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5 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
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9 proceeding of the United States Nuclear Regulatory  
10 Commission Advisory Committee on Reactor Safeguards,  
11 as reported herein, is a record of the discussions  
12 recorded at the meeting.  
1314 This transcript has not been reviewed,  
15 corrected, and edited, and it may contain  
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UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION  
+ + + + +  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
(ACRS)  
+ + + + +  
SUBCOMMITTEE ON ESBWR  
+ + + + +  
TUESDAY  
NOVEMBER 17, 2009  
+ + + + +  
ROCKVILLE, MARYLAND  
+ + + + +

The Subcommittee met at the Nuclear  
Regulatory Commission, Two White Flint North, Room  
T2B3, 11545 Rockville Pike, at 8:30 a.m., Dr. Michael  
Corradini, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

MICHAEL L. CORRADINI, Chairman  
SAID ABDEL-KHALIK  
J. SAM ARMIJO  
SANJOY BANERJEE  
DANA A. POWERS  
JOHN W. STETKAR

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1     CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

2             THOMAS S. KRESS

3             GRAHAM B. WALLIS

4     NRC STAFF PRESENT:

5     CHRISTOPHER L. BROWN, Cognizant Staff Engineer and  
6             Designated Federal Official

7             AMY CUBBAGE

8             HANNY WAGAGE

9             MOHAMMED SHUAIBI

10            JOHN McKIRGAN

11            ILKA BERRIOS

12            BRUCE BAVOL

13            JAY LEE

14            DENNIS GALVIN

15            JAMES O'DRISCOLL

16            PAUL PEIRINGER

17            ED FORREST

18            SYED HAIDER

19            AMAR PAL

20     ALSO PRESENT:

21            STEVE MOEN

22            WAYNE MARQUINO

23            MATT SOLMOS (via telephone)

24            MD ALAMGIR (via telephone)

25            JON McLAMB

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1 JESUS DIAZ-QUIROZ (via telephone)  
2 JACK TILLS  
3 RICK WACHOWIAK  
4 DONALD KALINICH  
5 ANTONIO BARRETT  
6 MIKE ARCARO  
7 MIKE SULVA (via telephone)

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

8:30 a.m.

CHAIR CORRADINI: Okay. Why don't we get started?

The meeting will come to order.

This is a meeting of the Advisory Committee on Reactor Safeguards, the ESBWR Subcommittee.

My name is Mike Corradini, Chairman of the Subcommittee.

Today's Subcommittee members in attendance are Said Abdel-Khalik, Sam Armijo, John Stetkar and Sanjoy Banerjee. And our consultants Tom Kress and Graham Wallis.

The purpose of the meeting is to discuss open items, containment, dose and PRA associated with the ESBWR DCD. The Subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and General Electric Hitachi Nuclear Energy regarding these matters.

The Subcommittee will also gather information and analyze relevant issues and facts, formulate proposed positions and actions as appropriate for deliberation by the full Committee.

Christopher Brown is the Designated

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1 Federal Official for this meeting.

2 The rules for participation in today's  
3 meeting have been announced as part of the notice of  
4 this meeting previously published in the *Federal*  
5 *Register* on October 22, 2009.

6 A transcript of the meeting is being kept  
7 and will be made available as stated in the *Federal*  
8 *Register* notice.

9 It's requested that speakers first  
10 identify themselves and speak with sufficient clarity  
11 and volume so that they can be readily heard.

12 We've not received any requests from  
13 members of the public to make oral statements or  
14 written comments.

15 I'll ask that everybody check their cell  
16 phones, make sure they're turned off or put in the  
17 silent mode.

18 We have people on the bridgeline, I  
19 thought. Is that correct?

20 DESIGNATED FEDERAL OFFICIAL BROWN: Yes.

21 CHAIR CORRADINI: Okay. Could you state  
22 your names and affiliation, whoever is there?

23 MR. MOEN: Hello. I'm Steve Moen. I'm  
24 with --

25 CHAIR CORRADINI: No, no, on the

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1 bridgeline. That's all right. We'll get it later.  
2 Okay. We'll skip that part.

3 Let me give some background statements  
4 and then I'll turn it over to Amy Cubbage of staff to  
5 try to introduce the speakers of the day.

6 This is kind of our third meeting over  
7 the last couple of years on containment issues. So  
8 we're coming together on the first topic to,  
9 essentially, review some of the calculations we saw  
10 back in June 17th and to get a better understanding  
11 of the applicant's calculations in comparison to the  
12 staff's audit calculations for containment for design  
13 basis accidents.

14 Also, we're reviewing from, I think,  
15 about 18 months ago work done on ventilation and dose  
16 issues, and tomorrow PRA and human factors  
17 engineering.

18 So with that, I'll turn to Amy and have  
19 your introduce the day's events.

20 MR. CUBBAGE: Good morning. This is Amy  
21 Cubbage, Lead Project Manager for ESBWR.

22 As we had our meetings last month, the  
23 same situation this month. There are a number of  
24 topics we're going to discuss. We're discussing them  
25 for a variety of reasons, some of which there were

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1 open items that the Committee had expressed in  
2 previous interim letters, and in some areas we were  
3 not done with our review at the time of the briefings  
4 in the past. So I'll just run down the events here.

5 On the containment topic there are still  
6 some remaining open issues we're resolving with GE.  
7 So this morning you're going to hear some  
8 presentations from GE, some of which have not been  
9 formally docketed to this staff at this time. So the  
10 staff will make our presentation of the MELCOR  
11 calculations. We may or may not be able to comment on  
12 all the materials that's being presented by GE this  
13 morning.

14 And similarly on the ventilation and  
15 dosage issues, on control and ventilation there still  
16 are remaining open items. We may be hearing from GE  
17 this morning or this afternoon on how they intend to  
18 address those open items.

19 And the design basis dose area, there are  
20 no remaining open items. So this will be a  
21 comparison between the staff calculations and GE's  
22 calculations.

23 And then tomorrow we'll be discussing PRA  
24 and human factors.

25 So I think GE's going to start off here

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1 this morning.

2 CHAIR CORRADINI: Is Wayne our leader  
3 here?

4 MR. MARQUINO: I'm speaking to the first  
5 presentation.

6 MEMBER STETKAR: Let me ask one thing  
7 about the topics. When we met earlier this month I  
8 had some questions about the new isolation and bypass  
9 for control rod drive. Is that part of the--

10 MS. CUBBAGE: Tomorrow.

11 MEMBER STETKAR: That's tomorrow?

12 MS. CUBBAGE: Tomorrow morning GE's going  
13 to make a presentation on that design change.

14 MEMBER STETKAR: I just wanted to make  
15 sure where it fits in. Thanks.

16 MEMBER ARMIJO: Mike, are we in closed  
17 session?

18 CHAIR CORRADINI: No, we are not.

19 MEMBER ARMIJO: Okay.

20 CHAIR CORRADINI: So there are pieces of  
21 information that have been given to the members and  
22 consultants that will not be discussed, but you have  
23 them as backup reference.

24 MEMBER ARMIJO: In this package?

25 CHAIR CORRADINI: In this packet.

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1 Everything will be open here, all proprietary  
2 information has been removed.

3 MEMBER ARMIJO: Okay.

4 CHAIR CORRADINI: And so we will look to  
5 the GE folks to hold us in check

6 MEMBER ARMIJO: Okay.

7 CHAIR CORRADINI: Wayne?

8 MR. MARQUINO: My name is Marquino. I  
9 work for GEH.

10 Matt Solmos, who I hope is on the phone  
11 line, contributed the calculations we're presenting  
12 and as well as Gels and John Burns.

13 Next slide, please.

14 In June there were several staff and ACRS  
15 observations on the TRACG model applied after 72  
16 hours. I'm going to cover calculations we made to  
17 address those observations. Cover vacuum breaker  
18 leak detection and design features to address  
19 radiolytic gases in the piping and heat exchangers of  
20 the ESBWR.

21 Next slide.

22 One of the ACRS consultants noted an  
23 error in the plot of noncondensable gas pressure, an  
24 RAI response. The upper drywell, which is Level 34,  
25 Ring 6 had been plotted as zero noncondensable

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1 partial pressure. And we've corrected that plot and  
2 provided a revised RAI response to the staff.

3 CHAIR CORRADINI: Now can I just ask  
4 about that, Wayne? We may have to roll back a bit,  
5 your memory is probably better than ours. So this  
6 has now been transmitted to staff?

7 MR. MARQUINO: Yes.

8 CHAIR CORRADINI: Okay. Can you identify  
9 what changed on this plot?

10 MR. MARQUINO: Yes. There's a burgundy  
11 line which --

12 CHAIR CORRADINI: Labeled what?

13 MR. MARQUINO: Labeled upper drywell. In  
14 the legend it's labeled upperdry Level 34, Ring 6.

15 CHAIR CORRADINI: Okay.

16 MR. MARQUINO: And at 84 hours the value  
17 is about 10, a little less than 10 kilopascal. And  
18 previously that line was at zero through the time  
19 period.

20 CONSULTANT WALLIS: Level 34; I had a lot  
21 of trouble figuring out where it is. It's not labeled  
22 in one of your figures you showed in July. And as  
23 this is drawn, it seemed to be at the top of the RPV,  
24 which is actually way up in the head. It doesn't  
25 make sense to me. So part of my question at that time

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1 was what is Level 34, where is it, and why is it  
2 characteristic of the upper drywell.

3 MR. MARQUINO: Yes. We had additional  
4 discussion on that in June. The location of Level 34  
5 is given in DCD Figure 6.2-7.

6 CHAIR CORRADINI: You don't happen to  
7 have that electronically in front of you?

8 MR. MARQUINO: I don't. I can't put it  
9 on the NRC computer, but I do have a paper handout of  
10 that figure.

11 CHAIR CORRADINI: That would be very good  
12 of you.

13 This goes back to Graham's original  
14 question and we want to understand where it was and  
15 how it was connected to the next volume. So is that  
16 correct, Graham?

17 CONSULTANT WALLIS: Well, it's not shown  
18 on this figure. And this figure, as we found out in  
19 June or July, whenever it was, is not really  
20 realistic in terms of the actual geometry.

21 CHAIR CORRADINI: Yes.

22 CONSULTANT WALLIS: So I still don't know  
23 where Level 34 is.

24 MR. MARQUINO: Okay. If we could flip  
25 forward two slides. This is slide 5 and it's

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1 intended to address the discussion we had on the  
2 location of Level 34 and 35

3 CHAIR CORRADINI: Graham, can I just  
4 before you -- you handed out this figure. So,  
5 Graham, I don't think I understand your question.  
6 Level 34 as I see it here is at 24.6 meters. You're  
7 saying that's not correct?

8 CONSULTANT WALLIS: It's not labeled.

9 CHAIR CORRADINI: Right. But there's 32  
10 and the next line is 33, and then a 34, is it not?

11 CONSULTANT WALLIS: But that's your  
12 implication. I mean, you could guess.

13 CHAIR CORRADINI: All the rest are  
14 labeled so I just counted.

15 CONSULTANT WALLIS: Yes, but then it goes  
16 across the top of the RPV, doesn't it? Is it on top  
17 of the RPV?

18 MR. MARQUINO: Yes. Now that's a feature  
19 of our nodalization. Yes. The elevation of Level 34  
20 corresponds to the top of the RPV.

21 CONSULTANT WALLIS: But that sticks up  
22 into the dome. It's not in the annulus?

23 Anyway, we had the same discussion before

24 CHAIR CORRADINI: Wayne, I think, I mean  
25 I just want to make sure we don't go through this

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1 again. I think Graham's original question was:  
2 Where is it and what is it connected it? Where is it  
3 physically? Is that correct?

4 CONSULTANT WALLIS: But also when you  
5 look at the physical diagram it doesn't look like  
6 this. The real physical diagram from the real  
7 drawing shows that the reactor is sticking up into a  
8 dome-like containment, the reactor vessel?

9 MR. MARQUINO: Yes.

10 CONSULTANT WALLIS: Which is above Level  
11 34. Level 34, the reactor head sticks up into Level  
12 35. And I don't want to push this because we had  
13 this discussion before.

14 MR. MARQUINO: Okay. I want to clarify  
15 one. I'm trying to explain the discussion we had  
16 before about the elevations of the upper drywell and  
17 the TRACG model. The elevations of Level 34, 24.6  
18 meters corresponds to the ceiling of the drywell  
19 excluding the drywell head. Okay. As you note, the  
20 drywell head extends above the flat ceiling of this  
21 drywell.

22 CONSULTANT WALLIS: Because it goes out  
23 of the picture in fact, well then in reality, right?

24 MR. MARQUINO: It extends above -- I  
25 believe it does extend above 27 meters a little bit.

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1                   CONSULTANT WALLIS: Right. Right. Thank  
2 you.

3                   MR. MARQUINO: The elevation 27 meters,  
4 which is the top of Level 35 corresponds to the  
5 bottom of the PCC IC pools.

6                   MEMBER BANERJEE: So it doesn't have that  
7 dome part? Because it's this dome part that sticks  
8 into --

9                   MR. MARQUINO: Yes.

10                  MEMBER BANERJEE: Maybe if you had  
11 physical picture, it would help as well.

12                  MR. MARQUINO: Well, you're describing  
13 the physical picture. So I think you have a good  
14 visualization of what the physical picture is. And  
15 we don't have a one-to-one correspondence between the  
16 elevations, say the top elevation and the drywell  
17 head area versus the TRACG model. So there's some  
18 approximations that we had to make in the TRACG  
19 model.

20                  MEMBER BANERJEE: Is it because you can't  
21 sort of capture a curved volume like that in TRACG or  
22 --

23                  MR. MARQUINO: Well, yes.

24                  MEMBER BANERJEE: -- is there some other  
25 reason?

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1 MR. MARQUINO: Because we'd have to put  
2 in many, many more cells and make it a CFD type  
3 analysis if you wanted to capture the curvature.

4 CHAIR CORRADINI: I don't know what that  
5 buys you, though.

6 MR. MARQUINO: And I don't think it would  
7 buy us anything. So --

8 CONSULTANT WALLIS: Well, it may not. I  
9 mean, it depends if you've got stratification, you  
10 might get something happening that gets held up in  
11 that region, right, because its got this dome?

12 MEMBER BANERJEE: I don't know. But a  
13 lighter gas could conceivably accumulate there or  
14 not? I mean, give me an answer.

15 MR. MARQUINO: Well, I'm trying to answer  
16 the specific question about what are the elevations  
17 and what is in the TRACG models.

18 MEMBER BANERJEE: You said its not.

19 MR. MARQUINO: So the drywell head space,  
20 it is above the top of the reactor head but it  
21 doesn't up quite as high as it would in reality. It's  
22 maybe a meter short of that. But I think what we had  
23 pretty specific discussion the last time on the GDSCS  
24 compartment. The GDSCS compartment, which is the  
25 outer part of Level 35 goes up to 27 meters, whereas

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1 physically the ceiling there is 24.6. Okay.

2 So you were asking why is there this volume in  
3 Level 35. That is actually a small fraction of the  
4 geometric volume, about 5 percent. So we don't show  
5 the volume fractions on this nodalization diagram,  
6 but the volume assigned to Level 35 in the outer  
7 rings is very small. And we've done a sensitivity  
8 study on these in combination, and we didn't see any  
9 change in the result. Any significant change in the  
10 result.

11 MEMBER BANERJEE: But does the GDCS pool  
12 in the physical world actually go up to the  
13 containment walls or is there a space? I mean here  
14 I'm not clear, but if I look at, say, what you call  
15 GDCS pool on the left hand side of the diagram --

16 MR. MARQUINO: Yes.

17 MEMBER BANERJEE: -- I have some  
18 difficulty making this correspond to the GDCS pool as  
19 I visualize it to be in your design. Does that pool  
20 go all the way to the wall?

21 MR. MARQUINO: Yes.

22 MEMBER BANERJEE: To the containment  
23 wall, right?

24 MR. MARQUINO: Yes.

25 MEMBER BANERJEE: So what is this little

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1 pool here then that you're showing in the diagram?

2 CHAIR CORRADINI: That's a catch pan.

3 MEMBER BANERJEE: That's a -- ahhh.

4 MR. MARQUINO: Yes, that's the fan  
5 discharge.

6 MEMBER BANERJEE: So it's not the GDCS  
7 pool, so why is it called the GDCS pool then?

8 CHAIR CORRADINI: IT just happens where  
9 they put the words.

10 MR. MARQUINO: Well, in the model that  
11 pan is part of the GDCS pool.

12 CHAIR CORRADINI: Right. So just for  
13 everybody's reference, the physical picture that  
14 Graham is talking about is on page 6.2-192 of Chapter  
15 6 of the DCD. And the nodalization is four figures  
16 later on 6.2-198.

17 So you're trying with this to answering  
18 two questions, but I'm going to separate them. One  
19 is what was the volume above the GDCS pool, and that  
20 it's small. That's your first point.

21 MR. MARQUINO: Yes.

22 CHAIR CORRADINI: And let's go back to  
23 the first point that Graham made and Sanjoy is asking  
24 about. So you've captured the proper volume and the  
25 proper elevation of the junction with your TRACG

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1 model, but you've gotten the right volume but not at  
2 the right elevations above the head.

3 And so at least I want to get back to  
4 their question relative to how it communicates to the  
5 rest. It communicates through that junction below on  
6 Level 34, is that correct? Otherwise, it's an  
7 isolated volume above the head.

8 MR. MARQUINO: Yes. It communicates  
9 through -- it's vented through a pipe to the rest of  
10 the drywell. We're talking about the air space in  
11 the GDCS compartment, right?

12 CHAIR CORRADINI: Well, no.

13 MR. MARQUINO: No?

14 CHAIR CORRADINI: That one you've  
15 explained. I'm talking about the first question they  
16 had, which is above where you had you figure labeled  
17 drywell head's airspace.

18 MR. MARQUINO: Yes.

19 CHAIR CORRADINI: That's connected only  
20 down at Level 34 to the rest of the drywell, is that  
21 correct?

22 Do you understand my question?

23 MR. MARQUINO: Yes, I understand your  
24 question. Let me check on that.

25 CHAIR CORRADINI: Because based on the

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1 physical arrangement that Sanjoy and Graham were  
2 asking about, that's the only place it can be  
3 connected.

4 CONSULTANT WALLIS: That's why I didn't  
5 understand where the gas came from at 104 hours, or  
6 something. There's a big squirt of gas into the  
7 drywell head. There's no gas in the drywell head at  
8 all until about 100 and something hours, isn't that  
9 correct? That curve that you've now corrected or is  
10 it in there?

11 There's some sudden events which didn't  
12 make sense to me. And I think it disappears from  
13 some of your later curves. This is flashing in the  
14 GDCS pool, I think.

15 CHAIR CORRADINI: You understand his  
16 question?

17 MR. MARQUINO: Yes, I understand.

18 Matt, are you on the phone? Can we open  
19 up the phone line.

20 CHAIR CORRADINI: Can we open up the  
21 phone line?

22 MR. MARQUINO: Your question is what's  
23 the connection area between the --

24 CONSULTANT WALLIS: How does that gas  
25 suddenly get into the drywell head at 100 and

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1 something hours, that big surge at the bottom there?

2 Do you see that? Where does it come from and why  
3 does it go there since the drywell head is at  
4 presumably an equilibrium with everything else  
5 pressure wise, there's no reason flow should go in  
6 there.

7 MR. SOLMOS: Hello. This is Matt Solmos  
8 at GEH.

9 MR. MARQUINO: We can hear you now, Matt.

10 MR. SOLMOS: Well, the drywell head is  
11 connected to the rest of the drywell just through a  
12 vessel connection down at the interface of Level 34  
13 there. And that flow area is roughly equal -- but  
14 there's also a connection between the GDCS airspace,  
15 and that's part of the sensitivity study that Wayne  
16 mentioned earlier and will be presented a little bit  
17 later. So there is an action between the GDCS  
18 airspace and the drywell head.

19 CONSULTANT WALLIS: Does it show that on  
20 this figure? Is it pipe 82, or what is it?

21 MR. SOLMOS: Pipe 82 and pipe 81.

22 CONSULTANT WALLIS: So it's at the  
23 drywell head?

24 CHAIR CORRADINI: And that's there in the  
25 design for just pressure equalization?

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1 MR. SOLMOS: It's in the model just as a  
2 way to connect the volumes -- GDCS airspace and the  
3 drywell.

4 CHAIR CORRADINI: Right. But from a  
5 design standpoint, forget about the model for the  
6 moment. But from a design standpoint that's pressure  
7 equalization between the upper drywell head and the  
8 GDCS airspace?

9 MR. MARQUINO: Yes. And there is a slot  
10 designed into the upper GDCS airspace that equalizes  
11 pressure with the drywell.

12 CHAIR CORRADINI: Okay. So just to  
13 repeat: There's connection via the equipment hatches  
14 to the rest of the drywell. There's pressure  
15 equalization connection to the upper GDCS airspace  
16 via this piping. And Graham's question is at 104  
17 hour what's happening that you get this bump in  
18 noncondensable gas.

19 CONSULTANT WALLIS: It also happens again  
20 at 158 or something.

21 CHAIR CORRADINI: Yes. Can you help us  
22 there?

23 MR. MARQUINO: Well, in TRACG, it's  
24 admitting noncondensable into the drywell head area.

25 CONSULTANT WALLIS: Why? Why? It was a

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1 big surge. It must be driven by pressure or  
2 something. I mean, in later figures it doesn't  
3 appear. This is an old figure. If you look at newer  
4 figures, that's not there. I think it's the old  
5 history of flashing in the pool.

6 MR. MARQUINO: So let me go back. So  
7 Matt answered the question about the Level 35  
8 communication and there's no communication at Level  
9 35. The communication is at Level 34.

10 CHAIR CORRADINI: Right.

11 MR. MARQUINO: So we have pressure  
12 fluctuations in the model, I should say they happen  
13 at different point. And when the pressure changes  
14 and we have a movement in or out of the drywell head  
15 compartment, that can allow noncondensibles if  
16 they're present at the connecting cell to move into  
17 the drywell head.

