they
8 were put in. As a result, you have a continuous
9 accumulation, as time goes on, of these gases, and
10 they are bled out. That causes that pressure
11 differential that causes additional leakage.

12 In early calculations, the pressures came
13 up in the long term, was pretty much flag. That is
14 what I consider as a pressure controlled system. Now,
15 you know, the nomenclature to call it pressure control
16 is getting less and less, because you are getting this
17 large increase, and the increase is primarily
18 dominated by the presence of radiolytic gases.

19 If you don't have them, the vacuum
20 breakers are continually functioning and opening
21 throughout this 72 hour period, because there is not
22 enough gases to accumulate for long periods of time,
23 and so the PCCS, because it's got excess --

24 MR. WALLIS: I don't understand that.
25 There's got to be some non-condensables.

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1 MR. TILLS: There is some. There is some.

2 MR. WALLIS: There has to be some fencing.

3 It has to overcome the hydrostatic pressure.

4 MR. TILLS: That's right.

5 MR. WALLIS: Which is a constant amount.

6 MR. TILLS: That's right.

7 MR. WALLIS: Not this difference that
8 makes the drywell pressure higher than the wetwell by
9 the amount of that hydrostatic and the submergence of
10 the vent.

11 MR. TILLS: That's right, and --

12 MR. WALLIS: That keeps the vacuum
13 breakers shut as well.

14 MR. TILLS: And if the gases, you know,
15 either through numerical instability or any
16 instability in boiling causes any little burp in the
17 system, those gases go out, because there is not very
18 much of those accumulated, and the vacuum breaker is
19 then open, and you go through a cycle of ratcheting
20 between vacuum breakers going on and off. That was
21 the old way that was --

22 MR. WALLIS: But if they are opening and
23 closing a lot of times, then the chance of them
24 sticking, seems to me --

25 MR. TILLS: Right. Right.

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1 MR. WALLIS: Do you see that scenario
2 where they open and close a lot all the time?

3 MR. TILLS: Well, in the tests -- The
4 tests were not run -- A few tests of the P series were
5 run long enough that you could see some opening and
6 closing, but they weren't on the frequency level that
7 we see in plant calculations.

8 What I am just bringing up to you,
9 though, is that there was a significant difference
10 when radiolytic gases were added to the problem, and
11 that problem made the situation worse, and that is
12 where you get --

13 MR. WALLIS: I'd like to press advantage
14 on this question, which intrigued me, that some
15 intermittent operation of the PCCS where you vent some
16 gases, then you build them up and you vent them, and
17 each time you do that you pump the vacuum breaker.
18 Then you've got an oscillating behavior which I don't
19 think is presented at all in the DCD. It might have
20 some significance.

21 MR. TILLS: If you look at earlier DCDs,
22 Rev. 0, Rev. 1 --

23 MR. WALLIS: You have to look at them all?

24 MR. TILLS: No. Well, I'm just saying, if
25 you look at those early ones, you will see a different

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1 signature, and you will see the vacuum breakers
2 operating and both the drywell and the wetwell having
3 very small pressure differences.

4 MR. WALLIS: So which is correct? Which
5 is right?

6 MR. TILLS: Well, I think, if you buy into
7 the fact that you are going to have radiolytic gases
8 at the rate that is being projected by GE, then
9 clearly you are going to have the accumulation, and
10 the other thing is that we have seen that with PANDA.

11 In the PANDA tests, we clearly saw, if you
12 had a small amount of gas in the drywell --

13 MR. WALLIS: Well, I'm sorry, but there
14 are these passive recombiners, whatever they are
15 called, PARs. So if you put them in, they make a
16 difference to the whole scenario, do they?

17 MR. TILLS: Well, they certainly would, if
18 they worked. They would certainly change the way you
19 would do an analysis, if you had them in there.

20 Our analysis is done without PARs, and
21 you know, that is the bounding situation. Whether or
22 not they qualify PARs for a very low steam
23 environment--

24 MR. WALLIS: They said they had no credit
25 for PARs, but they are there, aren't they? So I'm not

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1 sure whether they are -- I am trying to say, really,
2 what happens realistically? Are they realistically
3 recombining, or not?

4 MR. TILLS: Graham, realistically, if you
5 looked at conservatisms which you have identified as
6 probably excessive, you would see something very much
7 like a MARK-3 where the peak occurs very early, and
8 you probably didn't get a long term increase in
9 pressure, you know, above, say, the peak pressure.
10 That's my gut feeling of what it probably look like in
11 a best estimate reality case.

12 CHAIRMAN CORRADINI: So the pressure would
13 be coming down, Jack?

14 MR. TILLS: Not down, but probably leveled
15 off.

16 CHAIRMAN CORRADINI: At some steady --

17 MR. TILLS: Right, if you did not put in
18 the conservatisms, if you had -- especially if you had
19 PARs activated, you put in all the heat transfer
20 coefficients.

21 Let me mention another thing about the
22 TRAC where it is ultra-conservative. The heat
23 transfer coefficients that they use in TRAC is an
24 empirical correlation. For some of you that are
25 familiar with Uchida, it is a fit to -- and I know you

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1 are -- a fit to the mass fraction.

2 Those type of correlations are notoriously
3 known to not be able to scale with air density. That
4 means that, if you have large variations in air
5 density, you can get variations in --

6 MR. WALLIS: Or hydrogen rather than
7 nitrogen?

8 MR. TILLS: No, just nitrogen. So suppose
9 now we move -- we doubled the air density in the
10 wetwell -- Okay? -- as a result of moving all the
11 drywell over there. That means that these
12 coefficients will underpredict heat transfer
13 coefficients by a factor of two. So --

14 MEMBER BANERJEE: But I guess that depends
15 on the state of turbulence of the non-condensable,
16 doesn't it?

17 CHAIRMAN CORRADINI: No. It's diffusion
18 control at the --

19 MEMBER BANERJEE: All is purely diffusion?

20 CHAIRMAN CORRADINI: Yes. Pretty much,
21 at the surface, but I think Jack's point is that the
22 Uchida correlation has no pressure correction or
23 density correction.

24 MR. TILLS: Density correction.

25 MR. WALLIS: Well, it's diffusion

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1 controlled at the surface, but how thin the boundary
2 layer is, is determined by the turbulence outside it.

3 You can't just do a correction by itself.

4 MR. TILLS: But in the case of this
5 calculation of all this, usually in containment space,
6 we don't take -- We apply a turbulence but not a force
7 turbulence for condensation, which is bounding.

8 MEMBER BANERJEE: But there is a scale
9 effect here, isn't there? I mean, is it a -- So you
10 have a liquid seal. Let me try to understand this.
11 Then you have a film of non-condensables through which
12 something has diffused in order to condense.

13 The thickness of this non-condensable film
14 will depend on what the conditions are in the flow.

15 CHAIRMAN CORRADINI: But the assumption
16 that Jack -- What Jack said is important. That is,
17 all typical containment calculations do not take into
18 account any force convection and diminishment of the
19 boundary layers, essentially a natural convection
20 estimate.

21 MR. WALLIS: It can't be, because if you
22 have --

23 CHAIRMAN CORRADINI: I don't disagree with
24 you. I'm just telling you that's how it --

25 MR. WALLIS: You don't get a boundary

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1 layer. You just build up and build up, unless there's
2 some way to take them away.

3 MR. TILLS: No. You use correlation --
4 You use an analogy correlation to give you that limit
5 and that control over the boundary layer. And so the
6 more modern state of the art type of codes that are
7 using non-condensable, you know, degradation are
8 pretty much all using a heat mass transfer analogy
9 concept that is a film theory developed concept.

10 MR. WALLIS: But in some cases there is no
11 film unless there is a turbulence to pull it off. The
12 film will build up forever.

13 MEMBER BANERJEE: I guess what you assume
14 is the natural convection flow is giving rise to
15 turbulence.

16 MR. TILLS: That's right.

17 CHAIRMAN CORRADINI: We are going to move
18 on.

19 MR. TILLS: Go to the next slide. This is
20 just put up for your edification. It just kind of
21 indicates some of the target areas we looked at, and
22 there's about seven different references here that
23 just focus in on ESBWR type phenomena.

24 the next slide just shows you what you
25 have in front of you, which is that --

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1 MEMBER BANERJEE: You told me that PANDA
2 was one-dimensional. Every time I see PANDA, it looks
3 fairly three-dimensional to me. Is it one-
4 dimensional, because that solid is noted to be one-
5 dimensional or is it --

6 MR. TILLS: I mean one-dimensional in
7 terms of what is actually occurring. In other words,
8 a one-dimensional or a zero-dimensional code
9 calculates very well to PANDA. Multi-codes --

10 MEMBER BANERJEE: Then it would also be a
11 function of the number of adjustable coefficients you
12 have. Right?

13 MR. TILLS: Well, I mean, I look at
14 experimental data first, and the experimental data is
15 indicating the factor, not the code. It's well mixed.

16 MEMBER BANERJEE: It is well mixed across.

17 MR. TILLS: It's well mixed. It's very
18 well mixed, and it the important thing is that it is
19 well mixed at the initial condition, which starts one
20 hour after the accident.

21 In other words, the injection is decay
22 heat driven steam, not blowdown. So if it is well
23 mixed in that case, you pretty well -- here it is
24 going to pretty well mixed during the blowdown.

25 MEMBER BANERJEE: In a real drywell which

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1 has a larger length scale, do you expect that to be
2 well mixed as well?

3 MR. TILLS: I would expect it to be,
4 during the blowdown.

5 MEMBER BANERJEE: During the blowdown, but
6 post-blowdown?

7 MR. TILLS: Well, again if it was not
8 mixed -- I mean, this is where you get to the point of
9 transferring between best estimate, being asked to do
10 that, and doing an audit calculation or bounding deal.

11 You have to make a decision of what's the
12 capability of the code, and then also, you know, where
13 you find bounding situations. In this case, if you
14 retain, as I mentioned, any gas into the wetwell that
15 could later bleed out and degrade the PCCS, you
16 determine what that possibility would be.

17 Now 2000 to 3000 is really the max, all of
18 the annulus and all the lower drywell.

19 MEMBER BANERJEE: Well, if you well mix
20 the drywell, you will always retain some non-
21 condensables in the drywell, won't you?

22 MR. TILLS: Very, very small. I mean very
23 small, because the amount of steam that is coming in
24 with decay heat is fairly significant.

25 MEMBER BANERJEE: But by definition, when

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1 you well mix something, it's the third tank reaction.

2 MR. WALLIS: Well, it's e to -5T, and T is
3 hours.

4 MR. TILLS: It is small. I mean, we have
5 looked at how much is retained with a single cell, and
6 it is very, very small. It's negligible.

7 MR. WALLIS: Can I ask you about the
8 nodalization here? In the wetwell, you have 530, 531,
9 and 515. Presumably, you are thinking that what is up
10 at the top is different from what is down below, and
11 yet your vacuum breaker seems to be connected to the
12 515. I thought the vacuum breaker was on top.

13 MR. TILLS: We did both. In this case, we
14 are pulling in more nitrogen. More nitrogen is going
15 back into a --

16 MR. WALLIS: But isn't the vacuum breaker
17 connected to 530 or something like that?

18 MR. TILLS: It is 530.

19 MR. WALLIS: It should be. So this is not
20 drawn right?

21 MR. TILLS: Well, no, the leakage is
22 connected to 530, but the actual -- We are pulling --
23 In this calculation we are pulling it from --

24 MR. WALLIS: Oh, you sort of assume it
25 somehow inverts itself when the vacuum breaker

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1 operates?

2 MR. TILLS: Well, it's not really that so
3 much as it is just, when we added the cells to do the
4 stratification, we added them above the cell that we
5 normally had working with the vacuum breakers, and we
6 did it both ways, and it didn't have any significant
7 difference in the calculation.

8 I think, if you look -- You know, we can
9 look at the scenario. The vacuum breakers, you know,
10 because in this situation are not cycling, we only
11 have one window where they operate, and that is a
12 window of maybe a half-hour to an hour, a little
13 longer than an hour.

14 CHAIRMAN CORRADINI: Early in the
15 accident.

16 MR. TILLS: Early in the accident, and
17 then after that they shut. They don't open again
18 because of this bounding up of the PCC. So what I'm
19 trying to do is -- You know, I know it may sound like
20 I am jumping ahead to what I think is the answer, but
21 we have done sensitivities to verify what we are
22 focusing in on.

23 What we want to focus in on is what is
24 controlling the facility independent -- as much
25 independency of GE as we can, and then come up and see

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1 whether or not we get the same phenomena that is
2 driving it.

3 What we have determined is that the
4 phenomena -- and this report was written a year ago --
5 is that it is dependent upon bounding up of this PCC
6 and the leakage, the drywell leakage. Those are the
7 dominating things. The controlling parameters to that
8 is the rate at which radiolytic gases come in and also
9 any parameter that affects that leakage rate, and you
10 have already identified --

11 MEMBER BANERJEE: What do you mean by
12 drywell leakage? Leakage through the vacuum breaker?

13 MR. TILLS: Drywell to wetwell leakage
14 through the vacuum -- right. That's this one
15 centimeter squared issue that you have been focusing
16 on.

17 MR. WALLIS: Can I ask you something about
18 your report? In your report -- I'm quoting from your
19 report -- says, "The most important structure
20 affecting containment response is the outer wetwell
21 wall above the full surface."

22 MR. TILLS: That's correct.

23 MR. WALLIS: Seems to indicate to me that
24 heat transfer to that wall as it is going through some
25 transient is important in your calculation of the

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1 temperature of the gas space.

2 MR. TILLS: That's right. If you took out
3 that wall -- I'm saying right now with the wall in
4 there, with -- you know, as I mentioned, with a
5 calculation that has a heat transfer coefficient,
6 that's probably our best estimate of what that would
7 be. We sitting at 370.

8 If you take the wall out -- okay, just
9 take that wall out -- the pressure goes up to about
10 430-440.

11 MR. WALLIS: Well, that really bothers me,
12 and you also say the wetwell outer wall heats up in
13 5,000 to 35,000 seconds. So in one hour it heats up.

14 Well, heat to the surface in a swirl like that lasted
15 for days, if you look at the transient heat transfer.

16 So how does it heat up in an hour? There is
17 something strange about that.

18 MR. TILLS: It's not an hour.

19 MEMBER BANERJEE: It's 10 hours.

20 MR. WALLIS: Well, it says 5000 to 36,000
21 seconds.

22 MR. TILLS: Well, that's where the major
23 heat-up is occurring.

24 MR. WALLIS: How thick is it?

25 MR. TILLS: Okay. It is probably, I

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1 think, about maybe a meter and a half, two meters.

2 MR. WALLIS: Meter and a half, and the
3 transient is over in that short a time?

4 MR. TILLS: Well, that's where, you know,
5 the amount -- If you look at the pressure increase
6 that's going on here, this pressure is increasing,
7 what, maybe a half an atmosphere over three days.
8 That's very small. That's a small rate of change when
9 you are looking at heat transfer.

10 I mean, this is the problem, is it's a
11 small amount of heat transfer that is occurring in
12 this wetwell. Hitachi did a number of experiments,
13 and you may be familiar with it, where they put a
14 water wall on a suppression pool, and that was to take
15 the energy out of a suppression pool for something
16 maybe similar like this.

17 In this case, this wall is very, very
18 thick, and on the outside boundary is basically almost
19 adiabatic. You know, it's got a small --

20 MR. WALLIS: It starts cold, and you got
21 to take it off on one side.

22 MR. TILLS: It starts cold, but after a
23 long period of time the boundary condition on the
24 outside does have an effect on this leak time.

25 MR. WALLIS: After a very long time.

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1 MR. WALLIS: Yes, in a long time. So --

2 MR. TILLS: I'm sorry. You said this
3 makes a difference between 270 and 400-something
4 degrees?

5 MR. TILLS: If you take the wall out, if
6 you just take the wall out.

7 MR. WALLIS: Well, then --

8 MR. TILLS: That just gives you the upper
9 bounds of what it would be.

10 MR. WALLIS: That's a big heat sink.

11 MR. TILLS: It is a big heat sink.

12 MEMBER BANERJEE: How do you model it, as
13 a lump parameter with Newton's law or do you actually-
14 -

15 MR. TILLS: No, it's a solvent.

16 MEMBER BANERJEE: Radial solvent.

17 MR. TILLS: Yes.

18 MEMBER BANERJEE: So you've actually got
19 that?

20 MR. TILLS: Right.

21 MR. WALLIS: And it's not condensation?
22 It's just natural convection.

23 MR. TILLS: No, it's condensation on the
24 inside, you know, and natural convection on the
25 outside.

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1 MR. WALLIS: So how about -- The ceiling
2 is bigger than the outside wall, isn't it?

3 MR. TILLS: The ceiling -- What they did
4 with the ceiling was they lumped the area of the
5 ceiling into the outside wall. That's the way I
6 understand it. In other words, they did not just
7 eliminate the area. They just moved it over and
8 increased the area of the outside wall. I don't know
9 if Chester is here.

10 That's my understanding of how they
11 compensated for --

12 MR. WALLIS: I thought they said they
13 ignored the ceiling.

14 MR. TILLS: They ignored it from the
15 standpoint of bounding conditions.

16 MEMBER BANERJEE: But they --

17 MR. CHEUNG: This is Chester Cheung.

18 MEMBER BANERJEE: -- heat equivalent to
19 the ceiling?

20 CHAIRMAN CORRADINI: Well, let him answer.

21 MR. CHEUNG: Let me comment on that. We
22 ignored the horizontal heat slab by the horizontal top
23 of wall underneath the GDCS pool, but there is still a
24 horizontal surface from the -- or the GDCS pool all
25 the way to the wetwell. So that top of --

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1 MR. WALLIS: Why would you ignore the
2 ceiling which is there under the GDCS pool?

3 MR. CHEUNG: We want to make sure that --
4 We wanted to have conservatives, that whatever that go
5 into the top of the ceiling on the wetwell --

6 MR. WALLIS: But you aren't being very
7 conservative, because you are taking credit for
8 something which seems to reduce the temperature from
9 430 to 270. So --

10 CHAIRMAN CORRADINI: Not 270 -- 370. He
11 said 370, right?

12 MR. WALLIS: 370 -- that sounds better to
13 me. So it does have an effect, though.

14 MR. CHEUNG: We modeled the outer wall of
15 the wetwell and outer wall of the suppression pool.

16 MR. WALLIS: And you put non-condensables
17 in this steam that was condensing?

18 MR. CHEUNG: Well, what do you mean by
19 non-condensables?

20 MR. WALLIS: Well, affect the heat
21 transfer. Governed by the transients in the concrete.

22 MR. CHEUNG: Actually, after a very short
23 time, the wetwell is full of non-condensable, and
24 whatever that condensation is going to degrade
25 greatly.

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1 MR. WALLIS: Then on the inner wall -- the
2 inner wall seems to be hot here, but it's cold to
3 start with, isn't it?

4 MR. CHEUNG: The inner wall is hot on the
5 drywell side. It is slightly colder on the wetwell
6 side.

7 MR. WALLIS: It's almost two major sinks.
8 So it takes some days to come to equilibrium?

9 MR. CHEUNG: It takes days to come to
10 equilibrium.

11 MR. WALLIS: So it's cold. It's really a
12 cold wall.

13 MR. CHEUNG: Yes.

14 MR. WALLIS: So all these walls have a big
15 effect on the temperature, don't they?

16 MR. CHEUNG: We did parametric case
17 increasing the wall surface area 10 percent plus/minus
18 here.

19 MR. WALLIS: It makes a bi g-- Well, maybe
20 it doesn't. Okay, go ahead.

21 MEMBER BANERJEE: So the controlling heat
22 transfer resistance in your case is on the solid side.

23 MR. TILLS: Right.

24 MEMBER BANERJEE: Or is it on the gas
25 side?

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1 MR. TILLS: It's on the gas. Sorry, it's
2 on the solid side on the inside of the wall. Then at
3 later period of time, the boundary condition -- When
4 you say controlling, I wouldn't say that -- It's
5 significantly affecting.

6 What I did for sensitivities on it is I
7 looked at -- said, you know, if this wetwell is such
8 a significant part, you know, apart from doing fans,
9 what would be the natural thing that a designer would
10 look at? He would look at, you know, taking heat off
11 of that wall.

12 So I flooded it. I also increased the
13 heat transfer coefficient to kind of mirror a thin
14 wall, by taking the concrete out and looking at that.

15 MR. BANERJEE: I'm just trying to figure
16 out how you did the calculation, not what parameters
17 you varied right now.

18 MR. TILLS: Okay.

19 MEMBER BANERJEE: So you have gas on one
20 side, and you have a solid. Now the solid you are
21 resolving. You are not treating it as a lumped
22 parameter. So -- a conduction equation.

23 MR. TILLS: Finite difference transient.

24 MEMBER BANERJEE: With a realistic
25 geometry.

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1 MR. TILLS: Yes.

2 MEMBER BANERJEE: Okay. And you've got a
3 sufficient resolution to get the temperature gradient
4 properly on the solid side.

5 MR. TILLS: Yes.

6 MEMBER BANERJEE: What are you doing on
7 the gas side?

8 MR. TILLS: On the gas side is a natural
9 turbulent convective --

10 MEMBER BANERJEE: This is a closed system.
11 Right?

12 MR. TILLS: Well, the gas side. I'm
13 assuming you are talking about the outside, the
14 environment.

15 MEMBER BANERJEE: No, no. I'm talking
16 about -- Sorry, I'm talking within the wetwell.

17 MR. TILLS: Within it, we use the standard
18 containment type analysis of the heat mass transfer
19 analogy.

20 MEMBER BANERJEE: But this is a volume of
21 gas. Right?

22 MR. TILLS: Yes.

23 MEMBER BANERJEE: The ceiling there?

24 MR. TILLS: Yes.

25 MEMBER BANERJEE: And the liquid.

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1 MR. TILLS: Right.

2 MEMBER BANERJEE: So how are you treating
3 this gas? What is the standard way to treat that?
4 You treat it as stagnant gas? Do you treat it as a
5 conductive layer? Do you calculate the natural
6 convection?

7 MR. TILLS: The natural convection driven.

8 MEMBER BANERJEE: How do you calculate the
9 natural convection?

10 MR. TILLS: Using a natural convection
11 correlation.

12 MEMBER BANERJEE: What correlation?

13 MR. TILLS: Well, in this case what we
14 used is a --

15 MEMBER BANERJEE: I don't understand,
16 because this is a finite length, and you are going to
17 get a boundary.

18 CHAIRMAN CORRADINI: But in a transition
19 of Gratschalk numbers from about 10 to the 5th to 10
20 to the 12th, you can have essentially the old McAdams
21 correlation, which is essentially independent of
22 physical length, and length divides out, both sides.

23 MR. WALLIS: Does this work for
24 condensation on the ceiling?

25 MEMBER BANERJEE: But is this -- There is

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1 no condensation on this wall. Right?

2 MR. TILLS: Yes, there is condensation.

3 MR. WALLIS: There is?

4 MEMBER BANERJEE: On the side walls?

5 MR. TILLS: Yes.

6 CHAIRMAN CORRADINI: So I am going to take
7 a time check. You are very kind to have a
8 conversation with these gentlemen, but we are
9 proceeding through this presentation, are we not?

10 MR. TILLS: That's right.

11 CHAIRMAN CORRADINI: Okay. So I'm going
12 to ask this, because I had summoned some of the
13 members to what was going to be a lunch meeting. So
14 is it better that you are able to finish in 20 minutes
15 or should we take a break at 12:15 and come back and
16 have you resume?

17 MR. TILLS: Well, it just depends on the
18 questions. I can go through it in 20 minutes.

19 CHAIRMAN CORRADINI: Well, but the
20 questions can go infinite, can go on for infinity.

21 MR. TILLS: Right. If you are asking me
22 can I go through this in 20 minutes, yes, I can.

23 CHAIRMAN CORRADINI: Okay. So I'm going
24 to look at the committee, because I'm going to lose
25 three or four of you. Would you prefer to take a

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1 break at 12:15 and come back and hear this? Okay. So
2 can we get to some logical break point in the next few
3 minutes, Jack, and then we'll bring you back?

4 MR. TILLS: Sure.

5 MEMBER BANERJEE: Not getting off the
6 hook.

7 MR. TILLS: Let me just kind of summarize
8 kind of the points on --

9 MR. WALLIS: Well, could you --

10 CHAIRMAN CORRADINI: At least get
11 somewhere before -- All right? Go ahead, Jack.

12 MR. TILLS: Well, the RPV model was an
13 important part in order to do the coupling and, you
14 know, do a complete scenario. We did feedwater
15 breaks. We did main steam line breaks.

16 So on the left side of that model is the
17 RPV. This RPV looks similar to what you would
18 typically see with MELCOR except it does not have any
19 of the core functions that would be used for severe
20 accidents. In other words, the rods are put in as
21 heat surfaces, and thing is driven -- This is pot
22 driven, but it was important to know how much
23 quenching, what the time of the quenching would go,
24 and also get an approximate idea of what the level
25 would be, because that shuts off the time at which the

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1 GDCS quits draining.