18 CONSULTANT WALLIS: But you see I think  
19 there's a lot of history here. That wiggle at this  
20 100 and something hours was originally explained as  
21 being flashing in the GDCS pool. And you talked  
22 about a piston of steam driving out noncondensibile.  
23 I remember this about a year ago. And that now has  
24 disappeared from this scenario. Because in later  
25 figures this wiggle isn't shown.

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1 I think probably you want to throw away  
2 this figure because it's not the story today.

3 MR. MARQUINO: Well, that's --

4 CHAIR CORRADINI: Don't agree with him.

5 MR. MARQUINO: But we had to make a  
6 correction because the plot was incorrect.

7 CONSULTANT WALLIS: But isn't the --

8 MR. MARQUINO: The story today is in DCD  
9 Rev 6 where we have this calculation with crediting  
10 only four fans and we've provided additional detail  
11 to the staff in an updated RAI 6.2-140. So that had  
12 the same parameters, and actually more parameters  
13 covering fan performance. We had sent it with six  
14 fans operating and then we have recently formerly  
15 sent it with --

16 CONSULTANT WALLIS: Because they're  
17 different. So should we just ignore this figure?

18 CHAIR CORRADINI: Wait a minute. Wait a  
19 minute. Let's not go there just yet.

20 So just to be clear DCD Rev 6 that we  
21 have in front of us is the current calculation. And  
22 you did a recalculation with four fans, and that's  
23 what we're looking at here?

24 MR. MARQUINO: No.

25 CHAIR CORRADINI: Okay.

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1 MR. MARQUINO: This is with six fans.

2 CHAIR CORRADINI: Okay. Excuse me. So  
3 this is with six fans.

4 And so I think at least to start with, I  
5 want to understand -- to get back to Graham's  
6 original question what's happening at 104 hours and  
7 158 hours that caused this oscillation. Can anybody  
8 on the phone line answer that?

9 MR. SOLMOS: This is Matt Solmos, GEH.

10 There could be a couple of factors that  
11 could show this kind of oscillation or lead to this  
12 type of oscillation. The first would be the PCC  
13 pools -- we've seen that. As you add water to the  
14 PCC pools the efficiency of the PCC's heat exchangers  
15 changes slightly, actually it upsets the equilibrium  
16 of the system.

17 There's also the PCC fans themselves in  
18 our TRACG model that have a way of oscillating when a  
19 change in either drywell conditions or PCC heat  
20 exchangers conditions change.

21 So that would just be my guess as to  
22 what's going on here.

23 CHAIR CORRADINI: So let me just make  
24 sure. So we can take it as something you can look  
25 into, but I do think it's at least fair to ask the

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1 question so we get a clean answer on this.

2 So you're telling me that there might be  
3 some operator action or some refilling of the pool  
4 and that changes the PCCS efficiency, or vent and fan  
5 performance?

6 MR. SOLMOS: My guess is in this figure,  
7 yes, that could lead to that.

8 CHAIR CORRADINI: So could you take it as  
9 an action item to check that out?

10 MR. ALAMGIR: -- RAI 6.2-140 there's a  
11 corresponding figure S04-C4 that gives you the latest  
12 equivalent of this 6.2-139 RAI.

13 CHAIR CORRADINI: Can you please --

14 CONSULTANT WALLIS: That shows none of  
15 these wiggles. Excuse me. That figure shows none of  
16 these wiggles, the one you just cited. So I assume  
17 the wiggles have gone away.

18 CHAIR CORRADINI: So can you just cite it  
19 again? I didn't write it down fast enough.

20 MR. ALAMGIR: Yes., 6.2-140 S04-C4.

21 CONSULTANT WALLIS: Okay. And on that  
22 there are no wiggles like the ones we're talking  
23 about?

24 MR. ALAMGIR: This is the latest  
25 calculation.

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1 CONSULTANT WALLIS: So we should throw  
2 away this one?

3 CHAIR CORRADINI: I need an answer.

4 MR. MARQUINO: Yes, the pressure response  
5 of this figure is superseded by the 6.2-140 figure in  
6 DCD Rev 6 figure.

7 CONSULTANT WALLIS: Well that should be  
8 made clear right away. Right away. Then we wouldn't  
9 waste time with it.

10 Okay. If this is old stuff, we're not  
11 talking about it, that's fine.

12 MR. MARQUINO: Yes, it's old stuff.

13 CONSULTANT WALLIS: Thank you.

14 MR. ALAMGIR: I want to correct myself.  
15 The figure number is 6.2-140 S05-C4. Not S04.

16 CONSULTANT WALLIS: S04 shows a bounding  
17 case, is that right?

18 MR. ALAMGIR: We had to update to S05  
19 based on some of the questions from NRC. So --

20 CONSULTANT WALLIS: So S04 itself is  
21 superseded with something else?

22 CHAIR CORRADINI: I'm sorry. I'm now  
23 confused. Can you repeat --

24 CONSULTANT WALLIS: But I know S04-C4.

25 CHAIR CORRADINI: But let them answer

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1 first so it's clear what we're doing.

2 So the gentleman on the phone, can you  
3 please repeat yourself?

4 MR. ALAMGIR: Yes. This is Md Alamgir  
5 from GEH.

6 The figure that we sent to NRC for 6.2-  
7 140 S05-C4 is the latest and it has the corresponding  
8 noncondensable pressures in the drywell and GDSC  
9 airspace.

10 CHAIR CORRADINI: Okay. Thank you.

11 CONSULTANT WALLIS: And could you tell  
12 me, does then supersede S04-C4?

13 MR. SOLMOS: Yes, it does.

14 CONSULTANT WALLIS: So, again, we keep  
15 getting these things to analyze which then we're told  
16 is superseded by something else which we don't have.  
17 It's very difficult.

18 MEMBER BANERJEE: So do you have a copy  
19 of that figure?

20 MR. MARQUINO: I have a copy on my  
21 computer. I don't have a print of it.

22 CHAIR CORRADINI: Well, I've been looking  
23 through as you guys have been talking, I've been  
24 through at least what I have as RAI responses. I  
25 have S04, as Graham does. But I don't seem to have

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1 S05.

2 MS. CUBBAGE: S05 I don't believe has  
3 been formally submitted to the staff. And that's  
4 what I alluded to this morning that you may be  
5 hearing things that we don't have yet.

6 CHAIR CORRADINI: Okay. So let's move  
7 on. I think at least I understand where we are.

8 So just to summarize, now we understand  
9 the connections, but in terms of the response given  
10 that we understand the connections we have to look at  
11 something that is still to be submitted to staff, is  
12 that correct?

13 MR. MARQUINO: Yes.

14 MR. McLAMB: It was actually submitted.

15 I'm sorry. I'm Jon McLamb.

16 It was actually submitted yesterday  
17 evening, so it should arrive shortly.

18 CHAIR CORRADINI: Just in time  
19 submittals. I live it.

20 MR. McLAMB: Just in time, right.

21 CHAIR CORRADINI: Okay. Let's move on.

22 MEMBER BANERJEE: But what is the  
23 material difference? I mean it's okay that it was  
24 submitted yesterday. But what is the --

25 MR. MARQUINO: Well the material

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1 difference is four fans versus six fans.

2 MEMBER BANERJEE: Is that it?

3 MR. MARQUINO: This curve is with six  
4 fans. The S04 curve is with six fans. The S05 curve  
5 is with four fans.

6 CHAIR CORRADINI: Which was requested by  
7 staff.

8 MR. MARQUINO: The DCD is with four fans.  
9 We informally provided that data to the staff  
10 previously. I'm sorry that the formal transmittal--

11 MEMBER BANERJEE: That's okay.

12 Now the difference between what you've  
13 got here and S04, is it? What is the difference  
14 between those two?

15 MR. MARQUINO: Six fans operating versus  
16 four fans.

17 CHAIR CORRADINI: Higher stable pressure.  
18 The pressure is lower here with six fans operating  
19 versus the four fans operating for long times post 72  
20 hours. That's the material difference.

21 MEMBER BANERJEE: Okay. Post 72 hours.

22 CONSULTANT WALLIS: But there is a curve  
23 which updates this particular one?

24 CHAIR CORRADINI: Yes.

25 MEMBER BANERJEE: There's no difference

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1 pre-72 hours?

2 CONSULTANT WALLIS: And I think in the  
3 new one there are none of these wiggles we were  
4 talking about. So something has happened in the  
5 analyses or something to make the wiggles go away. I  
6 think it would be nice to have an explanation of what  
7 they were and why they went away.

8 CHAIR CORRADINI: I think that's fair.  
9 Why don't take it as an action item and move on?

10 MR. MARQUINO: Okay.

11 MEMBER BANERJEE: So the wiggles did go  
12 away in the figure?

13 CONSULTANT WALLIS: In S04 they went away  
14 and then they've come back in S05. I don't know.

15 MR. ALAMGIR: This is Md Alamgir from  
16 GEH.

17 There are some differences. One of the  
18 differences is it's a full refuel rate. But as you  
19 mentioned, we'll look into it and provide you through  
20 an NRC response.

21 CHAIR CORRADINI: Okay.

22 MR. MARQUINO: Let's see. I'll go to  
23 slide 4, which referenced to the S5 6.2-140  
24 supplement 5. It an update of the post-72 hour  
25 depressurization for the staff review. And it's

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1 updated to DCD Rev 6. And four of six fans  
2 operating.

3 We also defined the head flow  
4 characteristic of the fan to envelop the TRACG  
5 analyses at the staff's request.

6 CONSULTANT WALLIS: You're not going to  
7 present anything about the head flow factor 6 of the  
8 plan in your presentation today?

9 MR. MARQUINO: Well, I have a handout  
10 with that information.

11 CONSULTANT WALLIS: Well, I had some  
12 problems with it. It didn't seem compatible with the  
13 text and you had numbers in the text which didn't lie  
14 on the curve. And you had backflow, I think, at  
15 least in Jack Till's slide. He put in a figure from  
16 204D6 and flow going backwards through the fan, which  
17 puzzled me.

18 And it also has a very flat  
19 characteristic. I mean, it's very insensitive to  
20 pressure, which makes things a little difficult when  
21 you're trying to balance it against liquid levels  
22 here and there. I'm not sure that's a very good  
23 choice of a fan where flow rate is very insensitive  
24 to pressure difference.

25 And these questions, again, I don't think

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1 we're going to have time for today.

2 MR. MARQUINO: Yes. But we have reviewed  
3 available equipment that could meet the head flow  
4 characteristics that we've specified. It may provide  
5 -- so when you're saying it's flat, it means when you  
6 get to low DPs its flow is going up as much, right?

7 CONSULTANT WALLIS: No. Say the flow  
8 rate is insensitive -- it's very large flow rate  
9 changes over a very small change in head. Because it  
10 means you've got a few more inches of water somewhere  
11 and the flow rate changes immensely. And that's what  
12 bothered me. And I'm not sure you know those levels  
13 that accurately. So that was one concern I had about  
14 whether this was a good fan for the job.

15 MR. MARQUINO: Well, I think this is an  
16 equipment performance question. At some pressure  
17 drops the fan -- we have to provide a fan that will  
18 meet the performance characteristic at the most  
19 challenging pressure drop.

20 CONSULTANT WALLIS: But, see, the problem  
21 I have is if there are waves on the pool or anything  
22 that perturbs the pressure drop a little bit, the fan  
23 tries to vary its flow rate a lot. And maybe that's  
24 a good thing. But I wasn't sure it was, and I  
25 thought I'd like to see an analysis of why that's

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1 good and why it's adequate when there are things not  
2 quite on design conditions, or maybe oscillations and  
3 so on.

4           Again, I've just raised a question.  
5 Maybe sometime we'll hear about it.

6           MR. MARQUINO: Well, we have done a  
7 sensitivity to the fan rated head and flow, and it  
8 varied then within 10 percent.

9           CONSULTANT WALLIS: Okay.

10          MR. MARQUINO: Reduced the flow by 10  
11 percent. You'll see that in a later slide.

12          CONSULTANT WALLIS: Well, that was  
13 useful. And the flow rate, a negative flow of 30 cfm  
14 is okay?

15          MR. MARQUINO: The fan actually has a  
16 check valve in the line, as indicated in the DCD.  
17 The TRACG model does not have a check valve. That's  
18 why you see negative flow in the TRAC analysis.

19          CONSULTANT WALLIS: So aren't you going  
20 to put the check value in TRAC because that would  
21 help the realism?

22          MR. MARQUINO: It would help, but we  
23 don't plan to credit that in the TRAC analysis.

24          I'll pass around --

25          CONSULTANT WALLIS: Excuse me. Could I

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1 ask the staff, I mean you're quoting from an RAI we  
2 don't have so it's very difficult for me to know what  
3 I'm reviewing. For one thing could we see that RAI.

4 And in future, could we please see the RAI before we  
5 come here?

6 MS. CUBBAGE: I would love for GEH to  
7 have submitted it in time for us to support this  
8 meeting. And we have a Project Manager trying to  
9 track that formal response down that I haven't seen  
10 in my inbox yet.

11 MR. MARQUINO: Professor Wallis, you  
12 asked about the fan head flow curve. And this is a  
13 simple addition we made in the DCD. We extended the  
14 table at low DP to capture a higher flow rate that  
15 bounds the TRACG analysis. This was at the staff's  
16 request.

17 CONSULTANT WALLIS: So this is a new fan,  
18 Wayne, because in the response RAI 6.2-139 you said  
19 it supplies 307 cfm at 2400 pascals. At 2400 pascals  
20 in this table its down to less than -- well, I guess  
21 it is. Because it's CFF. Okay. Thank you.

22 MR. MARQUINO: Yes. This table is a much  
23 definition of the fan characteristic than we had  
24 before DCD Rev 6.

25 CHAIR CORRADINI: Can we just back up

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1 away from the details so I understand.

2 As I understand the DCD you have  
3 specified a fan performance curve but not a piece of  
4 equipment? And now staff with DCD 6 is going to, I  
5 think if I remember correctly in the previous  
6 discussion in June, both staff and you are using the  
7 same performance characteristics to look at the  
8 behavior of the accident. But as of yet, there is no  
9 piece of equipment necessarily that's going to meet  
10 exactly the curve. And that's why you did the  
11 sensitivity?

12 MR. MARQUINO: Yes.

13 CHAIR CORRADINI: Okay. All right.

14 Thank you.

15 CONSULTANT WALLIS: Can I ask something  
16 now? When I looked at this 300 cfm at 2400 which is  
17 the text of an RAI, it agrees with the table you just  
18 gave me. But when I looked at the figure in S04D6 I  
19 got half the pressure drop at that flow rate. So  
20 something was inconsistent. Should I now throw away  
21 S04D6 and there's a new response which supersedes it?

22 MR. MARQUINO: That table is based on the  
23 TRAC head flow performance. So we simply looked at -  
24 - we used homologous axial flow curves in TRAC and  
25 they're defined in the documentation. We put in a

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1 rate flow and head. And then the code tells us how  
2 the flow varies during the 30 day period. We tabled  
3 that, and that's the spec for the fan.

4 CONSULTANT WALLIS: That's good. But now  
5 if I look, I don't have a computer. My colleagues  
6 have a computer. If they look at S04D6, figure 6.2-  
7 140 will they find a curve that's compatible with  
8 this table or will they find something which is not?  
9 Because when I looked at it in the paper version I  
10 found it incompatible.

11 MR. MARQUINO: Right. That table is  
12 consistent with the DCD and the --

13 CONSULTANT WALLIS: But not with the RAI?

14 MR. MARQUINO: -- S5, the 6.2-139 flows  
15 are different.

16 CONSULTANT WALLIS: So I should throw out  
17 204 -- this is being superseded.

18 MR. MARQUINO: Yes.

19 CONSULTANT WALLIS: I think we need to  
20 have a list of what superseded what. Because I have  
21 a stack of paperwork. And if I look at it trying to  
22 reach conclusions, it keeps changing. And I don't  
23 have the updated paperwork and I don't have written  
24 on the updated paperwork this supersedes everything  
25 in S04 so-and-so. So it would help if that can be

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1 clarified somehow.

2 MR. MARQUINO: I'm sorry that you have to  
3 go through this material and then go through it  
4 again.

5 CONSULTANT WALLIS: But I haven't seen it  
6 again.

7 CHAIR CORRADINI: But he's expecting to.

8 MR. MARQUINO: I don't know what the  
9 answer to your question is. We have some databases  
10 that we use and I think the staff has some databases  
11 or spreadsheets that they use also.

12 CHAIR CORRADINI: So just to summarize:  
13 You guys have a most recent RAI response that staff  
14 has just received and we will eventually receive that  
15 is consistent with the DCD and this page that you  
16 gave us for clarification?

17 MR. MARQUINO: Yes.

18 CHAIR CORRADINI: But what we have here  
19 is the fan curve, which I finally found, on S02D6 is  
20 not compatible for the S04; for the figure of the fan  
21 curve you got in the S04 response is not compatible  
22 because it had been superseded by your most recent  
23 response, is that correct?

24 MR. MARQUINO: Right. Can you say the  
25 RAI again, please?

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1 CHAIR CORRADINI: S04. The RAI is S0 --

2 MR. MARQUINO: 6.2-140 S04?

3 CHAIR CORRADINI: Yes, sir.

4 MR. MARQUINO: Yes. That had a text  
5 description of the fan characteristic versus a table.

6 CHAIR CORRADINI: Yes, sir.

7 MR. MARQUINO: And that text description  
8 is superseded by the table in the DCD. And then in  
9 this RAI we added another row to the table.

10 CHAIR CORRADINI: Thank you.

11 MEMBER BANERJEE: Mike, I have a broader  
12 question for you. This seems a work in progress.  
13 What is the action required of ACRS out of this?

14 CHAIR CORRADINI: I think I know what  
15 you're asking. Let me try a response.

16 We wanted to hear back this time to get  
17 an indication of containment -- so the reason we're  
18 having this meeting. These are detailed questions  
19 that I think to the credit of GEH they're trying to  
20 answer that I might characterize in the weeds, but  
21 things that we were concerned about and they're  
22 trying to clarify.

23 The biggest reason we're here today is  
24 because back in June there was a major disagreement  
25 about that.

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1 MEMBER BANERJEE: I understand, yes.

2 CHAIR CORRADINI: Okay. So that's the  
3 main focus of today. These are some of the smaller  
4 questions that they wanted to clarify with us and  
5 essentially update some of the RAI responses.

6 If you remember, back in June staff  
7 wanted to see a series of sensitivity studies of six  
8 fans running, four fans running all the way up three  
9 to 30 days and they did not have the complete set of  
10 calculations done in June and they were in the  
11 process of doing so --

12 MEMBER BANERJEE: What is our product?  
13 Are we going to write a letter?

14 CHAIR CORRADINI: For this? No. For  
15 long term cooling on containment response, yes.

16 MEMBER BANERJEE: When is that letter  
17 due?

18 CHAIR CORRADINI: December.

19 MEMBER BANERJEE: Oh. And by then we  
20 have to resolve --

21 CHAIR CORRADINI: Not these details, but-

22 -

23 MEMBER BANERJEE: But the MELCOR, TRACG?

24 CHAIR CORRADINI: Correct. Correct.

25 MEMBER BANERJEE: Okay. So in a sense

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1 some of this can be done offline, right? We need to  
2 address the issues that we intend to address in the  
3 letter, right?

4 CHAIR CORRADINI: Correct.

5 MEMBER BANERJEE: Now Graham had a very  
6 detailed report which I went through. Is it possible  
7 that the issues he raises be sort of addressed by the  
8 staff directly --

9 CHAIR CORRADINI: No, I think --

10 CONSULTANT WALLIS: -- that we have other  
11 input as needed by GE?

12 CHAIR CORRADINI: I think we can pass on  
13 Graham's detailed comments to the staff through  
14 Chris.

15 DESIGNATED FEDERAL OFFICIAL BROWN: Amy  
16 has them.

17 CHAIR CORRADINI: Amy has them.

18 MEMBER BANERJEE: Well then --

19 CHAIR CORRADINI: We can do it offline.

20 MEMBER BANERJEE: Yes. otherwise, this is  
21 going to take three days before his comment is  
22 extremely detailed and he and ACRS is owned a  
23 detailed answer, I think. Because he raises my  
24 points which may or may not be germane to the issue,  
25 but we should have something if possible documented.

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1 If not, you know, that would be ideal. Then we can  
2 sort of take this off the table. Then if Graham is  
3 not satisfied with the answers, we're not, then we  
4 can go in for another round of clarifications.

5 CHAIR CORRADINI: That sounds fine.

6 MEMBER BANERJEE: But just suggesting.

7 Because to go through each point they're here --

8 CONSULTANT WALLIS: It doesn't make  
9 sense.

10 MEMBER BANERJEE: -- is going to take you  
11 -- this thing is seven pages or eight pages long  
12 detailed stuff.

13 CONSULTANT WALLIS: Now the problem with  
14 the work in progress is what are we reviewing when we  
15 keep getting changes in what we're looking at.

16 MS. CUBBAGE: Maybe if I could just put  
17 it in context to let you know where we're at right  
18 now. I think we share your frustration. It's been a  
19 long and difficult review. We are to the point where  
20 we're converging on what's left to be resolved. And  
21 this RAI response that's yet to be sent to us, we  
22 should be receiving it today I understand, basically  
23 is going to document all the remaining staff concerns  
24 and if acceptable, we could get done. It's  
25 unfortunate that we weren't coming into this meeting

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1 at that point where everything was resolved and  
2 complete.

3 I think when you hear the staff's  
4 presentation, we'll put a little more context into  
5 what's open and why, when you see comparisons between  
6 TRACG and MELCOR.

7 So maybe if we could move on through some  
8 of this discussion and we could caucus at some point  
9 and discuss on the best path forward to address all  
10 of the concerns that have been raised in the  
11 consultant's report, because I don't think we're  
12 going to be able to answer all of them today even if  
13 we had enough time.

14 CHAIR CORRADINI: That sounds fine. Let's  
15 move on. Okay. Okay.

16 MR. MARQUINO: Okay. Next slide, please.

17 I talked about this before. The one item  
18 that came up in June and --

19 CONSULTANT WALLIS: Excuse me. I'm sorry

20 MR. MARQUINO: Yes.

21 CONSULTANT WALLIS: Is this table  
22 correct? I mean, in the discussion it says pascals  
23 for the units, 2400 pascals is the pressure. Now  
24 2400 meters per second is 240 meters of water.

25 CHAIR CORRADINI: The density is one.

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1 CONSULTANT WALLIS: Something --

2 CHAIR CORRADINI: The density of air is  
3 one. It's the same thing.

4 CONSULTANT WALLIS: Isn't it --

5 CHAIR CORRADINI: I think it's  
6 normalized. This is a fan. I assume --

7 CONSULTANT WALLIS: Oh, okay. So it's  
8 pascals. Essentially it's the same as pascals?

9 CHAIR CORRADINI: Right.

10 CONSULTANT WALLIS: Okay. Thank you.  
11 Because it doesn't say that. I mean, okay. Because  
12 often things are quoted in terms of feet of water or  
13 something, or head. Okay. Thank you.

14 MR. MARQUINO: All right. In June there  
15 was an observation by the staff that the drywell head  
16 volume extended into Ring 5. And that was a correct  
17 observation that in the DCD model the drywell head  
18 volume goes out to Ring 5. Part of the drywell head  
19 volume is allocated to Ring 5.

20 We did a sensitivity study which I'll  
21 cover on the next slide to see how changing the  
22 volume distribution affected the results. That  
23 sensitivity doesn't affect the early -- we're not  
24 trying to cover the zero to 72 hour period because we  
25 have other nonmechanistic features in the model that

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1 provide a conservative result for the first three  
2 days.

3 For example, you have double pipes  
4 venting the GDCS compartment. So we get essentially  
5 no credit for noncondensable holdup in the GDCS  
6 compartment. And then at three days we purge all the  
7 noncondensibles into the wetwell, compressing the  
8 wetwell pressure and increasing the containment  
9 pressure.

10 Next slide, please.

11 CONSULTANT WALLIS: Well, I have a  
12 question about this. And you can make these  
13 conservative assumptions about one thing and it turns  
14 out to be nonconservative later on about something  
15 else. Don't you really need a realistic analysis that  
16 says where the noncondensibles go and how much of  
17 them is nitrogen, and all that sort of thing?  
18 Because these bounding analyses get very confusing  
19 when they're so far from reality.

20 MR. MARQUINO: Initially in the pre-  
21 application review we had a pretty good focus on  
22 providing best estimate evaluations and then making  
23 specific changes and providing bounding evaluations.  
24 I'd say we kind of lost focus on that in the  
25 containment analysis because the staff is very

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1 focused on us providing a bounding analysis. And  
2 then it gets difficult to maintain both when you have  
3 things like nodalization changes where you've got  
4 things you would have to take time to undo some  
5 feature of the model to get back to a realistic  
6 result.

7 We do provide you a sensitivity study  
8 with venting the GDCS compartment to some place, to  
9 the lower drywell and we show some results there  
10 where we document a lower pressure, as you'd expect.

11 CONSULTANT WALLIS: If all the  
12 noncondensibles go to the wetwell, as it says there,  
13 then they're not available later to have any  
14 influence until they come out through the vacuum --

15 MR. MARQUINO: Okay. Now that specific  
16 bottom lost line on the right, that is a hand  
17 calculation outside of the TRACG model that's done to  
18 establish a licensing basis peak pressure.

19 CONSULTANT WALLIS: But it is bounding  
20 for that pressure?

21 MR. MARQUINO: Yes, it's bounding. And  
22 the intent is to have a number in the DCD that it is  
23 a maximum containment pressure in which there's no  
24 question about the noncondensable distribution and  
25 about how much leftover noncondensable and the

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1 drywell effects the decontainment pressure.

2 MEMBER BANERJEE: So does TRAC actually  
3 keep track of the noncondensable composition?

4 MR. MARQUINO: The composition --

5 MEMBER BANERJEE: Hydrogen, oxygen,  
6 nitrogen, whatever?

7 MR. MARQUINO: In TRAC we've converted  
8 the hydrogen and oxygen to an equivalent nitrogen  
9 amount. And we --

10 MEMBER BANERJEE: What does that mean?

11 CHAIR CORRADINI: I think his answer is  
12 no.

13 MEMBER BANERJEE: Okay.

14 CHAIR CORRADINI: That's what I think he  
15 just said.

16 MR. MARQUINO: Yes. We only --

17 MEMBER BANERJEE: It does not?

18 MR. MARQUINO: Everything is modeled as  
19 nitrogen and we have an addition of --

20 MEMBER BANERJEE: Well how do you handle  
21 what we know is a real physical phenomenon that you  
22 get the hydrogen on top and potentially -- I mean all  
23 these things are different densities so when you  
24 stratify a flow, your system, you're going to get  
25 separation. You're likely to get your plumes of

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1 hydrogen going to the top, right, and your plumes of  
2 whatever, nitrogen staying at the bottom. But how do  
3 you handle that in TRAC?

4 MR. MARQUINO: So we aren't completely  
5 capturing that in TRAC.

6 MEMBER BANERJEE: So what happens if it  
7 catches fire?

8 CHAIR CORRADINI: Well, let's just --

9 MR. MARQUINO: I'm covering combustible  
10 gas control in a couple of slides later in the  
11 presentation.

12 MEMBER BANERJEE: Okay. All right.

13 CHAIR CORRADINI: So just to --

14 MEMBER BANERJEE: You don't have the  
15 capability in TRAC to track G2?

16 MR. MARQUINO: We have the capability,  
17 but we are not exercising it in this calculation.

18 MEMBER BANERJEE: So just to be clear if  
19 you get a plume of hydrogen, it completely mixes? I  
20 mean, suppose there's hydrogen generation in a  
21 volume. I can imagine a plume of something rising in  
22 another gas, right, without mixing completely. This  
23 is completely mixed in TRACG, the volume that it's  
24 generating?

25 MR. MARQUINO: Okay. So it's generated

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1 in --

2 MEMBER BANERJEE: In some volume, right?

3 MR. MARQUINO: We start with nitrogen in  
4 the drywell. We purge most of the --

5 MEMBER BANERJEE: So it comes out at the  
6 break?

7 MR. MARQUINO: -- a lot of the nitrogen  
8 and then we only generate hydrogen and oxygen in the  
9 core through radiolysis at pretty lean  
10 concentrations. And then it leaves the core with the  
11 steam.

12 MEMBER BANERJEE: Leaves the break, or  
13 whatever?

14 MR. MARQUINO: Yes, through the break and  
15 the DPVs and mixed with steam. And basically in TRAC  
16 it will mix all the gas components in a cell  
17 together. And then the gas-density differences are  
18 factored into the flow calculation.

19 MEMBER BANERJEE: But even the steam is  
20 lighter than the nitrogen, right?

21 MR. MARQUINO: Right.

22 MEMBER BANERJEE: Steam will rise to the  
23 nitrogen?

24 MR. MARQUINO: Right.

25 MEMBER BANERJEE: The plume.

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1 CHAIR CORRADINI: But once mixed, it's  
2 not going to unmix except through the condensation.

3 MEMBER BANERJEE: Yes. But why should it  
4 mix? I mean, unless you've got a high level of  
5 turbulence.

6 CONSULTANT WALLIS: Well, at the  
7 beginning you've got the break.

8 MEMBER BANERJEE: Yes.

9 CONSULTANT WALLIS: You've got it  
10 stirring.

11 CHAIR CORRADINI: Well, I'd say it's  
12 mixed --

13 MEMBER BANERJEE: Later on it's just  
14 coming out, right?

15 CHAIR CORRADINI: Right, but it's coming  
16 out. I think the assumption that I hear Wayne saying  
17 is, you correct me if I'm wrong, is that they assume  
18 a well mixed plume of steam and any sort of  
19 radiolytic decomposition gases from the beginning.

20 MEMBER BANERJEE: The steam and the  
21 radiolytic gases I have no problem with. But once it  
22 issues from the break unless the Reynolds number are  
23 high enough, it's not going to necessarily mix with  
24 its surroundings.

25 MR. MARQUINO: As I understand, it's

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1 hotter than the steam mixture in the drywell, so  
2 it'll tend to rise, yes.

3 MEMBER BANERJEE: Well, I don't know. So  
4 basically you've got a 1D calculation with well mixed  
5 assumption.

6 CHAIR CORRADINI: All the calculations  
7 for containment are 1D calculations. That is not one  
8 that we're going to see that is not.

9 CONSULTANT WALLIS: Not in TRAC.

10 CHAIR CORRADINI: No.

11 CONSULTANT WALLIS: TRAC has different--

12 MR. MARQUINO: They're 2D in TRAC,  
13 they're not 3D and it's not CFD calculations.

14 CHAIR CORRADINI: Well, we're going into  
15 thermal hydraulic mode here. But you basically have  
16 orifices and lumps. So you can call it 2D, you can  
17 call it 1D. You have lumps of mass and energy  
18 connected by orifices. So if you want to call it 2D,  
19 that's fine. But it's still an orifice and a --

20 CONSULTANT WALLIS: But it doesn't allow  
21 for plumes and circulation?

22 CHAIR CORRADINI: No. No. Not at all.  
23 Nor does MELCOR.

24 MEMBER BANERJEE: Why are we using these  
25 codes?

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1 CHAIR CORRADINI: I'm not going to answer  
2 that. I'll let staff answer that.

3 I guess I would let him go on and we can  
4 take this as a side comment. My sense of it is for  
5 this accident for long times you're still going to  
6 get pretty good mixing with the steam issuing forth  
7 in the drywell. But I --

8 MEMBER BANERJEE: What is the velocity of  
9 the steam coming out?

10 MR. ALAMGIR: Again, this is Md Alamgir  
11 from GEH.

12 Just to clarify TRACG descriptions has no  
13 the details section 313, basically the summary of  
14 your -- is that multiple noncondensable gases may be  
15 included or noncondensable gases assumed to be in  
16 thermal equilibrium with any steam and most the same  
17 velocity of steam, mechanical equilibrium.

18 CHAIR CORRADINI: I think the question  
19 that Dr. Banerjee is asking to calm is concerns is  
20 what's the Reynolds number of the long term steaming  
21 rate so that he decides whether we have mixing or no  
22 mixing.

23 MEMBER BANERJEE: Exactly. Put your  
24 finger on it.

25 All right. Just give me the velocity of

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1 the issuing --

2 CHAIR CORRADINI: What don't you take it  
3 as an action item. I'll write it down and we'll back  
4 to it.

5 Let's move on.

6 MR. MARQUINO: Okay. Next slide, please.

7 So these are the results of sensitivity  
8 studies we did to address the observations in June.

9 We renodalized the upper drywell in the  
10 GDCS airspace and changed the GDCS airspace to  
11 drywell head connection. And in the post-3 day  
12 period we found that the reduction in pressure was  
13 small, not as great as the base case, but it was a  
14 small difference and its offset by some of the other  
15 changes like moving the GDCS airspace to the lower  
16 drywell.

17 CONSULTANT WALLIS: Why was there a small  
18 reduction in pressure? Less condensation or  
19 something, or the PCC didn't work so well?

20 MR. MARQUINO: So when we made this  
21 change we were changing the concentration at the PCC  
22 inlet.

23 CONSULTANT WALLIS: You've got more  
24 noncondensibles there?

25 MR. MARQUINO: Yes.

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1                   CONSULTANT WALLIS: It would help if you  
2 gave a reason why. Because TRAC just gets a bump in  
3 it, and there's no explanation, we'll eventually ask  
4 why.

5                   MR. MARQUINO: Okay.

6                   CONSULTANT WALLIS: You know, and it's  
7 nice to know. Why is it; because you've got more  
8 noncondensibles going into the PCCS because you let  
9 them come out of the upper drywell somewhere or the  
10 upper head airspace, or where do they come from? It  
11 must be they've come out of the head space and store  
12 in noncondensibles, is that what it is?

13                  MR. MARQUINO: Yes. So we've moved that  
14 small volume back into Wing 4.

15                  CONSULTANT WALLIS: So it's something to  
16 do with the distribution of noncondensibles in the  
17 containment, which MELCOR wouldn't be able to-- is it  
18 MELCOR, whatever Jack uses wouldn't show that?

19                  MEMBER BANERJEE: How do you move it? Is  
20 there sort of a cross flow or what?

21                  MR. MARQUINO: No. In the input, instead  
22 of assigning the drywell head volume to Ring 5, we  
23 assigned into Ring 1, 2, 4.

24                  MEMBER BANERJEE: Okay. I got it. Okay.  
25

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1                   CONSULTANT WALLIS:  So you mixed two  
2 nodes, is that you do?

3                   MR. MARQUINO:  I think we mixed four --

4                   CONSULTANT WALLIS:  Nodes.

5                   MR. MARQUINO:  -- nodes.  So we took what  
6 was in Ring 6 and we put it back somewhere in Ring 1,  
7 2, 3, 4 and again it's a small volume, it's 10  
8 percent of the total drywell --

9                   CONSULTANT WALLIS:  So boxes with  
10 orifices that the Chairman talked about?

11                  MR. MARQUINO:  And they are boxes with  
12 orifices, yes.

13                  MEMBER BANERJEE:  So Ring 4 actually  
14 extends all the way down, does it?

15                  MR. MARQUINO:  Yes.

16                  Okay.  We also looked at the break  
17 discharge and the DPV pipe discharge and --

18                  CONSULTANT WALLIS:  Let me go back to  
19 that.  You're saying then that the pressure is reduced  
20 less because more noncondensibles go into the PCCS  
21 and that lowers its efficiency?

22                  MR. MARQUINO:  Yes, a little bit.

23                  CONSULTANT WALLIS:  Well, what does the  
24 PCCS discharge into?

25                  MR. MARQUINO:  Into the GDCS airspace.

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1 CONSULTANT WALLIS: In airspace?

2 MR. MARQUINO: Yes.

3 CONSULTANT WALLIS: Because in your  
4 figures you show it going into this train.

5 MR. MARQUINO: Okay. So the fan draws on  
6 the PCC lower header --

7 CONSULTANT WALLIS: Blows it into the  
8 DPVs.

9 MR. MARQUINO: -- it blows it into a try.

10 CONSULTANT WALLIS: Yes, which is full of  
11 water.

12 MR. MARQUINO: Yes, but the  
13 noncondensable are going to bubble through the water--  
14 -

15 CONSULTANT WALLIS: No, no, no. The steam  
16 I'm worried about. It's not -- so it's got steam  
17 coming through. Steam is not being condensed because  
18 it's not --

19 MR. MARQUINO: Right, right.

20 CONSULTANT WALLIS: So why doesn't it  
21 condense into this pool it levels into?

22 MEMBER BANERJEE: And why do you need the  
23 PCCS --

24 CONSULTANT WALLIS: Of course, that was  
25 just as efficient as before?

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1 MR. MARQUINO: Okay. Because the pool  
2 effects no net heat removal.

3 CONSULTANT WALLIS: Yes, it is. It gets  
4 the cold water --

5 MR. MARQUINO: Any steam that goes into  
6 this tray which is about one square meter, 10 inches  
7 high, and any steam is going to heat that water up to  
8 saturation and that steam --

9 CONSULTANT WALLIS: But does it? Because  
10 the water comes from the condensate from the PCCS,  
11 which is cooled by the PCCS pool. So I'm not sure  
12 that it just bubbles through. I want to see an  
13 energy balance and so on for that. Because you've  
14 got cold water coming from the PCCS discharge.

15 CHAIR CORRADINI: You have saturated  
16 water. Why --

17 CONSULTANT WALLIS: It's not saturated.  
18 It's been subcooled by condensate of the cooling of  
19 the pool. There's a pool around the condenser which  
20 cools the water to less than saturation, subcools it.

21 MR. MARQUINO: So if we have a condition  
22 where the PCC is not condensing all the steam and  
23 there's steam being drawn out the bottom --

24 CHAIR CORRADINI: Less condensate.

25 MR. MARQUINO: -- in that condition we're

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1 not going to have subcooled condensate.

2 CONSULTANT WALLIS: Why not?

3 MR. MARQUINO: Previously when we didn't  
4 have the fan on, we could have some subcooling  
5 because the water's just dribbling down in the tube.

6 CONSULTANT WALLIS: You have a film  
7 running down the condenser, and the film on the wall  
8 is contact with the pool, and the film on the wall is  
9 subcooled on that side. This is all about basics of  
10 condensation. A condensate film is cooled by a pool  
11 on the outside is subcool on the average.

12 MR. MARQUINO: Yes.

13 CONSULTANT WALLIS: Because it's kept  
14 cool on the outside. So there is subcooling there.

15 CHAIR CORRADINI: Yes, but do you really  
16 believe that there's going to be enough subcooling to  
17 overcome the --

18 CONSULTANT WALLIS: I don't believe  
19 anything until I see an analysis

20 CHAIR CORRADINI: Okay.

21 MEMBER BANERJEE: I guess the issue is  
22 that you've got in the middle of the flow of mixture  
23 of noncondensibles and steam at whatever is the vapor  
24 pressure of the subcooled water. I mean, if you  
25 assume equilibrium across the tube. So when the

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1 subcooled water is it caught in the tray and you  
2 bubble this stuff through, you could potentially  
3 condense the steam which is mixed with the  
4 noncondensibles. Because, of course, it's at  
5 whatever --

6 CONSULTANT WALLIS: You will condense  
7 some.

8 MEMBER BANERJEE: Yes, you could condense  
9 some.

10 CHAIR CORRADINI: But we're going to need  
11 to move on because time --

12 MEMBER BANERJEE: Well, does that matter  
13 if --

14 CHAIR CORRADINI: Well, I think I know  
15 where Graham's going with this. Because this is a  
16 question you brought up in June that I think we're  
17 coming back to, which is his concern is if I rid  
18 myself of all the steam, now I've got an interesting  
19 mixture of gases. So is that where you're going with  
20 this?

21 CONSULTANT WALLIS: Well, where I was  
22 going with it, here I'm just talking about drywall  
23 pressure here. I'm saying that if you have subcooled  
24 water in that pool, and you may do because it's  
25 cooled in the header at the bottom. So there may be

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1 enough subcooling in the, whatever you call it, the  
2 drain pan to condense the small amount of remaining  
3 steam. In which case, we don't care what the  
4 efficiency is of the PCCS. Everything is 100  
5 percent.

6 MEMBER BANERJEE: In fact, you're  
7 probably right. The thing will self correct because  
8 the self-cooled -- I think the whole thing is going  
9 to probably just condense all the steam. Yes.

10 CONSULTANT WALLIS: But we need to know  
11 the details of this drain pan.

12 MEMBER BANERJEE: Yes. You can probably  
13 do it by hand.

14 CONSULTANT WALLIS: Well, I don't think  
15 we know the temperature of the water that's coming  
16 out of the bottom of the PCCS condenser and going  
17 into that drain pan.

18 MEMBER BANERJEE: Well, you can just take  
19 a --

20 CHAIR CORRADINI: Before we do this, so  
21 I'll make a note of it and let's take it to the side  
22 and move on. Because I think where Graham's question  
23 is is consistent with what he asked back in June,  
24 which was he wants to understand the efficiency of  
25 the PCCS as you go through various stages of this

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1 long term to understand what's coming out of the  
2 condensate or coming out of the back end of the PCCS.

3 One concern is potential combustibles for long term  
4 because I've got hydrogen and oxygen mixed with the  
5 nitrogen, right? As well as steam.

6 CONSULTANT WALLIS: There's no nitrogen.

7 CHAIR CORRADINI: I'm sorry, no nitrogen.

8 But essentially steam and the gases.

9 And the other thing is what the condition  
10 in this catch pan. But I think that's a side note  
11 we're going to have to come back to. We're not going  
12 to answer it now.

13 CONSULTANT WALLIS: My first concern--

14 MR. MARQUINO: Is the question about when  
15 the fan is operating or before the van operates, or  
16 what?

17 CONSULTANT WALLIS: Yes. Well, before  
18 the fan operates you have an interesting mix to going  
19 down the pipe into the wetwell. But my first  
20 question is where does the pipe go? Because in June  
21 we had three versions.

22 Jack Tills is said into the airspace.  
23 There was a written RAI in which is discharges into  
24 the GDCS pool. And then there was another picture in  
25 the DCD which said it goes into a drain pan. So we

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1 have three versions of where the pipe goes.

2 Now we clarified that today, I think.

3 MEMBER BANERJEE: With the drain pan.

4 CONSULTANT WALLIS: The second time you  
5 answered you said it goes into the drain pan. The  
6 first time you said it went into the pool. But it  
7 goes into the drain pan?

8 MR. MARQUINO: Are we talking in the  
9 plant or in the TRAC model?

10 CONSULTANT WALLIS: In reality?

11 MR. MARQUINO: In reality it goes into a  
12 drain pan --

13 CONSULTANT WALLIS: TRAC model it goes  
14 into something else?

15 MR. MARQUINO: And in the TRAC model it  
16 goes into the GDCS pool. So we're using the GDCS  
17 pool to model the drain pan.

18 CONSULTANT WALLIS: But then you've got a  
19 humongous condensing capacity in the GDCS pool. It's  
20 just a suppression pool.

21 MR. MARQUINO: Well, I think we have two  
22 different concepts about whether that matters or not.

23 CHAIR CORRADINI: So go through those two  
24 concepts and then we'll move on.

25 CONSULTANT WALLIS: I am really bothered

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1 by this. You have a TRAC model which doesn't model  
2 the reality. I don't know why you do that.

3 CHAIR CORRADINI: Let's just weigh in.

4 MR. MARQUINO: Okay. I think that --

5 MEMBER BANERJEE: But let's see what the  
6 consequence would be. Tell us why us why you think  
7 it's of no consequence.

8 MR. MARQUINO: I think it is of no  
9 consequence because there is no heat removal  
10 mechanism in that compartment to take energy out of  
11 the containment. We're taking the energy out of the  
12 containment to the IC PCC pool.

13 MEMBER BANERJEE: But, okay, that's not  
14 the no consequence. Imagine that you're wrong now  
15 because of the reasons Graham gave. What is the  
16 consequence if there was subcooled water in  
17 equilibrium with a mixture of steam and  
18 noncondensable coming into the pool and then since  
19 you have finer bubbles, you know now you can condense  
20 it? From film wise condensation now you're going to  
21 -- so imagine that's the scenario.