2 So that's on the left side. The wetwell
3 side: The nodalization there was formulated based on
4 looking at what also was a similar feeling from us of
5 what things would increase the wetwell pressure, and
6 one of them was to stagnate the lower portion of the
7 pool, the suppression pool, after the blowdown, after
8 the turbulent region, so that you had a heated layer
9 above that.

10 So we used a very similar thing as what
11 TRAC had done there. So our nodalization was similar
12 in that case. We had the same walls. I mentioned
13 about the --

14 MEMBER BANERJEE: Are those dotted lines
15 your nodalization?

16 MR. TILLS: The dotted lines are the
17 nodalization.

18 MR. WALLIS: Did you have condensation on
19 the pool?

20 MR. TILLS: Yes.

21 MR. WALLIS: You do?

22 MR. TILLS: Yes, we do.

23 MR. WALLIS: So how do you calculate the
24 force convection over the pool?

25 MR. TILLS: It's not force convection.

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1 MR. WALLIS: Well, it must be.

2 MR. TILLS: Well, it's not in this model.

3 MR. WALLIS: You can't get the film
4 thickness for condensation unless you have some sort
5 of force convection model. Otherwise, it just builds
6 up forever.

7 MR. TILLS: Well, no, it doesn't build up
8 forever if you use a correlation. The correlations
9 will not let the film go up --

10 MR. WALLIS: It does, because the non-
11 condensables are dragged down to the surface, unless
12 there is something to take them away.

13 MR. TILLS: What happens is the lower
14 cells do get high concentrations of non-condensables.
15 That's clear, and that tends to shut it off.

16 You know, I'm not going to defend
17 horizontal heat transfer off of a pool at this point.

18 I'm just not going to go there, and I think that is
19 the standpoint of what GE is doing with even the
20 ceiling.

21 The reason that they have gone with that
22 thing is that, you know, TRAC cannot defend the
23 horizontal.

24 MR. WALLIS: Well, you've got some arrows
25 there showing circulation in there.

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1 MR. TILLS: Well, it's not --

2 MR. WALLIS: Which is really happening,
3 and how big is -- How intense is that circulation?

4 MR. TILLS: I don't know.

5 MR. WALLIS: It makes a big difference.

6 MR. TILLS: Again, the issue is if you
7 wanted to do best estimate, you could argue me down on
8 that. If you want to go to bounding, I think we have
9 a rational reason for why this is --

10 MR. WALLIS: It's not best estimate, but
11 you made some assumption about the circulation. You
12 didn't assume it's stagnant.

13 MR. TILLS: No, it is stagnant. I mean
14 stagnant from the extent that there is no implied or
15 force transfer coefficient.

16 MR. WALLIS: Well, if it's completely
17 stagnant, then you cannot have anything that is
18 scrubbing the film off the wall. The film would just
19 build up forever. You've got to have convection on
20 the wall to get a film.

21 MR. TILLS: Right.

22 MR. WALLIS: Got to get a coefficient.

23 MR. TILLS: And that's what you call in
24 when you use the analogy concept.

25 MR. WALLIS: But you can't do that. I

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1 mean, what happens in a room with heated walls and
2 cooled walls? Everything is interconnected. The
3 currents go around the room. They determine the
4 boundary layer, thickness on the wall, and everything
5 is interrelated.

6 Once you start making assumptions, you are
7 changing all the reality in some way, which I don't
8 understand.

9 MR. TILLS: Well, you know, I think I
10 would support what you are saying, except that that --
11 you know, we've done a number of -- a number of
12 containment experiments where we have the same type of
13 geometry as this, and very much the same type of deal.

14 And we get very good results with what we do, and to
15 calculate pressures and temperatures.

16 MR. WALLIS: And you have --

17 MR. TILLS: Locally -- Locally, I would
18 agree with you that there is local variations that we
19 cannot account for, but when you are looking at
20 something like global pressure, we do a very good job
21 with an analogy type concept.

22 You know, what you want is something that
23 is not really achievable today.

24 MR. WALLIS: No, I think, well, I'm in
25 this room, and that wall is cold and that wall is

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1 warm, and then there's steam oozing in through the
2 ceiling.

3 MR. TILLS: That's right.

4 MR. WALLIS: Doesn't the steam just spread
5 along the ceiling?

6 MR. TILLS: That's right.

7 MR. WALLIS: Does it get swept down the
8 wall by the convection, or not?

9 MR. TILLS: Some of it does.

10 MR. WALLIS: How much?

11 MR. TILLS: Well, I mean, I think that
12 would be an issue that you could raise, you know, and
13 probably not decide within the next few years, really.

14 It's probably a pretty good time to stop.

15 CHAIRMAN CORRADINI: So now we know at
16 least the base models, and then we are going to come
17 back and see the analysis.

18 Can we come back at 1:15? Is that
19 acceptable? I think, if you are going to get through
20 this meeting, you have to. Okay, 1:15. Thank you.

21 (Whereupon, the foregoing matter went off
22 the record at 12:13 p.m.)

23 CHAIRMAN CORRADINI: Okay, let's get
24 started. We'll come back into session. Jack, we'll
25 let you start with your next slide of your

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1 presentation.

2 MR. TILLS: Yes. I thought to save time
3 here, I'd go onto what the reference calculation looks
4 like in Melcor space, and because you've asked this
5 question before, of having a few of the events listed
6 on the figure so you can kind of follow along and see
7 what's happening in the containment.

8 This Slide 8 is an expanded procedure, log
9 scale. It kind of gives you a pretty good highlight
10 of both short term and then the long term. Because
11 this plant has a fairly small wetwell space, probably
12 about five times smaller than the Mark III, and that
13 the vents are significantly smaller, the main vents,
14 the issue of short term is not something to just, you
15 know, basically pass over. You do have to take a look
16 at it.

17 And so this basically takes you through
18 the vent openings, when the reactor isolates and the
19 peak pressure that occurs in the short term at about
20 75 seconds. Normally, in a Mark III or so, these
21 pressures are lower, and they occur very rapidly in
22 the first few seconds.

23 You can see that after that first peak
24 occurs, which is basically adiabatic compression in
25 the wetwell, the source is dropping off a bit, and

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1 there's a decline in the pressure. Until the ADS
2 activates, the DPV valves open and you get an
3 additional source, hence to level that out. Soon
4 after that --

5 MR. WALLIS: Well, that seems to be
6 important to me, because in the blowdown, everything
7 gets stirred up. You have a well-mixed drywell.

8 MR. TILLS: Yes.

9 MR. WALLIS: And so the non-condensables
10 are swept into the wetwell pretty effectively. But
11 then when the vacuum breakers open --

12 MR. TILLS: This is DPV.

13 MR. WALLIS: They stumble and come back
14 out again, don't they?

15 MR. TILLS: That's correct, that's
16 correct.

17 MR. WALLIS: And the vacuum breakers also
18 open in that space, don't they?

19 MR. TILLS: Well, they open just a little
20 bit later than that. After the GDCS begins to drain
21 down, and it takes some time to quench the RPV
22 steaming. What causes the vacuum breakers to open is
23 the termination of basically the source coming in, and
24 the PCCS is still activated and operating.

25 MR. WALLIS: Assuming that the vacuum

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1 breaker's open and that pressure drop is associated
2 with passive gas from the spectrum.

3 MR. TILLS: That's correct.

4 MR. WALLIS: It seems to me that by then,
5 the mixing up in the drywell has slowed down a little.
6 You don't have steam. You don't have blowdown
7 anymore, do you?

8 MR. TILLS: It's not blowdown at all.

9 MR. WALLIS: So this stuff coming out of
10 the wetwell won't have much incentive to mix with
11 what's above it?

12 MR. TILLS: No, and in this case, the main
13 steam line, the level in the GDCS does not draw up as
14 fast as it does say in the Piedwater break case. But
15 there is a dropping.

16 There's almost a sucking that's occurring
17 at the same time that the vacuum breakers are opening,
18 because there's this drawing down of the GDCS tank
19 level, and gases that are coming in, they're coming in
20 at the diaphragm floor level, which is above the
21 annulus and the lower drywell.

22 So the real active area is going to be
23 pretty much in that region of the upper drywell.

24 MR. WALLIS: And then the gases that are
25 coming out of the vent of the vacuum breakers are

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1 cold. They're colder than what's in this, and they
2 are rich in non-condensables, which are heavier than
3 steam.

4 So my -- a realistic outflow is not
5 expected to flow along the floor, go down into the
6 lower drywell. Flow along and fall down into the
7 lower drum.

8 CHAIRMAN CORRADINI: Just for order, I
9 know you guys are talking. Is it a seepage or is it a
10 blast of air, of gases?

11 MR. TILLS: What we're saying in terms of
12 the calculation, which pretty much mirrors what
13 they're getting with TRAC calculation, is about a
14 quarter, almost a quarter of the inventory of the
15 initial drywell comes back in.

16 MR. WALLIS: It doesn't come along with
17 much velocity does it? It squirts out sideways
18 through these valves?

19 MR. TILLS: Because these are big valves.

20 MR. WALLIS: But it squirts out sideways,
21 doesn't it? It doesn't squirt sideways along the rim
22 of this vacuum break. So it's squirting out
23 horizontal.

24 CHAIRMAN CORRADINI: But can I just --
25 just to make sure. They squirt out horizontally, but

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1 there's a valve that they have --

2 MR. TILLS: Okay. It's actually upstream.

3 CHAIRMAN CORRADINI: Upstream?

4 MR. WALLIS: Oh, it's upstream?

5 CHAIRMAN CORRADINI: Oh, it's upstream.

6 MR. WALLIS: So they fall on the floor,
7 and then they fall down into the lower drywell
8 presumably.

9 CHAIRMAN CORRADINI: Right.

10 MR. WALLIS: But do you assume they mix
11 with everything upstairs, up above them?

12 MR. TILLS: Well again, the same thing
13 occurs here, is that even though we mix, that's a
14 conservative case, because as soon this begins
15 steaming again, they go out more rapidly than if we
16 would have trapped them. So basically where we used
17 our hand calculation.

18 MR. WALLIS: Well then if long conundrils
19 (ph) did pull down into the lower drywell, which is
20 not very well connected to the upper drywell,
21 presumably they would stay there a long time.

22 MEMBER SIEBER: Which would reduce the
23 overall pressure.

24 MR. WALLIS: Well, it might do that, but
25 that's the realistic expectation --

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1 (Simultaneous discussion.)

2 MR. TILLS: Well, the realistic, and you
3 can see the pressure down here and then it rebounds.
4 The rebounding is due not to, you know, the K heat not
5 being taken out. The rebound is back --

6 MR. WALLIS: This advises me. In the
7 traditional calculations, we're moving away from
8 Appendix K and all those assumptions to realistic
9 calculations, trying to get an idea of what really
10 happens with some uncertainties.

11 You seem to have gone back to sort of a
12 pseudo-idealistic model of what happens, which is not
13 realistic at all in some aspects. That is considered
14 okay. I would think in the modern world, you'd make
15 an effort to do the realistic calculation.

16 CHAIRMAN CORRADINI: What do they have
17 from a licensing basis or a design basis to do a
18 better calculation? I don't think they have anything.

19 MR. TILLS: This is, I mean, they're
20 absolutely, positively sure that this is up, this is
21 giving the upper bound on the pressure. But to do
22 anything better, you'd have to have a fairly
23 sophisticated --

24 CHAIRMAN CORRADINI: I think Jack answered
25 it somewhat differently before, but he admits that he

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1 can do it better, but I'm not sure he can focus it
2 better --

3 (Simultaneous discussion.)

4 MR. WALLIS: Well, this is the issue. I
5 mean this is okay for regulatory purposes maybe, but
6 if I have a class and I present to them some curves
7 for their consideration, and say "This is what happens
8 in an accident."

9 In fact, your curves are not what happens
10 in an accident. They calculated it using what seem to
11 be more realistic assumptions. They come up with
12 something different.

13 It seems to me somehow you are
14 shortchanging the virtues of this design, by compiling
15 all these conservatisms on top of each other, and then
16 presenting curves as if this represents the way it
17 behaves.

18 MR. TILLS: Now let me address that. You
19 know, I think that's one of the reasons why we pursue
20 the scaling experiments, you know.

21 In this case, I have to admit that in some
22 sense, the experiments are at the edge of not
23 answering all the questions, because in the case of
24 the Panda, you know, there's no concrete walls. The
25 scale is off.

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1 But even in that case we saw in the Panda,
2 when they started at one hour and they put gas in
3 there, and ejected at the K heat rate, the drywells
4 were purged. You know, I think, you know, from my
5 experience, that people tend to underestimate the
6 degree at which when steam comes in, either at a K
7 heat rate or certainly at a blowdown, how much mixing
8 occurs.

9 There's tremendous amount of momentum-
10 driven mixing that occurs in the --

11 MR. WALLIS: During that stage?

12 MR. TILLS: During that stage where you
13 have a source on. If you turn to source off, you tend
14 to get these trapping areas and stuff. But if you've
15 got a significant source, and even at the K heat
16 level, that's a significant amount of steam coming in.

17 The tendency of things to be quiescent and
18 lay in the low areas is very low. That's what we saw
19 with Panda. Could the experiments be better? Could
20 we have -- would have liked to seem them go out longer
21 periods of time, more prototypical in terms of heat
22 structures? Certainly.

23 But you know, that's what we have in terms
24 of --

25 MR. WALLIS: I think that's very good. I

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1 think I agree with you. It's in the later stages,
2 when there isn't much that's stirring up anything, and
3 you've got all sorts of stratifications of things
4 everywhere, wetwell, drywell and so on where it might
5 be worthwhile.

6 Maybe some day it will start producing
7 more realistic analyses, and it may well show that the
8 pressures don't go up anything like as much as
9 predicted now.

10 MR. TILLS: Right. You know, the
11 difficult part of this, of course, is that last part,
12 and it's showing up more on a log scale there, and
13 that's this beginning, you know, somewhere around ten
14 hours or so, and then you start getting this heating
15 of this wetwell space that's driving the drywell
16 pressure up.

17 You can see that's the difficulty at the
18 end there, you know, that you're faced for design
19 purposes.

20 CHAIRMAN CORRADINI: But Jack, just to
21 unwrap that last part which is rising here, because of
22 just the way the scale is showing it. If there was
23 not radiolytic decomposition, as you had said it
24 before, and let's leave out the leak scenario, if it's
25 not radiolytic decomposition, I'd expect the red curve

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1 to flatten out. It doesn't go down.

2 MR. TILLS: It doesn't completely flatten
3 out, but the slope really goes down a lot. And when
4 we were first doing these calculations back a year and
5 a half ago, we were focusing on the feed water line
6 break case, and there was another reference.

7 We did an ESBWR containment performance
8 study, and when we were looking at that, at that time
9 we didn't know about radiolytic gases. We didn't have
10 them in.

11 We compared again with GE with their TRAC
12 calculations, but the curves were significantly
13 flatter than they are here. That was because we
14 didn't have the continuous bounding up of PCCS and
15 this large pressure differential remaining.

16 So things changed about a year and a half
17 ago, in terms of the slope of the lag time
18 performance.

19 CHAIRMAN CORRADINI: So just to say it
20 back, just to make sure I understand, when you say
21 "bounding up," is you're producing -- you're
22 generating additional non-gases or gases which are
23 coming out slow enough that you essentially degrade
24 the performance of the PCCS.

25 So you go through this kind of behavior,

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1 where you've got to generate enough of a delta between
2 drywell and wetwell, force it through and --

3 MR. TILLS: That's right, and bounding is
4 a different phenomenon than degrading by flow passing
5 through, and just degrading the heat transfer along
6 the tube wall.

7 The bounding is actually a stagnant layer
8 of gas filling up the bottom, and basically cutting
9 off. Instead of you having two meters of tube length,
10 you've got one meter.

11 CHAIRMAN CORRADINI: Right.

12 MR. TILLS: That you're working with.

13 CHAIRMAN CORRADINI: Okay.

14 MR. TILLS: So that's the reference
15 calculation. The next slide, Slide 9, it just goes
16 down and gives you a comparison based on events that
17 are occurring, and you know, the first clear one is
18 the vent clearing times, and you can see we're
19 matching pretty well what the TRAC calculation is
20 occurring.

21 The reactor isolation is an input time.
22 It's not calculated. It's input. The biggest
23 disparity, of course, and I mentioned it before, was
24 with the short term or the blowdown peak between the
25 two codes, and I mentioned what was the difference, in

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1 terms of trapping.

2 The other events are all pretty much
3 straightforward, except you get down to the time at
4 which the PCCS pooled has dropped to about a third of
5 the -- a quarter to a third of the top of the tubes
6 have uncovered.

7 At that point, a signal is given, and
8 there's a storage tank which floods again the PCCS
9 tanks and recovers some of that unflooded area of
10 tubes. There's a time shift that's occurring here.
11 It's only really due to the volume of water that we
12 had versus what was in TRAC.

13 I don't know if the issue was that we took
14 credit for equipment that was in there, and didn't
15 have quite the same volumes. In any case, it doesn't
16 make any difference, because even at this time,
17 there's much excess capacity in the condensers. So we
18 don't show any variation as a result of this flooding.

19 If you look at all the curves, you won't
20 see any blip or anything that is a result of
21 additional water coming in. That's because the PCCS
22 is already over capacity, and it's not making a big
23 difference. But that's something that we may need to
24 resolve with GE.

25 The final deal is the pressure. We're

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1 within about five percent of what they were at 72
2 hours. We're a little bit lower, and our belief is
3 probably that it has to do with heat transfer and the
4 wall.

5 MR. WALLIS: I have an observation here,
6 Jack. Yes, they look similar, but if you take the
7 slope of your pressure versus time over the last day
8 and a half or so, it's twice the slope predicted by
9 Track G over the same period.

10 So you're raising the pressure at twice
11 the rate, which means that something is very different
12 about the two calculations, it seems to me. If you
13 actually draw the line, it comes out --

14 MR. TILLS: At the 72 hours, when we look
15 at also the calculation where the double the leakage
16 rate, to compare to what they are right now, we come
17 up with 400 kilopascals --

18 MR. WALLIS: I'm not looking at the
19 absolute value. I'm saying that the heating is what's
20 causing the rate of rise.

21 MR. TILLS: That's right, and it's a --

22 (Simultaneous discussion.)

23 MR. WALLIS: And your rate of rise is
24 roughly twice what TRAC is predicting. So something
25 is different about the models.

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1 MR. TILLS: Well, and it would be nice --
2 I mean when you look at a DCD and you're doing audit
3 calculations, it would be nice, of course, to have
4 what the heat transfer rate is that they're predicting
5 on that wall, outer wall.

6 But that's not generally given. What
7 you're looking at is, you know, primary values like
8 pressure and temperature, and you're not given the
9 details. So certainly that would be something to look
10 at.

11 MR. WALLIS: We'll see if I compare the
12 curves. Your rate is lower at the beginning and it's
13 twice as much as the end. So something is different
14 about the modeling there.

15 MR. TILLS: Yes, yes. I mentioned to you
16 the pedigree of an empirical correlation, you know,
17 versus what we're using, being a best estimate. I
18 believe it's probably tied up in --

19 MR. WALLIS: Earlier you said that if you
20 ignore the heat transfer to the cold wall --

21 MR. TILLS: That's right.

22 MR. WALLIS: Which may or may not include
23 the ceiling -- I'm not quite clear about that -- that
24 the pressure goes up above 400 kilopascals.

25 MR. TILLS: Yes, about 430.

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1 MR. WALLIS: 430 you said or something?

2 MR. TILLS: Yes.

3 MR. WALLIS: So that is an important
4 thing?

5 MR. TILLS: Yes.

6 MR. WALLIS: Okay, thank you.

7 MR. TILLS: And then the last two points
8 on that figure, this is a 10, a slide. It's just
9 indicating what those dominating areas are.

10 You know, look at the, you know, the loss
11 factor, coefficients on the leakage term, and then
12 also realize that radiologic gases are a prime
13 contributor to this pressure rise.

14 I'll just go on to summary, which is the
15 last point. The model that we chose to look at was
16 quite different, in terms of where it came from than
17 the TRAC calculation. Also in terms of the pedigree,
18 what we consider the pedigree for doing containment
19 type studies.

20 Quite different from the TRAC, which is
21 basically a new addition to the containment analysis
22 area. We developed it independently as much as
23 possible, not taking TRAC input but rather deriving it
24 from what their design values were.

25 And you know, in general I would say that

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1 we've confirmed some of the major players in the, you
2 know, the whole analysis. The peak pressure, we're
3 pretty well in within reasonable tolerance with
4 theirs. There's nothing that jumps out at us there.

5 I mentioned a little bit about the short
6 term, that clearly if we were in a short term analysis
7 area, we would have some problems in terms of just
8 doing the DBA calculation. Even though having said
9 that, there's still below the margin that they needed
10 a standard design --

11 MR. WALLIS: Now your third bullet here I
12 don't think is quite right, because the way I
13 calculate it is that the pressure dropped from the
14 drywell to the wetwells, made up of two parts.

15 There's the pressure drop into and through
16 and out of the PCCS, and then there's the hydrostatic
17 submergence. The submergence is the bigger part of
18 the total pressure drop.

19 MR. TILLS: That's correct.

20 MR. WALLIS: So it's not true that it
21 results from bounding of the pieces. It results more
22 from the submergence, and then you add a little bit
23 more because of the bounding.

24 I think you have .9 kilopascals or
25 something from the submergence, and you have .3 or

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1 something from the bounding part. So the bounding
2 isn't really the part that's the reactor.

3 MR. TILLS: Well you know, it is the
4 bounding. If you did not -- if those PCCSs were not
5 bound, you would get very good communication with the
6 wetwell.

7 MR. WALLIS: You've still got to overcome
8 the submergence, though.

9 MR. TILLS: The only reason why you have
10 to overcome the submergence is because the PCCSs are
11 just barely leaking through, and letting gas through
12 there. If those gases were not there, you'd have
13 plenty of capacity to take down the pressure, and
14 basically the pressure would come down until you've
15 either got --

16 MR. WALLIS: But if there were just a tiny
17 trickle of gas, you'd still have to overcome the
18 submergence.

19 MR. TILLS: Yes, that's right, that's
20 right. But this has that in there, and you can see
21 that in the previous slide that had the delta P across
22 there. That delta P, as you correctly mentioned, is
23 made up of two components, the dynamic losses through
24 the inlet, and also the yield.

25 Now this alone would say okay, do you have

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1 an experiment that shows that you can predict all of
2 this yield, and we do. Panda, you know, clearly has
3 hit this pretty well, I think, you know, of being able
4 to predict what that pressure differential is, in a
5 bounding, what I would consider a bounding or
6 accumulated gas situation.

7 MR. WALLIS: Now wouldn't it be possible,
8 rather than letting the vacuum breakers open, to
9 simply vent the wetwell, because there's no
10 significant radioactivity release in the first hour or
11 so when the pressure goes up in there.

12 It would simply get rid of some of these
13 gases and vent them out. Wouldn't that be possible?
14 Vent them to the world.

15 MR. TILLS: You're out of DBA space at
16 that point --

17 CHAIRMAN CORRADINI: I think you have less
18 time --

19 (Simultaneous discussion.)

20 CHAIRMAN CORRADINI: --based on DBA
21 calculations or DBA assumptions, the amount of
22 radioactivity would not allow that. You would not
23 essentially meet your dose, based on DBA assumptions.
24 I think that's what we heard last time. We asked
25 that, I seem to remember.

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1 MEMBER MAYNARD: I'm not sure you'd be
2 able to legally do that and count it as containment.
3 It depends a little bit on how you -- I think you'd
4 run across --

5 CHAIRMAN CORRADINI: But ABWR does have
6 that capability for late time. They do fill to vent.
7 But I think it's for a different accident sequence
8 for different situations. But I seem to remember we
9 asked staff that last time, and that's the answer we
10 got back, was the amount of -- based on the
11 assumptions, the amount of radioactivity in the
12 atmosphere, it should be leaking out.

13 MR. WALLIS: These are realistic
14 assumptions?

15 CHAIRMAN CORRADINI: No. They are design,
16 DBA assumptions. But I think that --

17 MR. TILLS: Well, I'm pretty much done. I
18 would have to say, though, that we're -- this design
19 that you're seeing is somewhat dynamic. It's still
20 changing somewhat, and you know, we will be redoing,
21 revisiting the audit calculations based on significant
22 changes.

23 So I'd just like to mention that if you
24 have some suggestions or things that you would like to
25 see us perform, you know, give me an e-mail and we can

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1 talk about it, and we'd be glad to run anything.

2 These calculations run fairly quickly. It
3 takes about a half a day to run out a three-day
4 scenario. So there's no problem with that.