22 MR. MARQUINO: Okay.

23 MEMBER BANERJEE: Now what is the  
24 consequence of that? Any?

25 MR. MARQUINO: So if the pool was

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1 subcooled and at 20 degrees C. Let's say it's at 20  
2 degrees C. And we have steam coming out of the fan  
3 because the PCC didn't condense all the steam. The  
4 energy from that steam is going to go into the pool  
5 and warm the pool and heat it up until eventually it  
6 is saturated.

7 MEMBER BANERJEE: But that's not what  
8 he's saying.

9 CONSULTANT WALLIS: It's coming in cold.

10 MEMBER BANERJEE: It's coming in with  
11 subcooled water. Let's not get into that.

12 MR. MARQUINO: Okay.

13 MEMBER BANERJEE: Leave it. Is there any  
14 consequence if there is condensation in the pool?

15 MR. MARQUINO: I don't see a consequence  
16 if there's subcooled water --

17 MEMBER BANERJEE: Okay. That's the most  
18 important point.

19 CONSULTANT WALLIS: No, there is a  
20 consequences.

21 MR. MARQUINO: There's a continual  
22 subcooled drips coming through the GDCS line and that  
23 --

24 CONSULTANT WALLIS: Now look, Wayne,  
25 you're condensing 95 percent of the steam. So the

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1 flow of water that's coming out, which is slightly  
2 subcooled, is 95 to five as much as the steam. And  
3 if it's got 20 degrees subcooling, it could  
4 condensate all that 5 percent of steam. It doesn't  
5 take much subcooling with that large flow of water  
6 relative to the steam to condensate the steam.

7 The consequence is that the combination  
8 of the PCC as in the drain pan is 100 percent  
9 efficient and you get a better reduction in drywell  
10 pressure.

11 MEMBER BANERJEE: He's helping you?

12 CONSULTANT WALLIS: That's what I figure  
13 is the difference between what -- and that's why TRAC  
14 ought to model it. I can't understand this business  
15 of TRAC modeling something which has no view of the  
16 case.

17 MR. MARQUINO: Well, let me come back to  
18 you after we take a break. Because we have done some  
19 calculations where we've modeled it outside of the  
20 GDCS pool. And to my knowledge those calculations  
21 didn't show a significant pressure change. So --

22 MEMBER BANERJEE: I have, actually, a  
23 different feeling from what you were saying. I  
24 thought you were going to say I like having some  
25 steam around so that I am at the lower flammability

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1 limit off this hydrogen/oxygen mixture. That's what  
2 I thought your answer was. Now you're saying it  
3 doesn't --

4 CONSULTANT WALLIS: No, he hasn't got  
5 there yet.

6 MEMBER BANERJEE: He hasn't got there  
7 yet? All right.

8 CHAIR CORRADINI: Let's move on. I think  
9 we've got the point. We have to move on. I want to  
10 get to -- because we have less than an hour and I  
11 want to get to the staff's presentation too.

12 CONSULTANT WALLIS: Let's make it clear.  
13 The discharge now is into the drain pan? Because  
14 there was a question about that last time. And how  
15 it goes in and whether its a sparger that makes small  
16 bubbles or big bubbles makes a difference? So we  
17 can't just gloss over it, you know.

18 MR. MARQUINO: I have some material on  
19 that I can hand out. I think at that point we'd have  
20 to -- it's proprietary information.

21 We also moved the GDCS airspace vent to  
22 the lower drywell and that effected a larger  
23 reduction in pressure, which is counter to the first  
24 sensitivity study. So I think overall we have --

25 CONSULTANT WALLIS: What does this mean?

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1 "The GDCS airspace is several walls away from the  
2 lower drywell."

3 MR. MARQUINO: Yes.

4 CONSULTANT WALLIS: It doesn't make  
5 sense.

6 MR. MARQUINO: To give some  
7 quantification to your observation that nitrogen  
8 would tend to accumulate in the lower drywell. Now  
9 in this node we've drawn the nitrogen back from the  
10 wetwell into the drywell. It's being pumped around.  
11 And in this sensitivity we discharged -- we connect  
12 the GDCS compartment to the lower drywell so the  
13 nitrogen goes to the lower drywell first. And that  
14 in TRAC reduced the noncondensable mass fraction, it  
15 caused the pressure to drop --

16 MR. QUEEN: I don't understand this at  
17 all. My point was that when the vacuum breakers  
18 open, the nitrogen comes out of the wetwell, is cold  
19 and it has a molecular weight of about 50 percent  
20 greater than the steam and its colder than the steam  
21 so it has a density of twice the density of the steam  
22 and just flows along the floor into the drywell.  
23 That was my point. I didn't understand what the GDCS  
24 airspace has to do with it.

25 MEMBER BANERJEE: There's nitrogen in the

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1 GDCS airspace as well, right?

2 CONSULTANT WALLIS: Yes, but they can't  
3 get through the wall.

4 MEMBER BANERJEE: It has to -- yes, it  
5 has to go over the top.

6 CONSULTANT WALLIS: No. The stuff from  
7 the vent from the vacuum breakers is really much  
8 heavier than the steam around it. There is going to  
9 be a flow, there's going to be like sort of water  
10 flowing across the floor going down into the lower  
11 drywell. That was my point.

12 MEMBER BANERJEE: So you transferred the  
13 nitrogen from the surface of the GDCS pool into the  
14 wetwell, is that what you did?

15 MR. MARQUINO: Not the wetwell. The  
16 lower drywell.

17 MEMBER BANERJEE: Oh, the lower drywell?

18 CONSULTANT WALLIS: Lower drywell? How  
19 does it get back up to the PCCS or does it?

20 MR. MARQUINO: And then it has to diffuse  
21 and get back up.

22 CONSULTANT WALLIS: Okay.

23 MEMBER BANERJEE: I have a question which  
24 maybe you can have an answer to. Can we track the  
25 LFL of what's coming out, the lower flammability

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1 limit? Because you've got steam in there and  
2 according to TRAC you're mixing it in. So probably  
3 its always below its lower flammability limit. But  
4 could we have an answer to that? Because I'd like to  
5 know what the LFLs are in the various volumes.

6 CONSULTANT WALLIS: It all depends on how  
7 efficient the PCCS is as a condenser. If it's a 100  
8 percent efficient --

9 MR. MARQUINO: Yes.

10 MEMBER BANERJEE: That is a question I  
11 ask you.

12 MR. MARQUINO: I think that's basically  
13 the answer is that the PCC performance, which we have  
14 test results on, will establish how concentrated  
15 noncondensibles can be in that heat exchanger at any  
16 decay heat level. And that noncondensibile fraction,  
17 it is going to be mostly hydrogen and oxygen in the  
18 later phases of the three day period.

19 CONSULTANT WALLIS: Well, Wayne, this is  
20 a difficult question, but I think noncondensibile  
21 behavior of hydrogen in a condenser is different than  
22 the noncondensibile behavior of air because you're  
23 dealing with diffusion through a thin boundary layer  
24 where the steam and the condensation is occurring and  
25 you're building up noncondensibles. And the

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1 diffusion coefficient of hydrogen is very different  
2 from what it is for air.

3 MR. MARQUINO: Yes.

4 CONSULTANT WALLIS: So the performance of  
5 the PCCS in a hydrogen/oxygen atmosphere is different  
6 than it is in air. And I don't think you've done  
7 tests with PCCS full scale with the hydrogen/oxygen -

8 -

9 MR. MARQUINO: Well, we've done helium  
10 tests.

11 MEMBER BANERJEE: Yes.

12 MR. MARQUINO: We do have helium steam  
13 tests.

14 CONSULTANT WALLIS: Well you've got  
15 helium. Well, maybe that's scalable somehow.

16 MEMBER BANERJEE: Yes, that's scalable.

17 CONSULTANT WALLIS: Good thank you.

18 MEMBER BANERJEE: That's a pretty good  
19 test.

20 CONSULTANT WALLIS: Yes, that's good.

21 MR. MARQUINO: Next slide, please.

22 The closest we can get to the staff's  
23 MELCOR calculation is by degrading the PCCS heat  
24 transfer. If we reduce the tube area in the PCC, we  
25 can get a drywell pressure trace that agrees better

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1 with the MELCOR trace.

2 MEMBER BANERJEE: Degrade by how much?

3 MR. MARQUINO: About half.

4 CHAIR CORRADINI: Yes, about half.

5 MR. MARQUINO: The exact number is on the  
6 proprietary.

7 CONSULTANT WALLIS: How much does it  
8 change the efficiency when you're doing it? What was  
9 efficiency before you changed it and what is it after  
10 you changed it? It's in the 90s, isn't it, at both  
11 times, or is it proprietary?

12 MEMBER BANERJEE: Look in the slides.  
13 It's there.

14 CONSULTANT WALLIS: Well, I don't have  
15 any slides for this.

16 MEMBER BANERJEE: We have this curious  
17 situation that we have some proprietary and some  
18 nonproprietary.

19 CHAIR CORRADINI: But I think Wayne's  
20 point -- so let's just repeat Graham's question a  
21 different way so we get to some acceptable  
22 qualitative.

23 So Graham's point is if you're reducing  
24 the efficiency by about half --

25 CONSULTANT WALLIS: No, you're not. He's

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1 reducing the area. But I think the efficiency hasn't  
2 changed much.

3 MEMBER BANERJEE: Well, it's the same  
4 thing.

5 CHAIR CORRADINI: It's the same thing.

6 CONSULTANT WALLIS: No, it's not.

7 CHAIR CORRADINI: Yes, it is.

8 MEMBER BANERJEE: It's area.

9 CHAIR CORRADINI: It's area.

10 CONSULTANT WALLIS: It's how much of the  
11 steam you condense --

12 MEMBER BANERJEE: It's the same thing.

13 CONSULTANT WALLIS: Aren't you condensing  
14 95 percent. Just give you half the area doesn't mean  
15 you condense half the steam.

16 MEMBER BANERJEE: That's true. That's  
17 true.

18 CONSULTANT WALLIS: Come on.

19 MR. MARQUINO: So in all of these you're  
20 always condensing all of the decay heat generated  
21 steam. It just what noncondensable fraction --

22 CONSULTANT WALLIS: All of them? No, the  
23 PCCS --

24 MR. MARQUINO: Yes.

25 CONSULTANT WALLIS: -- emits some steam

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1 with the noncondensibles. Nine percent or ten  
2 percent?

3 MEMBER BANERJEE: He wants to know what  
4 is the faction -- the difference in the fraction of  
5 the steam --

6 CONSULTANT WALLIS: What we call  
7 efficiency. What we've been calling efficiency is  
8 how much of the steam.

9 MEMBER BANERJEE: Give a straight answer,  
10 or get somebody --

11 MR. MARQUINO: But I don't know --

12 CONSULTANT WALLIS: You see the thing  
13 that Jack Till's --

14 CHAIR CORRADINI: You've got to let him  
15 answer the question before you ask him another  
16 question. That's not fair.

17 CONSULTANT WALLIS: I am trying to  
18 explain the questions. He doesn't even understand  
19 the question.

20 MR. MARQUINO: I don't have the exit  
21 steam flow rate from the PCC from the sensitivity  
22 calculations. We'd have to look that information up  
23 and get that to you.

24 CONSULTANT WALLIS: Jack Tills had a  
25 curved graph where he showed percent of steam that

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1 goes in that's condensed That's what I'm looking  
2 for. And he had them up in the 90s and he was saying  
3 well if it's 95 rather than 98 makes a big  
4 difference. That's what I'm looking for.

5 MR. MARQUINO: We'll have to look that up  
6 and get back to you.

7 CHAIR CORRADINI: So let me broaden the  
8 question and then we put it on this list. I think  
9 there's two questions here that are related.

10 One is: As Graham calls it, what is the  
11 amount of steam coming out relative to how much is  
12 going in? A ratio, whatever.

13 And secondly, Sanjoy brought it up but I  
14 think it got lost in the discussion, which is Now  
15 with that difference, what is the ratioing of that  
16 exiting steam to the noncondensibles coming out? And  
17 I think that leads us to other downstream questions.

18 But it's that mixture of what's coming out under  
19 various performance modes that is essentially what  
20 Graham and Sanjoy are after. Is that correct,  
21 gentlemen?

22 MEMBER BANERJEE: Yes.

23 CHAIR CORRADINI: Okay.

24 MEMBER BANERJEE: Graham has an  
25 interesting point that probably it doesn't matter

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1 because, you know it's a self-adjusting system.  
2 You've probably condensed all the steam anyway in the  
3 drain pan in reality if you model it correctly.

4 CHAIR CORRADINI: So I've got it written  
5 down, Wayne. Wayne, we can move on.

6 MR. MARQUINO: Okay. We did  
7 sensitivities to the fan head and flow. The head,  
8 reducing the fan rate at head slows the pressure  
9 reduction in the drywell.

10 CONSULTANT WALLIS: Do you reduce it by  
11 ten percent?

12 MR. MARQUINO: Yes. Reducing the fan  
13 rated flow had a less significant effect.

14 CONSULTANT WALLIS: What is the typical  
15 cfm going through the fan?

16 MR. MARQUINO: Early in the event it's  
17 about 300 cfm.

18 CONSULTANT WALLIS: This is perhaps where  
19 my flat characteristic comes in if you change the  
20 head by 10 percent -- 300. If you increase it--

21 MEMBER BANERJEE: It's very sensitive.

22 CONSULTANT WALLIS: And you change the  
23 cfm immensely, yes.

24 MEMBER BANERJEE: Yes, it's very  
25 sensitive.

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1                   CONSULTANT WALLIS: You might actually  
2 shut it off.

3                   MR. MARQUINO: Now we had some discussion  
4 in June about the wetwell heat loss. And--

5                   CONSULTANT WALLIS: I'm sorry, I don't  
6 want to interrupt you. But if you just give us --  
7 TRAC says something when you decrease something by 10  
8 percent.

9                   MR. MARQUINO: Yes.

10                  CONSULTANT WALLIS: That doesn't help me  
11 because when I look at the fan curve it says well  
12 it's going to shut the fan off completely. And that  
13 doesn't make sense. So there's got to be some  
14 physical explanation, not rather than just "TRAC  
15 says."

16                  MR. MARQUINO: Well, it makes sense that  
17 if you change the rated head of the fan in the early  
18 part of when its trying to draw from the heat  
19 exchanger and the heat exchanger has mostly steam in  
20 it and there's a low suction pressure, that that's  
21 going to degrade the ability of the fan to produce  
22 flow.

23                  CONSULTANT WALLIS: Well, I understand  
24 that. It's just when I look at your fan  
25 characteristic, it looks as if 10 percent is going to

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1 shut it down to essentially zero flow. It doesn't  
2 seem compatible; that's what I'm saying. Something  
3 is off.

4 MEMBER BANERJEE: Yes. What you have  
5 shown here in the fan characteristics is let's say  
6 you had 300 cfm. That would be 2380 meters squared  
7 per second square. If you increase that by 10  
8 percent, you shut off the fan the way your  
9 characteristic is there.

10 I mean if your characteristic, this is  
11 just yours.

12 MR. MARQUINO: Yes. So when you say  
13 "shut off the fan." In the early portion of the  
14 event we can have the fan go to very flow when its  
15 pulled steam in, the fan flow can be low. And later  
16 on in the event when we've got noncondensable and the  
17 suction pressure is higher, the upstream pressure on  
18 the fan is higher, then it's able to flow through the  
19 heat exchanger. And we showed some results in the  
20 last meeting where it's about the first 15 minutes of  
21 the 30 days where it's in this low flow mode.

22 MEMBER BANERJEE: That's going to be a  
23 strong pressure reduction, is that it?

24 MR. MARQUINO: Yes. A strong reduction  
25 in the upstream pressure on the fan.

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1           The last point on this slide is the  
2 wetwell heat loss to the reactor building. We  
3 actually have a similar net heat loss to the reactor  
4 building between TRAC and MELCOR --

5           CHAIR CORRADINI: So, I've got to just  
6 interrupt you there.

7           MR. MARQUINO: Okay.

8           CHAIR CORRADINI: I thought in June, at  
9 least I remember writing down a substantial  
10 difference. Did I misunderstand at that time?

11          MR. MARQUINO: I think we were talking  
12 sensible heat versus latent heat. I don't want to  
13 speak for the staff.

14          CHAIR CORRADINI: Fine. But you guys  
15 have resolved it now?

16          MR. MARQUINO: But I think the bottom  
17 line is neither one of us think that that is an  
18 explanation of the TRAC-MELCOR differences.

19          CHAIR CORRADINI: Okay. So you have  
20 similar heat losses when you looked at it  
21 consistently?

22          MR. MARQUINO: Yes.

23          CHAIR CORRADINI: Outside, from the  
24 drywell to outside the building?

25          MR. MARQUINO: Yes.

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1 CHAIR CORRADINI: Okay.

2 CONSULTANT WALLIS: That was pretty  
3 different in June. It's been resolved?

4 MEMBER BANERJEE: This is the wetwell.  
5 This is to wetwell heat loss?

6 CONSULTANT WALLIS: It's been resolved  
7 now?

8 MR. MARQUINO: Yes, wetwell to reactor  
9 building.

10 CONSULTANT WALLIS: That's been resolved?

11 MR. MARQUINO: So we're looking at the  
12 wetwell as a box. In the TRAC model it's the only  
13 thing that communicates to the environment and what's  
14 the net loss from the wetwell. I think that's the  
15 figure of merit.

16 CHAIR CORRADINI: Fine.

17 MR. MARQUINO: Next side.

18 MEMBER BANERJEE: Was it wrong then that,  
19 at least we got the wrong idea at the last meeting  
20 that these were very different between TRAC and  
21 MELCOR?

22 MR. MARQUINO: Well, I'm not sure that we  
23 had -- in terms of the overall, I don't think we were  
24 talking different numbers. In terms of the breakdown  
25 by levels and that that may be where there was some

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1 difference in what GEH and the staff was reported.  
2 But I think we're converged on the overall loss from  
3 the wetwell to the environment.

4 CONSULTANT WALLIS: Because the numbers  
5 you showed in June were very different from Jack  
6 Tills' numbers.

7 CHAIR CORRADINI: They have resolved it.  
8 I'm going to leave it at that.

9 MS. CUBBAGE: Let's defer that to the  
10 staff's presentation?

11 CHAIR CORRADINI: Fine. Okay. Go ahead  
12 then.

13 MR. MARQUINO: All right. So I tried to  
14 address all the staff and ACRS observations from the  
15 June meeting. We still have a difference between the  
16 TRACG and MELCOR results, but they both predict that  
17 the containment pressure is reduced by the fan  
18 operation and it stays reduced. We don't have the  
19 situation where one is predicting an increase in  
20 containment pressure at the 30 day point and the  
21 other is predicting a decreasing trend.

22 MEMBER BANERJEE: You were showing a  
23 decrease, right?

24 MR. MARQUINO: Yes.

25 CHAIR CORRADINI: I think the fair thing

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1 to say is there was a stabilization and there was an  
2 increase, and we'll see the staff's presentation  
3 next.

4 MR. MARQUINO: Yes.

5 CONSULTANT WALLIS: Because at no time  
6 did you reduce the pressure rapidly.

7 CHAIR CORRADINI: They reduce it rapidly  
8 at 72 hours with the turning on of the fans, and then  
9 it stabilizes.

10 CONSULTANT WALLIS: And that meets the  
11 GDC -- there was an RAI about reducing the pressure  
12 rapidly and all the response was to reiterate  
13 description of what happens. It doesn't address the  
14 question.

15 MR. MARQUINO: Okay. Our definition of  
16 rapid is to reduce the pressure to 350 kilopascals at  
17 144 hours. So we're --

18 CONSULTANT WALLIS: So 144 hours is  
19 rapid?

20 MR. MARQUINO: Yes.

21 MS. CUBBAGE: That was discussed in the  
22 June meeting. And the staff was done with that  
23 topic, and I don't believe the Committee had any  
24 comments at that time.

25 CHAIR CORRADINI: Now you're going to go

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1 on to vacuum breakers, I assume?

2 MR. MARQUINO: Yes. Next slide, please.

3 CHAIR CORRADINI: We want to hear about  
4 that.

5 CONSULTANT KRESS: There was a question  
6 about that, and that was whether or not the operation  
7 made that particular piece of equipment a safety  
8 component and it had to be treated as such.

9 MS. CUBBAGE: No, there wasn't an issue  
10 on that in June.

11 CHAIR CORRADINI: I'm not remembering  
12 that. Can you repeat what you're concerned with?

13 CONSULTANT KRESS: Well, it's a  
14 nonpassive piece of equipment. And I don't think it  
15 was designated as a safety systeming component.

16 MS. CUBBAGE: Oh, yes. I understand what  
17 you're saying. The discussion was that the rapid  
18 reduction happens at 72 hours when the RTNSS systems  
19 are credited.

20 CONSULTANT KRESS: Right.

21 MS. CUBBAGE: Right. But that was --

22 CHAIR CORRADINI: So it's the RTNSS  
23 that's not -

24 CONSULTANT KRESS: Yes. The question was  
25 whether it shouldn't some more than just RTNSS.

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1 Because it has to be invoked to meet this rapid  
2 reduction.

3 CHAIR CORRADINI: So that's probably  
4 you're saying. My thought there at the time, and I  
5 thought the Committee was satisfied with the answer,  
6 which it's one of the RTNSS system. It's not safety  
7 grid, but it's one of the RTNSS system.

8 CONSULTANT KRESS: Well, the Committee  
9 might have been, but my question is it should have  
10 been safety grade.

11 CHAIR CORRADINI: Okay. I got it.

12 CONSULTANT KRESS: Okay.

13 CHAIR CORRADINI: So I guess I'm not  
14 personally understanding the difference in terms if  
15 it fits within a RTNSS framework, I would think that  
16 it has certain maintenance requirements and certain  
17 inspection requirements such that it will have  
18 reliability of operation under accident conditions.  
19 That's my interpretation.

20 CONSULTANT KRESS: Well, there are  
21 differences between the treatment. If it's required  
22 to meet a GDC, it seems to me like it ought to be a  
23 safety system. But that was the issue.

24 MS. CUBBAGE: If it was required before  
25 72 hours, then it would need to be safety-related.

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1 CONSULTANT KRESS: I see, it's the  
2 timing?

3 MS. CUBBAGE: It's the timing.

4 CHAIR CORRADINI: Okay. Any other  
5 questions over here?

6 Wayne, do you want to go on to the vacuum  
7 breakers?

8 MR. MARQUINO: Yes. In June we also  
9 presented information on the logic for detecting  
10 vacuum breaker leakage. And the staff followed up  
11 with an RAI 6.2-148, which we've recently responded  
12 to.

13 CHAIR CORRADINI: And just to be sure,  
14 what is that response number?

15 MR. MARQUINO: 6.2-148.

16 CHAIR CORRADINI: Okay.

17 CONSULTANT WALLIS: This is another thing  
18 we haven't seen, is it?

19 MR. MARQUINO: It was very recent, so you  
20 may not have seen it.

21 CONSULTANT WALLIS: So I would like to  
22 know the process here. Are we supposed to review  
23 these things that we haven't seen yet and then write  
24 a separate report to this Committee about them, or  
25 what?

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1 MS. CUBBAGE: By "recent," I just want to  
2 clarify. The staff sent this RAI to GE. You have  
3 the RAI. We have not received a response.

4 CONSULTANT WALLIS: You have not received  
5 a response?

6 MR. MARQUINO: But in any case, I'll  
7 present the information in the RAI to you.

8 So the question was whether the -- we  
9 provided a TRAC analysis previously that was proof of  
10 concept of the temperature detection --

11 CONSULTANT WALLIS: So, Wayne, you've  
12 showed us a TRAC plot in June and it didn't make  
13 sense. It had a temperature going down as the steam  
14 came in. And it had a temperature of the stream  
15 coming in of 160 -- wait a minute. A 166 C.  
16 Whereas, the drywell is 140 C. So it seemed to have  
17 the wrong boundary condition and a nonphysical answer  
18 from the TRAC analysis.

19 MR. MARQUINO: The boundary conditions  
20 were from the TRAC model at 50 seconds into the  
21 event.

22 CONSULTANT WALLIS: Was the temperature  
23 166 C?

24 MR. MARQUINO: Yes. And --

25 CONSULTANT WALLIS: Right at the

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1 beginning of the transient you're doing that? You  
2 are interested in what's the leakage, it's what's  
3 driving this 72 hour thing over three days; the  
4 leakage is driving all this pressure rise?

5 MR. MARQUINO: Right.

6 CONSULTANT WALLIS: That's what you need  
7 to detect during that period when the drywell  
8 temperature never goes 140 C.

9 MR. MARQUINO: Yes. So that as the crux  
10 of your question was that we provided a calculation.

11 And the purpose of the calculation was to show that  
12 we can differentiate high leakage from low leakage  
13 with this temperature difference logic.

14 CONSULTANT WALLIS: You had a temperature  
15 which was so much bigger than you're ever going to  
16 get when you're interested in detecting this.

17 MR. MARQUINO: So under those conditions  
18 we were able to differentiate a leak at the  
19 analytical limit used in the three day containment  
20 analysis from a lower value, that would be the  
21 surveillance/acceptance criteria for the vacuum  
22 breaker.

23 CONSULTANT WALLIS: But this was based on  
24 the TRAC analysis?

25 MR. MARQUINO: It was based on the TRAC

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1 analysis. Now we're not trying to claim that that  
2 analysis covers all possible conditions that happen  
3 over the three days. We --

4 CONSULTANT WALLIS: But you had a  
5 temperature difference between the drywell and the  
6 wetwell which was far bigger than you show in any of  
7 your plots. And so you're giving yourself an  
8 advantage of a huge temperature difference which you  
9 then say you can detect. It doesn't seem to make  
10 sense to me.

11 MR. MARQUINO: But the --

12 MR. DIAZ-QUIROZ: Wayne, this is Jesus  
13 Diaz-Quiroz, GEH.

14 And I'm just looking at the 72 hour plots  
15 in the DCD. And initially there is a large  
16 temperature difference between the drywell and the  
17 wetwell. As the event progresses through the  
18 analysis it does decrease. What we're looking at,  
19 say, in the 6th hour after the event we're looking at  
20 80 degrees in the wetwell and about 140 still in the  
21 drywell. And the vacuum breakers cycle in the first  
22 hour within the first 72 hours. So there is a large  
23 difference and it does last quite a lot. Of course,  
24 at the end of 72 hours the wetwell temperature the  
25 wetwell temperature does lag, and that temperature

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1 started to decrease as you stated.

2 CONSULTANT WALLIS: So you can detect  
3 this early on, in the six hours? When it's cycling  
4 you can detect leakage. What do you do about the  
5 leakage over that long period of three days where the  
6 pressure is slowing going up and its being driven by  
7 the leakage, if there is?

8 MR. DIAZ-QUIROZ: Can you restate your  
9 question, please?

10 CONSULTANT WALLIS: The interesting  
11 period is after the first opening/closing of the  
12 vacuum breakers things go very slowly up over three  
13 days.

14 MR. DIAZ-QUIROZ: Right.

15 CONSULTANT WALLIS: Long drawn out  
16 agonizing slow increase in pressure driven entirely  
17 by the leakage to the vacuum breaker. That's when  
18 you should be detecting it, it seems to me. You  
19 shouldn't be saying we can detect it in the first six  
20 hours. You want to know is it happening later on.

21 CHAIR CORRADINI: I think Dr. Wallis'  
22 question is if you were doing a limiting analysis,  
23 you would do the limiting analysis at the delta T at  
24 the end of the of the 72 hours, not at the beginning  
25 of the 72 hours. That's kind of what I think you're

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1 asking.

2 CONSULTANT WALLIS: During most of the 72  
3 hours. Yes.

4 CHAIR CORRADINI: Yes. Do you  
5 understand, Jesus?

6 MR. DIAZ-QUIROZ: Yes, I understand.  
7 Right. And as Wayne explained it initially, this was  
8 because during the first hour is when you do have  
9 vacuum breaker cycling and that's when you would  
10 expect if a failure were to occur in sealing, it  
11 would happen then when they do cycle. Those are the  
12 conditions we chose at the time.

13 We're not trying to cherry-pick, if  
14 that's what you're saying.

15 CONSULTANT WALLIS: And then you have a  
16 TRAC response which had the temperature falling at  
17 the sensor as the steam was coming in. And that  
18 didn't make sense to me.

19 MR. DIAZ-QUIROZ: No.

20 MR. MARQUINO: I think that may have to  
21 do with the extension pipe on the vacuum breaker  
22 inlet. The purpose of that extension is to cool the  
23 leakage flow and allow us to differentiate high  
24 leakage from a low leakage flow.

25 CONSULTANT WALLIS: And how does it cool

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1 the sensor? Okay. And the other problem is that  
2 you've got a very slow leakage rate. This stuff is  
3 oozing in. It's really producing a layer of steam  
4 which is much lighter than the gas below it, which  
5 simply acts as a piston and drives out the nitrogen,  
6 which is cold and heavy. And so it should be very  
7 insensitive to flow rate. It just means the piston  
8 goes slower if there's less team. It doesn't mix.  
9 TRAC says it mixes, but it doesn't mix.

10 MR. MARQUINO: TRAC isn't mixing. The  
11 calculation we did was a 1D pipe calculation in TRAC.

12  
13 CONSULTANT WALLIS: But you've got to  
14 test it anyway, is that right?

15 MR. MARQUINO: And we're going to test  
16 it.

17 CONSULTANT WALLIS: Okay. Well, there  
18 were several I had about TRAC, the TRAC calculation  
19 didn't make sense to me.

20 And another thing that bothered me was  
21 that you seem to have a step change. You said  
22 doesn't leak, then all of a sudden it leaks whereas I  
23 think it's more likely that it's been leaking for  
24 some time and that this team has driven out the  
25 nitrogen. And then you've already heated up your

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1 sensor, how you going to detect an increased link?

2 Anyway, I don't want to prolong this.

3 But I had several questions about this which bothered  
4 me. And you're going to test it, so then we're  
5 getting the real scoop. And I think you've got to  
6 test it with just not a step change in leak break,  
7 which is what you analyzed.

8 CHAIR CORRADINI: I think I'm not  
9 completely appreciating your question, Graham. Your  
10 point is that you want to have a pre-existing leak  
11 over a long time?

12 CONSULTANT WALLIS: We did an analysis.  
13 Say we can detect it if it doesn't leak at all and  
14 then it suddenly spills above the limit. I was  
15 saying that's okay, that's interesting analysis if  
16 TRAC does it right, but it's more likely that it  
17 mixed for a long period of time.

18 CHAIR CORRADINI: And degrades?

19 CONSULTANT WALLIS: And degrades. And  
20 then you have to say well what would we measure then,  
21 you know, because our temperature has already changed  
22 because of this long period of leaking.

23 Well, anyway, you're going to look into  
24 that?

25 MR. MARQUINO: Yes.

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1 CONSULTANT WALLIS: Thank you.

2 MR. MARQUINO: Next slide please.

3 So we were asked to talk about radiolytic  
4 hydrogen accumulation.

5 CONSULTANT WALLIS: And oxygen.

6 MR. MARQUINO: And oxygen. And we are  
7 committed to address Generic Issue 195. And we've  
8 considered this in our review of operating  
9 experience, which is an integral part of the ESBWR  
10 design process.

11 We've started system-by-system reviews  
12 and we're tracking the findings and the  
13 recommendations of these review to assure that  
14 they're dispositioned in detailed design.

15 CONSULTANT WALLIS: But the existing  
16 plants don't have a PCCS, so I don't see how existing  
17 experience which has had ruptures due to explosion,  
18 why would that have anything to do with ESBWR PCCS  
19 behavior?

20 MR. MARQUINO: Well, the fact that  
21 existing plants have had hydrogen combustion problems  
22 was flagged in this operating experience review and  
23 it's caused us to put requirements to assure that our  
24 system lines are effectively arranged to prevent  
25 hydrogen buildup.

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1                   CONSULTANT WALLIS: This was because of  
2 poor venting that they had these events?

3                   MR. MARQUINO: Yes. But the PCCS isn't a  
4 vent, it's a thing that creates a combustible gas as  
5 it works. It doesn't build up something which is  
6 vented.

7                   MR. MARQUINO: Yes, but --

8                   CONSULTANT WALLIS: But its very nature  
9 it creates this combustible gas.

10                  MR. MARQUINO: But let me talk about the  
11 general case first, which is venting of -- making  
12 sure we don't have a deadend pipe that's not vented  
13 which will build up combustible hydrogen gas. And  
14 then if we look at the steam piping in the plant, we  
15 have the IC heat exchanger and the PCC heat  
16 exchanger. So the IC, which is connected to the main  
17 steam line, this has to be addressed during normal  
18 operations, And we have connected a vent line from  
19 the IC to a lower pressure portion of the steam line  
20 piping. So we'll always have a small flow out of the  
21 IC to remove any radiolytic gases that enter the IC.

22                  Next slide, please.

23                  For the PCC, as you --

24                  CONSULTANT WALLIS: I see. Excuse me.  
25 We haven't talked about the IC before, have we?

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1 MR. MARQUINO: No, I don't think so.

2 CONSULTANT WALLIS: But it does the same  
3 thing. It takes material from the reactor, condenses  
4 the steam --

5 CHAIR CORRADINI: Returns to the reactor.

6 CONSULTANT WALLIS: Returns to the  
7 reactor. It also has a vent pipe for noncondensibles.  
8 And I just ask myself what are those  
9 noncondensibles? The only gases that I know that is  
10 in the reactor system are hydrogen and oxygen and any  
11 leaking of radioactive gases. So you have the same  
12 sort of situation that you have in the PCCS if you  
13 have any noncondensibles. You have radiolytic gases  
14 in the IC, don't you?

15 MR. MARQUINO: Yes.

16 CONSULTANT WALLIS: So what do you do to  
17 control the flammability limit in the IC?

18 MR. MARQUINO: Well, there's no ignition  
19 source in the heat exchangers themselves, there is no  
20 ignition source. And the IC is operating at a higher  
21 pressure. I believe we'll have a lower concentration  
22 of radiolytic gas in the IC relative to the PCC.

23 CONSULTANT WALLIS: Well, I think if you  
24 look at the past history of pipe end rupture causes  
25 by explosions of radiolytic gases, there was no

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1 ignition source there either. If you get the stuff  
2 at the right mix, it will go off spontaneously,  
3 apparently.

4 MEMBER BANERJEE: Where are your  
5 recombiners? Are they at that roof?

6 MR. MARQUINO: Yes. Our recombiners will  
7 be in the drywell and the wetwell and distributed so  
8 that we will be recombining and removing the  
9 radiolytic gas. Now that's going to reduce the  
10 overall concentration in the containment as a whole,  
11 but I don't think we can claim that it will present  
12 any radiolytic gases from being present in the PCC.  
13 Because we have a self-venting mechanism from the  
14 PCC. But there will be some residual hydrogen and  
15 oxygen in the PCC.

16 MEMBER BANERJEE: But from the break to  
17 the PCC, if you like, are there recombiners on the  
18 way?

19 MR. MARQUINO: Well, it depends on where  
20 the break is.

21 MEMBER BANERJEE: That's the problem, I  
22 guess.

23 MR. MARQUINO: It's sort of the situation  
24 where over a long duration we can expect that the  
25 gases find the PARS units, but we can't guarantee

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1 that they always go through a PARS unit on their way  
2 to the PCC inlet.

3 So we will apply appropriate industry  
4 codes to the PCC fans. We can make the fans out of  
5 brass or a nonsparking material. So we have API  
6 codes, Air Movement Control Association codes, NFPA  
7 codes that apply to fans or blowers in industrial  
8 applications similar to this?

9 CHAIR CORRADINI: So we're talking post-  
10 72 hours?

11 MR. MARQUINO: We're talking post-72  
12 hours.

13 CHAIR CORRADINI: So let me make sure I  
14 understand this. Because Sanjoy asked it before. I  
15 wrote it down. I have two big action items that I  
16 want to repeat when you're done with your  
17 presentation, but one of them kind of comes to this.

18 He asked, and I wrote it down that are you tracking  
19 a lower flammability limit, and in particular as you  
20 exit the PCCS that's the point where I think there's  
21 concern by some of us that you could get in a  
22 situation at long term that you would go above it.  
23 So is this being tracked in the analysis?

24 MR. MARQUINO: In the TRAC analysis it is  
25 not. But if the question is what's our evaluation of

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1 the concentrations in the heat exchanger --

2 CHAIR CORRADINI: Correct.

3 MR. MARQUINO: We can provide that  
4 information if that's an important question.

5 CHAIR CORRADINI: Well, it's kind of one  
6 of the subquestions that originated from Graham  
7 asking the questions about performance of the PCCS  
8 under your modeling conditions versus staff's  
9 modeling conditions and the drain pan, and what  
10 essentially is the overall efficiency. Because I  
11 think one of the outgrowths of that is are we getting  
12 the position in that local region where you could  
13 have some hydrogen burning.

14 Graham and Sanjoy, I think I've captured  
15 right, is that correct?

16 MEMBER BANERJEE: Yes. As long as you  
17 have lots of steam around, there's no issue because  
18 you're going to be a little --

19 CONSULTANT WALLIS: That's right. Now I  
20 have another question, though. You're saying this is  
21 when the fan's operating. Even before the fan  
22 operates the PCC has been sweeping out the nitrogen  
23 and -- I don't know if I recall. The residence time  
24 for nitrogen is less than a hour. So after days the  
25 nitrogen's gone from the containment. What goes

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1 down then from the PCCS to the wetwell, the  
2 noncondensibles going down that pipe are also  
3 radiolytic gases. So even before you turn the fans  
4 on during this long period of three days, you have  
5 to, it seems to me, monitor the flammability limit in  
6 that pipe because spontaneous combustion has been  
7 know to occur. I don't know. I'm not an expert on  
8 combustion. I just know that at least in the one  
9 Swedish reactor they had hydrogen/oxygen went off by  
10 itself in a pipe without any ignition source  
11 anywhere. And so I just don't know that.

12 MR. MARQUINO: I agree that the -- I  
13 would say once the fans are operating and stabilized,  
14 you're pumping this noncondensable around and high  
15 flow rates and you've drawn nitrogen back in from the  
16 wetwell.

17 CONSULTANT WALLIS: Yes. Yes.

18 MR. MARQUINO: Over about a half day you  
19 build nitrogen back --

20 CONSULTANT WALLIS: When you first turn  
21 the fans on you're concerned because there's no  
22 nitrogen there yet.

23 MR. MARQUINO: Yes. I think that's the--

24 CONSULTANT WALLIS: But what I said  
25 before was even before you turn the fans on you have

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1 this radiolytic gases and the noncondensable is going  
2 down the pipe to the wetwell, isn't that true?

3 MR. MARQUINO: That is true.

4 CONSULTANT WALLIS: And I think you need  
5 to resolve that somehow. It's not just what happens  
6 when you've turned the fans on.

7 MEMBER BANERJEE: Yes, I hadn't thought  
8 of that.

9 CONSULTANT WALLIS: These are specific to  
10 the ESBWR, aren't they? I mean, you don't have these  
11 features in other boiling water reactor systems.

12 MR. MARQUINO: We don't have a low  
13 pressure heat exchanger. We only have a high  
14 pressure heat exchanger.

15 CONSULTANT WALLIS: But you do have the  
16 intermediate condenser, or whatever you call it.  
17 Isolation condenser, you do have that?

18 MR. MARQUINO: Yes.

19 CONSULTANT WALLIS: So that, presumably,  
20 is being considered for the isolation condenser  
21 because it's the same problem but not quite so much  
22 because you haven't been producing -- well, maybe it  
23 is. I don't know. It is the same problem, isolation  
24 condenser.

25 MEMBER BANERJEE: Do you have a rough

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1 number you can give me the rate of production of  
2 radiolysis in sort of the early stages and the late  
3 stages?

4 CONSULTANT WALLIS: He gave us some  
5 numbers the last time that seemed very high, 680  
6 cubic feet or something humongous.

7 MEMBER BANERJEE: As large as that?

8 And what's the recombiner rate? Steady  
9 state it must be 600 cubic feet, right?

10 MR. MARQUINO: Yes. The recombiners will  
11 become effective at about four hours into the event.

12 The bolt concentration has built up after four hours  
13 to the point that we'll start scavaging the --

14 MEMBER BANERJEE: And they're not  
15 sufficient capacity to recombine everything, right?

16 MR. MARQUINO: Yes.

17 MEMBER BANERJEE: That's easy to do.

18 MR. MARQUINO: And they're distributed.

19 MEMBER BANERJEE: Yes.

20 CHAIR CORRADINI: So it's more a matter  
21 that you've -- I guess I didn't understand answer. So  
22 just to make sure I get it right, so you're saying  
23 that after a few hours you've come to a point where  
24 the recombiners can more than accommodate what is the  
25 assumed decomposition rate?

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1 MR. MARQUINO: Yes. And on a bulk basis.

2 CHAIR CORRADINI: On a bulk basis?

3 MR. MARQUINO: Okay. So we're not going  
4 to have a continually increasing radiolytic gas  
5 concentration in the containment.

6 CHAIR CORRADINI: But you'll have a  
7 continuing source?

8 MR. MARQUINO: We have a continuing  
9 source.

10 MEMBER BANERJEE: You may get some local  
11 areas, that's what he's saying. Yes.

12 CONSULTANT WALLIS: When we met in June  
13 you gave us a list of noncondensable gases at various  
14 times. And you said at 72 hours there were 689  
15 kilogram of noncondensibles. And I said in the  
16 drywell. I said these have to be radiolytic, because  
17 the nitrogen's all gone. And then you gave a one  
18 percent fraction of noncondensable which seemed to be  
19 compatible with that. That's what I was going on.

20 MR. MARQUINO: Yes.

21 CONSULTANT WALLIS: Maybe this is a  
22 vastly overrated -- overestimated number, this 689  
23 kilograms of radiolytic gas.

24 MR. MARQUINO: Well, I didn't get  
25 Professor Banerjee was asking me if I had the numbers

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1 and we have a derivation of the radiolytic gas  
2 production. So we can go back to that to get the  
3 hydrogen and oxygen production rate. It's  
4 proportionate to decay heat so we now how it varies  
5 over the three days.

6 CONSULTANT WALLIS: Was this 689  
7 something that we had to assume because of some  
8 bounding analysis requirement and it's not realistic?  
9 Is that why it was so high? It's very high.

10 MR. MARQUINO: Well, the GE value that we  
11 use is from a Regulatory Guide and --

12 CHAIR CORRADINI: They are using the  
13 required value.

14 CONSULTANT WALLIS: Which is unrealistic  
15 by a large amount, is it?

16 MR. MARQUINO: I have no feel of whether  
17 it's unrealistic or in the ballpark.

18 CHAIR CORRADINI: I think that's going to  
19 have to be a side discussion. But the one thing I've  
20 written down that we're clear on is you're going to  
21 look at the inventory at some set amount of times to  
22 clarify the number that Graham has from the June  
23 meeting, is that correct? You've just said you can  
24 go back and give us an inventory at various times.

25 MR. MARQUINO: Yes. Now what we can do is

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1 we can provide the production rate --

2 CHAIR CORRADINI: Yes.

3 MR. MARQUINO: -- of hydrogen and oxygen  
4 in the core that's fed into the TRAC model.

5 CHAIR CORRADINI: Right.

6 MR. MARQUINO: Is that useful?

7 CHAIR CORRADINI: Yes, it helps.

8 MR. MARQUINO: Okay.

9 CONSULTANT WALLIS: Let me say something  
10 here, I think I ought to say it, really. This is an  
11 issue which came up this year. And personally, I'm  
12 not speaking for the Committee or anything, I think  
13 it's one of the more important issues of the ESBWR.  
14 Because this is a new feature of the design and it  
15 has to be very systematically worked on in terms of  
16 numbers like flammability limits and whatever, and  
17 predictions made. All the other things I think we've  
18 resolved. This one still seems to be up in the air.

19 And to me personally it could be a major issue.

20 MEMBER BANERJEE: Can you take credit for  
21 recombiners? Are you allowed to?

22 MR. MARQUINO: Yes, we take credit  
23 recombiners at 72 hours and that allows us to  
24 classify them as a RTNSS system.