5 MR. WALLIS: Well, your report was very
6 useful, because you did discuss the mechanisms and you
7 discussed why things happen the way they do, in a way
8 which was very helpful, that I had difficulty
9 extracting from the other communications that I got
10 from the various parties. So that was helpful. Thank
11 you.

12 CHAIRMAN CORRADINI: Jimmy, you want to
13 now go on to the post 727 --

14 MS. CUBBAGE: Go ahead, Hossein.

15 MR. ESMAILI: Hossein Esmaili, Research.
16 I'm just going to show the results of what happens
17 past three days. I'm picking up where Jack left off,
18 and just focusing on the three to seven days.

19 CHAIRMAN CORRADINI: Do we have this
20 Hossein? Do we have this in front of us? We should.

21 (Simultaneous discussion.)

22 CHAIRMAN CORRADINI: We'll catch up.

23 MR. ESMAILI: Okay. All right. So what
24 are the modeling assumptions at three days? First, we
25 are refilling the PCCS pool at 200 GPM, at a

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1 temperature of 100 degrees Fahrenheit.

2 Just to give you an idea, at about three
3 days for a 4,500 megawatt reactor, you need about 110
4 just to remove the K. It goes on to about 90 GPM at
5 about seven days.

6 So part of the pool refilling is going
7 into removing the --

8 MR. WALLIS: Can I ask you something here?

9 MR. ESMAILI: Yes.

10 MR. WALLIS: The gas flow you have through
11 these vent valves, it's 727 CFM through each of six
12 vent valves?

13 MR. ESMAILI: Through each of the six vent
14 valves, each.

15 MR. WALLIS: Is 73 cubic feet is sunken,
16 which is about half of the steam flow you need to
17 extract 20 megawatts. So it indicates to me is that
18 what's going into these PCCSs is one-third non-
19 condensables. But there isn't that much non-
20 condensables around to possibly make that amount. How
21 come there's such tremendous flow through these
22 valves?

23 MR. ESMAILI: This is the rate of
24 condition for the fans --

25 MR. WALLIS: It makes no sense. You can't

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1 pump something which isn't there.

2 MR. ESMAILI: I can show you the flow
3 rates for the PCCS. It's in one of the slides.

4 MR. WALLIS: Well, according to this, to
5 remove 20 megawatts, you need 160 cubic feet per
6 second of steam is what I calculate, and you're taking
7 out 73 cubic feet per second of non-condensables with
8 it? It doesn't make any sense.

9 MR. ESMAILI: Right. Something goes
10 through with it also. So you have steam and non-
11 condensables going through the PCCS.

12 MR. WALLIS: So most of what is going
13 through the fan is steam?

14 MR. ESMAILI: Yes.

15 MR. WALLIS: Okay. So then you're
16 bubbling steam into the GDCS pool?

17 MR. ESMAILI: No. We are taking steam and
18 non-condensables from the drywell, oh sorry, from the
19 bottom of the PCCS, the lower half, and pumping it
20 back into the drywell.

21 MR. WALLIS: Well, the picture shows it
22 being pumped back into the GDCS pool.

23 MR. ESMAILI: In the analysis, you know,
24 based on our discussions with GE, I think --

25 (Simultaneous discussion.)

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1 MR. WALLIS: So the -- in the GE
2 presentation is wrong?

3 MR. CHEUNG: Figure 3 is wrong.

4 MR. ESMAILI: This is an assumption that
5 we made, based on our discussion with GE, that they
6 are pumping into the drywell. It doesn't -- to tell
7 you honestly, it doesn't matter that much.

8 MR. WALLIS: Well, if you're blowing a lot
9 of steam in the GDCS pool, you change its temperature
10 and you have pumping and all kinds of stuff going on
11 in there.

12 MR. ESMAILI: You're not pumping into the
13 pool; you're pumping into the atmosphere.

14 MR. WALLIS: The figure shows you pumping
15 into the pool.

16 (Simultaneous discussion.)

17 MR. WALLIS: You have a cartoon which is
18 incorrect?

19 MR. CHEUNG: This is what is shown. This
20 one probably we did not get a chance to discuss it.
21 Once the vent is activated, the PCCS to bottom of it,
22 and the drywell pressure goes down real quick. Then
23 the wetwell, the vacuum breaker opens.

24 MR. WALLIS: Where does the fan exhaust?
25 Where does the vent fan exhaust?

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1 MR. CHEUNG: The vent exhausts in the GDCS
2 pool, where it's about ten inch of a submergence.
3 It's ten inch.

4 MR. WALLIS: Under water? Under water?

5 MR. CHEUNG: Under water.

6 MR. WALLIS: Okay. So he says it goes
7 into the gas?

8 MR. CHEUNG: No. In the calculation that
9 we have, the first calculation of this morning that we
10 have also go into the drywell, and --

11 MR. WALLIS: But it doesn't actually -- is
12 it designed to go in -- you say it's designed to go
13 into --

14 MR. CHEUNG: The mixed stuff is designed
15 into the GDCS pool with submergence, to make sure that
16 is sealed off, there's no backflow.

17 MR. WALLIS: And it has a loop seal or
18 something?

19 MR. CHEUNG: Yes.

20 MR. WALLIS: So these -- as I said this
21 morning, these design details are important.

22 MR. CHEUNG: Absolutely, yes.

23 MR. WALLIS: There's a difference to what
24 happens.

25 MR. CHEUNG: Yes. But the point I'm

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1 trying to make is once it activates, the drywell will
2 be the full to about .2 or the mass fraction is about
3 .2 or 20 percent air and non-condensable gas, and then
4 it goes with the steam that's coming out of the DPV
5 and then go back to the --

6 MR. WALLIS: How big is the pipe that goes
7 into the GDCS pool?

8 MR. CHEUNG: I do not have the number.
9 It's probably 16 --

10 MR. WALLIS: It's got to be pretty thick,
11 because you're pumping a lot of steam and gas through
12 those lines.

13 MR. CHEUNG: Yes. We have six of them.

14 MR. WALLIS: It just seems overkill to
15 pump so much stuff, if it's all steam. All you need
16 to do is make steam go into the PCCS. Not much has to
17 come out in order to make that happen. Why do you
18 have such a big fan?

19 MR. CHEUNG: It pump out the non-
20 condensable gas.

21 MR. WALLIS: But there isn't any.

22 MR. CHEUNG: No. But once it opens, it's
23 kind of gas going back to the drywell, and the drywell
24 -- once it goes to the drywell and goes back into the
25 PCCS --

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1 MR. WALLIS: It recirculates around.

2 MR. CHEUNG: Recirculates. That's why we
3 call the drywell --

4 MR. WALLIS: So it came out of the vacuum
5 breakers?

6 MR. CHEUNG: Yes.

7 MR. WALLIS: Okay. So you assume that
8 what comes out of the vacuum breakers then mixes up
9 with everything?

10 MR. CHEUNG: Will mix up with the big
11 drywell volume. And once it's activated, look at it.
12 The drywell, the wetwell pressure is going to be a
13 very small difference. Sometimes the drywell pressure
14 most of the time is lower than the wetwell pressure.

15 The pump keeps circulating, and now once
16 it's activated, the condensation power or the PCCS
17 depends on two things. The mass fraction, the non-
18 condensable mass fraction coming from PCCS, and then
19 the flow rate.

20 MR. WALLIS: And the vent fan is never
21 switched off, because if it's switched off, you're
22 going to suck water up from the drain into the vent
23 fan.

24 MR. CHEUNG: The one other case that we
25 have is two of the PCCS have no fan, and that two

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1 PCCS, just they don't turn it on.

2 MR. WALLIS: I said you musn't switch it
3 off, because if you switch off the fan, you're likely
4 to have water sucked up into the fan from the GDCS.

5 MR. CHEUNG: Why suck up?

6 MR. WALLIS: Because of the hydrostatic in
7 the other one.

8 MR. CHEUNG: No. The other one, the one
9 that have no fan belt, the vent turn off the water,
10 just seal off the tail end of it. The other four,
11 they still have the pump. They keep pumping,
12 circulating the non-condensable gas back into the GDCS
13 pool gas space.

14 MR. WALLIS: I'm just thinking of cold
15 water seeing steam and rushing up to meet it by
16 condensation.

17 MR. CHEUNG: Once it seal off, the bottom
18 half of the PCCS vent is always full of non-
19 condensable.

20 MR. WALLIS: Wow, okay.

21 MR. MARQUINO: We'd like to let the staff
22 continue. We do have a couple of slides on this that
23 we can talk to, if there's time available.

24 MR. WALLIS: We're just wondering whether
25 the staff accepts all of the arguments of GE, or

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1 whether they asked the kind of questions that we're
2 asking?

3 MS. CUBBAGE: We've just received this
4 information from GE just a few days ago. We did the
5 best we could to come here and present calculations,
6 to show what we think happens with this system. We've
7 not made any conclusions about this yet.

8 MR. WALLIS: So it's not surprising that
9 your assumptions might be different from GE's?

10 MS. CUBBAGE: Well, we tried to use the
11 same assumptions to the extent we understood them,
12 based on some communications in a meeting we had.

13 CHAIRMAN CORRADINI: Go ahead, Hossein.

14 MR. ESMAILI: Okay. So anyway, so we have
15 six vents, 727 discharging, reacting to the drywell
16 atmosphere. This is based on the discussion we had
17 with GE.

18 The PARs are activated, again at three
19 days. So we do not generate any new non-condensables.

20 Whatever we had generated during the past three days
21 still remains. That means that we are not explicitly
22 modeling the PARs.

23 Next slide. Okay. So you've seen the
24 results of the first three days. Immediately at three
25 days, once we start the fans, you see a dip in

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1 pressures. What happens is that they -- the fans
2 start to purge the bottom of the PCCS tubes, and
3 condenses steam.

4 So you get a very, very fast reduction in
5 the pressure.

6 MR. WALLIS: Does it condense something
7 like 64 megawatts though?

8 MR. ESMAILI: I can actually show you the
9 -- I will get to the PCCS heat removal in a few
10 slides, on Slide 6. I don't think it's 60 megawatts
11 but, you know, we matched -- initially, there is a
12 very, very high heat rush from inside the PCCS tubes.

13 MR. WALLIS: --so good, you might as well
14 run it from the beginning.

15 MR. ESMAILI: No, but after some time.
16 After some time the pressure is, you know,
17 equilibrating. So you're not going to get that much
18 flow through the PCCS.

19 MR. WALLIS: But you wait until you have
20 to run it before you start it? You could start it
21 earlier.

22 (Off the mike comment.)

23 MR. WALLIS: Oh, 72 hours.

24 MEMBER MAYNARD: There's a lot of things
25 they would probably be doing in the first 72 hours.

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1 But for credit --

2 MR. ESMAILI: Okay. Right show --

3 MR. WALLIS: You're not allowed to start
4 it until 72 hours? Is that it?

5 CHAIRMAN CORRADINI: They're not taking
6 credit for it.

7 MR. WALLIS: Credit for it.

8 CHAIRMAN CORRADINI: You've got to stay
9 with the rules of the game, Graham.

10 MEMBER ARMIJO: But I think it's their
11 intention not to run it for the first 72 hours.

12 MR. WALLIS: So the rules are very
13 interesting. I mean the picture throws a fast ball,
14 and the rules of the game says I've got to play a
15 curve ball. So I strike out.

16 MEMBER MAYNARD: Now what they're doing is
17 consistent with other licensing basis deals. It's
18 what you take credit for and what you have. You
19 always remember --

20 (Simultaneous discussion.)

21 MR. WALLIS: Always remember.

22 MEMBER BLEY: But Sam, what Sam suggested,
23 they wouldn't use it until the 72 hours. And from the
24 last meeting, I thought they hadn't decided about
25 that.

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1 MEMBER ARMIJO: Well maybe we should ask
2 GE. But is it the intent of GEH that the fans be used
3 before 72 hours?

4 MEMBER BLEY: If they're available.

5 MEMBER ARMIJO: If available.

6 MR. MARQUINO: The fans are going to be
7 used if available and the power's available before 72
8 hours. They'd have the beneficial effect on the
9 containment response.

10 MEMBER BLEY: Are the procedures likely to
11 tell people to do that?

12 MR. MARQUINO: Yes, although we haven't
13 worked through the emergency procedures yet.

14 MEMBER ARMIJO: But you've found no
15 downside of operating them right away?

16 MR. MARQUINO: There's no downside, that's
17 correct.

18 MEMBER ABDEL-KHALIK: Oh, wait a minute.

19 (Off the mike comments.)

20 MEMBER ABDEL-KHALIK: Is there a check
21 valve at the end of the discharge line of these fans?

22 MR. CHEUNG: The check valve is a ball
23 type, you know, floating ball.

24 MEMBER ABDEL-KHALIK: Whatever. Something
25 to prevent water from going back up from the GDCS tank

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1 to the --

2 MR. CHEUNG: Yes, yes.

3 MEMBER ABDEL-KHALIK: Okay. So there is a
4 check valve, right?

5 MR. CHEUNG: There's a check valve.

6 MEMBER ABDEL-KHALIK: At the discharge?

7 MR. CHEUNG: Yes.

8 MEMBER ABDEL-KHALIK: Okay, thank you.

9 MR. ESMAILI: I just want to clarify my
10 position. I'm just doing an audit calculation, using
11 the same assumptions that GE has done, and based on.

12 MR. WALLIS: Well, I think it would be
13 better if you presented this thing as a design, and
14 said we thought about water being sucked in, so we up
15 in a check valve.

16 If you said all that in your presentation,
17 we would understand it. We don't have to extract it
18 by waiting until the right question comes up.

19 CHAIRMAN CORRADINI: Well, that's partly
20 my fault, because we ran out of time.

21 MS. CUBBAGE: That's not for the staff to
22 explain. That would have been GE's, but they didn't
23 get an opportunity. Let's move, yes.

24 MR. ESMAILI: Okay, so in the insert, you
25 saw that we were talking about the bypass catching it

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1 for the first three days. We have steam going from
2 the drywell inside the wetwell. At three days, once
3 the fans start working, they're purging all the non-
4 condensables from the PCCS tube.

5 As a matter of fact, you will see we have
6 reverse leakage. That means that we have at times
7 leakage from the wetwell back into the drywell. These
8 are the leakages from the vacuum breakers.

9 As a matter of fact, the vacuum breakers,
10 I don't have the figures in front of me, but they only
11 open right at about 72 hours. They open for a very,
12 very short period of time, and maybe for the next four
13 days, maybe two times more.

14 MR. WALLIS: Well, let me ask you a
15 question. If you have the fans operating all the
16 time, would you need the vacuum breakers at all?

17 MR. ESMAILI: Well see sometimes the
18 drywell pressures at certain instances in time, from
19 three to seven days, the drywell pressure falls below
20 the wetwell pressure enough to actuate the vacuum
21 breakers.

22 MR. WALLIS: No, I'm suggesting if vacuum
23 breaker leakage is a big problem in all that, then if
24 you had the fans operating all the time to make --

25 MS. CUBBAGE: But they're not going to do

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1 that.

2 MR. WALLIS: --it work, you might not need
3 --

4 MS. CUBBAGE: So it's not really worth
5 talking about.

6 (Simultaneous discussion.)

7 CHAIRMAN CORRADINI: Yeah, but the initial
8 blowdown will carry a lot.

9 MR. WALLIS: Oh, that's the initial
10 blowdown or something.

11 MS. CUBBAGE: It's a passive design.

12 MR. WALLIS: Okay, right.

13 MS. CUBBAGE: So if you were to credit the
14 fans from day one, you'd be an active plant with
15 safety-related diesel generators and the whole nine
16 yards, and then they could take out the GDCS and put
17 in pumps.

18 (Simultaneous discussion.)

19 MR. ESMAILI: Part of the reason we are
20 doing this calculation is trying to understand. I
21 mean this research is trying to understand what's
22 going on from three days to seven days with the fans
23 working.

24 Next slide. Next. So this is what
25 happens to the PCCS pools. By about three days, we

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1 have two-thirds of the tubes covered. After that, you
2 see that water level is going up, but it's saturated
3 and that's actually four days to completely recover
4 the water level to the top of the tubes.

5 Next slide. Okay. Here you see --
6 actually you see what's happening inside the tubes.
7 In the first three days that Jack was mentioned, you
8 know, the insert shows a steam void fraction inside
9 the tubes, okay, from the upper half all the way to
10 the lower half.

11 In the bottom portion of the PCCS tubes,
12 you can see that, you know, see more fractions of the
13 order of, you know, like 40 to 60 percent. So there's
14 a non-condensables accumulating there.

15 At 72 hours, once the fans start to work,
16 we are sucking all the non-condensables back into the
17 drywell, and you see -- you get a more or less uniform
18 distribution of the non-condensables and steam inside
19 the PCCS tubes.

20 What happens is that at 72 hours, you also
21 because of the reverse leakage and the short duration
22 of the vacuum breakers operating, you can see that,
23 you know, the non-condensable gases that were
24 originally pushed back into the wetwell are coming
25 back into the drywell, okay.

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1 As a matter of fact, if you look at the
2 steam concentration inside the upper half of the PCCS
3 tubes, it's following whatever is happening inside the
4 drywell. So initially the drywell is full of steam --

5 MR. WALLIS: I guess I'm interested in the
6 figure we saw right at the beginning. Curve 6 shows
7 that there's a lot of pressure drop across the pipe
8 that feeds the PCCS.

9 So if you are now running these fans and
10 they're pumping steam, which isn't condensed, it seems
11 to me you have an ability to have more steam going
12 into the PCCS than ever before.

13 MR. ESMAILI: Actually, the next --

14 MR. WALLIS: That pressure drop going into
15 it will be bigger than ever before, and will open --
16 could open the top half.

17 MR. ESMAILI: No. The top end never
18 opens.

19 MR. WALLIS: Well, I'm just saying, that
20 you have to calculate the pressure drop now, because
21 you're sucking all that steam all the way through the
22 PCCS, and blowing it out through the fan, and you've
23 got steam being condensed in there.

24 So I'm saying the total flow rate going in
25 could be bigger than it's ever been.

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1 MR. ESMAILI: Well, here's the flow rate
2 actually going to the PCCS. I'm showing it right
3 here.

4 MR. WALLIS: Going through it or into it?

5 MR. ESMAILI: Well, the top one -- you see
6 for the first three days? You see, that's the steam
7 flow right through the PCCS, going to the top of the
8 PCCS, okay.

9 The first three days is passing. After
10 the fans start working, immediately at 72 hours you
11 see a big spike, in terms of flow of steam and non-
12 condensables into the --

13 MR. WALLIS: Is it bigger than it's ever
14 been?

15 MR. ESMAILI: It's about, I don't know.
16 It's about maybe 13, 14 kilograms. That's a very
17 short duration.

18 MR. WALLIS: That probably opens the top
19 half then, because the pressure drop goes as V
20 squared, and that's over twice as much as before.

21 MR. ESMAILI: You're talking about that
22 main horizontal vent?

23 MR. WALLIS: Yes.

24 MR. ESMAILI: They never open, because as
25 a matter of fact, what happens is that once you're

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1 equilibrating the pressure between the drywell and the
2 wetwell, you are recovering the water level. So if I
3 show you --

4 (Simultaneous discussion.)

5 MR. WALLIS: But a parallel path. I mean
6 the pressure drops or the PCCS has to match the other
7 path that goes down through the vent path.

8 MR. ESMAILI: But nothing goes through
9 there. You know, once --

10 (Simultaneous discussion.)

11 MR. WALLIS: It does, if the pressure drop
12 is big enough to open the vent. If the pressure drop
13 between the drywell and the wetwell is big enough, it
14 will open the vent.

15 MR. ESMAILI: Yes, it will open the vent,
16 but it's not.

17 MR. WALLIS: You've got this humongous
18 steam flow going in. It just seems to me that could
19 be enough to give you enough pressure drop by what you
20 showed us before, or Jeannie showed us at the very
21 beginning, to open the top vent.

22 Not that it matters that much, but you
23 know, you need to calculate the pressure drop
24 associated with this slide.

25 MS. CUBBAGE: Mike? We just need to do a

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1 time check, because I know that Jose needs to catch a
2 plane. We've got like five more presentations.

3 MR. WALLIS: Well, go ahead. I will stop
4 asking questions.

5 MR. ESMAILI: Okay. So you've got the
6 spike, and then you've got flow through the PCCS. As
7 a matter of fact after that initial spike, you can see
8 that the heat being generated inside the vessel and
9 the steaming rate is perfectly matched with the PCCS
10 removal.

11 The next slide is just the bypass leakage
12 and the sensitivity to the bypass leakage area. You
13 know, you go to two centimeters, of course you're
14 going to get through the design by about three days.

15 But you get -- because now you have a
16 bigger area between the vessel and the drywell. You
17 are depressurizing the containment faster.
18 Eventually, you get a twin equilibrium state.

19 So in the final analysis, we are
20 confirming, you know, some of the calculations that GE
21 has done.

22 MEMBER ARMIJO: Because you activate a
23 margin, do you actually get more margin as GE
24 calculated?

25 MR. ESMAILI: We're actually a little bit

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1 higher than -- you're talking about that seven days?

2 MEMBER ARMIJO: Yes, right at the end, the
3 spread --

4 MR. ESMAILI: At the end, for the one
5 centimeter spread, and I'm referring to one of the
6 figures that GE did not present, but it's in their
7 handouts, they come to about three PARs at seven days.
8 We are sitting at about 3.2, 3.3 bars at the end of
9 seven days.

10 MEMBER ARMIJO: And they didn't take
11 credit for PARs but you did?

12 MR. CHEUNG: Our understanding was that
13 they did not base, you know, the assumptions that PARs
14 are activated, so was based on the discussion we had
15 with GE. So I don't know. You'd have to ask if they
16 assumed that the PARs are activated or not.

17 In the presentation that I pass out this
18 morning, the PAR was not on, or no credit for the PARs
19 from three days to seven days. But we have another
20 set of calculations, three days to seven days. We
21 have the PARs turned on.

22 But basically, the mass, they
23 redistribution from wetwell to drywell. So a little
24 bit of turning off the rate algebra test is not going
25 to make a big difference.

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1 MR. ESMAILI: We actually did a
2 sensitivity to the PARs activation, non-activation.
3 It just changes the total pressure by about a tenth of
4 a point. It doesn't make that much of a difference.

5 CHAIRMAN CORRADINI: Thank you very much.

6 Yes.

7 (Off the mike comment.)

8 MEMBER ABDEL-KHALIK: --that maximum flow
9 rate in the PCCS after about an hour or so is 310
10 kilograms per second? Look at the beginning of the
11 graph.

12 MR. ESMAILI: Oh yes, the first. Okay.

13 MR. WALLIS: Do you have some more copies
14 of those things somewhere?

15 MEMBER ABDEL-KHALIK: In the best of
16 circumstances, this is all steam, and going through
17 the PCCS, and it's fully condensed as it goes through
18 the PCCS? You'd be removing about 23 megawatts. Why
19 GE claim that they're removing --

20 MR. ESMAILI: All right. Let me
21 paraphrase something. I forgot to mention. This is
22 the rate -- the proof. So I'm just showing you three
23 of the PCCS units. So whatever you see here, you have
24 to multiply by two. This was not made clear.

25 Okay. So this is about, you know, just

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1 multiply ten by -- so 20 kilograms per second. This
2 is half of it. The other half is just exactly the
3 same. It's just --

4 MEMBER ABDEL-KHALIK: All right.

5 MR. WALLIS: So the fan is pumping mostly
6 steam?

7 MR. ESMAILI: The fans are pumping mostly
8 steam. But it goes down as time goes on, because
9 you're getting more non-condensables back from the
10 wetwell into the drywell. Whatever is coming out is
11 constant, because I'm assuming a constancy in that.

12 CHAIRMAN CORRADINI: Do we have the next
13 set from the staff?

14 MS. CUBBAGE: Great. Yes, we're going to
15 switch gears here. I have the handouts.

16 (Pause.)

17 MR. WANG: Okay. I'm Weddington Wang, and
18 today we are going to present the GDCS main line
19 confirmatory calculation for the ESBWR stability.
20 Before we do this confirmatory calculation, we would
21 like to address a few new IRAs to address, from the
22 last ACIS meeting concerns.

23 The first IRA is about the GDCS main line.
24 Dr. Wallis asked the last time when the GDCS starts,
25 the water level inside of vessel actually is below the

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1 inlet of the GDCS.

2 So we asked GE to address if there's a
3 possibility of the steam flowing back, and if TRAC has
4 the capability to TRAC on this phenomena, or what is
5 the design to prevent this phenomena.

6 We also issued new IRAs on chimney
7 modeling. From the outlet of the core to chimney,
8 there's a non-fully developed flow. We would like GE
9 to address if this TRAC can model it correctly,
10 because strategy has a static flow regime.

11 This is non-fully developed flow regime.
12 If it cannot be modeled correctly, what's the impact
13 on the safety?

14 Also, we would like -- we issued another
15 IRAs to address the turbulence of the slug in the
16 chim, turbulence transitions, which basically is kind
17 of noisy noise in the chimney. We would like to see
18 what the impact on this phenomena, and also if
19 strategy can model it correctly.