25 We don't credit them in the zero to 72

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1 hour pressurization calculation.

2 CHAIR CORRADINI: That's why the pressure  
3 is rising?

4 MEMBER BANERJEE: Right.

5 CHAIR CORRADINI: Do you understand what  
6 he just said, Graham?

7 CONSULTANT WALLIS: While the pressure is  
8 rising?

9 CHAIR CORRADINI: The way the analysis is  
10 done pre-72 hours the combiners are not credited nor  
11 analyzed as part of the response of the containment.

12 CONSULTANT WALLIS: That's not why the  
13 pressure is rising. The pressure is rising because  
14 of leakage into the wetwell.

15 CHAIR CORRADINI: It's rising for two  
16 reasons.

17 CONSULTANT WALLIS: But the leakage is  
18 the dominant factor.

19 CHAIR CORRADINI: I think about a year  
20 and a half ago we unwrapped it and it does have a  
21 noticeable effect due to the radiolytic  
22 decomposition.

23 MEMBER BANERJEE: Right.

24 CHAIR CORRADINI: Because it's leaking  
25 noncondensable gas and because there's a continuing

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1 noncondensable gas source, the PCC has to vent all  
2 the time.

3 CONSULTANT WALLIS: That's true. That's  
4 true.

5 CHAIR CORRADINI: Okay.

6 CONSULTANT WALLIS: That's true. But I  
7 think if you have no leakage through the vacuum  
8 breakers, the pressure just slowly goes up. I've seen  
9 that curve.

10 CHAIR CORRADINI: Yes, it would still  
11 increase.

12 CONSULTANT WALLIS: Right.

13 CHAIR CORRADINI: But at much slower  
14 rate.

15 CONSULTANT WALLIS: Correct. Okay.

16 MEMBER BANERJEE: So you're not allowed  
17 to take credit for the recombiners or you chose not  
18 to?

19 CHAIR CORRADINI: Well, that's a --

20 MR. MARQUINO: IF they are RTNSS system,  
21 we're not allowed to take credit for them. So in our  
22 licensing setup and the requirements we put on them,  
23 we're not allowed to credit for them.

24 MEMBER BANERJEE: So you will get a  
25 buildup of hydrogen and oxygen mixtures during this

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1 time then? At least in theory. In practice you may  
2 not.

3 MR. MARQUINO: Okay. The recombiners  
4 don't know what licensing requirements --

5 MEMBER BANERJEE: Right. I realize that.  
6 I'm trying to separate the two issues. I realize in  
7 reality they'll be operating for four hours.

8 CONSULTANT WALLIS: Well, maybe you'd  
9 better start taking credit for them.

10 MEMBER BANERJEE: You can't, right?

11 CHAIR CORRADINI: Well, wait. I think  
12 we're deviating. So I think your presentation is  
13 done. I want to see if the Committee has any other  
14 questions.

15 Okay.

16 MEMBER BANERJEE: Well I think I want to  
17 reiterate though that it would be interesting to know  
18 the LFLs.

19 CHAIR CORRADINI: I agree. I have it.

20 MEMBER BANERJEE: And where they are.

21 CHAIR CORRADINI: Okay. Why don't we  
22 take a break and come back at quarter of and have the  
23 staff give their updates analysis.

24 (Whereupon, at 10:30 p.m. off the record  
25 until 10:47 p.m.)

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1 CHAIR CORRADINI: Okay.

2 MR. WAGAGE: Hello. My name is Hanry  
3 Wagage. I'm the Lead Reviewer for Containment  
4 Analysis for ESBWR.

5 I have here Jack Tills for consignment  
6 from Sandia National Laboratory. And both Jack and I  
7 will be making this presentation.

8 The next slide, please.

9 This is the Project Managers Technical  
10 Review Team. You have Ilka Berrios, who is Chapter 6  
11 Project Manager. You know Amy Cubbage, who is Lead  
12 Project Manager.

13 I would like to recognize the excellent  
14 support we got from Office of Research staff members  
15 Allen Notafrancisco and Hossein Esmaili.

16 The purpose of this presentation is to  
17 present to the Committee comparison between TRACG and  
18 MELCOR ESBWR containment long term heat removal  
19 analysis.

20 During the discussion we will be telling  
21 about the open issues we have.

22 The current status of the analysis is  
23 that we have completed the MELCOR component of the  
24 analyses. And last time when we came to the  
25 Committee there was differences between the MELCOR

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1 and TRACG analyses. We understood the trend in TRACG  
2 and MELCOR long-term containment pressures.

3 Jack Tills will be going into more  
4 details on that.

5 Still we have the differences in  
6 immediate pressure drop at 72 hours. Jack will just  
7 explain the reason he think what causes that.

8 We have an open item RAI 6.2-140. Based  
9 upon our inquiry this RAI from GE. This is to ensure  
10 that design basis analyses is documented in the DCD.

11 GE has responded yesterday and we are in receipt of  
12 it.

13 In addition, there are two other open  
14 items. Identification of -- breaker leakage and  
15 isolation of -- breaker isolation valves. It's an  
16 open item. We haven't received response to RAIs yet.

17 There is another emerging issue that  
18 hydrogen accumulation in PCC condensers will be  
19 another issue that goes to our open item.

20 I will hand over to Jack.

21 MR. TILLS: Yes. I'd kind of like to  
22 address just some of Dr. Wallis' questions that were  
23 left over from clarification items from last.

24 The first one was the issue of geometry,  
25 since I had brought these slides up at our last

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1 meeting, the differences in the geometry. And there  
2 was really two questions that we were asking General  
3 Electric to address.

4 The first one was our interpretation  
5 correct in terms of a misorientation of the TRACG to  
6 the actual containment design in that upper head  
7 region. And the issue was whether or not the GDCS,  
8 for instance, was connected to the upper drywell head  
9 or should it have been connected to the drywell that  
10 was where the PCCS take off was. So that was the  
11 action item.

12 And then the other action item, of  
13 course, was does it make a difference.

14 So I think from what we understand from  
15 General Electric's response and our discussion with  
16 them was that, yes, there was a difference in the  
17 TRACG versus the actual design of the plant. And  
18 instead of redoing the whole calculation, they  
19 started at 72 hours and did the sensitivity starting  
20 from that point and looked at what the impact was.

21 And as I think Wayne had indicated from  
22 General Electric, the impact looks small, but it was  
23 the nevertheless when they ran out to 144 hours it  
24 was about a tenth of bar difference, meaning that  
25 they were in the original calculation that was in the

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1 CDC about a tenth of a bar lower than what they would  
2 have been if they made that correction. And that was  
3 at, you know, 144. And I think they later ran it out  
4 to 182 hours. But never ran it all the way out to  
5 720 hours. So, you know, there was a difference with  
6 that. That's the first item.

7 CONSULTANT WALLIS: And so, Jack, I think  
8 that helps. It means that so the bottom line didn't  
9 change much. The problem that we have is when we  
10 look at the figures like the one you saw this  
11 morning, which has now been discarded and you see  
12 these bumps in noncondensibles --

13 MR. TILLS: Right.

14 CONSULTANT WALLIS: -- suddenly appearing  
15 somewhere, that that's the sort of thing which has to  
16 be related to the decals of the code.

17 MR. TILLS: Right.

18 CONSULTANT WALLIS: And those are more  
19 obvious things which don't seem to be quite  
20 consistent with physics or something.

21 MR. TILLS: Right.

22 CONSULTANT WALLIS: But the overall trend  
23 path doesn't change very much.

24 MR. TILLS: It doesn't change very much.

25 But what seems to be what you would call

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1 insignificant from that standpoint is not  
2 insignificant when we're talking about four-tenths of  
3 a bar is over what they are. So when you're trying to  
4 do comparisons --

5 CHAIR CORRADINI: When you're unwrapping  
6 it, it --

7 MR. TILLS: When you're unwrapping it, it  
8 does become significant.

9 CHAIR CORRADINI: Okay.

10 MR. TILLS: The second point is in  
11 relationship to the heat transferring to wetwell.  
12 What I had showed last time here was sensible heat  
13 transfer into a gas volume, not total heat transfer  
14 on the walls of the wetwell, and Wayne was correct.

15 When we went back and compared apples to  
16 apples, so to speak, then the agreement was quite  
17 good. And so that's I call that energy transfer, not  
18 heat transfer. However, you know there is a  
19 difference. We're not exactly right on. The General  
20 Electric heat transfer is about half of what we  
21 predict. And the reason for that, and I gave them a  
22 paper on it, was again, because of the difference  
23 between Uchida correlation in the wetwell versus the  
24 MELCOR's more mechanistic treatment. The density in  
25 the wetwell is twice the atmospheric air density. And

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1 when that happens, Uchida will predict or under  
2 predict heat transfer by about a factor of two.

3 So the bottom line is is that we  
4 understand our differences between the two. They're  
5 not significant in light of what the total heat  
6 transfer out of the whole system is by the  
7 condensers.

8 Now, you know, before we had a slide that  
9 showed the difference as we were in the June  
10 presentation. And there was an issue with respect to  
11 MELCOR increasing in late time. There is also an  
12 issue with respect to the vary transient response  
13 that occurs when the fans are initially turned on.

14 So the next slide.

15 CHAIR CORRADINI: What I have is the June  
16 calculation.

17 MR. TILLS: It was the June that kind of  
18 promoted us to go back, look. See if we could  
19 converge a little bit better in terms of if we had  
20 the same things. There's a number of issues that  
21 were involved.

22 We didn't really understand the details  
23 of what General Electric was proposing for a fan, you  
24 know, in the post-3 day period.

25 And in addition, we also understood that

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1 there would be constant refill and, you know,  
2 evidently that was not actually being used in the  
3 General Electric. They were using some refill  
4 management of the PCCS pool. So we're talking about  
5 two different pools: The PCCS pool which is going to  
6 be refilled, and then we're talking about a GDSC  
7 which has a fan outlet and possibly varying  
8 submergents and varying fan flows.

9 And the next slide.

10 CONSULTANT WALLIS: Well, it was dramatic  
11 how rapidly they reduced the pressure. So rapid you  
12 can't even see the rate.

13 MR. TILLS: Right. And we'll talk a  
14 little bit about that as we go into it.

15 This is just an outline of the  
16 presentations. We'll start, again, the 0.72 hours  
17 just to kind of indicate to you as we redid these  
18 calculations that both General Electric and ourselves  
19 predicting the same 72 hour pressure.

20 CONSULTANT WALLIS: But when you  
21 presented it in June or it may be in your written  
22 text or in a slide or something that the PCCS  
23 noncondensable exhaust goes into the airspace.

24 MR. TILLS: Yes.

25 CONSULTANT WALLIS: And I think now it

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1 goes into a drain tank or some drain core, or drain  
2 pan.

3 MR. TILLS: Drain pan.

4 CONSULTANT WALLIS: And then that  
5 probably makes a difference?

6 MR. TILLS: We did sensitivities in both  
7 cases. It makes a very small difference.

8 CONSULTANT WALLIS: Doesn't it have a  
9 potential to condense the steam, which --

10 MR. TILLS: Yes. Right.

11 CONSULTANT WALLIS: -- it didn't  
12 condense.

13 MR. TILLS: And so there'll be a small  
14 difference in the pressure.

15 CONSULTANT WALLIS: I thought the whole  
16 idea of your saying the difference between MELCOR and  
17 there was that MELCOR didn't condense all the steam.

18 MR. TILLS: Well, if you put it into the  
19 GDCS pool, it will condense the steam. There isn't  
20 that much steam that's coming out. When you have the  
21 condensers --

22 CONSULTANT WALLIS: Is that a difference?

23 MR. TILLS: --in front of it a good  
24 portion of the steam is in the condensers. So what is  
25 exhausted in a very low, you know, amount of steam

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1 coming out even though -- because the condensers are  
2 still very efficient. And so it's not like the whole  
3 steam is coming through.

4 CONSULTANT WALLIS: Well, I thought that  
5 was your point last time was that if you didn't get  
6 the coefficient right, you could make a very big  
7 difference to the depressurization?

8 MR. TILLS: Yes. Well, during the  
9 transient, we've got to be careful we're talking the  
10 same thing.

11 CONSULTANT WALLIS: Yes.

12 MR. TILLS: In the transient case you can  
13 have a sizeable difference in the initial drop of  
14 pressure. But in the longer term after the transient  
15 goes through, then you can to an equilibrium point,  
16 and that equilibrium point it's not much difference.  
17 That's the point I think I was making.

18 MEMBER BANERJEE: So I am not completely  
19 following this. So maybe you should tell us, are you  
20 going to tell us what the bottom line is here? Why  
21 TRACG is showing sort of a gradual decrease --

22 MR. TILLS: Yes.

23 MEMBER BANERJEE: -- and you're showing a  
24 gradual --

25 MR. TILLS: I'll try to do that.

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1 MEMBER BANERJEE: Yes. But do we have to  
2 wait until to the end of the presentation or --

3 MR. TILLS: No, it's not. It's just not  
4 in the first one or two slides here.

5 MEMBER BANERJEE: Is it a simple thing or  
6 is it a complicated thing?

7 MR. TILLS: It's not a complicated thing.  
8 You know, for instance like the first three days  
9 period when we're talking about pressurized, that's a  
10 very simple thing. The PCCS is bound up with  
11 noncondensibles that are the radiolytic gases coming.

12 MEMBER BANERJEE: This is post-72 hours  
13 or pre-72 hours?

14 MR. TILLS: Pre-72 hours.

15 MEMBER BANERJEE: But there the  
16 difference is very small, right?

17 MR. TILLS: The difference between their  
18 analysis and us is very small. Okay. And that's due  
19 to the leakage that you have talked about.

20 CONSULTANT WALLIS: It's self-correcting  
21 essentially.

22 MR. TILLS: It's very self-correcting.  
23 And so if your PCCS model off one percent than the  
24 other, you will not see a difference because one will  
25 carry a little bit more gas in the condensers and the

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1 other one will not. And so that's not a problem.

2           The difficulty that we were having was  
3 during the transient when you first turn on the fans,  
4 okay, for the first maybe hour period and even during  
5 the first really half hour period where we see a  
6 larger drop in the GE versus our calculations is you  
7 notice that the fans are operating in a region that  
8 we normally wouldn't operate fans. They're operating  
9 in the flat region, which means that a small little  
10 difference in heads makes a big difference. That  
11 means that your model will have a feedback. So like  
12 a pumping action on the condensers.

13           And so when you originally turn the fans  
14 on, you might get a small increase in flow that wipes  
15 out or takes out nine condensers on the bottom of the  
16 condensers, but as soon as that happens, the fans  
17 also see a larger pressure drop and they start to  
18 shut down. And then it kind of goes back and forth.

19           In a very transient situation, and this  
20 is a very small volume in the condenser tubes. And  
21 the condensers are very sensitive to how much  
22 noncondensibles are in the tubes. About 40 percent  
23 of the tubes are uncovered during this period of  
24 time. So we're talking about the lower portions of  
25 the tubes.

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1           So any types of instability that you get,  
2 you could get a large flow in either direction. So  
3 basically what we're saying is is that this region of  
4 operating with a fan with, in our case we put the fan  
5 in an explicit manner.

6           MEMBER BANERJEE: Yes.

7           MR. WAGAGE: 200 cfm.

8           MR. TILLS: And so it's an explicit add  
9 on to the MELCOR model.

10          MR. WAGAGE: Yes.

11          MR. TILLS: Which will give you even more  
12 feedback than you probably would normally expect.  
13 You're getting this kind of almost pumping action in  
14 here.

15          MEMBER BANERJEE: But didn't you see a  
16 much more rapid --

17          MR. TILLS: You see a rapid drop --

18          MEMBER BANERJEE: -- during this period?

19          MR. TILLS: Yes. About maybe -- you  
20 know, it's not as severe as it looks when we did this  
21 last calculation when we put the fan actually in  
22 there. But, you know, where they calculate maybe .6  
23 bar drop, we calculate a .4 or .3

24          MEMBER BANERJEE: Okay. Sort of a  
25 transient deal?

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1 MR. TILLS: You know, what we wanted to  
2 get a little idea also from both the Committee as  
3 well as the staff was is this important. Is this an  
4 issue that's important? You know, and I think Wayne  
5 had mentioned. You know, if you're dropping between  
6 the pressure at really four bars, say, at 72 hours  
7 and within a 100 hours you're dropping down it  
8 doesn't make any difference if you drop in 15 --

9 MEMBER BANERJEE: So you're attributing  
10 the early post-72 hour difference to putting in the  
11 fan. What is the reason that in the long term you  
12 show a pressure increase?

13 MR. TILLS: In the long term there's an  
14 offset and you'll see in our calculations we have one  
15 an offset of about .4 bars. In other words, at 30  
16 days they're predicting approximately 265  
17 kilopascals. We predict a little over 300 in the  
18 long --

19 MEMBER BANERJEE: There's more than that.

20 CHAIR CORRADINI: I think Sanjoy's  
21 question is --

22 MEMBER BANERJEE: Why is yours going up,  
23 theirs going down?

24 CHAIR CORRADINI: No, no, that's slide  
25 11.

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1 MR. TILLS: That's the old June  
2 calculation. Dr. Banerjee, this is not going up  
3 anymore.

4 MEMBER BANERJEE: What did you do? Just  
5 the fan curves --

6 MR. TILLS: Fan curves and also refill  
7 management. So both are in the slide packet that  
8 you've--

9 MR. SHUAIBI: And Dr. Banerjee, if I  
10 could interrupt. This is Mohammed Shuaibi from the  
11 staff. I guess --

12 CHAIR CORRADINI: Wait, wait, you're  
13 talking over each other. Go ahead.

14 MR. SHUAIBI: I guess what we would like  
15 to do if it's possible is if we can get through the  
16 presentation, or at least get to the slides that  
17 would address this. We were planning to address some  
18 of this information but we're still on the outlying  
19 slide in terms of what we want to cover.

20 MEMBER BANERJEE: Right. Right.

21 MR. SHUAIBI: So if it's acceptable to  
22 you all, I'd like to continue with the presentation.

23 MEMBER BANERJEE: I just get impatient.

24 CHAIR CORRADINI: Yes, we sense that.  
25 Right.

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1 MR. TILLS: I mean I'll answer your  
2 questions, but it'll go -- all right.

3 So this the zero to 72 hour period, and  
4 you've already seen this. This is just reemphasizing  
5 again that with her recalculations both General  
6 Electric and MELCOR are the same.

7 Now let me make a point about the  
8 calculations. Throughout this presentation I used  
9 two different adjectives for what these calculations  
10 are.

11 In the first case when we have a  
12 calculations that's a DBA calculation, in others an  
13 audit or DBA calculation, that means that we tried to  
14 follow the design as well as we understand the  
15 design. We're not trying to match another code.  
16 Okay. But then in the interest of trying to  
17 determine the MELCOR versus TRAC calculation, in that  
18 calculation we call that confirmatory where we're  
19 trying to understand the comparison between two  
20 different models, okay?

21 So there's two different things I'm going  
22 to present here. One is the comparison as Dr.  
23 Banerjee wanted to see, between MELCOR and TRAC.

24 CHAIR CORRADINI: Which you call  
25 confirmatory?

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1 MR. TILLS: Confirmatory. Confirming  
2 that we understand where we're at. And then the  
3 other calculation is a DBA calculation.

4 The reason they're two difference is  
5 because of what's modeled in the national  
6 containment, okay?

7 So in this case the confirmatory the DVA  
8 for the first passive period of time are the same.  
9 Okay. Both the design as well as operating and so  
10 forth are the same between the codes and the design.

11 CHAIR CORRADINI: Now, if I might just  
12 clarify one thing.

13 MR. TILLS: Yes.

14 CHAIR CORRADINI: At this point I seem to  
15 remember, but I could be wrong, you have much less  
16 nodalization with MELCOR in the drywell --

17 MR. TILLS: That's correct. That's  
18 correct.

19 CHAIR CORRADINI: -- compared to --

20 MR. TILLS: Our drywell is a single well  
21 mixed body.

22 CHAIR CORRADINI: Okay.

23 MR. TILLS: And we follow what we believe  
24 is the conservative, but probably not very much  
25 conservative because we believe that during the

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1 blowdown this thing is well mixed and even after the  
2 blowdown these are significant sources still coming  
3 in. And the volume is not big. We're not doing large  
4 PWR volume.

5 CHAIR CORRADINI: It involves Sanjoy, but  
6 I'll make you say that again eventually.

7 MR. TILLS: Okay. Well mixed.

8 CONSULTANT WALLIS: So if you are well  
9 mixed, that means that all the noncondensibles are  
10 always mixed with the steam?

11 MR. TILLS: That's right. And they go  
12 out into the wetwell.

13 CONSULTANT WALLIS: And since the, sort  
14 of, turnover time, whatever you want to call, is less  
15 than an hour for these things, in 20 hours everything  
16 is down to eight to the minus some enormous number?

17 MR. TILLS: That's right. That's right.

18 CONSULTANT WALLIS: So there's no  
19 noncondensibles left in terms of nitrogen?

20 MR. TILLS: That's right. That's right.

21 And issues on hydrogen per our operations are kind  
22 of out in left field here. All right.

23 MEMBER ARMIJO: I want to make sure I  
24 understand. In your analysis do you include that  
25 volume above the vessel head? Is that connected in

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1 your analysis?

2 MR. TILLS: That's included in one large  
3 volume. In other words, that one mixes. In the  
4 General Electric case that volume even during the  
5 blowdown never gets cleared because it's a dead-ended  
6 cell. Okay. There's no way it's being forced up,  
7 compressed --

8 CHAIR CORRADINI: It does flow.

9 MS. CUBBAGE: Right, it doesn't flow in  
10 anyway.

11 MR. TILLS: And in the link time after  
12 three days they still have gas in there and that's  
13 where they do their adjustment. Wayne talked about a  
14 nonmechanistic deal. That means at three days any  
15 case that's in that region is soon to go over and we  
16 do a separate hand calculation to adjust the  
17 pressure. So, you know, it goes up a small amount.  
18 It's not a big amount. From maybe 300 in 95 or so to  
19 right around 400 kilopascals. So they add a small  
20 amount.

21 MEMBER ARMIJO: Okay.

22 MR. TILLS: Next slide.

23 I'm not going to belabor this one. This  
24 is just a better cartoon view of what the plant model  
25 is.

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1 I will mention though that one of the  
2 adjustments that we had made for this long term  
3 calculation was to layer or nodalize the PCCS tank.  
4 And that's shown right here in this figuring, this  
5 layering that's going on here. And we did that in  
6 order to better model the saturation pool temperature  
7 in the PCCS tank.

8 CHAIR CORRADINI: So MELCOR, with this  
9 layering, because it's such a deep pool, the  
10 saturation temperature is different?

11 MR. TILLS: That's right. It varies by a  
12 few degrees.

13 CHAIR CORRADINI: Okay.

14 MR. TILLS: You know, not much but it  
15 does make a -- we saw a difference in terms of how  
16 fast we dropped the pressure when the fans came on.

17 The other thing is we put in the fan,  
18 you'll see a GDCS fan there. And this tray, I'll  
19 have another slide that has a little bit more detail  
20 on the tray, and that's showing where the fan and the  
21 condensate drain from the PCCS pools goes into.

22 CONSULTANT WALLIS: -- the condensate  
23 from the PCCS. Because it's less than saturation  
24 temperature because of the noncondensibles and the  
25 partial pressures and so on, and it's also less

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1 because it's colder on the wall and they get the  
2 subcooled variation of temperature through the film.

3 And it's also cooled when we gets into that tank at  
4 the bottom, that plenum or whatever you want to call  
5 it, and gathers all the water, it's cooled in there.

6 MR. TILLS: Right,

7 CONSULTANT WALLIS: Do you have an  
8 estimate of the temperature of that water stream  
9 coming out into the drain pan?

10 MR. TILLS: I don't have that number  
11 exactly. It's going to be at the saturation -- you  
12 know, as you pointed out, there will be some sensible  
13 heat taken out of it, but basically its going to be  
14 at the saturation temperature of the drywell.

15 CONSULTANT WALLIS: I just wonder what it  
16 is. What it is. Because if you have noncondensibles  
17 influencing the condenser for about half its length,  
18 I think the partial pressures change that temperature  
19 significantly, but I'm not sure. I'm not sure.

20 MR. TILLS: That pressure in the  
21 condenser is basically the pressure in the drywell.

22 CONSULTANT WALLIS: Oh, but the pressure  
23 of the steam is that: (1) It's noncondensibles.

24 MR. TILLS: Right. Right. Right.

25 CONSULTANT WALLIS: So at the bottom you

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1 have a much lower partial pressure of the steam and  
2 the water can get colder at the bottom of the  
3 condenser.

4 MR. TILLS: Yes. I mean, the pool  
5 temperature is at 373 at the bottom of the condenser.

6 CONSULTANT WALLIS: The pool temperature?

7 MR. TILLS: The pool --

8 CHAIR CORRADINI: The outside pool.

9 MR. TILLS: The outside pool.

10 CONSULTANT WALLIS: Say that again.

11 MR. TILLS: It's at around 373 --

12 MEMBER ABDEL-KHALIK: That is Kelvin.

13 MR. TILLS: Yes. Yes. Kelvin.

14 CONSULTANT WALLIS: Kelvin. Because it's  
15 the boiling point of water --

16 MR. TILLS: Yes, right.

17 CONSULTANT WALLIS: So it's colder than  
18 that?

19 MR. TILLS: Yes.

20 CONSULTANT WALLIS: So I just wonder how  
21 cold the water is that's going into that drain pan?

22 MR. TILLS: Yes, I don't have that.

23 CONSULTANT WALLIS: Because that mass  
24 flow is significantly more than the mass flow of  
25 steam going into that drain pan. Okay. Well, it's

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1 something to be looked into.

2 MR. TILLS: Yes. Next slide.

3 CHAIR CORRADINI: Let me just ask the  
4 question differently because it's going to come back  
5 up. So you have it somewhere, you just don't know  
6 it?

7 MR. TILLS: Yes.

8 CHAIR CORRADINI: Okay.

9 MR. TILLS: I just didn't bring it.  
10 Rather than saying what it is, I just can't remember.

11 CONSULTANT WALLIS: And you put in all  
12 these effects like the partial pressure and the heat  
13 transfer and so on?

14 MR. TILLS: Yes. Yes.

15 CONSULTANT WALLIS: And the subcooling of  
16 the film and everything?

17 MR. TILLS: Yes.

18 CONSULTANT WALLIS: Thank you.

19 MR. TILLS: The refill, and I make this  
20 distinguished in here between DBA and confirmatory.  
21 The DBA, as we understand it, has no refill  
22 management in he sense that when the injection comes  
23 in to fill the tanks, the PCCS tanks, comes into this  
24 region called the expansion tanks, the level will  
25 rise. The only refill management that we've been led

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1 to understand occurs is if the tanks overflow. Okay.

2 To keep the tanks from overflowing. But if they  
3 don't overflow or up into the point where they tend  
4 to overflow, there is no refill management.

5 In other words, we don't tailor the  
6 refill to try and get better heat transfer in the  
7 tubes.

8 In the confirmatory calculation there is  
9 a refill management. In other words, the tubes are  
10 allowed to cover up as a result of the 200 gallons  
11 per minute flow. But then later when the level has  
12 reached the top of the tubes, the operation in this  
13 case would throttle back to keep the tubes just  
14 covered. So we call that refill management in a  
15 proper sense. And what we model, we do not model  
16 that.

17 CHAIR CORRADINI: That's fine. But just  
18 to say it differently: The difference in height  
19 between overflow and top of the tubes is what  
20 distance?

21 MR. TILLS: Well, when we don't do any  
22 refill management, it gets up maybe about a meter and  
23 a half above the top of the tubes. Its almost to  
24 where it was when it initially was drained down.

25 CHAIR CORRADINI: Okay. So it's about

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1 .15 bars difference in terms of head --

2 MR. TILLS: Yes.

3 CHAIR CORRADINI: Okay.

4 MR. TILLS: This is a slide that just  
5 basically shows the difference about what we are  
6 modeling in the confirmatory and audit calculation  
7 with respect to the tray. The tray is in there to  
8 keep the fan vent covered for reasons other than what  
9 we're discussing here in terms of hydraulics. It's a  
10 matter of stopping flow from going back through the  
11 fan.

12 In this case our interest is how much  
13 static head is associated with having the tray  
14 modeled with a lip on there so that you have a  
15 constant submergence on the fan vent. And so the DBA  
16 audit from our understanding is that there will be a  
17 10 inch -- if the trays are there, a 10 inch  
18 submergence because there's lips on the trays. So  
19 any condensate coming in will keep the fan covered  
20 approximately 10 inches.

21 The uncertainly there may be something  
22 like around a half an inch in terms of the design.

23 CONSULTANT WALLIS: So we don't know the  
24 design of the fan discharge line?

25 MR. TILLS: Pardon?

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1                   CONSULTANT WALLIS: We don't the design  
2 of the end of the fan discharge line? If it had a  
3 big sparger in there --

4                   MR. TILLS: No, we don't know that  
5 detail. It's just a matter of static head at this  
6 point.

7                   CONSULTANT WALLIS: But the tray has to  
8 be big enough that what you've been saying is  
9 correct?

10                  MR. TILLS: That's right. That's right.

11                  CONSULTANT WALLIS: And we don't know  
12 anything about the details. And if it were small and  
13 were bubbling through it, it would bubble up and  
14 overflow and all that.

15                  MR. TILLS: That's right. That's right.  
16 It's not designed.

17                  CONSULTANT WALLIS: So in order to say  
18 this will work, we need to know perhaps something  
19 more about the details of that tray?

20                  MR. TILLS: That's right. And you'd  
21 probably need some tests.

22                  CHAIR CORRADINI: I guess I understand.  
23 I guess I should know this, but I don't remember.

24                  The purpose is that when after post-72  
25 hours the fans come on they take their suction from

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1 the gas side of the bond with the PCCS. So instead  
2 of the gas is going down to the wetwell, they get  
3 blown through this and through this submerged about a  
4 foot of water?

5 MR. TILLS: Right.

6 CHAIR CORRADINI: And the only reason to  
7 have this pan is to essentially check any back flow  
8 into the fan?

9 MR. TILLS: That's correct.

10 CHAIR CORRADINI: Okay.

11 MR. TILLS: That's correct.

12 CHAIR CORRADINI: And the assumption in  
13 both set of models right now is if the water in the  
14 tray were subcooled, it would do some condensing. I  
15 have that right. But I'm curious about what the  
16 calculations -- Wayne indicated, maybe he'll correct  
17 me if I'm wrong, but right now TRAC does not model  
18 it. And the reason being its saturated, the pool is  
19 saturated, everything is saturated. And that's where  
20 we are.

21 What does MELCOR do in this case now?

22 MR. TILLS: MELCOR for the DBA  
23 calculation it imposes a fixed 10 inch head on the  
24 outlet of the fan. And because we don't know the  
25 details of how large the tray was, and like Dr.

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1 Wallis was saying about the sparger effects, we put  
2 all of the fan exhaust into the gas space.

3 In other words, we assume that there's a  
4 small enough tray here that we don't get significant  
5 condensation. So that's our model.

6 The confirmatory model tries to mimic  
7 what they did in TRAC was they have fan submergence,  
8 outlet submergence, but its variable. As the GDCS  
9 pool level drops, their static head will drop whereas  
10 ours for the DBA is fixed.

11 They do not uncover. I think theirs is  
12 something like 14 inches below the initial level of  
13 the GDCS pool at 72 hours. So they barely almost  
14 uncover, but not quite uncover at the end of 30 days.

15 But the change in the static head is effecting the  
16 fan performance in how what the fan is doing.

17 CHAIR CORRADINI: And how much the fan is  
18 pulling through the --

19 MR. TILLS: That's right.

20 CHAIR CORRADINI: Okay.

21 MR. TILLS: So they have a slightly  
22 higher late time fan flow than what we do because of  
23 the static head.

24 CHAIR CORRADINI: Okay. But from the  
25 standpoint of an energy transfer --

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1 MR. TILLS: And the energy transfer is  
2 different because I think they inject their steam  
3 outlet into the GDCS pool, whereas as we, seeing that  
4 the tray is small, and ours goes into the gas space.

5 So --

6 CHAIR CORRADINI: So if there heat  
7 transfer, you skip it.

8 MR. TILLS: That's right. Which would  
9 mean that ours would generally be conservative,  
10 whereas ours would not.

11 CHAIR CORRADINI: Okay.

12 MEMBER ABDEL-KHALIK: What's the shutoff  
13 head of the fans?

14 MR. TILLS: Well, I think it's around 24,  
15 maybe 2450 you know --

16 MEMBER ABDEL-KHALIK: Is the shutoff head  
17 in inches of water or psi, whatever power units you  
18 want to use?

19 MR. TILLS: I think it's a little over f  
20 kilopascals, as I remember. Maybe Wayne would have a  
21 better number on what that number is.

22 MR. MARQUINO: We provide the table --

23 MEMBER ABDEL-KHALIK: Well, the table  
24 just goes down to 150 cfm. It doesn't go to the  
25 shutoff point.

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1 MR. MARQUINO: Let me look at the plot of  
2 head versus --

3 MR. TILLS: I think we have a figure in  
4 kPascals later in the presentation. In fact, I think  
5 if you look at slide 18 you'll see it in kPascals.

6 The point is it does shutoff. Because  
7 we're on the -- you normally would operate on near  
8 the rates point of the curve or slightly above the  
9 rated point. You wouldn't operate way in the flat  
10 field. But, you know, General Electric is  
11 comfortable I think with that. But it does create  
12 some analytical --

13 CONSULTANT WALLIS: Yes, I was surprised  
14 that they choose to operate in the flat region of the  
15 fan.

16 MR. TILLS: Yes. Yes.

17 CONSULTANT WALLIS: I mean that gives  
18 rise to instabilities and all kinds of things.

19 MR. TILLS: We did, too. And we had a  
20 conference with them. And I think they brought in a  
21 person that indicated that they've had experience  
22 operating in this regime from an equipment  
23 standpoint.

24 MR. MARQUINO: I want to agree with what  
25 was said about the steam condensation in the tray or

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1 the GDCS pool. That there was a question about the  
2 design features of the tray. And if there's time and  
3 you wish, I have a backup slide on the design  
4 features that we consider to address I think your  
5 point about the entrainment from the tray.

6 CHAIR CORRADINI: Well, let's hold that  
7 and --

8 CONSULTANT WALLIS: Well, can I ask then  
9 do you have from your tests of the PCCS, you did full  
10 scale tests under realistic conditions with  
11 noncondensable, you should have a figure of the  
12 subcooling of the water that came out due to the  
13 noncondensable and other effects. You should have  
14 actually numbers from tests.

15 MR. MARQUINO: Yes, we have information  
16 from the tests on subcool.

17 CONSULTANT WALLIS: And that would be the  
18 best evidence, I think.

19 MR. WACHOWIAK: This is Rick Wachowiak  
20 from GEH.

21 So we've been talking a lot about this  
22 tray and its heat transfer contribution a lot this  
23 morning. And I'm wondering why we go down that path.

24 Because the function of the tray is to provide a  
25 water seal so we don't get backflow and have a

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1 containment bypass. And the heat transfer  
2 characteristics of the tray are not part of the  
3 design basis for it.

4 CONSULTANT WALLIS: Well, the reason we  
5 emphasized this was because Jack told us last time  
6 that the difference between a rate of  
7 depressurization at 72 hours between him and you was  
8 the efficiency of the PCCS. And we said if this tray  
9 is cold, it condenses the steam anyway and you don't  
10 care about efficiency of the PCCS because all the  
11 steam gets condensed anyway. That was the fact.

12 CHAIR CORRADINI: But I think, and I  
13 thought I heard Rick to say and I think we need to  
14 move on is, it's a water seal. They're taking it it  
15 has no effect in this because they're saying whatever  
16 goes in, bubbles out.

17 MR. WACHOWIAK: Right.

18 CHAIR CORRADINI: And it's only there as  
19 a check valve to stop back flow. Am I  
20 misunderstanding?

21 MR. WACHOWIAK: That's what I was trying  
22 to say, yes.

23 CONSULTANT WALLIS: Is that conservative?  
24 And this is a conservative idea, isn't it?

25 MR. TILLS: Why don't we go on.

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1 CHAIR CORRADINI: Okay.

2 MR. TILLS: Okay. So this calculation is  
3 a confirmatory calculation. And this is our  
4 calculation on the top. The dashed calculation is  
5 the MELCOR calculation where we simulate pool level  
6 control. We simulate the fan vent with varying  
7 submergence similar to TRAC.

8 And you can initially there's a very  
9 rapid drop in pressure in the first few tens of  
10 minutes and then we go towards an equilibrium. And  
11 that equilibrium at the end of 30 days is roughly an  
12 offset of a little over .4 bars.

13 So the conclusion from this was is that  
14 if we model as best as we can the TRAC simulation, we  
15 get the similar trends long term. In other words,  
16 we're not going up when they're going down. We still  
17 have an offset for the early time period and we have  
18 an offset for the late time period.

19 Now the early time period has not  
20 phenomena, as I mentioned, than the late time. So  
21 you can't expect by just shifting things, like  
22 increasing the efficiency of the model, that you'll  
23 capture the transient better and then that will  
24 translate to what's going on --

25 CONSULTANT WALLIS: Let me ask you

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1 another something. You assume a perfectly mixed  
2 containment.

3 MR. TILLS: Yes.

4 CONSULTANT WALLIS: So the nitrogen that  
5 comes out of the vacuum breakers is immediately  
6 available, does not cause condensation in the PCCS.

7 MR. TILLS: That's right.

8 CONSULTANT WALLIS: In reality my view is  
9 that the cold nitrogen moves along the floor and goes  
10 to the bottom of the containment and doesn't go up to  
11 the PCCS at all. In which case, the pressure would  
12 drop far further, wouldn't it?

13 MR. TILLS: Right.

14 CONSULTANT WALLIS: And more rapidly than  
15 you show here?

16 MR. TILLS: Right. And the next slide  
17 shows that sensitivity.

18 CONSULTANT WALLIS: Okay. So this is,  
19 perhaps, a very conservative assessment?

20 MR. TILLS: Yes.

21 CONSULTANT WALLIS: Yes.

22 MR. TILLS: Okay. So we have two things  
23 we wanted to try and investigate: (1) was why the  
24 transient might be higher and why the late time may  
25 be higher in MELCOR.

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1 So the next slide --

2 CHAIR CORRADINI: You do have two effects  
3 here, I want to make sure. The stabilization of the  
4 pressure is really the fan curve?

5 MR. TILLS: Yes.

6 CHAIR CORRADINI: The, I think you called  
7 pool level control, will effect some Delta P in the  
8 performance of the PCCS, but that doesn't effect the  
9 stable, the positive slope versus what I'll stable  
10 stabilized slope?

11 MR. TILLS: Right. Right.

12 CHAIR CORRADINI: Okay.

13 MR. TILLS: Right.

14 MEMBER ARMIJO: You told us once before I  
15 think that what is the main reason for the .4 bar  
16 offset at late -- with the long-term offset?

17 MR. TILLS: From what we've been able to  
18 tell it's the difference between the two PCCS models.  
19 Their model predicts a slightly higher energy  
20 removal rate than we do. And when we did our  
21 calculation, that in this case is somewhere around 10  
22 to 15 percent difference. In other words, they  
23 predict a little bit higher than we do for the same  
24 concentration of inlet gas than we do. And so we do  
25 that analysis later.

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1 MEMBER BANERJEE: Both of --

2 CHAIR CORRADINI: Sorry. You go ahead.

3 MEMBER BANERJEE: Both of your models  
4 have been tuned to the same experiments, I take it?

5 MR. TILLS: I wouldn't call them tuned.

6 MEMBER BANERJEE: They're not tuned?

7 MR. TILLS: I would say that they're  
8 calculated the same experiments. When we were  
9 originally doing the modeling of the condenser with  
10 MELCOR, I mean we started not with MELCOR but with  
11 CONTAIN code back in the mid-'90s. And we were doing  
12 both analytical analysis of single tube tests and  
13 also numerical with the actual codes.

14 And so at that point in time the main  
15 interest of looking at this condenser was to turn  
16 around the pressure after the GDCS had stopped  
17 draining down and the RPV started to steam again, and  
18 so you wanted to see where it turned around. That  
19 was only a few hours in the accident.

20 Now we're talking about 30 days into the  
21 accident. The decay heat is much less. The flow  
22 going into the condensers is much less. And good  
23 portion of those early experiments that were done  
24 with single tube at UCB as well as the stuff that was  
25 done at MIT, now we're in a much lower flow

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1 condition. We're not in forced flow, we're in a mix  
2 transition region, quite different. So we extended  
3 some of our comparisons.

4 We were doing very good in terms of just  
5 a few percent off where we were in a forced flow  
6 high--

7 MEMBER BANERJEE: Are you saying that now  
8 you have mixed convection? But this is facing  
9 downwards --

10 MR. TILLS: Right. But the flow is in the  
11 -- forced to natural flow as you're going low in the  
12 tube as the flow going down --

13 MEMBER BANERJEE: What's the Reynolds  
14 number?

15 MR. TILLS: The Reynolds coming in is in  
16 a few -- you know, tens of thousands coming in,  
17 probably 20,000. But as you're going through the  
18 tubes, it's dropping.

19 MEMBER BANERJEE: But on a tube-wise  
20 basis it is a few thousand coming in, even in this  
21 regime?

22 MR. TILLS: Oh yes.

23 MEMBER BANERJEE: So eventually if there  
24 were no noncondensibles, it would become all water,  
25 right? So the gas Reynolds number would go to zero.

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1 MR. TILLS: Would go to zero.

2 MEMBER BANERJEE: Liquid Reynolds number  
3 because --

4 MR. TILLS: The liquid, it stays within  
5 the laminar flow. It's only a few, you know, less  
6 than a thousand.

7 MEMBER BANERJEE: So experimental data  
8 ranges, which I said you tuned your codes to, were  
9 not in this low range?

10 MR. TILLS: Inlet was not. But outlet  
11 was not. I mean, it had gone to very low. And when  
12 we done analytical analysis of keeping forced flow we  
13 got very good results as long as kept forced flow  
14 correlations.

15 MEMBER BANERJEE: But the film is always  
16 laminar, right?

17 MR. TILLS: The film goes laminar. I'm  
18 talking about the boundary layer for noncondensibles.

19 MEMBER BANERJEE: Right. So you're going  
20 through a transitional region, and there are no  
21 experiments in this region?

22 MR. TILLS: Well, I think the experiments  
23 are single tube experiments.

24 MEMBER BANERJEE: Right.

25 MR. TILLS: Okay.

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1 CHAIR CORRADINI: Those are the Berkeley  
2 experiments, right?

3 MR. TILLS: These are the Berkeley  
4 experiments. But the PANTHERS experiments do not  
5 have the details of what the heat flow is critically  
6 on the tube.

7 MEMBER BANERJEE: Right. But did they go  
8 down to these low slopes?

9 MR. TILLS: Yes.

10 MEMBER BANERJEE: So effectively you both  
11 compared against whatever correlations you used. I  
12 don't know. But you compared against the PANTHERS  
13 experiments, right?

14 MR. TILLS: Yes.

15 MEMBER BANERJEE: So did you come to the  
16 same sort of agreement with these experiments, or did  
17 you --

18 MR. TILLS: Yes.

19 MEMBER BANERJEE: Did you adjust  
20 correlations?

21 MR. TILLS: No. We adjust our  
22 correlations only to do sensitivity calculations.  
23 But the correlations are the actual --

24 MEMBER BANERJEE: So you were able to  
25 correlate the PANTHERS data using the original UC

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1 Berkeley correlations?

2 MR. TILLS: We do not use the UC Berkeley  
3 correlations.

4 CHAIR CORRADINI: No. They have a model.

5 I guess I wanted to get to this. They have a model  
6 in MELCOR which they consistently use, and it did a  
7 reasonably good job of the Berkeley single tube in  
8 the PANTHER. And now they take the same model and  
9 they apply it here, and it's different at these sets  
10 of conditions. That's what I hear Jack saying.