20 MEMBER BLEY: Excuse me, just to get me on
21 the right page. Exactly which pipe are we talking
22 about?

23 MR. WANG: For GDCS? For GDCS, there is a
24 GDCS in pipe, right.

25 MR. WALLIS: Which in later drawings has a

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1 loop seal in it?

2 MR. WANG: That's what we're asking for GE
3 to address, and we haven't got a response back yet.

4 MS. CUBBAGE: No, no, no. Not for that
5 drain. This is the actual injection line into the
6 vessel that we're talking about.

7 MEMBER BLEY: Oh, the one to the vessel.

8 MR. WALLIS: Yes, it does, it does. It
9 has a down and up again in the later drawing I saw.

10 MS. CUBBAGE: Yes. This is a question
11 we're actually raising as a result of some of the
12 comments from you all at previous meetings, about
13 concerns about whether there could be any blockage in
14 that line.

15 MR. WALLIS: I think we need to have a
16 design which is stabilized, because some of these
17 early drawings show one kind of pipe design, and then
18 another one shows a different pipe design, and
19 tomorrow it could be another pipe design.

20 The shape of the pipe makes a difference,
21 to whether or not this phenomena can happen.

22 MEMBER BLEY: Also, the isometrics would
23 really help us.

24 MS. CUBBAGE: Right. Are you speaking
25 about the GDCS injection line? We have the PNID. I'd

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1 be happy to get that to you.

2 MEMBER BLEY: It's not the PNID. It's the
3 isometrics.

4 MS. CUBBAGE: The isometrics?

5 MEMBER BLEY: --to the actual layout.

6 MS. CUBBAGE: Well, we don't -- I don't
7 think we have that. GE would have to submit it, and
8 then we'd be happy to give it to you.

9 MEMBER BLEY: There were others this
10 morning they talked about, giving us the isometrics.

11 MEMBER BANERJEE: I guess there's a
12 general concern which Amy you're aware of, from the
13 committee about the trapping of gas in this line,
14 which needs to somehow be dealt with.

15 MR. WANG: We can move to the next slide.
16 Okay. Our main calculation is going to be
17 confirmatory calculation, using LAPUR curve. The
18 LAPUR curve was developed by NRC and maintained at Oak
19 Ridge Laboratory in the 70's.

20 There is a manual actually, I think. At
21 the last meeting, we have distributed to PM, and
22 hopefully you have a look at what the LAPUR code is.
23 It is a frequency domain solution, and calculates the
24 transfer function. It can estimate decay ratios from
25 three stability modes: channel, core-wide and

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1 regional.

2 Next slide please. I will briefly discuss
3 about what the LAPUR model is and Jose from Oak Ridge,
4 he'll discuss about detailed input and also the
5 calculation results. The model, we use a quarter core
6 model, and in later slides, we'll show a rough idea of
7 what the core quarter model is.

8 Basically, it can capture three modes of
9 instabilities: core-wide, channel and regional, since
10 it's symmetric. It's using, it generates from
11 PANACEA.

12 The main portal we use from PANACEA is 3-D
13 power distribution, like axial and radial power show,
14 and void reactivity coefficients, and also the flow
15 rate. So that's steady state condition.

16 In the chimney, we see made with an outlet
17 pipe module, which have a single chimney per bundle.

18 MR. WALLIS: I thought there was a chimney
19 for four bundles?

20 MR. WANG: Yes. This is a limitation from
21 this LAPUR code. But however in this LAPUR
22 simulation, we mainly focus on this core, and also
23 chimney is not significant for this instability study,
24 because mainly chimney has pressure job on gravity and
25 frictional pressure job is less important.

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1 MR. WALLIS: But the void fraction in the
2 chimney is very important.

3 MEMBER BANERJEE: The gravity --

4 MR. WALLIS: Yes. That's what's driving
5 the whole thing.

6 MEMBER BANERJEE: I mean it doesn't
7 circulate if we don't have gravity.

8 MR. WANG: Okay. This model actually is
9 only model the core. We focus on the steady state to
10 calculate the solution from the core, and then we have
11 perturbation, and from the perturbation we have the
12 transfer function and calculation of the K ratio.

13 MEMBER BANERJEE: So let me ask a question
14 here. Suppose you put in, in the chimney, fairly
15 large amplitude noise. Would due to actually the RAI
16 you asked GE to do, would there be a wave number
17 selection here, where it would couple to any of the
18 modes?

19 MR. WANG: I believe it's not. Maybe Jose
20 you can --

21 MEMBER BANERJEE: I mean why not?

22 MR. WANG: Because this model, we mainly
23 for the core, and this is a code limitation.

24 MEMBER BANERJEE: But this would be
25 driving, right? I mean if you put in a driving, broad

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1 -- not a broadband noise, but let's say noise with
2 substantial amplitude. Why wouldn't one of the modes
3 couple?

4 MR. MARCH-LEUBA: It will drive the
5 reactor. It will be eventually you put perturbations
6 of density on the chimney, you will have different
7 heads driving the inlet flow, and the reactor will see
8 there's a change in the inlet flow. It will have some
9 fluctuations of the inlet flow.

10 The question you're really asking is what
11 the amplitude of the flow? If you went to
12 Susquehanna, we were there last year, and we saw the
13 APRM was 83 percent up and down, and that is because
14 the flow is changing in the reactor.

15 It happens in Susquehanna, it happens in
16 Hatch, happens everywhere. The question is when they
17 build it, we have a one percent flow, we will have ten
18 percent, 25 percent.

19 If it's 25 percent, it won't be able to
20 operate. We fully expect that this noise will be
21 there at one to three percent as normal reactors.

22 MEMBER BANERJEE: But yes. Maybe you are
23 right, maybe you are wrong, because nobody knows this
24 at the moment. But is there -- I mean your code is a
25 linear stability analysis code, right?

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1 MR. MARCH-LEUBA: This is correct.

2 MEMBER BANERJEE: So you don't have any
3 amplitude information here right, in this code?

4 MR. MARCH-LEUBA: None whatsoever.

5 MEMBER BANERJEE: So the only couplings
6 that you would see would be through some mode
7 coupling, but as it's not a non-linear analysis, how
8 would you know the amplitude effect?

9 MR. MARCH-LEUBA: If it's a noise driving
10 a linear system, then it's just a noise driving a
11 transfer steam. But this multiplication is probably
12 the --

13 MEMBER BANERJEE: But there would be some
14 wave number to represent this.

15 MR. MARCH-LEUBA: Yes. Now there is the
16 obscure or the difficult probability that it is non-
17 linear. And just because you have a mold in the
18 chimney, you're suddenly producing a different
19 physical phenomena. Something like that --

20 (Simultaneous discussion.)

21 MEMBER BANERJEE: But turbulence is.

22 MR. MARCH-LEUBA: Yes. Something like
23 that --

24 MEMBER BANERJEE: I don't know, because
25 you see there's so much numerical dissipation in these

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1 codes, that it's hard to know whether there would be a
2 coupling, because there are two things that happen as
3 you know. Even if you fix the dissipation, you still
4 get dispersion.

5 MR. MARCH-LEUBA: Yes.

6 MEMBER BANERJEE: And the dispersion will
7 take things out of wave number and then tend to
8 flatten it. So it's very hard to know without a
9 spectral code, whether actually this will happen or
10 not.

11 MR. MARCH-LEUBA: The real answer to your
12 question is that we were concerned about all these
13 issues, and we receive a commitment from General
14 Electric. Once they fill their reactor, they'll test
15 it, okay. So we will not know the answer to your
16 question.

17 MEMBER BANERJEE: Because I don't think
18 they need to build the reactor to test it.

19 MR. MARCH-LEUBA: To test it.

20 MEMBER BANERJEE: I think it would be very
21 helpful to have a little bit more information on even
22 the experiments they have done, the experiments on
23 void fraction that they've done. There was a question
24 asked as to whether there were large amplitude
25 fluctuations in the gravity head, even in this

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1 channel.

2 Now the reason it couldn't be got is they
3 were also having fluctuations of pump flow. I looked
4 at that data, the Ontario Hydro report. So you
5 couldn't separate out easily.

6 But there were two gamma densitometers,
7 and if you could find the cross-correlation function
8 with large density fluctuations which was correlated,
9 then you would have a measure other than the pressure
10 losses, because the pressure losses were coupling to
11 the pump.

12 MR. MARCH-LEUBA: Yes.

13 MEMBER BANERJEE: So it wasn't a perfect
14 experiment. But if the experiment was done more
15 carefully, this question could be answered, I think,
16 directly.

17 CHAIRMAN CORRADINI: Can I ask another
18 question? You mentioned some operating experience.
19 So what is it about this design that could make it
20 non-linear, where you were mentioned with current
21 BWRs.

22 If you have something in the chimney which
23 causes an oscillation, it will just feed back because
24 of the recirculation ratio?

25 MR. MARCH-LEUBA: I have not -- I cannot

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1 come up with any physical phenomena that would make it
2 non-linear.

3 MR. WALLIS: But it's not a question of
4 non-linearity. It's a question of response to an
5 actual external source, isn't it? You don't get --

6 MR. MARCH-LEUBA: If it's a linear
7 response, it will be a response from an external
8 source, and the only question is how much the
9 amplitude and the noise in the reactor will be.

10 MR. WALLIS: If you had sort of slug flow
11 bubbles that form themselves with some kind of a
12 frequency, it would give you perturbations in the
13 chimney. Does that -- what effect does that have on
14 the whole circulation? Does it get amplified? Does
15 it get damped out very much or what?

16 MR. MARCH-LEUBA: It will not get
17 amplified. It will get propagated.

18 MR. WALLIS: How much does it get damped
19 out?

20 MR. MARCH-LEUBA: Right.

21 MEMBER BANERJEE: So if you force at a
22 certain frequency, is there a frequency of forcing,
23 where you will get some sort of a coupling and a
24 resonance effect?

25 MR. MARCH-LEUBA: Obviously. It will be

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1 the frequency of the oscillation. That's where you
2 get high amplification.

3 MEMBER BANERJEE: Yes, but what is that
4 deficiency?

5 MR. MARCH-LEUBA: That I can't tell you
6 with reference to this, yes. LAPUR can tell you.
7 LAPUR can tell you what the frequencies and what the
8 amplification factor is. So it doesn't function from
9 flow to power, for example.

10 MEMBER BANERJEE: Well, the question then
11 is even a fairly small forcing at that frequency can
12 lead to some sort of amplification, right?

13 MR. MARCH-LEUBA: Yes, especially is the
14 factor is close to one, then amplification is larger
15 and larger; correct?

16 (Simultaneous discussion.)

17 MEMBER BANERJEE: I mean is that frequency
18 considered out of the question or what?

19 MR. MARCH-LEUBA: That frequency is about
20 .7, .8 hertz. We call it one hertz in ESBWR.

21 MR. WANG: We'll have some results from
22 the calculation, right. Yes.

23 MEMBER ABDUL-KHALIK: Does the fact that
24 the actual chimney being pumped as a super cell,
25 versus the single bundle, introduce another mechanism

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1 for non-linearity, if you have significant radial
2 power gradients?

3 MR. MARCH-LEUBA: They're always non-
4 linear. The word is non-linear, but fortunately
5 behaves most linearly, and the possibility does exist.
6 But I don't see the non-linearity really doing
7 anything of relevance. What mechanism were you
8 thinking about? I cannot think of one.

9 MEMBER ABDUL-KHALIK: Well, I mean if you
10 had significant differences in steam flow between
11 neighboring bundles within a single super cell, that
12 would cause significant mixing in the lower part of
13 the chimney.

14 MR. MARCH-LEUBA: Yes. That would be
15 linear, though, I think. I think it would be linear.
16 It would be a perturbation, and it would operate
17 linearly.

18 MR. WALLIS: Well, it might lead to sort
19 of intermittent behavior, where you release a bubble,
20 then another bubble and another.

21 CHAIRMAN CORRADINI: If I could just ask,
22 so what was the name of the reactor that was
23 mentioned?

24 MR. MARCH-LEUBA: DODOWR.

25 CHAIRMAN CORRADINI: And what is the size

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1 of that, in terms of how many bundles to the chimney?
2 I can't remember.

3 MR. MARCH-LEUBA: It had a single chimney.

4 CHAIRMAN CORRADINI: Oh, I thought it was
5 more than that.

6 MR. MARCH-LEUBA: DODOWR was not
7 partitioned, was it? It was partitioned?

8 (Off the mike comment.)

9 CHAIRMAN CORRADINI: So four to one?

10 MEMBER BANERJEE: But the chimney was what
11 diameter?

12 (Off the mike comment.)

13 MR. MARCH-LEUBA: I believe he was saying
14 that the chimney in the official DODOWR is four by
15 four bundles or 16 bundles, and the chimneys on the
16 ESBWR were two by two. So that's four bundles.

17 MEMBER ARMIJO: They were big chimneys on
18 DODOWR.

19 MS. CUBBAGE: DODOWR. You said ESBWR a
20 couple of times.

21 (Simultaneous discussion.)

22 MR. MARCH-LEUBA: What?

23 MS. CUBBAGE: You said ESBWR twice?

24 (Simultaneous discussion.)

25 CHAIRMAN CORRADINI: So the reason I guess

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1 I'm asking is that -- so this one has it such that
2 it's larger, there would be larger land scale between
3 the transverse distance. But was anything seen in
4 DODOWR that would indicate at least in the two by two
5 that you would see some sort of different
6 amplification?

7 MR. MARCH-LEUBA: Just next to DODOWR,
8 there was a very good Delph (ph) University people,
9 which have really very qualified noise analysis, and
10 they have great reputation in the area. They were
11 studying the noise of the reactor for many thesis, and
12 they never saw anything. It was a very quiet reactor.

13 MEMBER BANERJEE: Yes. I was on the
14 review board. It was Vanderhoggen. But it was --
15 there was an action in GE actually to assess. Well,
16 it's not an action but we certainly discussed it last
17 meeting that assessed what applicability the DODOWR
18 data might have on the ESBWR.

19 Maybe that is also something that you
20 people might look at, because it's not clear that all
21 the scaling and everything --

22 MR. MARCH-LEUBA: It's not the same
23 reactor.

24 MEMBER BANERJEE: It was a reactor. But
25 it could be that some of the data could be useful, in

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1 terms of setting our minds at rest about this --

2 MR. MARCH-LEUBA: In my mind, the chimney
3 -- yes. DODOWR had a large, long chimney. It was not
4 exactly a four by four. It was a two by two. But and
5 they have basically even natural circulation, and they
6 never saw much noise.

7 MEMBER BANERJEE: Yes. But that would be
8 coupling to the density waves in a small set of
9 channels. Sort of like if your stability was due to
10 small group of channels taking off and oscillating,
11 which of course happens.

12 MR. MARCH-LEUBA: There is something in
13 the rolling of the core, and it's almost four
14 symmetry. So once you capture four channels, kind of
15 16 look about the same as four.

16 If you take only one bundle per chimney,
17 you're having big difference as well. Once you get
18 four channels, you have the checkerboard pattern.

19 MEMBER BANERJEE: How many chimneys did
20 DODOWR have?

21 MR. MARCH-LEUBA: Don't know really. One
22 chimney would be four bundles.

23 MEMBER BANERJEE: Yes.

24 MR. MARCH-LEUBA: It was more reactor,
25 much more.

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1 MEMBER BANERJEE: 20 or 30 or 60?

2 MR. MARCH-LEUBA: Something like that.

3 MEMBER ABDUL-KHALIK: 65 megawatts. It
4 wasn't much. It was a small plant.

5 MEMBER BANERJEE: Okay. Anyway, we should
6 look at that data.

7 CHAIRMAN CORRADINI: Do we need to --

8 MR. MARCH-LEUBA: Move on?

9 CHAIRMAN CORRADINI: Yes.

10 MR. MARCH-LEUBA: In the interest of time,
11 we'll move fast through this. I just was going to
12 give you a presentation on what the input data of the
13 LAPUR code was, and this shows the radial power
14 distribution at the beginning of cycle and end of
15 cycle is the blue line, and the flow distribution,
16 which is the red line.

17 The only thing of interest I find here is
18 that at beginning of cycle, you have all the gallium
19 still is in the core and all the control rods, and
20 most of the high power channels cluster on a single
21 peak.

22 Towards the end of cycle, you see those
23 two peaks separating into themselves, and you see a
24 high power bundle and a medium power bundle. That's
25 bad for stability.

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1 So whenever at the end of cycle, you have
2 now significant function of the core, which is 130
3 percent radial power, whereas at the beginning of
4 cycle everything was 120. That makes the number
5 increase towards the end of cycle.

6 Next slide. The axial power distributions
7 are also very important for stability and during most
8 of the cycle, the blue line and the kind of dark line,
9 dark gray line, are beginning at middle cycle. Only
10 towards the end of cycle, when we're running out of
11 uranium, there is a shift of the power towards the top
12 of the core.

13 MEMBER ABDUL-KHALIK: What is the actual
14 average value in terms of power to flow ratio in the
15 previous TRAC? I mean 100 percent represents --

16 MR. MARCH-LEUBA: 100 percent is 4,500
17 megawatts divided by 1132 channels.

18 MEMBER ABDUL-KHALIK: Yes.

19 MR. MARCH-LEUBA: And the flow is same
20 thing. So this is the average. 100 percent is the
21 average channel, including the periphery.

22 MEMBER ABDUL-KHALIK: Okay.

23 MR. MARCH-LEUBA: So that's the axial
24 power shape. It's fairly bottom peak early in the
25 cycle, and then fairly top peak by the end of the

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1 cycle. So it's hard to make a decision about which
2 one is going to be more unstable.

3 Next slide. This you are going to have to
4 look at it on your own transparencies. One of the
5 things we do when we do confirmatory calculations, the
6 purpose of this one was to confirm the stability of
7 the ESBWR, calculate the K ratio.

8 But we look at other things, and we are
9 trying to figure out whether there's any physical
10 phenomena that the vendor has not modeled.

11 MR. WALLIS: So you're predicting flows
12 and pressures drops almost exactly the same as
13 PANACEA?

14 MR. MARCH-LEUBA: Very much the same.

15 MR. WALLIS: Is this because it's
16 dominated by a single phase region?

17 MR. MARCH-LEUBA: No. Actually, it's two
18 phase region.

19 MR. WALLIS: And you have the same void
20 fraction correlation?

21 MR. MARCH-LEUBA: No, very different. Let
22 me --

23 MR. WALLIS: That's miraculous that the
24 two phase four calculations are so close.

25 MR. MARCH-LEUBA: I don't have a pointer,

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1 but you can see somewhere here on the right there is a
2 regional channel that has three and four bundles. Can
3 you find it? There are two or three of those. That
4 is where the control rows are.

5 So whenever we have channels with control
6 rows inserted, you have lower power to flow ratio, and
7 we have different void fractions. Then we have
8 differences between the pool and the --

9 MEMBER ABDUL-KHALIK: Isn't this just a
10 consistency check?

11 MR. MARCH-LEUBA: It's a confirmatory.

12 MEMBER ABDUL-KHALIK: Right. I mean
13 you're using input generated by PANACEA?

14 MR. MARCH-LEUBA: No. We're using the
15 power in the PANACEA. We're calculating the flow from
16 First Vintage (ph).

17 MEMBER ABDUL-KHALIK: It's not --

18 MR. MARCH-LEUBA: We're using the same
19 friction coefficient, but --

20 MEMBER ABDUL-KHALIK: But the pressure
21 drops are the same.

22 MR. MARCH-LEUBA: Pressure drop is also
23 matches. So even though we have a completely
24 different void fraction model, this is a slip model,
25 LAPUR. This is PANACEA, which is a different model.

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1 We do benchmark that, and in essence it's
2 a good benchmark of LAPUR, because PANACEA is
3 benchmarking reactors every day. So in PANACEA
4 they're all standard, but we do get a good benchmark.

5 Next slide please. Okay. So here is the
6 main result. We took the axial and radial power
7 distributions and exposed the coefficient on 12 points
8 within the cycle.

9 So we didn't do just a single calculation,
10 but we took beginning of cycle, a couple of weeks into
11 the cycle, all the way to the end of the cycle.

12 We show here on the first column the core-
13 wide declination (ph). The second column is the
14 regional declination, and the last column is the
15 channel declination. LAPUR has a problem calculating
16 channel declinations, which are very stable, because
17 it just cannot calculate the frequency.

18 Instead of reporting them .03, .02, .01, I
19 just put approximately zero. So you are not
20 distracted by terms which are numerical and have
21 nothing to do with the stability of ESBWR.

22 On the core-wide, where we see the core-
23 wide, according to LAPUR, dominates the response and
24 tends to be more unstable towards the end of the
25 cycle, but still only .25 declinations. Very, very

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1 stable. The regional is very stable too, always less
2 than .2.

3 So we confirm GE's calculations and claims
4 that ESBWR will be stable and will be operable.

5 For the regional mode, we used subcritical
6 reactivity that was caused by a separation of 80 cents
7 that was calculated. That accurate number was .78.

8 An interesting thing that you can see is
9 that the frequency keeps changing and becoming shorter
10 towards the end of the cycle, indicating that we have
11 like a longer transit time of the bubbles, the
12 effective transit time of the bubbles. It is hard to
13 explain, but that's what LAPUR calculates.

14 I will have to -- I mean everybody, when
15 we were doing the review of this, everybody had
16 expected it to be the other way around, as the axial
17 power head shifts to the top. But it does not.

18 CHAIRMAN CORRADINI: So if you have a
19 period base detection algorithm, you have a hard time
20 figuring out what frequency you're looking for?

21 MR. MARCH-LEUBA: No, no, no. The period
22 base finds the frequency that it happens to be
23 oscillating at. For example, in Hatch, at 100 percent
24 flow, the reactor always was at a .8, .9 hertz. When
25 it trips, it only was .4, .5 as you change the flow.

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1 So it's more variability with frequency,
2 you know, than the reactors under ESBWR, because of
3 the flow change. But an important feature of this is
4 that, and GE is working on this, is for a long
5 devolution, there are some hard wire parameters, like
6 the corner frequency and tolerances, which need to be
7 adjusted to these higher frequencies.

8 So one thing we have already told them is
9 DSSCD is not applicable to ESBWR today, because it has
10 some hard wire frequencies, which they need to take
11 exception to and recommend new parameters.

12 So DSSCD will be applicable, but as it is
13 in the books, we recommend the values of the
14 parameters, it will not work for ESBWR for the reason
15 we said.

16 Next slide. Now we do have some -- I've
17 run some sensitivities to both power and the adiabatic
18 separation for the core-wide mode. Here, on the left,
19 the first two columns, flow and power over the start-
20 up path. This kind of represents the natural
21 circulation line on an operating reactor.

22 We calculated the decay ratio as we
23 increased power, maintaining the core temperature. We
24 see that even at the 120 percent power, which is above
25 the scram line, we got a result of .03 for the core-

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1 wide.

2 And as I said, the adiabatic separation
3 that we used was .8 dollars, and let's assume that
4 these changes in Cycle 2, Cycle 3 is different
5 loadings. At 60 cents or one dollar, you will see
6 that even then, the decay ratio for the regional does
7 not become a problem.

8 A bounding case will be for the adiabatic
9 separation of zero, which is the very first column.
10 That's a non-realistic, non-physical case, but there
11 will be bounding. And even with the bounding case, at
12 120 percent power we get the result of .067.

13 CHAIRMAN CORRADINI: I'm sorry. Where
14 does the flow percentages? Where do the flow
15 percentages in the first column come from?

16 MR. MARCH-LEUBA: That was my calculation.
17 I put into LAPUR 100 percent power, 100 percent flow,
18 and calculated a delta P across the core. Now I set
19 the power to 90 percent, and I kept taking on the flow
20 until I got the same delta P as before.

21 CHAIRMAN CORRADINI: So you need 102
22 percent flow to get 90 percent with the same delta P?

23 MR. MARCH-LEUBA: Correct, and if you see
24 if that's turned around, we always have discussion
25 before of why the circulation is not vertical? It's

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1 not vertical. It's a parabola. It's a competition
2 between flow and friction.

3 So those are the flows calculated by
4 LAPUR, so that you have the same delta P, which is
5 equivalent to the same level on that outcome.

6 MR. WANG: Let me make the conclusion.
7 Basically, from this confirmatory calculation, we say
8 yes, ESBWR exhibits high degree of stability, and as a
9 calculation we found the flow distribution and the
10 jobs predict by PANACEA is confirmed. Also, the flow
11 declination value for all three density wave stability
12 mode is also showed as very small.

13 And next, for this confirmatory
14 calculation actually one bullet I didn't talk
15 important is what we're using is just for nominal
16 operation points, which is the feeder water
17 temperature is just as T zero.

18 If you remember, there's a topical report
19 that GE submitted later, and on the review is feeder
20 water temperature operation domain. There's other
21 operating points, and the next step we will do more
22 calculations with those points.

23 MEMBER ARMIJO: With the feed water
24 variation?

25 MR. WANG: With the feed water temperature

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1 variation, yes.

2 MEMBER BANERJEE: Is TRACS -- sorry. Is
3 TRACE now able to do these calculations with PARs?

4 MR. MARCH-LEUBA: The valuation of TRACE
5 for stability is ongoing and very successful.

6 MEMBER BANERJEE: I looked at some
7 results, which looked very nice.

8 MR. MARCH-LEUBA: They look fantastic.

9 MEMBER BANERJEE: Are they actually
10 validated, or does it look fantastic?

11 MR. MARCH-LEUBA: They look very good. I
12 mean the errors are systematic. So I like a benchmark
13 when the actual -- the results don't match the --.

14 MEMBER BANERJEE: In fact, it's much more
15 reassuring when they don't.

16 MR. MARCH-LEUBA: Yes, they don't. And
17 then when you find out what assumptions you made wrong
18 on the modeling, there's very few. We went -- that's
19 a different presentation.

20 MEMBER BANERJEE: Yes, but in any case,
21 are there any plans to do independent confirmatory
22 work on this very important subject with TRAC?

23 MR. MARCH-LEUBA: With TRACE?

24 MEMBER BANERJEE: TRACE, sorry.

25 MR. MARCH-LEUBA: TRACE ESBWR?

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1 MR. WANG: Right now, it's not yet in
2 plant.

3 MEMBER BLEY: Could I take you back to
4 your Slide No. 2? The first item on Slide No. 2 you
5 haven't talked about, unless I somehow missed it.

6 MR. WANG: So it's I-I?

7 MEMBER BLEY: The flow in the pipe. That
8 was a question, but there --

9 MR. CHARY: Let me try to address that.
10 This is Mohammed Chary. All we're trying to do with
11 this slide is tell you we've heard you, you had a
12 comment, you wanted us to pursue this and we've asked
13 a question of GE to address this item. We're not
14 ready to get into how we're dealing with this. That's
15 all this was.

16 MEMBER BLEY: I thought it was an
17 introduction to the PARs.

18 MR. CHARY: No, this is just we have heard
19 you, you've asked the question from the last meeting
20 that we had or the previous one. I forget which one.
21 That's all we're trying to say on this one.

22 MEMBER BLEY: I assume you're going to get
23 the isometrics for yourself, to think about that one?

24 MS. CUBBAGE: Actually not, what you're
25 thinking of.

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1 MEMBER BLEY: Oh?

2 MS. CUBBAGE: I mean that --

3 MR. CHARY: Let me just make sure. The
4 isometrics are not the types of documents that we
5 normally get on a docket for applications.

6 MEMBER BLEY: I understand that.

7 MR. CHARY: Right, so I wouldn't expect
8 that we would be asking them for isometrics on these
9 systems. We need enough information to make sure that
10 we understand the response, that we've non-
11 condensables in a way, that we've evaluated non-
12 condensables in a way that satisfies us.

13 But that doesn't mean that we're going to
14 be asking them for isometrics. We don't normally ask
15 for isometrics in these applications.

16 MEMBER BLEY: We'll be interested to hear
17 how you reviewed their work without understanding the
18 layout of the pipe.

19 MR. CHARY: Well, I'm not -- understand,
20 understand.

21 MEMBER BLEY: For next time.

22 MR. WALLIS: Now can you go back -- since
23 you're on the first slide here, these seem to be
24 questions that we asked quite a long time ago.

25 MS. CUBBAGE: Actually, yes. I believe

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1 you asked them in January. We sent them to GE
2 attached as RAIs.

3 MR. WALLIS: And all these questions we've
4 been asking lately about how you calculate the
5 temperature in the wetwell and so on, those are new
6 RAIs or what?

7 MS. CUBBAGE: Those are old RAIs.

8 MR. WALLIS: No they're not, because we
9 haven't asked those questions specifically before.

10 MS. CUBBAGE: How you calculate the
11 temperature?

12 MR. WALLIS: How do you calculate the
13 wall, what happens in the ceiling and --

14 MS. CUBBAGE: I think what you heard is
15 there's a bounding conservative approach with some of
16 these parameters. If there's some specific thing
17 missing --

18 CHAIRMAN CORRADINI: I'm not sure what
19 you're asking Graham. You're saying -- I was going to
20 just -- are you saying the stuff we asked today or the
21 last subcommittee meeting?

22 MR. WALLIS: These questions we asked in
23 January.

24 MS. CUBBAGE: Right.

25 MR. WALLIS: We had a meeting here, and

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1 there's been some other questions raised since then
2 out there or not? You think those are all old
3 questions?

4 MS. CUBBAGE: I don't know whether they're
5 old or not. All I can tell you is that we asked
6 specific RAIs to GE --

7 MR. WALLIS: Yes, but I mean these
8 questions about the non-condensables that get hung up
9 in the GDCS pool or above the reactor or something,
10 where GE predicts something different from Melcor.
11 You just -- you're not asking those questions? You're
12 sort of assuming everything's okay because someone has
13 a bounding calculation?

14 MR. CHARY: Let me go back a little bit to
15 how we do this. You know, why is it that we're here
16 telling you we're asking these questions? Obviously,
17 we want to let you know that we're asking these
18 specific questions that we've asked.

19 We come here and we present to the
20 committee. There's a lot of dialogue that happens
21 over a day, over two days. We hear a lot of things.
22 We take some things back on our own initiative and we
23 issue questions to GE to get answers back.

24 The rest of it, we wait for your letter to
25 come out, and if your letter says you have an issue,

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1 we'll evaluate that. We'll look at it and we may send
2 them to GE as additional RAIs.

3 But those specific questions that are on
4 this slide are things that we took back as items from
5 one of the previous meetings and we've asked
6 questions. We don't have responses to these yet.

7 MR. WALLIS: You heard this morning -- I
8 don't know if you were here or not -- you heard a lot
9 of questions from various people here about how the
10 energy balance, the mass balance, where the steam
11 went, where the non-condensables went, will evaluate
12 throughout the main steam line break.

13 There were all kinds of questions. Are
14 those old questions to you or are those new questions?
15 Are they going to be part of RAIs if they're not old
16 questions?

17 MR. CHARY: There was a lot of discussion
18 this morning, and we will take what we think is
19 appropriate to ask in RAIs and we will pursue those,
20 and you need to capture the rest of it, whatever you
21 believe needs to be captured in a formal letter back.

22
23 CHAIRMAN CORRADINI: I think if you guys
24 remember, we had the meeting, the two-day meeting in
25 January, and we chose to hold off on this until we had

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1 this subcommittee to write a letter.

2 Then our plan is that after this, we'll
3 decide, talk about it with the full committee tomorrow
4 and Friday, to either write a letter or ask for
5 another subcommittee in May. But we are not going to
6 write a letter this month on this. That was the plan.

7 MR. WALLIS: But before there's a letter,
8 you don't formally do RAIs?

9 CHAIRMAN CORRADINI: Well, I think they're
10 in a situation now where they're trying to respond to
11 a number of responses from GE on a whole bunch of
12 things, and they're kind of picking the ones that
13 they're sensing are the big ones from us, and they're
14 trying to get ahead of the game.

15 But until we write them a letter as we did
16 for the other chapters, they're kind of shooting in
17 the dark.

18 MR. MARQUINO: Dr. Wallis, there's a lot
19 of dialogue over the number of days that we have with
20 the committee, and we don't take every comment that's
21 made and turn it into an RAI. There's a lot of
22 dialogue, there's a lot of back and forth.

23 You have comments. GE responds. You have
24 comments, we respond. At the end of the day, we pick
25 the ones that we think are appropriate RAIs and we ask

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1 them, and then we wait for your letters to address --

2 (Simultaneous discussion.)

3 MR. WALLIS: Well, what concerns me is
4 that when we meet again, if we're going to meet again
5 and we're going to discuss these issues again, you're
6 going to have the same questions from us again.

7 MR. CHARY: Well, if we're going to meet
8 again on this topic, we will work with you to get the
9 specific issues that you want us to address, and we
10 will come back and we will try to address those
11 issues.

12 CHAIRMAN CORRADINI: So let me direct this
13 a couple of ways, because we're -- time is passing.
14 So the GE has three presentations. I've recommended
15 to Amy just privately that they have one on stability
16 and oscillations that in some sense mimics or at least
17 is parallel to what the staff and their contractors
18 have presented.

19 We do that. We take a break. We then
20 have to choose. I want to go through Chapter 18,
21 because there's a whole other contention of GE folks
22 here only for human factors, that we have to do today.

23 There is a closed session on new data that
24 staff just got on the Canadian experiments, relative
25 to the different -- I should say the new ESBWR fuel

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1 bundle, and we can choose to look at those now or
2 wait, okay.

3 There's also additional work on a third
4 topic, which right now escapes me off the top of my
5 head. But I don't think that it's possible that we
6 can go through all fo those today. So my proposal is
7 we have the presentation that mirrors what staff has
8 just presented on oscillations, take a break, and then
9 decide -- then I propose to do Chapter 18.

10 MEMBER BANERJEE: Can I ask you something,
11 Mike, on this? So we're getting new data on
12 predicting heat flux.

13 CHAIRMAN CORRADINI: Just arrived a few
14 days ago.

15 MEMBER BANERJEE: Okay, fine. Now all
16 this is going to filter into the process of the
17 critical power issues and what is done for normal
18 operation, transience, this, that and the other.

19 Presumably that's going to be a separate
20 presentation at some point, that we will deal with at
21 --

22 CHAIRMAN CORRADINI: Yes. We have gone
23 long enough today that we don't have time to see.
24 Again, it's a closed session presentation.

25 MS. CUBBAGE: Our plan is GE to do a

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1 stability piece. It's a couple of slides, Chapter 18
2 and if there's any time left, we can go into closed
3 session to briefly describe to you this report that
4 was provided to Dave Bessette a few days ago.

5 You may or may not have it in your
6 possession, but you know, that topic is an open item
7 in the Chapter 4 safety evaluation report.

8 When we come to you with the final SER, we
9 would need to explain how that issue was closed, as
10 with the containment peak pressure. That was a
11 primary open issue the staff still has in the Chapter
12 6 SER. So at this point --

13 MEMBER BANERJEE: Well, I don't know what
14 is common in each of the chapters, but as long as
15 things like critical power issues and all are covered
16 in some detail after we've looked at these reports,
17 and then there is also the issue as to whether, what
18 sort of material they have, if there's any additional
19 material measurements of void fraction in these
20 bundles.

21 CHAIRMAN CORRADINI: Right. But I guess
22 the path forward that I see is that we're going to
23 have to decide, given the information we have, should
24 we write a letter and give them some official feedback
25 on Chapter 4, 6, 15 and 21, or have another

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1 subcommittee?

2 MEMBER BANERJEE: So where is critical
3 power issue?

4 CHAIRMAN CORRADINI: Chapter 4.

5 MS. CUBBAGE: Chapter 4. I believe it's
6 the intent of the new data to confirm what you've
7 already seen, in the form of a correlation.

8 CHAIRMAN CORRADINI: Well, we should get
9 the report and look at it, since they just received
10 it, staff just received it themselves a few days ago.

11 Should we go ahead now with the one presentation by
12 General Electric? Then we'll take a break.

13 MEMBER BANERJEE: Where are those palm
14 trees, by the way?

15 CHAIRMAN CORRADINI: Bermuda.

16 MEMBER BANERJEE: Not Santa Barbara,
17 right?

18 MR. MARQUINO: I'm Wayne Marquino of San
19 Jose. I'll try and give you a flow while we're
20 setting up the presentation. In the review of the
21 ESBWR stability application, there was a lot of
22 discussion with the ACRS on the role of the chimney in
23 stability, and numerical damping in the chimney.

24 In particular, there was a letter from GE.
25 It's letter MFN-060336, where we use a finer

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1 nodalization with more nodes, and we show that we
2 could essentially eliminate numerical damping in the
3 chimney.

4 We got the same decay ratio in that case,
5 as in the base case with our coarser nodalization.
6 Based on that, we've proceeded with the coarser
7 nodalization, since it doesn't have an effect and it's
8 the same nodalization that we use from AOO analysis.
9 So in the mechanical execution of our calculations, it
10 is an efficiency improvement for us.

11 During the last meeting in January, there
12 was a question raised on the GENESIS test, and you
13 pointed to a paper that had been submitted at the
14 NURIF Conference in Pittsburgh. We've gone back and
15 re-executed the case that had been submitted for
16 numerical damping in the chimney, and that's a lop
17 oscillation case, where we magically changed the void
18 fraction in the chimney and the downcomer, and we take
19 mass out of the downcomer, put in the chimney, so that
20 we retain the total mass in the vessel, but we have a
21 perturbation of the density head and then we watch
22 that cycle through.

23 MR. WALLIS: This is with the fine
24 nodalization or is this --

25 MR. MARQUINO: This is with the fine

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1 nodalization.

2 MR. WALLIS: So the Courant number is one
3 or something? Is that the idea?

4 MR. MARQUINO: Yes.

5 MR. WALLIS: Thank you.

6 MR. MARQUINO: Next slide please. So with
7 this -- George, can I borrow that? So what we are
8 showing here is that in GENESIS, they had a simulation
9 of neutronic feedback, and they were also able to turn
10 that feedback off and just run the facility with a
11 constant power.

12 When they run it with neutronic feedback,
13 they see characteristic frequencies similar to what we
14 calculate with TRAC, .7 hertz. When they turn the
15 neutronic feedback off, they see a frequency of .1
16 hertz. So a loop long period characteristic.

17 When we turn off neutronic feedback in
18 TRAC, we see the same thing. So we are producing
19 frequencies that are very similar to what was measured
20 in the GENESIS facility.

21 CHAIRMAN CORRADINI: Remind me. I'm
22 sorry, but I should remember this. The GENESIS
23 facility. Is this the one in the Netherlands?

24 MR. MARQUINO: Yes, this is the one in the
25 Netherlands. It's freon and basically it simulates a

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1 single channel and a single chimney.

2 CHAIRMAN CORRADINI: Thank you.

3 MR. MARQUINO: Next slide, please. So
4 this is reiterating the numerical damping. I went
5 into this in more detail in the stability ACRS review,
6 but with our coarse nodalization, the perturbation at
7 the inlet to the chimney doesn't go all the way
8 through, and it's somewhat damped at the exit.

9 When we apply a finer nodalization, we're
10 able to eliminate numerical damping and we've
11 explained before, it doesn't have an effect on our
12 core decay ratio calculations, because that's driven
13 by the fuel channel response.

14 (Off the mike comment.)

15 MS. CUBBAGE: Mike.

16 CHAIRMAN CORRADINI: The mike.

17 MR. WALLIS: I'm sorry. If you go back to
18 Slide 3, I think you have a calculation somewhere,
19 where the two frequency is combined? You can actually
20 site both of them, and the big one decays and the
21 other one decays?

22 MR. MARQUINO: That's right.

23 MR. WALLIS: But they're both there
24 together?

25 MR. MARQUINO: Yes. So that's all I had.

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1 I did want to answer that question that came up.

2 MR. WALLIS: That's very helpful. Thank
3 you.

4 MR. MARQUINO: All right, thank you.

5 CHAIRMAN CORRADINI: Questions?

6 MEMBER ABDEL-KHALIK: On Slide 3, are
7 these really a percentage of the average flow?
8 Maximum amplitude is less than one percent?

9 CHAIRMAN CORRADINI: I'm glad somebody
10 else has to do that.

11 MR. MARQUINO: That's percent of the
12 initial flow.

13 MEMBER ABDEL-KHALIK: So these are just
14 tiny variations in the flow rate?

15 MR. MARQUINO: Yes. It's kind of -- I
16 think it's kind of arbitrary what magnitude of
17 perturbation we apply. We've done, in the full
18 stability review, we did a lot of sensitivities on
19 what the magnitude of perturbation is, the pulse width
20 and also whether you perturb flow, pressure. It
21 didn't make much difference in terms of the decay
22 ratio.

23 MEMBER ABDEL-KHALIK: (off mike) Well,
24 how do you appreciate that instability in TRAC G?
25 Sorry.

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1 MR. MARQUINO: Usually in TRAC G, we
2 perturb the inlet velocity to the fuel channels.

3 MEMBER ABDEL-KHALIK: And usually you do
4 that by what percentage?

5 MR. MARQUINO: I think it's about one
6 percent. It's a relatively small perturbation.

7 MEMBER ABDEL-KHALIK: Well if I recall,
8 it's ten percent.

9 MR. MARQUINO: I'll have to check on that.
10 Your memory may be better than mine.

11 MEMBER ABDEL-KHALIK: I think it would be
12 a good idea to verify this TRAC.

13 MR. MARQUINO: All right. I'll get back
14 to you on that. So the question is what's the
15 perturbation in Chart 3 and what's the perturbation in
16 our normal stability calcs?

17 MEMBER ABDEL-KHALIK: Correct.

18 MR. MARQUINO: Okay.

19 MR. WALLIS: What's the perturbation in
20 GENESIS?

21 MR. MARQUINO: I do not know.

22 MR. WALLIS: I think it's bigger than
23 this, but again, we'd have to look it up.

24 MEMBER SIEBER: (off mike) The chart on
25 page four, if I ignore everything after that. Wait a

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1 second. Increases in --.

2 MR. MARQUINO: On Chart 4, it's showing
3 the flow perturbation moving up the channel.

4 MEMBER SIEBER: Okay. The second cycle is
5 larger than the first, and that is damped. I was
6 curious as to why that happened?

7 MR. MARQUINO: I think that has to do with
8 the -- we changed the void fractions in two regions,
9 in the downcomer and the chimney. So I think this is
10 showing the time lag that it takes the void to cycle
11 around into the chimney again.

12 MEMBER BANERJEE: Yes, it's an interesting
13 point.

14 MR. WALLIS: It grows and then suddenly
15 disappears.

16 MEMBER SIEBER: Yes. I can't think of any
17 reason why it should do that.

18 MR. MARQUINO: So the question is why is
19 the -- why is the perturbation larger at five seconds
20 than at two seconds?

21 MEMBER SIEBER: Yes.

22 MR. WALLIS: And then why does it suddenly
23 disappear between 6 and 12?

24 MEMBER SIEBER: Right. That's magic. I
25 know about magic. It goes away.

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1 MEMBER BANERJEE: What is the magic?

2 MEMBER SIEBER: The magic is it goes away
3 all together in the second cycle.

4 MEMBER BANERJEE: Why? That was the
5 question, I think.

6 CHAIRMAN CORRADINI: Other questions.
7 Okay, thank you very much.

8 MEMBER SIEBER: I guess we should
9 understand this.

10 CHAIRMAN CORRADINI: So I would propose
11 that we take a break for a few minutes, all right.

12 MEMBER BANERJEE: Just what is the transit
13 time for the perturbation? What is it?

14 CHAIRMAN CORRADINI: And then we'll come
15 back with Chapter 18, Human Factors.

16 MEMBER SIEBER: In how many minutes are we
17 due back?

18 CHAIRMAN CORRADINI: Ten, ten after.
19 Return at ten after.

20 (Whereupon, a short recess was taken.)

21 CHAIRMAN CORRADINI: Mr. Jenkins, are you
22 the --

23 MR. JENKINS: Yes.

24 CHAIRMAN CORRADINI: Organizer here?

25 MR. JENKINS: Yes sir. My name is Tom

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1 Jenkins, and I manage the human factors for the ESBWR
2 program, and we're going to run through that program,
3 Chapter 18 and go from there.

4 So we'll go, we'll dig right into it.
5 This is the draft concept of our control room, and
6 it's a highly digital plant. You can see that most of
7 it is computer screens, and I don't have a pointer,
8 but I'll try to walk you through some of it.

9 If you look at the left-hand side of the
10 sitdown console, you'll see the safety-related
11 screens. No, down below. There we go, thank you.
12 Then there's a redundant set of screens on the side
13 panel, just to the left of it.

14 That represents the safety-related systems
15 in the control room, including some dedicated switches
16 and hard wire controls, but mostly computer-driven.

17 If you go to the large panel, what we call
18 the wide display panel, that is all non 1E equipment
19 driven from our non-safety related distributed control
20 information system. That's all dynamic. It's huge
21 VDUs and we intend to use that throughout the
22 operation of the plant, in different modes of plant
23 performance.

24 So start up will have its own set of
25 screens. Normal operations, shutdown, refueling. So

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1 we consider that a substantial advantage. The sitdown
2 console is patterned after some of our other work,
3 including our advanced BWR work, and it's a number of
4 screens running right to left.

5 It's in dual pairs of VDUs, because part
6 of this design concept is heavy use of computerized-
7 based procedures. So we'll be putting those
8 procedures on the screen at the same time that the
9 operator is operating with the other screens.

10 Right now, there's a large number of
11 screens, but we'll be, as we go through our program,
12 we'll be evaluating whether we really need that many
13 screens. We've identified an outer envelope, we
14 think, of the construct.

15 Let's see. What else did I have here? On
16 the right-hand side, there's another control panel,
17 and that's for functions that are rarely used or in
18 some cases just used at start-up. So they may be on
19 there, the generator, synchroscope. Certainly the
20 fire protection is going to be on that side panel, and
21 possibly some other generator controls, diesel
22 generator controls potentially.

23 In the back there is the senior reactor
24 operator's desk. It's kind of horseshoe-shaped.
25 Partly we take advantage of the real estate there, to

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1 have a place for the reactor operator, I mean the
2 reactor engineer on the left-hand side, and other
3 folks visiting the control room on the right-hand
4 side.

5 Okay. So that's as much as I had to say
6 about this slide. Yes sir.

7 MEMBER BLEY: That big panel is clearly
8 visible from the central area, there where the --

9 MR. JENKINS: Yes sir, and we have --
10 we're doing all the anthropometrics on that. It's
11 very similar to what we did on our Lung Min (ph)
12 plant, and we fit the same anthropometric envelope
13 that Lung Min had developed.

14 MEMBER BLEY: Now none of this is in the
15 DCD?

16 MR. JENKINS: This picture is not in the
17 DCD.

18 MEMBER BLEY: Or any of the kind of detail
19 that you were just telling us?

20 MR. JENKINS: That's correct, that's
21 correct.

22 MEMBER BLEY: Is it going to be or is that
23 a ITAAC item or --

24 MR. JENKINS: That's an ITAAC item.

25 MEMBER BLEY: That follows design cert?

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1 Is that how that works?

2 MR. JENKINS: That's correct. So this is
3 a program that gets certified, and then we apply that
4 program, and then we come back in through the
5 inspection test and acceptance criteria. We resolve
6 it. We follow the program.

7 MEMBER BLEY: Okay, now that's my
8 impression of essentially everything in Chapter 18 in
9 this program.

10 MR. JENKINS: Uh-huh, that's correct.

11 MEMBER BLEY: So everything in the design
12 cert is programmatic; nothing real until --

13 MR. JENKINS: Well, except that as we walk
14 through the program, we'll be trying to close some of
15 those ITAACs even before we actually get the
16 certification.

17 MEMBER BLEY: But that's not a requirement
18 for the certification?

19 MR. JENKINS: That's not a requirement,
20 no.

21 MEMBER MAYNARD: What's the purpose of
22 showing this dead space under the floor?

23 MR. JENKINS: Oh, that's just where
24 they'll be running cable work. It's an elevated
25 floor. This is the actual design that we have

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1 internally for our use.

2 MEMBER ABDEL-KHALIK: So would all the
3 alarms and enunciators show up on the big screen, or
4 would some of them show up on one of the many screens?

5 MR. JENKINS: Well, there's various forms
6 of alarming that will be done. There will be on the
7 large panel, similar to what you have in existing
8 plants, alarm windows. They'll be in soft control,
9 but they will be there.

10 They will direct you to other areas of the
11 control room or the seated areas, where you'll have
12 detailed alarm response procedures and scrolling alarm
13 screens, and all of that is in process to be
14 thoroughly fleshed out in the human factors program.
15 We'll be picking up some of the new things in the
16 industry on how to deal with those alarms.

17 MEMBER ABDEL-KHALIK: So whatever is on
18 the small screens will be essentially amplification of
19 something that is exhibited on the large screen?

20 MR. JENKINS: Yes, yes, yes. So you may
21 see a flashing valve on the large screen and you'll
22 jump to the system on your smaller screen if you don't
23 have it already up, right.

24 MEMBER BLEY: Do these things come in from
25 local digital systems to the boards, or do they all

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1 get processed through some control room computer
2 before they're up on any screen?

3 MR. JENKINS: Well, there's various levels
4 of control system and computers, and when you do
5 Chapter 7, I believe they'll march through all those
6 layers. There's certainly a display layer and a
7 controls layer, and there's actually several different
8 layers.

9 MEMBER ABDEL-KHALIK: We'll get the detail
10 on that in Chapter 7.

11 MR. JENKINS: That's correct.

12 MEMBER MAYNARD: Again, what is the
13 overall intent of how much of this is to be done in
14 the design certification stage, versus COL? It looks
15 like from what I'm seeing and what you're saying, a
16 lot of this is just -- this is a commitment to do a
17 good job in accordance with the regulations on this.

18 I'm trying to figure out what our role is
19 in reviewing this, and what do we come out with at the
20 end of the design cert stage?

21 MS. CUBBAGE: Sure. I mean from a staff
22 perspective, I can tell you that we do have a few
23 slides to explain the design acceptance criteria or
24 DAC process, where this all gets verified. The design
25 gets completed in accordance with the process that's

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1 been approved. So at this stage, it's more of a
2 process that we're going to be reviewing and
3 approving, and then the design gets fulfilled through
4 the ITAAC process.

5 MEMBER MAYNARD: Why do this chapter this
6 way and not for the other approach? I mean you could
7 almost take that approach with --

8 MS. CUBBAGE: The Commission has set
9 policy in this area, where in the control room design
10 and I&C, because of the rapidly-evolving technology,
11 because a certification lasts for 15 years and then
12 after that, a combined license applicant would take
13 some period of time to build the plant, you could have
14 as much as say 20, 25 years down the road before the
15 plant comes on line. So the technology is expected to
16 evolve.

17 MEMBER MAYNARD: Okay. I understand.

18 MR. JENKINS: So I just wanted to spend a
19 few minutes on our approach to this, and what
20 objectives we had, as it is programmatic. First and
21 foremost, of course, is compliance with applicable
22 regulatory basis. It goes without saying. I think
23 the staff is going to discuss that a little deeper.

24 The second item up there is elimination
25 and mitigation of human error. I'm certain that's

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1 embedded in it. I think keep in mind this is beyond
2 just what is done in the safety systems, but it's well
3 what also occurs in the secondary of the plant,
4 because we're protecting the safety, but we're also
5 trying to protect the efficiency of the rest of the
6 systems.

7 So it does cover things like inspection
8 and maintenance, and how that relates to the
9 operability.

10 Then part of our development here is that
11 we're trying to reduce the number of design
12 iterations, particularly in detailed design on needs
13 to add instrumentation late in the plant project or a
14 change of display graphics and those things.

15 So this top-down process I'm going to
16 speak to in a few minutes, is heavily focused on
17 trying to reduce the number of iterations.

18 MR. WALLIS: When you do those iterations,
19 do you have -- sorry. When you do these iterations,
20 do you have some sort of criteria you're trying to
21 meet, in terms of the level of human error and
22 operability risk? How do you know when your design is
23 good enough?

24 Has it met some sort of criteria which
25 says the probability of human error is below some

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1 level or something, or is it all just that it feels
2 good?

3 MR. JENKINS: Well, it's not just that it
4 feels good. There are quantitative measures and
5 they're sort of -- not sort of. There are risk
6 assessment measures in our human reliability
7 assessment. But I'm going to talk in a few minutes
8 about the verification and validation of these
9 efforts, because I think that's --

10 MR. WALLIS: Because when I read the SER,
11 I was full of the same sort of refrain all the time,
12 which was saying you've set some sort of high level
13 discursive objectives. But there's no indication of
14 how you're going to analyze them in order to meet
15 them.

16 It kept on repeating throughout the SER.
17 I could give you quotes here, but I mean the same
18 -- yes, you've set these objectives which sound good,
19 but you haven't put in place a mechanism to make them
20 happen.

21 MR. JENKINS: Well sir, I don't know if
22 you've had a chance to review all the plans that have
23 been submitted in licensing topical reports, but
24 there's a thousand pages of plans. That's quite
25 literal. There are a thousand pages of plans that

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1 describe every step of the process that I'm going to
2 walk you through in a few minutes.

3 I also wanted to mention that we do
4 consider this a process that helps to integrate the
5 plant design in many areas. It is cross-functional
6 with many of the other disciplines, very much like the
7 PRA and some of the safety analysis work. It touches
8 all aspects of the engineering design process, and we
9 take advantage of that.

10 Then last, we also take the opportunity to
11 bring in customer requirements at an early stage of
12 the development. This is done like what's done in
13 airline industries and many other industries.

14 So at the center of our program is the
15 concept of human-centered design. This is terminology
16 right out of our new Reg 0711. But basically, it
17 simply says that all of design aspects should think
18 about operability.

19 Again, it's not all that unusual. It's
20 very much the military's been doing this for many,
21 many years. We design the helicopter around the
22 helicopter pilot, as a key and critical part of the
23 overall function.

24 So the new regs that define the guidance,
25 new Reg 711 and 0700, and I'm just going to quickly

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1 walk through some of those materials shortly. It
2 includes all the plant systems that are germane to the
3 safety and economic operation of the plant, including
4 what gets displayed and operable from the main control
5 room, the technical support center, the remote
6 shutdown system and safety-significant local panels.
7 So those are the panels out in the field.

8 As well our group has the organizational
9 design authority, which the staff looks for very
10 carefully. I'm on the same level as my peers in
11 mechanical and electrical and I&C systems, to help
12 drive human factors requirements into the rest of the
13 design process.

14 MR. BONACA: You don't have yet EPGs
15 developed, right?

16 MR. JENKINS: Yes sir.

17 MR. BONACA: You do?

18 MR. JENKINS: No, we don't have EPGs
19 today, but we will, yes. I mean Wayne Marquino from
20 GE spoke earlier about the development of EPGs, but
21 they are an integral part of the human factors process
22 as well.

23 MR. BONACA: Because I mean some of the
24 location of the instrumentation may be keyed on some
25 critical EPG.

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1 MR. JENKINS: That's exactly right, and
2 you'll see as we do this, early development of this
3 instrumentation is critically important.

4 I've got another slide to walk you through
5 when that happens. There was a question over here I
6 didn't quite hear, sir?

7 MEMBER BLEY: No, go ahead.

8 MR. JENKINS: Okay. The new reg is rather
9 prescriptive on suggesting what a team of human
10 factors folks might look like, and I'm going to walk
11 through that just quickly. But it is
12 multidisciplinary and very comprehensive.

13 Then we also track issues that are
14 developed out of human factors, in a process that
15 drives for resolution.

16 I would like to jump to operating
17 experience. Certainly, we have a program that
18 captures operating experience from not only the
19 existing BWR fleet and non-BWR nuclear power plants,
20 but we also look outside the country.

21 We have spent quite a lot of time looking
22 at the performance of the ABWR in Japan. We've talked
23 to the French folks who have got quite a lot of
24 digital equipment in the N4 plants, and in the non-
25 nuclear industry, we've been talking to people who run

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1 fossil power plants, as well as -- I'm jumping ahead,
2 but in the interest of time.

3 We collect predecessor plant data, and
4 that is what were the design basis for the previous
5 BWRs. Most notably, the ABWR and the SBWR, where we
6 developed some simulation of these processes.

7 The ABWR for Lung Min follows new Reg 0711
8 Rev 1, and we've built upon that in our development
9 here in Rev 2.

10 MEMBER BLEY: Can I ask a question about
11 that?

12 MR. JENKINS: Yes.

13 MEMBER BLEY: You cited the Japanese
14 experience with the ABWR and the DCD talked about that
15 too. Are you really getting real information out of
16 the Japanese plant?

17 (Simultaneous discussion.)

18 MR. JENKINS: Yes sir. I think you'd be
19 surprised. What happened here is that we took a trip
20 there that was well organized in advance. You recall
21 that we have a Japanese partner, Hitachi. They hosted
22 us quite well.

23 We went with a questionnaire of 50
24 questions. They answered them rather clearly. So
25 it's mostly verbal. But they also gave us some

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1 Japanese material that we had interpreted with some
2 help, and yeah, it's a substantial report on their
3 experience.

4 Just to give you one example, they changed
5 the size of the screens after they had the VDU screens
6 themselves. They were too small from the original
7 design. That plant had a black background for those
8 wide display panels with a contrast experience with
9 that, versus the green background that we had in our
10 Lung Min, Taiwan plant.

11 So there's several questions we went there
12 with, and we got some pretty good answers. We were
13 surprised that we could get such answers. We didn't
14 expect that.

15 MEMBER BLEY: I think the one in Taiwan's
16 not running yet, right?

17 MR. JENKINS: That's correct.

18 MEMBER BLEY: But are you getting
19 information somehow? Are they having operators
20 interact with --

21 MR. JENKINS: Oh yes. We are -- in fact,
22 we just recently completed the site acceptance test of
23 the simulator, and they've been running plant
24 operators through the simulator, and we have collected
25 experience from that as well. Yes sir. They've been,

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1 I think, quite supportive.

2 Okay, let's move on. Now this is a bit of
3 an eye chart. If you can look at your paper, this
4 chart comes pretty much derived from the new Reg 0711.

5 MEMBER BLEY: Before you start on that --

6 MR. JENKINS: Yes.

7 MEMBER BLEY: This page, the previous
8 page, you talk about -- the previous page you talk
9 about the operator participation in the control room
10 design. I've been involved in three of those
11 projects, and that's probably the most important
12 thing.

13 I would also use the operator as well as
14 senior operators, because they're the ones that day to
15 day have to manipulate the controls. I think you need
16 your procedures before you design the control room.

17 MR. JENKINS: I think --

18 MEMBER BLEY: Everything should be in
19 order if you can do it that way.

20 MR. JENKINS: So I'll jump ahead. We have
21 21 senior reactor operators on our staff, and that's
22 representing more than -- that's 21. That represents
23 more than 400 years of senior reactor operator
24 experience.

25 MEMBER BLEY: And they're current?

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1 MR. JENKINS: They are current.

2 MEMBER BLEY: Not used to be.

3 MR. JENKINS: They are current.

4 MEMBER BLEY: On actual operating plants?

5 MR. JENKINS: Yes sir. Out of -- I got
6 several out of the Brown's Ferry restart. I have
7 several from Brunswick, and I have several who have
8 had experience with digital upgrades at power plants.
9 Put in either fuel water cold system upgrades --

10 MEMBER STETKAR: That's not an integrated
11 digital upgrade. Do you have any experience with
12 people who have gone through complete digital
13 upgrades, as have several plants internationally?

14 MR. JENKINS: I personally have. I worked
15 at the Temela plant in the Czech Republic, and we
16 learned quite a lot out of that.

17 MEMBER STETKAR: You worked at Temela?
18 Okay.

19 MR. JENKINS: Yes. I was directly
20 involved in the independent V&V of the I&C system that
21 Westinghouse established there.

22 MEMBER STETKAR: By the way, I certainly
23 didn't get the impression of the depth of operating
24 experience that you have on the team from the
25 information in DCD, where in fact in the DCD, it's

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1 notable that the operating experience requirements on
2 the team are much less than any other discipline.

3 The DCD indicates that you need an SRO
4 with two years of operating experience, where
5 everybody else needs at least four years of
6 experience. So I didn't hear that you have that.

7 MR. JENKINS: We were very aggressive at
8 this, because for a number of reasons. Firstly, we
9 asked for utility SROs from our customers, and they
10 supplied four actually, who've been living with us
11 from day one.

12 They're in our offices; they work under
13 our procedures to develop the HFE. But going beyond
14 that, the engineering management for ESBWR is an ex-
15 SRO and plant manager from Brunswick, and that has
16 certainly helped us to gather that experience.

17 MEMBER STETKAR: Well but again, ex-SRO
18 and plant manager isn't the same as a real reactor
19 operator. I'm an ex-SRO, but I never sat on the
20 boards in my life, except for one night.

21 MR. JENKINS: Well, I'm referring to --
22 I'm referring to licensed operators who stood watch.

23 MEMBER STETKAR: Stood watch.

24 MR. JENKINS: Including our engineering
25 manager.

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1 MR. STADDLE: Actually, because beyond
2 that --

3 VOICES: Use the microphone.

4 MR. STADDLE: I'm Rick Staddle. It
5 actually goes beyond that, because we also involve the
6 current operators at our customers in our review of
7 these topical reports and also the RAI responses.
8 That's built into our process as well.

9 MEMBER STETKAR: That's a lot better.

10 MR. JENKINS: Thank you. The next slide.

11 So again, this comes right out of the new reg. I
12 just want to walk through this as quickly as I can.
13 Across the top are design inputs. Certainly, the DCD,
14 heavy influence from the probabilistic risk assessment
15 and its associated human reliability assessment.

16 Again as well, a heavy influence of
17 operating experiences, and that includes going through
18 databases like the INPO database and the NRC database,
19 as well as OE from outside the industry.

20 The element there called the baseline
21 review record, BRR, is our internal collection of
22 previous BWR designs and design data. Then the D3 is
23 the Defense Indepth and Diversity Analysis of the I&C
24 system, and that is to deal with common cost failures
25 of the DCIS.

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1 All of that is fed into, and more, is fed
2 into our operational analysis, going to the question
3 earlier the gentlemen asked this. This is where we
4 determine how this plant will be operated.

5 It begins with the functional requirements
6 analysis, FRA, identifying exactly what functions we
7 need, what sort of redundancy we desire. We then jump
8 into the allocation of functions, where we determine
9 whether that function is going to be automatic, manual
10 or both, and most of the elements here are both.

11 Finally is the detailed task analysis, and
12 this task analysis walks through every system and
13 determines point by point how will those valve line-
14 ups be, what pumps get started first. It's very
15 specific and it leads to procedures, to your earlier
16 question.

17 That's similar to a job task analysis, but
18 it goes beyond that. It does convert rather carefully
19 and closely to the actual procedures of the plant. It
20 also develops concepts and requirements that go into
21 the staffing and qualification of the operators.

22 We do begin with a baseline, but then we
23 have the ability to modify that baseline for
24 particular skills sets or education. We circulate on
25 these things more than once, including things like the

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1 HRA, where we're going back and forth with the PRA
2 folks as the detail plant design evolves.

3 Going beyond that, they feed into three
4 big boxes. In the middle there is the human system
5 interface, and this is the primary interface with the
6 operator. This is all about the development of
7 alarms, the development of how the screens look, how
8 do you interact with the computer-based procedures, as
9 well as what does the lighting look like, what does
10 the furniture look like, very much of the
11 anthropometrics and ergonomics you've heard of before.

12 We have developed a mock-up of how this
13 will look. It's in foam board at the moment, but it
14 will be replaced with plywood that will include the
15 mounting of display units, and then of course we are
16 building a part task simulator as we speak, that will
17 simulate most of the plant functions.

18 MEMBER BLEY: I've got a little bit of a
19 general question for you. With this new design you're
20 working with, with all digital I&C systems and control
21 systems, can you tell me just a little bit about the
22 interaction between your group and the group that's
23 doing Chapter 7, and now you have a machine that
24 really has an integrated control system that's a
25 little different from the machines before, where

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1 operators knew the machine well and the I&C was kind
2 of an overlay.

3 Your possible problems, I'm guessing in
4 the I&C, can lead to a machine that might not respond
5 the way just the hardware system would, and how is
6 that being factored into your derivations?

7 MR. JENKINS: Well, we have another slide
8 on it, but let me jump ahead. So we develop
9 requirements for the I&C folks, including response
10 requirements. How fast does a display need to update?

11 I mean it goes well beyond that. What do colors look
12 like? What does symbology look like?

13 So we developed those requirements. They
14 go into the I&C system. They're partly -- they're
15 wholly tracked by the software QA elements of the I&C
16 production. Then we come to the back end of it, and
17 we do verification and validation, that they've
18 implemented the design that we specified.

19 So we're a specifying group.

20 MEMBER BLEY: Well, one last question.
21 Coming back the other way, you had to work with the
22 idea that failures, faults in the digital systems,
23 either software or hardware, how that can affect the
24 operator and how that works into your procedure
25 planning?

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1 MR. JENKINS: Yes sir. So again, it's
2 been part of our working together with them. But to
3 give you an example, one of the requirements that
4 we've developed is that if you have loss of
5 communication with your digital network, okay, we want
6 to see that clearly in the operator's face.

7 We want him to have, you know, some color
8 code or some flashing mode that tells us that he's
9 lost communication on a particular parameter or a
10 group of parameters. So we're back and forth with
11 them rather -- well daily, I would say.

12 MEMBER BLEY: Are you co-located with
13 them?

14 MR. JENKINS: I'm sorry?

15 MEMBER BLEY: Are you co-located with
16 them?

17 MR. JENKINS: Well no, except that they
18 have staff that are co-located with us. It's a small
19 staff, but --

20 MR. WALLIS: Can I ask you something here?
21 I'm trying to follow this process. We heard this
22 morning that lots of other things that are analyzed in
23 the DCD are conservative analysis for various
24 regulatory purposes.

25 When you get down to a simulator, I would

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1 think you'd want to have a realistic model of what
2 happens?

3 MR. JENKINS: That's correct, sir. It's a
4 best estimate model.

5 MR. WALLIS: Right.

6 MR. JENKINS: Yes sir, that's correct.

7 MR. WALLIS: And it may be rather
8 different from what's in the DCD then?

9 MR. JENKINS: That's right, and in fact,
10 you asked earlier about the EOPs, and how those
11 procedures are developed. Well, they're developed in
12 this process. They use a best estimate simulation to
13 decide what are the operator actions that would be
14 taken within that first 72 hours, for example.

15 MR. WALLIS: So when you're on the
16 simulator, the pressure in the wetwell doesn't follow
17 the curve which is in the DCD then presumably?

18 MR. JENKINS: Well, I can't answer that
19 specific. Our guys have run out, I think.

20 MR. STADDLE: Yes. A lot of these things
21 come out when the operators perform the task analysis.

22 So we're developing the simulator. We're building
23 the simulator in parallel with this whole HFE process.

24 So that's why we're using part task simulator, to
25 kind of learn from how -- what the operators need to

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1 see in order to respond to the various events.

2 We take those, and we feed those back into
3 not only the simulator development but also the plant
4 development processes, so that we can evolve the
5 design.

6 MR. WALLIS: So the accident to which they
7 are responding is a realistic accident. It's not the
8 design-basis accident. It's something which is more
9 realistic than that?

10 MR. JENKINS: Yes, and let's leave that
11 for the safety analysis folks to answer. But sir, our
12 approach to the simulator build is that it will have
13 TRAC as its middle point, and it will be running the
14 best estimates decks of TRAC, if you will.

15 MEMBER BLEY: Can you fill in the gap of
16 my knowledge? What's a part task simulator?

17 MR. JENKINS: Well, this ANS 3.5 now has
18 an appendix that describes what is a part task
19 simulator. So it may be part, in terms of the number
20 of systems that it models. But those systems are
21 modeled to the full fidelity of what you find in the
22 rest of the ANS 3.5 requirements.

23 Okay. So again, it's critically important
24 to understand that both the procedures, the plant
25 design, if you will embodied, in simulation and the

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1 training program get validated and verified as a
2 composite holistic set. Then there's feedback to the
3 rest of the plant design on do we have to address
4 procedures? Do we have to address the human system
5 interface? Where do we have to add instruments, as
6 someone asked earlier?

7 MEMBER BLEY: Have there been cases so far
8 where your work has led to some modification in the
9 design?

10 MR. JENKINS: There have been cases where
11 we have recommended modifications to the design. They
12 are still under consideration, whether those
13 recommendations will be made. But I'll give one
14 example where it was made, and that is that there is a
15 new floor plan layout for the control room.

16 We've moved some walls around and that
17 will be an update in the next DCD update. So that's
18 direct impact of actually the application of 0711, and
19 operating experience.

20 MEMBER ABDEL-KHALIK: If TRACG is going to
21 be the heart of the modeling engine in the simulator,
22 how would you independently validate it?

23 MR. JENKINS: Well, this is always a
24 question in simulation, especially as it relates to
25 training simulators. The validation is not meant to

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1 be the same level as safety-related validation, okay.

2 It isn't. But we will have a simulator validation
3 that walks through various scenarios.

4 Again, if you look at ANS 3.5, it defines
5 the acceptance criteria of those scenarios.

6 MEMBER ABDEL-KHALIK: But it's defined in
7 terms of percentage difference between --

8 MR. JENKINS: Yes, it is.

9 MEMBER ABDEL-KHALIK: --the simulated
10 values of the parameters. But what other tool are you
11 going to compare against?

12 MR. JENKINS: You mean in terms of other
13 codes?

14 MEMBER ABDEL-KHALIK: Right. I mean if
15 this is the best tool you've got, and it's the heart
16 of your simulator, what are you going to apply these
17 acceptance criteria in ANS 3.5 to?

18 MR. JENKINS: I will have to get back to
19 you on that question, with the safety analysis folks
20 and whatever tools they're going to use. There is a
21 process within GE for code validation, and it will be
22 applied here. But they're the right folks to answer
23 that question.

24 MEMBER ABDEL-KHALIK: Okay.

25 MEMBER STETKAR: Tom, I need some help

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1 getting something straight in my mind, and that is if
2 I place an order for ESBWR today --

3 MR. JENKINS: Thank you.

4 MEMBER STETKAR: You're welcome.

5 (Laughter.)

6 MEMBER STETKAR: Is there today, could you
7 show me the control room design, and then tell me how?

8 MR. JENKINS: No.

9 MEMBER STETKAR: You could not?

10 MR. JENKINS: I could show you the mock-
11 up; I could show you our conceptual design that I'm
12 showing you here. But it will go through several
13 iterations before it's finalized, including -- let me
14 give you an example of capturing later technologies.

15 We haven't yet decided whether those
16 screens will be plasma or they'll be LCD or real
17 projection LCD.

18 MEMBER STETKAR: Those are small details
19 compared to the bigger things that Dennis alluded to,
20 and that is if I'm an operator, one of my operators,
21 because I'm ordering this plant, needs to know how to
22 interact with the integrated digital instrument
23 control system.

24 How do I reset signals? How do I override
25 certain signals? Under what conditions? What type of

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1 human interaction does that take? I don't have any
2 idea how that will be done right at the moment, do I?

3 MR. JENKINS: Except for specific areas,
4 and you mentioned overrides, the nuclear
5 instrumentation, for example, and its bypasses are
6 still done in basically four position toggle switches
7 that are on the left-hand side of that.

8 MEMBER STETKAR: I'm talking about larger,
9 larger integrated --

10 MR. JENKINS: Right, right. That's going
11 to be evolutionary.

12 MEMBER STETKAR: Thanks. That helps me at
13 least to get a picture of where we are, specification
14 versus design versus something that's actually real
15 space.

16 MR. JENKINS: So, okay. Let's move on to
17 the next screen. I can't read this, but basically
18 the skill set, it comes out of the definitions as
19 established in the Reg 07 web, and then what I wanted
20 to do with this slide is show you how we apply those
21 skills sets to each of the various activities.

22 MR. WALLIS: Do these people have to know
23 anything about thermohydraulics?

24 MR. JENKINS: Well, there's certainly the
25 plant operations. But don't leave out this system

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1 engineer column, if you see that second column there.

2 That system engineer comes from the mechanical part
3 of the project. It comes from the safety analysis
4 part of the project. That's a generic term for other
5 disciplines.

6 MR. WALLIS: Well, I was intrigued,
7 because on Side 4 you said you were integrating HFE
8 into all engineering disciplines.

9 MR. JENKINS: That's -- well, there's not
10 a lot of impact to civil, for example, but some, as
11 the example I just gave of the changing around the
12 control room structure.

13 MR. WALLIS: So do these guys read the DCD
14 or something? What do they do?

15 MR. JENKINS: Yes. They study the DCD.
16 They participate in design reviews. They're trained
17 in all the same procedures, yes sir.

18 MR. WALLIS: So they pretty well
19 understand a lot of the technology, how it works and
20 where the energy goes and where the vegetables go and
21 things like that?

22 MR. JENKINS: A large percentage of the
23 reactor operators, for example, are degreed engineers,
24 and have been system engineers in their previous life.
25 They do get loaned out to other groups to assist in

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1 some ad hoc issues. We've had one of our engineers
2 heavily engaged in some of the DCD revisions that are
3 going on right now.

4 Okay. I think we've got so much more to
5 cover. The next slide really does try to address your
6 question about the design integration, and the -- so
7 these boxes are color-coded to show which disciplines
8 are engaged in this particular example.

9 The operating experience review, for
10 example, is actually managed by the system engineer,
11 mechanical engineer, electrical engineer. We support
12 him; we provide him with the tools. We do a lot of
13 the searches for him. But he owns the answer and the
14 result there.

15 This is not a sidebar project. This is
16 integrated deeply into the plant system development.
17 Moving right along, as we go down that path,
18 requirements coming out of our functional area and
19 allocation and task analysis do get embedded in the
20 system design specs, that again the system engineer
21 owns, as well as drive into the I&C logic development
22 in the green boxes.

23 Then you see that we come back and we're
24 responsible --

25 MR. WALLIS: These remind me of the

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1 various sections of your document and of the SER.
2 There's FRA, gap analysis, function allocation, task
3 analysis and so on. When I read the staff conclusions
4 on almost all of these items, I saw the same things I
5 said before, that you've sort of put in plans at a
6 very general level, but there aren't any specific
7 criteria for analysis. Are you going to give more
8 specifics in the future?

9 MR. JENKINS: Again, I could let staff
10 discuss that, but we've submitted a thousand pages,
11 and behind each of those thousand pages there are the
12 work instructions and other work plans.

13 MR. WALLIS: It just didn't get, didn't
14 come to the surface somehow?

15 MR. JENKINS: Yes, that would be my
16 opinion.

17 MEMBER ABDEL-KHALIK: But there are
18 systems that heretofore have not been built anywhere.

19 MR. JENKINS: I'm sorry?

20 MEMBER ABDEL-KHALIK: There are some
21 systems that don't exist in any other planes.

22 MR. JENKINS: That's correct.

23 MEMBER ABDEL-KHALIK: So where do you
24 collect the operating experience the guides the civil
25 engineer?

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1 MR. JENKINS: Okay, so our group has done
2 a review, for example, of DODOWR. DODOWR came up
3 earlier in this conversation. We've also done a
4 review of some of the older plants that did have, for
5 example, isolation condensers. So we do collect
6 operating experience anywhere and everywhere we can
7 get it.

8 Let's jump to the next page, and this goes
9 to the question that was asked earlier, about what is
10 our integration with the I&C and the software
11 development.

12 I briefly explained on the bottom there is
13 the software life cycle. That's a Chapter 7-described
14 process, following IEEE standards for software
15 development. On the top there is the HFE process, and
16 we're just showing some very specific interface
17 between those two processes.

18 They're also embodied in the main MMIS,
19 that's man-machine interface system human factors
20 engineering program plan that describes this back and
21 forth.

22 On the top level, it means we're sending
23 in requirements, and they're verifying and validating
24 those requirements as they're being developed.

25 I missed on the bigger chart, I missed one

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1 element that I'd like to talk about here, and that is
2 that computer screens can be changed, right? It's not
3 so hard to change what a video looks like. But this
4 program has, is referred to as Human Performance
5 Monitoring.

6 It goes into the plant. It's a plan that
7 the operator absorbs from our process, and he has to
8 maintain that design basis. So that means that if he
9 makes or suggests that he make modifications, he
10 actually has to back up and go through these earlier
11 elements to convince the staff that he is still
12 following the overall plan.

13 MEMBER BLEY: Could you give us an example
14 of something like that?

15 MR. JENKINS: Yes sir. So before, you
16 made a substantial change to maybe how the piping
17 looks on a safety-related screen. You would go
18 through an analysis that says does it still support
19 how the task analysis was written? Does it still
20 support the procedures that were constructed, and then
21 can you test it in a simulator with operators, and
22 determine that it still meets the criteria?

23 You can include evaluating if he made
24 -- in that first evaluation, did he make errors trying
25 to use the system. You can actually capture that with

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1 a good simulator, and that's what we're building here.

2 Let's jump to the next one. I've already
3 mentioned the LPRs and the staff is not just reactor
4 operators. There are human factors engineers; there
5 are simulation engineers; and human system interface
6 design folks. Some of those HSI folks are I&C-based
7 folks, with a lot of years experience.

8 Then there are two people assigned to our
9 group, that interact with the PRA and the HRA groups
10 on a regular basis. But they are trained in HRA and
11 they are trained in PRA, but they're assigned to my
12 group.

13 We've hosted three audits from the staff,
14 demonstrating compliance, reviewing interim products
15 and detailed work instructions and methodologies. So
16 back to the question earlier about where's the detail.

17 We've been able to show them some interim
18 products similar to some we showed here today. We've
19 established the integrated engineering process in a
20 formal way within our project, and we have developed
21 an integrated schedule, again capturing the logic that
22 you've seen in these previous charts.

23 We've established the issue tracking
24 system. I've covered the other elements. Go ahead.
25 I've already mentioned the visits to Japan, the ABWR

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1 review, the French Connection, if you will. We did
2 back on the SBWR development we go to France.

3 INPO recently went to France, and we have
4 their result from their benchmarking study. We also
5 made some calls to France recently about their use of
6 computerized procedures and their use of touch
7 screens. They have abandoned touch screens, and they
8 are still refining how they use computerized
9 procedures.

10 MEMBER BLEY: Why have they done that?

11 MR. JENKINS: I'm sorry?

12 MEMBER BLEY: Did they tell you why
13 they've abandoned the touch screens? What kind of
14 problems did they have?

15 MR. JENKINS: Yes. They had reliability
16 problems. They were replacing them quite often, and
17 of course you need to keep in mind they had -- they've
18 been in operation for 10, 12 years already. So
19 they're wearing out, if they were good to begin with.

20 MEMBER BLEY: Touch it and it doesn't
21 work.

22 (Laughter.)

23 MR. JENKINS: I've already mentioned -- I
24 did also go to Boeing. We looked at how they use
25 interacting devices at Boeing. They use a fixed touch

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1 pad on the pilot's right hand, and they also use for
2 the equivalent of their flight bag, they have a touch
3 screen on the left-hand side. So they actually use
4 both. But we learned a bit from that.

5 We went and looked at the Osprey
6 development. That was quite interesting as well, is
7 how they use colors. We are in fact looking to adopt
8 some of their color scheme. Let's see if I've covered
9 these already.

10 MR. WALLIS: How about chemical plants?
11 Have you looked at chemical plants?

12 MR. JENKINS: No, not in visits. We have
13 some reports, I believe --

14 MR. WALLIS: They have a similar problem,
15 and they have a big system and they have all kinds of
16 screens and defense and so on.

17 MR. JENKINS: We focused on two fossil
18 power plants to get a better view of that. You know a
19 number of process plants aren't quite as integrated as
20 you might think a power plant is.

21 We've done functional requirements
22 analysis of 16 systems, operating experience reports,
23 specific reports for 16 systems. The last bullet
24 here. We have prototyped our process all the way
25 through to the development of procedures and training,

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1 and that was something that we showed the staff in one
2 of their audits, again deriving procedures from the
3 task analysis.

4 Let's see. One more point here. It's not
5 just General Electric Hitachi doing this. Our
6 architect engineers also have a responsible part of
7 this. They're doing the functional requirements
8 analysis first time through under our guidance and
9 training. Then we are evaluating the results and
10 providing feedback and control.

11 Next slide. Going a bit further on the
12 program execution, I mentioned that we've already
13 developed a simulation platform. We've developed a
14 mock-up on the floor plan modifications. We've done
15 several studies to support what we're doing, and a
16 study of color schemes.

17 Man Machine Interface or Human System
18 Interface, pointing devices, the debate over touch
19 screens versus a mouse, anthropometrics and
20 demographics, what's happening with the demographics
21 of who's going to operate these plants over many
22 years. There's been a debate around the units of
23 measure as they show up in the control room.

24 MR. WALLIS: Are you going to go to some
25 international unit, or are you going to stick with PSI

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1 and that sort of thing?

2 MR. JENKINS: Our customers clearly want
3 U.S. customary units. A good part of our safety
4 analysis is in SI units.

5 MR. WALLIS: These are things called
6 ancient British units, you mean, the ones --

7 MR. JENKINS: Yes. That's U.S. customer.
8 Yes sir.

9 MEMBER STETKAR: You mentioned the part
10 scale simulators. What are your plans for final
11 implementation of the full scope simulator?

12 MR. JENKINS: Well Thank you for
13 mentioning that or asking that. Everything that we're
14 doing in the modeling space build-up and when we've
15 completed all the systems, and it is a full scope
16 simulator for training purposes.

17 MEMBER STETKAR: So it's just growing?

18 MR. JENKINS: It's growing.

19 MEMBER STETKAR: But do you have a -- I
20 hesitate to ask this, but a time line or a schedule
21 for that? Because from the human factors engineering
22 and evaluation process, until you have that integrated
23 simulator, where you can look at real time evolution
24 of responses, all of the man machine interface studies
25 and kind of paper, regardless of what you do, they're

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1 not realistic.

2 MR. JENKINS: Right. Well, they're well
3 along the way. I mean the part task simulator is
4 going to cover, you know, 60, 70 of the 100 systems.
5 So it's going to cover the primary loop and all the
6 circulated systems, as well as the program is
7 iterative, right.

8 So we'll do all that verification again on
9 the full scope simulator, and that is a commitment.
10 We've also been working with the COL applicants about
11 when do we have to have that full scope simulator
12 ready in order to train a number of new operators and
13 different classes and all of that? So we're deeply
14 into that conversation.

15 MEMBER STETKAR: But the plan is not to
16 have that in place before, certainly before the design
17 certification?

18 MR. JENKINS: That's right. It will be
19 standard for all the plants, as will the procedures
20 and the training.

21 MEMBER STETKAR: Yes, that was my -- yes.
22 I mean the whole -- part of my confusion is if you're
23 headed towards a standardized design for all of the
24 plants, including standardized procedures and all of
25 the human interface things, you know, when does that

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1 see fruition?

2 MR. JENKINS: The current plan is that the
3 procedures and training developed for the first
4 customer will be adopted by all the future customers,
5 and so far they've agreed to that.

6 MEMBER STETKAR: At the lead COL stage?

7 MR. JENKINS: Yes.

8 MEMBER STETKAR: I'm sorry. You can wait
9 until the staff's presentation if you want.

10 MR. JENKINS: Okay. These are just some
11 of the other activities. I'll jump to the last
12 bullet. So where we've been actively engaged in the
13 program design manual that determines things like
14 plant tags and equipment component numbering, and
15 we've modified the basic GE previous years of
16 standard.

17 As it is, a number of plants have retagged
18 equipment after GE delivered it. With the support of
19 the customers we won't face that in this plant. We
20 will as well pass that obligation down to our vendors.

21 So equipment that we purchased will have a human
22 factor tag hanging on it when it's delivered to the
23 plant. Okay. Yes. Any other questions?

24 MEMBER BLEY: Yeah, I've got a couple. In
25 the beginning of the DCD, you talk about the HFE

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1 program goals, and there's a couple of them. I'd like
2 to hear a little bit about how you've been able to
3 reach these goals.

4 One is how you're ensuring that operator
5 vigilance is maintained, and the other ones are how
6 you're ensuring that personal tasks are accomplished
7 within time limits.

8 MR. JENKINS: Okay. So the time limits,
9 let me take the easy one first. There are certain
10 assumptions made in the PRA and as well derived from
11 data from the safety analysis, on how quickly an
12 operator needs to take action.

13 From the safety basis, it's 72 hours.
14 But not dealing with the question of what would we do
15 beyond that. So that data is fed into our process,
16 and we have to validate that that operator can perform
17 whatever time constraints have been given to us,
18 including that verification.

19 If he has to, you know, go out of the
20 control room or send an auxiliary operator out to a
21 local panel, we'll have to validate how long it takes
22 him to actually get there.

23 MEMBER BLEY: Will there be some aspects
24 of the PRA then feeding back to the operator, in
25 places where the operator wouldn't normally know he

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1 had certain time limits?

2 MR. JENKINS: That's correct. The PRA
3 input to us is substantial. They give us a list of
4 what they consider to be requirements into our
5 process, and we close the loop. We go through that
6 and we come back to them and say "You know, that's
7 unrealistic" or we think we can do better than that,
8 and refine the PRA.

9 MEMBER BLEY: The harder question?

10 MR. JENKINS: Oh, I almost got through
11 that. Operator vigilance in an all-digital plant
12 where not much happens for 18 to 24 months is an issue
13 in existing plants. You know, we can develop
14 procedures. We'll develop training, but it comes down
15 to how the operator or the infrastructure of the plant
16 actually operates the plant.

17 What does the SRO do? What are his tasks,
18 and even things like administrative tasks, what do
19 they get engaged in on an hour by hour basis. There
20 are certainly things that they -- data that they
21 collect, like operator logs and other events.

22 It's not a simple answer. We're going to
23 verify and validate as much as we can. We'll be
24 looking for vigilance as we go through our testing,
25 and the human performance monitoring aspect of what

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1 the owners are obligated to take on, we'll certainly
2 be challenging that.

3 MEMBER BLEY: Was I misreading your goal?
4 The way I understand it --

5 MR. JENKINS: No, the goal is clear.

6 MEMBER BLEY: You were trying to improve
7 the vigilance through your design of the human system.
8 I mean that is --

9 MR. JENKINS: Uh-huh. Yes, that is our
10 goal, absolutely our goal. It's a question of how to
11 measure that.

12 MEMBER BLEY: Ways to measure and do it.
13 One last one if I might is there's a lot of talk in
14 the DCD about how the PRA and the human reliability
15 analysis feeds into the design work. Are your people
16 directly involved in the HRA? That's the first half
17 of the question.

18 The second half, are you driving the kinds
19 of human actions that are to be modeled in the PRA?

20 MR. JENKINS: The first question yes. We
21 are integral to the HRA development. We have been in
22 discussions with them on what are their filtering
23 factors or performance factors. So then we feed back
24 to them as well, what might be adjustments to their
25 program or their calculations.

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1 MEMBER BLEY: That's what I was getting
2 at. I suspect there are areas where experience won't
3 help them in identifying the kinds of actions and
4 potential errors that might occur with these new
5 systems. Your people might be better equipped to do
6 that. Is that part of your role now?

7 MR. JENKINS: Yes it is, sir. Yes, it is.
8 I mean the operating experience that we get out of,
9 for example, the digital upgrades that we already have
10 on individual systems in the U.S. has created quite a
11 lot of operating experience.

12 That will go two ways. That will go into
13 the design of the I&C system, and that would go back
14 into the PRA as well.

15 MEMBER BLEY: I guess we're going to see
16 the PRA next meeting or something like that?

17 VOICE: In June.

18 MEMBER BLEY: In June. Maybe some of your
19 people will be at that meeting?

20 MR. JENKINS: Probably our HRA fellow,
21 which is -- yes. Okay, thank you.

22 CHAIRMAN CORRADINI: Thank you. We turn
23 to the staff now.

24 MR. GALVIN: My name's Dennis Galvin. I
25 guess they're passing out the slides momentarily. I'm

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1 the project manager and the staff here is joining us.

2 Slide 2. You know, the purpose of the
3 briefing today is to brief you on our continuing
4 review of the DCD. I've just listed the sections of
5 the DCD. We're covering all the sections in Chapter
6 18.

7 GE gave you a pretty good overview of all
8 the reports they've given. The sections are the same.
9 We're also here to answer your questions.

10 Slide 3. Again, my name is Dennis Galvin.
11 I'm the lead project manager for the staff. Our
12 technical reviewer is James Bongarra, and we also have
13 today with us John O'Hara from Brookhaven. Jim
14 Higgins also reviewed it. He is not available today.

15 Our presentation will cover the
16 regulations, the RAI status summary. We've already
17 have a brief discussion on DAC. I'll make a few more
18 points again. Then the technical staff will talk
19 about the review objectives we used, the NOR review of
20 the review. There's raised review levels we
21 performed. We'll give you an overview of the open
22 items and then an overall summary.

23 So the key regulations, of course, are 10
24 C.F.R. 52. The particular regulation for human
25 factors is 10 C.F.R. 50.34(f)(2)(iii). Control room

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1 design reflects state of the art human factors
2 principles. That's the key regulation. All the rest
3 flows from that.

4 Press review guidance. Again, new Reg
5 0800, Chapter 18. The majority of the detailed review
6 criteria, acceptance criteria come from new Reg 0711,
7 which was developed over many years, and also review
8 of the human system interface draws on new Reg 0700.

9 Slide 6. Originally, there was a total of
10 266 RAIs. There's been a number of supplements.
11 Number of RAI resolved is 200. Number of remaining
12 open items is 66. That's what's in the SER. GE has
13 responded to 54 of the open items, many rather
14 recently, and the response is on 12 of the open items.

15 MEMBER BLEY: Is there anything about
16 certifying a process rather than a design, that's
17 caused you folks any difficulties or concerns?

18 MR. GALVIN: I think the technical staff
19 can answer that question. I don't know. Do you want
20 to say anything right now?

21 MEMBER BLEY: Well, I'll be glad to wait
22 for it.

23 MS. CUBBAGE: Well, I guess the one thing
24 I'll add is this is the fifth design certification.
25 So we've done this four times before, and maybe Jim

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1 can elaborate, if he has anything specific to say
2 about that.

3 MR. BONGARRA: If I may, Jim Bongarra.
4 I'd like to try and address that when Dennis finishes
5 his introduction, and perhaps in the process of going
6 through the overall approach that we take, it might
7 become clear that I think there, you know, there are
8 problems, but we're trying to deal with them.

9 MR. GALVIN: I've given you the -- Slide 7
10 has the basic Commission policy statements. Design
11 acceptance criteria is a set of prescribed limits,
12 parameters, procedures and attributes which go into
13 the DCD, which the NRC relies on in a limited number
14 of technical areas, to support our final safety
15 determination.

16 A list of design certification. That's in
17 a case where the design is not complete. So in Slide
18 8, currently the three design areas where the
19 Commission uses DAC is piping, instrumentation and
20 controls, and the control room, which is human factors
21 engineering.

22 I've got a statement. Amy said it
23 previously. This comes from those four Commission
24 papers. It's used repeatedly that I&C and the control
25 room area is the area where the technology is rapidly

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1 developing. If you certify that design, then it's
2 likely to become obsolete before it's implemented.

3 So you don't really have to do that.
4 They've used -- you certify the process, and then
5 through audits and inspections, you verify that the
6 design was complete, that the design was done
7 according to the process. So the staff has somewhat
8 of an involvement in looking at the design.

9 Actually, I've included it in DCD Tier 1.

10 It's a special kind of ITAAC. Normally, you can call
11 it design ITAAC, and this would have -- there's DAC
12 ITAAC and a normal ITAAC. The DAC ITAAC, both of
13 those would apply to areas we have DACs, such as the
14 control room.

15 Again, you verify that the systems were
16 designed in accordance with the license and the
17 regulations, with the process or the attributes or
18 procedures or methods used put into the design
19 certification.

20 MS. CUBBAGE: Getting back your question
21 earlier, Mr. Stetkar, the ITAAC will become a
22 condition of the license when we issue a combined
23 license. They are completed and fulfilled post-
24 issuance of the license, but prior to authorization to
25 load fuel.

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1 There are some specific regulatory
2 requirements with some of the human factors area, that
3 pull those completions to much earlier than loading
4 fuel. For example, you have to have trained operators
5 a certain period of time before.

6 MEMBER STETKAR: Those types of -- if I
7 can talk about training and procedures, are one type
8 of human factors, engineering requirements that are in
9 a sense, if I can use the term, soft. They're easily
10 changed. They don't affect anything substantial in
11 terms of capital investment or basic design.

12 Many other parts of human factors
13 engineering can and should have a direct impact on the
14 design. How systems instrumentation and control are
15 designed; how the control panels are laid out;
16 response times; the type of information that's
17 displayed; how it's displayed and hierarchic designers
18 need to do this. It's not the same as rewriting a
19 procedure.

20 MS. CUBBAGE: Right, and with having the
21 two different types of ITAAC, design and as-built, the
22 NRC will be involved in verification of the design
23 portion prior to the construction. So you mentioned
24 capital investment and things like that.

25 We're going to be involved at all stages

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1 along the line, such that we're going to make
2 conclusions about verifying that they've designed the
3 equipment in accordance with the license, and then
4 later we can verify that the as-built is in
5 conformance with the design.

6 MEMBER STETKAR: In time, that first
7 review occurs at the COL application stage?

8 MS. CUBBAGE: After we issue the license.
9 The ITAAC are a condition of the license. Those
10 activities may be ongoing, but there's no requirement
11 that they be completed or verified prior to issuance
12 of a combined license.

13 MEMBER STETKAR: Thank you.

14 CHAIRMAN CORRADINI: But they must all be
15 -- just to -- I thought I got you, in your answer
16 John, up to a point. So that before loading fuel, all
17 must be completed?

18 MS. CUBBAGE: All ITAAC, yes.

19 CHAIRMAN CORRADINI: But anywhere in the
20 time period between the time that the COL is license
21 and a load of fuel, these could be completed, but they
22 will be checked at the end by some sort of inspection
23 process?

24 VOICE: Before fuel up.

25 CHAIRMAN CORRADINI: Before fuel up.

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1 MEMBER STETKAR: But the problem I have is
2 suppose during the review you identify a substantial
3 deviation from implementation of basic human factors
4 engineering process, that would require a change to
5 the control room layout.

6 Rather severe, but according to your
7 process, you would not identify that until the
8 permission to load fuel? That's it. That seems
9 rather late in the whole process here.

10 MS. CUBBAGE: That's not what I said.
11 There's two different types of ITAAC, and it's
12 certainly incumbent upon any licensee to get us to
13 verify that the design has been completed in
14 conformance with the license prior to them procuring
15 and fabricating and installing equipment.

16 MEMBER STETKAR: Well, it's incumbent on
17 them, but there's also --

18 MS. CUBBAGE: And we're getting into a
19 whole other area of DAC closure, which is something
20 that the NRC is working on with the Construction
21 Inspection Program, and the what and the how of DAC
22 closure is still being worked out with industry.

23 But I guess what I'm conveying to you is
24 the vision that these design portions could be
25 completed and verified prior to installation.

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1 MEMBER STETKAR: They could. I mean I
2 personally would be, because I don't -- I haven't been
3 on the committee. I haven't been through any of the
4 other design certifications. I was quite surprised
5 that the design certification didn't have that
6 finality of control room design in it.

7 From a vendor and from a licensee's
8 perspective, if I can be a bit cynical here, if I were
9 the vendor or the licensee, I would like as much
10 flexibility to postpone those decisions as long as
11 possible, because that allows me that flexibility.

12 MS. CUBBAGE: And the Commission has
13 allowed the use of DAC in these areas.

14 MEMBER STETKAR: Okay. Thanks. I'll have
15 to learn how that process works.

16 MR. GALVIN: I would briefly mentioned
17 that the staff has a RAI open with the applicant, that
18 they need to work out the schedule. It's the reg
19 guide, and it's open, so it hasn't been finalized yet.

20 The staff has repeatedly notified GE and
21 the other applicants that they need to give us a
22 reasonable schedule, or you're going to have the exact
23 problem you discussed. So the staff's aware of that
24 and is working the issue.

25 Next, technical lead Jim Bongarra will go

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1 into the details of the review.

2 MR. BONGARRA: Good afternoon. My name,
3 as Dennis mentioned, is Jim Bongarra, and I'm the lead
4 technical reviewer for the ESBWR human factors portion
5 of the design certification review. Before I begin
6 here, I'd just like to thank the ISO committee for
7 allowing us to come before you today, to present our,
8 really what I consider to be short of a status report
9 here, more than certainly a complete report on where
10 we stand with a review of Chapter 18 for ESBWR,
11 because this is truly a work in progress.

12 As you know already, we have completed
13 essentially a safety evaluation with open items. And
14 as Dennis mentioned in his presentation, there are
15 number of open items that we're still working actively
16 with GEH to resolve. So there are many questions that
17 remain open with us in Chapter 18, and we feel
18 confident with continuing to work with GEH, that we
19 will certainly resolve these questions before we
20 actually write our final SE.

21 I'd like to also introduce or further
22 introduce to you Dr. John O'Hara, who is sitting to my
23 right. As Dennis also mentioned, John is with
24 Brookhaven National Lab, and Jim Higgins, a colleague
25 who is not with us today, have been principal

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1 contributors to the review of Chapter 18 for the SBWR.

2 So I'm going to be calling on John from time to time,
3 to say a few words as well.

4 I might also add here that John and Jim
5 have worked with the staff for all of the design
6 certification reviews that we've done over the years,
7 starting with ABWR right on through to the AP 1000,
8 and of course now ESBWR. So they've had a wealth of
9 experience working with the staff, and we certainly
10 appreciate having had them with us and we can
11 certainly look forward to continuing to have them with
12 us.

13 And also both Jim and John were principal
14 contributors or are principal contributors to
15 developing the staff's review guidance. That has been
16 referred to a number of times in the presentation
17 here. That is, new Reg 0711. I will just hold up
18 there a copy of this document for you.

19 In case you have not been familiar with
20 it, it's certainly available to the committee and the
21 subcommittee, and we'll I'm sure make it available to
22 you if indeed you wish to have it. But this is
23 essentially our guidance and criteria that we use to
24 review new plant designs, human factors aspects of new
25 plant designs.

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1 Okay. The next slide, which is already
2 up, thank you. What I'm really showing here to the
3 subcommittee is really an overview or in the sense of
4 background here, the activities really that comprise
5 the NRC's human factors engineering evaluation
6 process.

7 Tom in his presentation really has already
8 gone through, in a little different fashion, what you
9 see up on the slide. This is indeed the process that
10 we use to evaluate the human factors aspects of new
11 plant designs.

12 I'm going to go into more detail as we
13 continue here on these review activities, the 12 that
14 you see in front of you, in just a few moments.

15 The staff has used the process that you
16 see in front of you, with some variation and I think
17 improvements over the past decade or so, to review all
18 of the HFE programs for the four previously certified
19 designs.

20 So it's not a new process. It's a process
21 that has evolved, as our experience with reviewing,
22 essentially as Dr. Bligh had mentioned, a process as
23 opposed to a complete design. It's evolved, to allow
24 us to hopefully do a robust job in essentially working
25 with information that we have at the time of design

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1 certification.

2 One of the things that's on the slide is a
3 statement here of rationale for the process, and I
4 thought what I would do here, given the fact that Dr.
5 O'Hara has indeed authored, through the document. I
6 was going to give him an opportunity at this point to
7 kind of go over just quickly with you the rationale
8 for the program. John?

9 DR. O'HARA: Hi. As Jim said, he asked me
10 to give a little bit of the rationale and background
11 for this process. As you can see, I can see from some
12 of your questions, this is a different approach than
13 probably what you're used to seeing.

14 But this -- for those of you that remember
15 back to the 80's, and even into the 90's, when the
16 control rooms were reviewed post-TMI, basically what
17 happened then was folks went into the control room.
18 They had checklists, you know. They walked around the
19 control room, they looked at the meters, they measured
20 how high the work stations were, and basically did a
21 review using the staff's available guidance, which
22 came out in the 80's, in new Reg 0700 and they did
23 detailed control room design reviews.

24 Okay. In the late 80's into around 1990,
25 when the ABWR was submitted for the staff review and

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1 as you all know, that was the first of the Part 52
2 reviews. When you turn to Chapter 18, rather than
3 seeing a control room, you saw some concept designs,
4 some key features that might be in this control room,
5 might be in this control room.

6 So we as the reviewers were left to ask
7 well how do we review this? You know, we certainly
8 cannot use the guidance that we have at hand, because
9 the guidance we have at hand is deficient in two ways.

10 One is you need a control room, and we
11 didn't have a control room. Secondly is the, you
12 know, the new generation of control rooms are
13 computer-based control rooms, tied up with digital
14 information control systems.

15 The guidance available to the staff at the
16 time was really for the 1950's, 60's type control
17 room, pretty much analog technology, boiler gauges,
18 flip switches, all that type of technology. So even
19 if a control room was presented, which it wasn't, you
20 really couldn't use the available guidance to review
21 it because it was for a much older technology.

22 That set us off on a pathway to figure out
23 a way to try to evaluate the control rooms. We knew
24 the ABWR wasn't going to present the control room, and
25 we had good suspicions based on what Westinghouse was

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1 doing and what Combustion Engineering was doing, that
2 we weren't going to see finished control rooms for
3 those applications either.

4 So basically what we did is we stepped
5 back and started from square one, and asked well, if
6 we don't have a control room, how are we going to do a
7 safety review?

8 That led us to looking at well how are
9 control rooms designed, not just in the nuclear
10 industry, but in other complex safety-critical type
11 systems like military systems, like aerospace systems?

12 You know, what does a human factors program look
13 like, that I could at least begin to look at
14 something, in order to do an evaluation.

15 So we actually did a pretty extensive
16 study, looking at again, you know, the nuclear
17 industry, the standards for control room and human
18 system interface design, what's done in other
19 industries.

20 We basically boiled it down to saying you
21 know, there's a set of core activities that has to
22 take place, and those are the activities that are in
23 that diagram that Jim has up there.

24 We went then further to say well, if I go
25 in and I look at these core activities, what can I

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1 look at to see if they're doing these core activities
2 in a positive way? How would I know how well they're
3 doing task analysis, or how would I know how well
4 they're doing verification and validation?

5 It was that study that originally led to
6 this approach of not only looking at the end product,
7 because first of all we couldn't do that, but second
8 of all we concluded that's not a good idea. There's a
9 much better idea with systems that are highly tied in
10 with software, where what you see with the physical
11 control room itself is almost unimportant relative to
12 how the information is displayed, how the alarms are
13 processed.

14 Because everything's processed. You know,
15 it's not like the old control rooms where if single
16 sensors, single enunciator type of control room. No,
17 these are processed, and they're processed using
18 different rules.

19 The information that's displayed goes
20 through signal validation. You know, you're not
21 necessarily looking at straightforward information,
22 you know, coming from the sensors, and the same is
23 true of controls. There's various levels of controls.

24 I don't want to answer Dennis' question now about
25 vigilance, but a lot of the current approaches to

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1 automation have keeping operators in the loop mentally
2 as part of their logic.

3 You know, you could start up the plant on
4 auto, but it's not a good idea to do that. So
5 basically what we did is we set out. We developed
6 this review model. It had the key activities, it had
7 the review criteria which we developed into it.

8 That was reviewed by your ACRS; not you
9 guys, ACRS, but the ACRS back around the ABWR time
10 frame. It's also been out for public comment and
11 review on several occasions, and we have revised it
12 several times based on lessons learned.

13 You know, the ABWR, the first time this
14 approach to review was published, it was published as
15 an appendix to the SER for the ABWR, and then it was
16 published as a new reg unto itself and then revised,
17 you know, based on use and lessons learned.

18 I might also just throw in, this document
19 is used very broadly. It's used in other industries;
20 it's used by the military. It's used -- portions of
21 it have been adopted by various standards
22 organizations like ISO and IEEE.

23 So through our use of it and through our
24 experience using it and getting feedback from others,
25 you know, we have made modifications to this process

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1 over time. But it is a process and product-oriented
2 review, as you've seen.

3 MR. CHARY: Thank you, gentlemen. I think
4 we're going to try to speed this up a little, hoping
5 to be done with this topic by five o'clock.

6 MR. BONGARRA: Okay. I had planned to
7 talk in some level of detail, and I think I'm going to
8 try and shorten that up a little bit, about each of
9 the 12 elements that you saw in the figure in front of
10 you, which is no longer in front of you.

11 But what I was really trying to get across
12 here in these next few slides is essentially you've
13 heard already from Tom Jenkins, essentially how
14 Westing, I mean GEH -- apologies, apologies.

15 VOICE: Apologize to me.

16 (Laughter.)

17 MR. BONGARRA: I knew that was going to
18 happen. How GEH has essentially proposed to address
19 the elements, and what I just simply want to do is
20 tell you what we do as the staff, in terms of
21 reviewing those elements.

22 Let me just start with the first one,
23 which is on your slide. It's identified as human
24 factors engineering program management, okay. Now we
25 have certain objectives, and these are objectives are

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1 called out in new Reg 0711 and in the standard review
2 plan.

3 This is the, represents our objectives for
4 ensuring that each one of these activities or elements
5 is met, and along with those objectives, we have
6 criteria. Somebody asked earlier about criteria.
7 Well this is where we the staff have criteria. They
8 are included in our review document.

9 So the staff's objective for, and if I go
10 too quickly here, please stop me. The staff's
11 objective for evaluating the activity of human factors
12 engineering program management, as an example, is to
13 verify that the applicant has the human factors
14 engineering design team, the processes and procedures
15 and the technical program to carry out an overall
16 human factors process in place, to make sure that
17 human factors engineering is incorporated in the
18 overall engineering design of this new plant.

19 That's what we look for essentially in
20 that particular element. We want to verify that those
21 items are there, that those items are incorporated in
22 the plan.

23 Now I just want to mention here in terms
24 of what GEH has accomplished here, they have provided
25 us already, as part of their design certification,

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1 essentially a complete human factors engineering
2 program management plan.

3 So what we have done, then, is we have
4 been able to, and you'll see in a moment there are
5 different levels of review that we accomplish,
6 depending upon the level of information that's
7 provided, we close this item out, as part of the
8 design certification.

9 It's not an open item; it's complete, and
10 we believe that that was the case because of the level
11 of information that GEH provided us with.

12 MR. WALLIS: But isn't it like saying in
13 order to play basketball, you have to have a team. It
14 doesn't say anything about how good the team is, does
15 it?

16 MR. BONGARRA: Well what it says, sir, is
17 it's not just the team, but it has qualifications that
18 are associated with the team as well. It's quite a
19 bit more than just the team.

20 MR. WALLIS: Very specific, yes. Okay,
21 thank you.

22 MR. BONGARRA: Okay. You're welcome.

23 MEMBER STETKAR: Can I just ask a follow-
24 up, because we're not going to get through all the
25 slides, so I'm skipping ahead here, but you've

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1 completed a complete element review for the program
2 management plan.

3 You've completed -- you're in the process
4 of performing an implementation plan review for all of
5 the rest of the elements, which is just basic human
6 factors engineering.

7 MR. BONGARRA: Yes.

8 MEMBER STETKAR: Is there -- will a
9 complete element review be performed and finished, of
10 all of those other elements of the human factors
11 engineering, before the design certification SER is
12 issued?

13 MS. CUBBAGE: No.

14 MR. BONGARRA: No, no. We are --

15 MEMBER STETKAR: So we don't even have a
16 complete review of a plan or process.

17 MR. BONGARRA: No, we have a complete
18 review of implementation plans. In other words, by
19 the time the design certification is complete and we
20 issue our final SE, we will have -- hopefully we will
21 have a complete implementation plan for each of the
22 remaining 11 activities that compose the overall
23 program.

24 MEMBER STETKAR: What's the difference
25 between a complete element review of a plan and an

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1 implementation plan review of a plan? It sounds to me
2 like if I was reviewing a plan, I would want to review
3 the whole plan.

4 MS. CUBBAGE: The difference between an
5 element being complete and an implementation plan
6 being reviewed and approved, to be implemented later
7 and verified --

8 MEMBER STETKAR: Well, is this like an
9 implementation plan, as I plan to drive from
10 Washington to San Francisco, and that requires me to
11 go from east to west, and that's an implementation
12 plan, compared to a complete plan, which would be the
13 actual roads that I'm going to drive on and things
14 like that?

15 I'm confused about the level of -- what's
16 reviewed for the design certification?

17 MR. BONGARRA: We do have two slides on
18 the difference between an implementation plan and a
19 complete element review. Let me just quickly try and
20 tell you what that is.

21 Essentially, an implementation plan
22 identifies a process to accomplish a particular
23 activity. For example, there is one element or one
24 activity within that 12 activities I had in the first
25 slide, and it has to do with completing a task

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1 analysis. We've heard this before, okay.

2 What GEH has indicated to us or given to
3 us for review at this point is a methodology, a
4 process for doing this task analysis, and it's a
5 relatively robust methodology. I say that, and let me
6 also just kind of circle back to a question I believe
7 that was asked earlier or mentioned earlier.

8 The DCD for the Chapter 18 for the ESBWR
9 is not terribly detailed, and the reason for that is
10 because similar to other vendors in the past, what GEH
11 has chosen to do was to put a good number of details,
12 if you will, in their -- in NEDOs. These are
13 documents that were also on your screen earlier.

14 So with that said, there is a methodology
15 for doing a task analysis. They haven't completed
16 doing the task analysis. If they had completed doing
17 the task analysis, then we would review a complete
18 element. We'd do a complete element review. We'd
19 have a product, a complete product.

20 That's the difference between doing an
21 implementation plan review, i.e. reviewing a
22 methodology for producing a product, versus doing a
23 complete element or complete activity review, i.e.,
24 looking at that final product, looking at a final task
25 analysis, a complete task analysis. Does that clear

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1 things up, make sense?

2 MEMBER STETKAR: That helps me.

3 MS. CUBBAGE: I think I understand why --

4 (Simultaneous discussion.)

5 MEMBER STETKAR: I'm a little more
6 confused, because they haven't really done the
7 management. So I'm not sure --

8 MS. CUBBAGE: Well, I think what's
9 confusing you as well is that first topical report,
10 33217, has the title of "Implementation Plan." But
11 you've determined that they've done enough to complete
12 that element.

13 MR. BONGARRA: Yes.

14 (Off the mike comment.)

15 MEMBER STETKAR: Well, not being part of
16 the process and only being able to read what we can
17 see, it's confusing.

18 MR. BONGARRA: And I'm sure you have --

19 MEMBER STETKAR: I come back to my analogy
20 about driving across the country. I'm trying to
21 figure it out.

22 DR. O'HARA: Yes. It's a little
23 confusion. That first, you know, so-called element of
24 human factors. I mean basically, you know, all that
25 really is is their plan. So you have to separate that

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1 off from all the others. All the others are actually
2 analyses or design efforts are going to be with
3 products, with specific products.

4 MEMBER STETKAR: That's true, even though
5 the NEDO documents all use the word "plan," because
6 what we have so far is all in the plans.

7 DR. O'HARA: Right. We don't have the
8 completed products of those plans yet. So but it's a
9 bit of an unfortunate set of terminology, in the sense
10 that that first element, you know --

11 MEMBER STETKAR: Is also called a plan.

12 DR. O'HARA: Is also called a plan, but
13 really that's all you have is the plan.

14 (Off the mike comment.)

15 DR. O'HARA: That's what set up. The
16 product is what gets produced by all these other
17 implementation plans.

18 (Off the mike comment.)

19 DR. O'HARA: Yes. There would probably be
20 a better way to represent it than what we did.

21 MR. BONGARRA: Hopefully that puts it in
22 better perspective. Thanks John for doing that. I'm
23 not going to obviously have time to go through these,
24 and I'm not sure that the subcommittee wants to go
25 through these, okay.

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1 Let me then see if I could just quickly
2 move on to some of the real meat here of this slide.
3 What did you say Amy?

4 (Off the mike comment.)

5 MR. BONGARRA: Yes. Let me just skip
6 through all of the other elements that I didn't talk
7 about, and let's see here. Well, I could -- 15? Let
8 me go to slide -- I've had a request for Slide 15,
9 which is -- thank you. Okay. I apologize here. My
10 slides are not numbered the same for some reason.

11 Okay, Slide 15. This just an overview
12 here of essentially what GH has provided to us.
13 Again, the material that we received from GEH is truly
14 consistent with the proposed design acceptance
15 criteria approach that Amy and Dennis have spoken to
16 earlier.

17 That design acceptance criteria approach
18 is what we've just been talking about really, in terms
19 of the fact that what GEH is giving us for human
20 factors engineering are methods. It's a process, not
21 the complete product.

22 We don't have, as Tom mentioned in his
23 presentation, a complete design, i.e., we don't have a
24 control room. We have something close to it perhaps,
25 in terms of the simulator. But nonetheless, the staff

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1 does not have an essentially complete design, as far
2 as this human system interface goes, for the control
3 room, and for that matter for any control facilities
4 in the plant. So we're using the DAC approach, and
5 that is indeed consistent with what we've done in the
6 past for previous reviews.

7 MR. WALLIS: Fundamentally it's something
8 I understand. I mean if someone said I have a plan to
9 evaluate the energy and mass balances and the heat
10 transfer in the LOCA, that sounds good. But we've
11 learned that the devil is always in the detail, and
12 until you look at exactly how it's done, you don't
13 really have much of an idea about how good it is.

14 MR. CHARY: Let me try to address that. I
15 guess this is one of those where --

16 MR. WALLIS: It's the same thing with
17 these human factors?

18 MR. CHARY: Yes. Let me try to address
19 that. This is one of those areas that have gotten all
20 the way up to the Commission in terms of what level of
21 detail we would be reviewing.

22 MR. WALLIS: But doesn't the problem
23 eventually come down to getting the details right?

24 MR. CHARY: And we do that through the DAC
25 process.

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1 MR. WALLIS: That's when the real
2 decisions get made, is in the DAC process?

3 MR. CHARY: That's where the detailed
4 design in the actual control room is actually procured
5 and designed and built and yes, that's where it's
6 done.

7 But in those areas, and those are three
8 unique areas, and you'll be hearing about those in the
9 coming months. The first one is human factors. This
10 is the first time we talked about DAC.

11 Human factors, I&C and piping design.
12 Those three areas have been approved to use this
13 process, the DAC process.

14 CHAIRMAN CORRADINI: What are the three
15 again?

16 MR. CHARY: Human factors, which is this
17 Chapter 18, I&C and piping.

18 CHAIRMAN CORRADINI: And is GE going to
19 use all of those as DAC, or are they going to do the
20 piping?

21 MR. CHARY: All three.

22 CHAIRMAN CORRADINI: All three?

23 MR. CHARY: Yes.

24 CHAIRMAN CORRADINI: Why piping? Or no,
25 that's the wrong verb.

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1 MS. CUBBAGE: June 18th.

2 CHAIRMAN CORRADINI: Oh, June 18th. Thank
3 you.

4 MS. CUBBAGE: We'll defer that, yes.

5 CHAIRMAN CORRADINI: That's a perfect
6 answer. Thank you.

7 MR. WALLIS: What does piping mean in this
8 context? Is piping a technical term, or does it
9 actually mean pipes that carry fluid or something?

10 MS. CUBBAGE: It's pipes, and we're going
11 to talk about it on June 18th.

12 MR. BONGARRA: Okay. To keep things
13 moving here, I'd like to know if there are further
14 questions at this point. I'd like to go to Slide 19,
15 which really is kind of the nub of things here. This
16 slide is to identify really what are we consider to be
17 some of the more pertinent open items that are
18 remaining to be addressed, before we can actually
19 complete our safety evaluation.

20 And as you can see from the slide I think,
21 and certainly from probably the discussions you've had
22 with other tech review groups, we really don't have
23 many items of the 60 or so that were identified
24 earlier, that I would consider that kind of bend the
25 flagpole here.

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1 We have a few, however, but they're not
2 overwhelming. At least we don't believe they are.
3 One of them in that slide that you're seeing there is
4 identified as level of design in some implementation
5 plans.

6 Most of the remaining items, open items,
7 relate to requests that we have that are outstanding
8 for basically what we have been kind of classifying,
9 if you will, as clarification issues. There's just
10 not enough information in some of the open items that
11 we have to give the staff confidence that we have the
12 technical background that we need in order to close
13 out an item.

14 So a number of what the issues that we
15 have are what are related to level of detail in these
16 plans. Task analysis, HSI design, which we didn't
17 talk about, and verification and validation plans. A
18 very important plan, by the way that GEH has been
19 working on to revise, and we have just received some
20 input from them.

21 Pardon me. We still have need to look at
22 those most recent responses. But when we put these
23 slides together, that was an item that came up as
24 being one of the open items that we wanted to mention
25 to you. A second one is --

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1 MR. WALLIS: I'm sorry. I'm just an
2 outsider to this, but it seems to me that you're
3 asking for the meat. When you're getting something,
4 you're saying here, you presented us the philosophy
5 and the sort of overview of things. Now give us the
6 meat.

7 That seems to be a major task. What's
8 missing seems to be something major here, isn't it?

9 MS. CUBBAGE: Well, in light of the fact
10 that GE has responded to 54 of the remaining 66 open
11 items --

12 MR. WALLIS: But if I were looking at this
13 in terms of a critique of the sort of analysis I
14 understand, I would say you've told us how you might
15 approach it, but you haven't given us any analysis
16 yet. That means that most of the answer is missing.

17 MS. CUBBAGE: Well, we've asked for more
18 detail and it's being provided.

19 MR. WALLIS: Isn't it a lot that's
20 missing, or is it just rounding out a few details?
21 It's a lot.

22 DR. O'HARA: Yes. I think when you looked
23 through the SER, you obviously saw all those open
24 items related to detail, and that's more or less where
25 we are now. But I just want to make -- since you

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1 probably haven't had a chance to really look at these
2 NEDOs, these implementation plans, okay.

3 This isn't I'm going to Washington, D.C.
4 I'm going to go west. These are very detailed plans
5 that detail the scope, the specific analysis methods
6 they're going to use, criteria they'll use.

7 You know, so for each of these activities,
8 we're looking for a lot of detail, so I can be
9 confident that I could say at this stage of the game,
10 if they do these analyses in this way, document them
11 this way, check them in this way--

12 MR. WALLIS: Are you saying the detail has
13 to be created now, or is already in the NEDO. It just
14 has to be articulated.

15 DR. O'HARA: In many cases, that's exactly
16 what it is. If you look at GE's hierarchy of the way
17 information is presented, you have the DCD. You have
18 these NEDOs, which have additional detail. Then they
19 have what they call work instructions.

20 Those are the things we've audited. I
21 think Tom put on there that we've been to a couple of
22 audits. So when we look at these plans, we generally
23 will say okay, you know, here's what you're saying
24 you're doing for -- we've been using task analysis --
25 for the task analysis.

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1 We then go there and we look at how they
2 implement those plans. Now they're not done yet.
3 That's why we can't close that out. The plans are
4 done, but the -- they will be done by the time design
5 cert comes. But we can see specifically what they do.

6 Sometimes the details that we're looking
7 for are in the work instructions.

8 MR. WALLIS: So the plan isn't like a sort
9 of Lewis and Clark type of thing. We're going to go
10 west until we find something.

11 DR. O'HARA: No, very detailed.

12 MR. WALLIS: There's more than that to it.

13 DR. O'HARA: It's got to be detailed. We
14 sort of use two litmus test type criteria. One is
15 when I read the level of detail in this plan, do I
16 think they can give this plan to a qualified engineer
17 and they could execute this plan in a reliable,
18 consistent way? When the answer is no, we want more
19 detail.

20 The other question we ask is this is
21 intimately tied up with the DAC. Okay, the closure of
22 the DAC involves doing what you said you were going to
23 do in our NRC-approved plan, which is very detailed.

24 So when they're going to do -- the plans
25 have to be detailed enough that at some point, you can

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1 look at what's produced --

2 MR. WALLIS: And check that it's being
3 done.

4 DR. O'HARA: Exactly. You could have the
5 verification criteria that that DAC has been
6 satisfactorily addressed. So when we review those
7 plans, we use those two criteria. Do I think I can
8 hand this to somebody else and they could actually do
9 this in a reliable way?

10 And secondly, is there enough detail here
11 that downstream, somebody can use this plan and
12 evaluate what they've done, along with the new Reg
13 0711 criteria, to make sure that that they've
14 acceptably met that DAC commitment.

15 MEMBER BLEY: Mr. Chairman, we don't have
16 any of those NEDOs. I think we need to see those.

17 CHAIRMAN CORRADINI: Yes, we do.

18 MEMBER BLEY: We do have those.

19 CHAIRMAN CORRADINI: Oh, we've got NEDOs.

20 MEMBER BLEY: I've got NEDOs about
21 thermohydraulic stuff, and I haven't found any of
22 these.

23 CHAIRMAN CORRADINI: No, I'm sure we do.

24 MEMBER BLEY: I'm not sure about the "we."

25 MR. SHACK: The two of us are kind of

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1 interested in this stuff. Many of them are actually
2 in ADAMS, public ADAMS.

3 MEMBER BLEY: Oh no. That's not a great
4 help to some of us.

5 MS. CUBBAGE: I'm going to be quite honest
6 here, that this is a challenge that the staff has,
7 that there is an enormous amount of material
8 available, and a lot of it is being provided in
9 advance. I know you all don't have time to read all
10 of this, but it has been made available.

11 MR. WALLIS: We're just smart enough to
12 get hold of it.

13 MS. CUBBAGE: No. I mean it was given to
14 the ACRS staff.

15 MR. WALLIS: Oh, okay.

16 (Simultaneous discussion.)

17 MR. BONGARRA: Well, I've been asked to
18 end by five o'clock here. It sounded like somebody
19 needed to do a presentation right on time, so I'm not
20 going to go over the other three items essentially on
21 the slides.

22 I'm just going to simply say here that
23 over the past two and a half years or so that we, the
24 staff, have been reviewing material from GEH, we feel
25 like there has been considerable progress made to

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1 address open items through the RAI responses and the
2 document revisions that they've made for us.

3 I can certainly just simply say to you
4 that there have been a number of revisions. This has
5 been a relatively intensive review for us, so it's
6 been a learning experience, I think, for both parties.

7 So based on the progress that we see to
8 date, it's our belief that there are no major
9 obstacles that are expected to resolve the remaining
10 issues. We think that GEH has used the state of the
11 art techniques for human factors engineering, in terms
12 of developing their HFE program.

13 And where the staff has completed its
14 review, either of the program, the plans or an actual
15 product, we think that the plans and the products have
16 been pretty comprehensive. So thank you very much. I
17 apologize for taking perhaps a minute or two longer.
18 If there are any other questions, certainly please
19 feel free to ask. If not, I will step away.

20 CHAIRMAN CORRADINI: Other questions?

21 (No response.)

22 CHAIRMAN CORRADINI: Okay. If I might
23 suggest to the committee, there is one last thing that
24 I'd like to get time to talk about, and that is GE
25 would like to present their critical reflux data from

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1 the Canadian tests, and we'll have to go into closed
2 session.

3 Other than I say that, I'm not sure what
4 else has to be done.

5 MS. CUBBAGE: They have to change the
6 transcript and we have to clear the room if there's
7 anybody who's --

8 CHAIRMAN CORRADINI: A closed transcript.

9 MS. CUBBAGE: And we need to verify all
10 attendees.

11 CHAIRMAN CORRADINI: Is this like --

12 MEMBER BLEY: (off mike) You look around
13 and make sure we're all acceptable.

14 MS. CUBBAGE: Mike? Alrightee, thanks.

15 (Whereupon, at 4:58 p.m., the meeting was
16 adjourned to closed session.)
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