11 MR. TILLS: That's right. That's right.

12 MEMBER BANERJEE: The model is the same  
13 or different?

14 CHAIR CORRADINI: Same model.

15 MEMBER BANERJEE: Okay. But you get  
16 equally good agreement as GE gets, or no?

17 MR. TILLS: No. No.

18 MEMBER BANERJEE: Ah. Who is more  
19 accurate?

20 MR. TILLS: Well --

21 CHAIR CORRADINI: I don't know if we want  
22 to clarify --

23 MR. TILLS: -- we have backup --

24 MEMBER BANERJEE: Well, I want to know  
25 the reason for the difference.

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1 MR. TILLS: Let me go to a backup. Not  
2 this one, this is hydrogen. The other one. And we  
3 go to -- let's see here.

4 MEMBER BANERJEE: Wayne, you wanted to  
5 say something?

6 MR. MARQUINO: We don't have any backup  
7 material, but we did provide information to the staff  
8 on comparisons of TRACG against the PANTHERS test,  
9 which are very representative of this fan operation  
10 mode. I think we could get Dr. Shiralkar who made  
11 the comparisons available after lunch --

12 MEMBER BANERJEE: No, that's not  
13 necessary. But you got good agreement, right?

14 MR. MARQUINO: Yes. And I think  
15 basically what someone said that if this .4R  
16 difference is a life-or-death situation, then we  
17 would drive to determine exactly what the difference  
18 is and basically we agreed to disagree. And we don't  
19 consider that these differences which are not  
20 affecting the conclusion that the pressure is coming  
21 down are worth further work at this time.

22 MEMBER BANERJEE: Yes, I agree with you.  
23 I just wanted to make sure that you agreed with the  
24 PANTHER experiments. And yours, I imagine, agrees  
25 better than them if they did not tune their

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1 correlations. But I would like to eventually see  
2 your agreement with the PANTHERS data to see how far  
3 off you were.

4 CHAIR CORRADINI: I think Jack, not in  
5 June but a previous --

6 MR. TILLS: This is a comparison that was  
7 made on the single tube back in the mid-'90s. And  
8 what's called here a film model that goes through, in  
9 this case it's going right through one of the UCB  
10 tests, is essentially the same model that's in  
11 MELCOR. It's the heat and mass transfer analogy  
12 model.

13 The higher curve here was an early curve.

14 There's a Vierow/Shrock curve that was an empirical  
15 model. And then that model, this is an updated  
16 correlation. And this is just showing, the green  
17 line up there is not old model in the mid-'90s and he  
18 web and the blue dash line here are the updated,  
19 what's called the KSP model to the flow. It's an  
20 improvement, but for the single tubes its showing a  
21 little bit higher.

22 The reason I'm showing the single tube  
23 because this is tube-side and we've got good data on  
24 the tube-side deal.

25 When we go to PANTHERS, then we involve

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1 not only the tube-side, but there's about 25 percent  
2 of the resistance that's in the pool-side. And we  
3 actually are using a slightly different correlation.  
4 We're using the Rosenhaur, and I think they're using  
5 Frost or Zuber correlation for nuclear boiling. So  
6 we have a slight difference in that. I don't think  
7 it's a really major deal. But the difference that  
8 we're talking about between PANTHERS calculations for  
9 low flow cases is like around 10 to 15 percent, okay.

10 So where they seem to calculate those tests better  
11 than we do.

12 CHAIR CORRADINI: Okay.

13 MR. TILLS: We're like about 10 to 15  
14 percent lower than they do in terms of heat removal.  
15 And that has been translated then to a calculation  
16 for the plant to see what this 10 or 15 percent in  
17 PCCS difference in heat removal make for long-term  
18 equilibrium. And it makes about a four-tenths bar.

19 MEMBER BANERJEE: So let me reconstruct  
20 what you told me so I make sure I understand it.

21 You use some version of a correlation you  
22 have in there which corresponds either to that red  
23 line or the blue line?

24 MR. TILLS: No. No. That's theirs.  
25 That's their calculation.

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1 MEMBER BANERJEE: What are you using?

2 CHAIR CORRADINI: They're using mass  
3 transfer analogy

4 MR. TILLS: Heat and mass transfer  
5 analogy.

6 MEMBER BANERJEE: Reynolds analogy?

7 MR. TILLS: Right. We're using Reynolds  
8 analogy, diffusion layer deal. And, you know --

9 MEMBER BANERJEE: How does that analogy  
10 include in laminar flow? I thought it was a  
11 turbulent flow analogy.

12 MR. TILLS: From the gas.

13 MEMBER BANERJEE: Yes. Is the gas always  
14 in turbulent flow?

15 MR. TILLS: It goes into a laminar flow  
16 later, and what we use is the maximum of laminar and-  
17 -

18 MEMBER BANERJEE: How is the Reynolds  
19 analogy for laminar flow?

20 MR. TILLS: Well, we're not going into  
21 laminar flow. We don't use the laminar flow --

22 MEMBER BANERJEE: I thought you said it  
23 went to laminar flow.

24 MR. TILLS: At the end of the tube we  
25 could go to zero flow.

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1                   MEMBER BANERJEE: So at what point in the  
2 tube does the gas flow become laminar?

3                   MR. TILLS: Well, it just depends on what  
4 inlets -- what inlet.

5                   CHAIR CORRADINI: So, I'm going to stop  
6 this here and ask e can pursue this, but they've got  
7 a few other things they need to get through. But I--

8                   MEMBER BANERJEE: I am just trying to  
9 determine the accuracy of the calculation.

10                  CHAIR CORRADINI: I don't think Jack is -  
11 - I won't speak for Jack. But what I hear him saying  
12 is that both sides think the .3 to .4 bars is not  
13 crucial. So we can investigate this further, but I'd  
14 like to at least get through all this stuff first.

15                  MEMBER ABDEL-KHALIK: I would like to ask  
16 about the operation of the fans, if I may?

17                  MR. TILLS: Yes.

18                  MEMBER ABDEL-KHALIK: In just looking at  
19 the numbers in the table, the shut off head of the  
20 fans is about a third of the psi. And the question  
21 in my mind is there any situation in which you would  
22 have enough water in that pan that if the operator  
23 were to start that fan early, it would never come on?

24                  MR. TILLS: If the GDCS pool level is  
25 above -- I mean, this has been an issue. When we

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1 start the calculation at 72 hours, General Electric  
2 has said that the lip of the tray would be right at  
3 the water level of the GDCS at 72 hours. And I think  
4 that's my understanding.

5 Okay. If the tray would be, say, a foot  
6 below, okay, then you would have much more static  
7 head in the -- and you could get a much less -- you  
8 know, less flow of the fan definitely. Whether or  
9 not it would not come at all is a question.

10 MR. MARQUINO: If the fan was turned  
11 before the GDCS pool drained, it wouldn't produce any  
12 flow or any significant flow, it's set up that way to  
13 take advantage of the condensate coming from the PCC  
14 to provide a loop seal. So to do that, we had to put  
15 it in the GDCS pool. We had to put the tray in the  
16 pool. It is above the elevation of the main steam  
17 line. So in any conceivable break when the DPV is  
18 open, the pool is going to drain below the tray. And  
19 then when you turn the fan on we'll get flow through  
20 because we only have ten inches of submergence on the  
21 discharge.

22 MEMBER ABDEL-KHALIK: I guess I'm just  
23 trying to imagine if there was any scenario in which  
24 the inlet pressure to the fan is low enough and the  
25 line is voided completely so that just having 8

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1 inches of water in that pan would completely disable  
2 the fan.

3 MR. MARQUINO: No.

4 MEMBER ABDEL-KHALIK: But there is no way  
5 that this could happen?

6 MR. MARQUINO: No. The discharge  
7 pressure is limited by the 10 inches of submergence.

8 MEMBER ABDEL-KHALIK: Right.

9 MR. MARQUINO: Once the pool's drained,  
10 it can't be any higher than that.

11 MEMBER ABDEL-KHALIK: Right.

12 MR. MARQUINO: And then on the upstream  
13 side when we've turned the fan on when there's  
14 basically a pure steam environment in the drywell and  
15 evaluated that steam going in and the fan is still  
16 able to function and start up in that condition.

17 MEMBER ABDEL-KHALIK: I just can't see  
18 that because the shutoff is so low that only 10  
19 inches of water in that tray will stop the fan.

20 CONSULTANT WALLIS: So it will never work  
21 at all.

22 MEMBER ABDEL-KHALIK: Right.

23 CHAIR CORRADINI: I don't think you guys  
24 are communicating. I hear one thing from one side.

25 MEMBER ABDEL-KHALIK: Maybe I am

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1 misinformed, so please let me know how to view this.

2 MR. MARQUINO: Okay. Let me go back to  
3 the -- I have the flow versus line and flow versus DP  
4 that's part of the RAI 140 data. And I will look at  
5 the shutoff head on that, compare it to the table to  
6 address your --

7 CONSULTANT WALLIS: Well, I have the same  
8 problem. If I look at this table here, this shutoff  
9 head seems to be remarkably low.

10 MEMBER ABDEL-KHALIK: Right.

11 CONSULTANT WALLIS: Less than the 10  
12 inches it's got to produce to blow into the pool.

13 MEMBER ABDEL-KHALIK: Correct.

14 CONSULTANT WALLIS: So it'll never work.  
15 Something doesn't seem right.

16 MEMBER ABDEL-KHALIK: That's is my  
17 question.

18 CONSULTANT WALLIS: Absolutely. Yes, I  
19 did the same calculation.

20 MEMBER ABDEL-KHALIK: Something seems to  
21 be odd.

22 CONSULTANT WALLIS: Maybe we're wrong.

23 MR. TILLS: The shutoff depends on two  
24 things. It depends on submergence, but it also  
25 depends on the pressure loss coming into the

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1 condenser tube.

2 MEMBER ABDEL-KHALIK: Right. But the  
3 lowest -- you know, you have to cross the system  
4 curve with the characteristic curve of the fan.

5 MR. TILLS: Right.

6 MEMBER ABDEL-KHALIK: And what I'm saying  
7 is the static part of that system curve may be above  
8 the shutoff head, so they'll never cross.

9 MR. WAGAGE: You actually take that, the  
10 static head is about a little bit half the shutoff  
11 head. And the static head of -- so water cannot --

12 MEMBER ABDEL-KHALIK: Not according to  
13 this.

14 CONSULTANT WALLIS: Not according to this  
15 table. That's the problem.

16 MR. TILLS: I'm sorry. Wayne, did you say  
17 that you were going to go back and look something up  
18 and bring back to the Committee for clarification?

19 MR. MARQUINO: That would be fine. Okay.

20

21 MEMBER ABDEL-KHALIK: Okay.

22 MR. TILLS: Okay. Next slide.

23 To answer Dr. Wallis' question in terms  
24 of the rapid response if you did not have vacuum  
25 breaker opening or they opened and the gases did not

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1 get up to the PCCS, we ran a case which is in this  
2 pink line here of the transient response if we  
3 isolated the vacuum breakers. In other words, we  
4 didn't allow the vacuum breakers to turn on.

5 The vacuum breakers do not put in a lot  
6 of gas compared to the late time behavior. So it's  
7 only a small transient case that come on at about 8  
8 minutes or so in the actual baseline calculation.

9 So you can see that the pink line just  
10 shows you the sensitivity of this condenser to inlet  
11 flow. You know, whether or not the vacuum breakers  
12 are allowed to put gas into the PCCS or not. You can  
13 avoid rapid drop off and then later there's a rebound  
14 effect. And the rebound effect is because now you're  
15 pulling in gas from leakage going back into the  
16 system. And that we didn't fool with.

17 So that was just here in the sensitivity.

18 CONSULTANT WALLIS: So you can never get  
19 as far as the GE cliff or the beginning?

20 MR. TILLS: No. No.

21 CONSULTANT WALLIS: That seems rather  
22 mysterious.

23 MR. TILLS: No. But, you know, but we're  
24 basically just going after that in terms of trying to  
25 identify. That drops very, very rapidly.

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1 CHAIR CORRADINI: But the cliff has  
2 something to do with the heat transfer model. But  
3 the heat transfer model for the PCCS. That's the  
4 only place it can come in.

5 MR. TILLS: Right. And the interaction  
6 with the fan with that whole system, I mean to drop  
7 that fast.

8 CHAIR CORRADINI: Okay.

9 MR. TILLS: So the blue line here,  
10 though, is a blue line where we looked at PANTHERS  
11 test in this low flow regime and looked at the  
12 MELCOR, and we were about 10 to 15 percent lower than  
13 PANTHERS. And so we jumped up the multiplier to  
14 raise up that agreement another 10 or 15 percent to  
15 see if just raising that up would make this  
16 difference. And it does not. It does not make that  
17 difference. But it does effect the offset on the late  
18 time.

19 So basically what we were just saying is  
20 that, hey, if you want to go after this transient  
21 deal, you're going to need a much more sophisticated  
22 model of fan interaction with PCCS. It's not even  
23 clear that additional tests would help this  
24 situation, you know because it's a very difficult  
25 situation to try and model transiently the flow of

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1 gases in tube. We can barely do a reasonable job in  
2 a steady state, let alone trying to track it down  
3 transient-wise.

4 CHAIR CORRADINI: Okay.

5 CONSULTANT WALLIS: What did you use for  
6 your found bed characteristic? You use this one?

7 MR. TILLS: Yes. I just don't have that  
8 one in front of me.

9 CONSULTANT WALLIS: What is the rho here?  
10 Is the rho density to steam, or noncondensibles.

11 MR. WAGAGE: On page 19 of the  
12 presentation.

13 CONSULTANT WALLIS: This is your  
14 presentation?

15 MR. WAGAGE: That one show curve.

16 CONSULTANT WALLIS: You haven't got to  
17 it? Okay. We'll get to it.

18 MR. WAGAGE: I just had a table.

19 CONSULTANT WALLIS: When we get to it, we  
20 can talk about it.

21 MR. TILLS: Okay. Next line slide is  
22 really not -- it's just showing the final  
23 equilibrium. When we isolate the vacuum breaker.

24 Next one. The long term offsets --  
25 again, these are the steps that we run through. We

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1 reviewed all of the heat and mass transfer modeling  
2 from single tube tests to confirm are actually on the  
3 tube-side. This is coming in as well as going out  
4 the head transfer coefficient along the tube.

5 We reviewed the independent reports on  
6 MELCOR modeling. Both single tube tests has been in  
7 the open literature just fairly recently.

8 And we also viewed some PUMA test results  
9 that used the MELCOR model.

10 Third, we performed additional PANTHERS  
11 tests at these low flow conditions to confirm that we  
12 were under predicting compared to the data by about  
13 15 percent. We applied then that 10 or 15 percent  
14 conservatism on the modeling to show that that  
15 translates into about .4 to .5 bar difference in late  
16 time pressure.

17 So our understanding is that, yes, we're  
18 a little bit more conservative in terms of PANTHERS  
19 comparisons than they are and that translates into  
20 this offset. But I would remind you, you're dealing  
21 with proprietary tests, not open literature  
22 investigation. You're in a region in which there is  
23 no viable tests. In other words, these are partially  
24 flooded tubes. They're not fully flooded tubes. You  
25 know, so there's a number of reasons that we would

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1 still want to have some conservatism, and we're going  
2 with the 10 or 15 percent.

3 MEMBER BANERJEE: What is the percentage  
4 of noncondensibles particularly coming in in these  
5 tests?

6 MR. TILLS: Coming in? This is going  
7 from -- our calculations at 30 days is somewhere  
8 between .15 to .2 Mole.

9 MEMBER BANERJEE: Mole fraction?

10 MR. TILLS: Mole fraction. Not Mole,  
11 mass fraction. And the --

12 MEMBER BANERJEE: I have trouble with  
13 that because the difference in molecular --

14 MR. TILLS: Not much difference --

15 MEMBER BANERJEE: Oh, okay. Because it's  
16 hydrogen --

17 MR. TILLS: Right, this isn't hydrogen.

18 MEMBER BANERJEE: Not an oxygen mixture.

19 MR. TILLS: This is nitrogen. Yes. This  
20 is nitrogen. I'm giving you nitrogen.

21 MEMBER BANERJEE: With steam.

22 CHAIR CORRADINI: Wait, wait, wait. You  
23 guys are conversing, so you lost me. So stop  
24 conversing.

25 So he asked you at some point in time--

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1 MR. TILLS: Right.

2 CHAIR CORRADINI: -- what the inlet  
3 noncondensable is. So the answer is at what time and  
4 --

5 MR. TILLS: At the time of 30 days we're  
6 calculating somewhere between .15 to .2.

7 MEMBER BANERJEE: And this is in mass  
8 fraction.

9 MR. TILLS: Mass fraction of nitrogen.

10 CHAIR CORRADINI: Of nitrogen? Okay.  
11 And this is when again? I'm sorry, you said and I  
12 didn't catch it. When?

13 MR. TILLS: Thirty days. And I think  
14 from what I remember from the TRAC, I think their  
15 like .25. They're a little bit higher than we are.

16 CHAIR CORRADINI: So the nitrogen now at  
17 30 days is coming from the fact that we've had  
18 leakage from what?

19 MR. TILLS: Back leakage, coming back  
20 from wetwell to drywell.

21 CHAIR CORRADINI: Okay. So essentially  
22 the fact there is leakage gives us a noncondensable  
23 fraction.

24 MR. TILLS: That's right. And it's  
25 almost like you have a reservoir of noncondensibles

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1 that can self-regulate, again these condensers.  
2 Because you remember the decay heat for both codes is  
3 removing almost exactly at 30 days the actual decay  
4 heat.

5 CHAIR CORRADINI: Right.

6 MR. TILLS: So these condensers will  
7 always seek the decay heat removal.

8 CHAIR CORRADINI: Right. But so now so  
9 you've answered at 30 days and the inlet gas is  
10 nitrogen. So now let's back us up just prior to 72  
11 hours before I turned on the fans, right?

12 MR. TILLS: Yes.

13 CHAIR CORRADINI: And let me ask, what is  
14 the inlet --

15 MR. TILLS: Hydrogen. The inlet hydrogen  
16 is almost, you know, you can't hardly determine what  
17 it is. I mean it's still very low. It's almost pure  
18 steam coming in. Because the radiolytic gases are  
19 very, very small --

20 CHAIR CORRADINI: So Mole fraction-wise,  
21 we're talking ten to the minus something?

22 MR. TILLS: Less than a tenth of a  
23 percent, probably.

24 CHAIR CORRADINI: Okay.

25 MR. TILLS: You know, very low.

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1 CHAIR CORRADINI: Graham, did you hear  
2 that?

3 CONSULTANT WALLIS: I am working on  
4 something else.

5 CHAIR CORRADINI: But you got to listen  
6 to this so that you're not going to ask the question  
7 later. So he's saying coming into 72 hours the  
8 hydrogen concentration coming in is less than a tenth  
9 of a percent.

10 MR. TILLS: It is practically pure steam  
11 coming in from the drywell into the condenser.

12 CONSULTANT WALLIS: What GEH told us in  
13 June was one percent.

14 CHAIR CORRADINI: What who?

15 CONSULTANT WALLIS: GEH told us that a  
16 concentration in the drywell at 72 hours was .01 no  
17 units. I thought that meant one percent. That's all  
18 the 689 kilograms of whatever.

19 MR. TILLS: It's very, very small. I  
20 mean, I don't have an actual --

21 CONSULTANT WALLIS: It probably is very  
22 small. The numbers that we got in June seemed to be  
23 much higher.

24 MR. TILLS: I do have the number on the  
25 plot.

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1 CHAIR CORRADINI: The reason we're asking  
2 -- we can belay this, Jack, if you need to look it  
3 up. But I think the reason we're asking this goes  
4 back to the the other question that we had come to.

5 CONSULTANT WALLIS: Right.

6 CHAIR CORRADINI: I just want to make  
7 sure -- when you were just quoting for Sanjoy at  
8 various times.

9 CONSULTANT WALLIS: So you're saying it's  
10 --

11 MR. TILLS: This is the plot of hydrogen  
12 Mole fraction in the drywell and wetwell. The green  
13 is in the --

14 CONSULTANT WALLIS: So point -- point --

15 MR. TILLS: And the red is in the  
16 drywell.

17 MEMBER BANERJEE: Did you have this slide  
18 or --

19 MR. QUEEN: I don't have any of that, no.

20 CHAIR CORRADINI: This is a backup.

21 MR. TILLS: This is a backup slide.

22 CONSULTANT WALLIS: That's because its  
23 all be swept down into the wetwell?

24 CHAIR CORRADINI: Post-72 hours that's  
25 where it goes.

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1                   CONSULTANT WALLIS: That's right. It's  
2 been swept down, just like the nitrogen, it's swept  
3 down into the wetwell.

4                   MR. TILLS: Right.

5                   CONSULTANT WALLIS: So when GEH said in  
6 June that the concentration in the drywell was .01,  
7 that must have been a mistake.

8                   CHAIR CORRADINI: It's got to be a  
9 mistake. Because these are very small concentration.  
10 I wanted to make sure we're clear on this.

11                   CONSULTANT WALLIS: It was a handout.

12                   MEMBER BANERJEE: That's why I wanted the  
13 LFLs.

14                   CONSULTANT WALLIS: I've got hard copy of  
15 a handout that says its .01 in the drywell.

16                   MR. WACHOWIAK: This is Rick Wachowiak  
17 from GEH.

18                   The amount in the drywell includes the  
19 area that's in the drywell head, right? And so that  
20 isn't participating in any of this steam --

21                   CHAIR CORRADINI: That's the dead area,  
22 Graham. That's why the one percent --

23                   MR. WACHOWIAK: -- that's the dead area  
24 that we moved into the wetwell at the end of that  
25 calculation. So you're talking about applies and

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1 bananas here. It's not what's mixed in. No.

2 CONSULTANT WALLIS: When you made that  
3 comment, when you're talking about the concentration  
4 of the drywell, you add the stuff which is not in the  
5 drywell somewhere else?

6 CHAIR CORRADINI: They purposely do it to  
7 bump the pressure.

8 CONSULTANT WALLIS: Well, okay.

9 MEMBER BANERJEE: Well, that's what he  
10 said, right?

11 CHAIR CORRADINI: Yes. Thank you.

12 MR. TILLS: Okay. This is just showing  
13 steam Mole fraction in the drywell.

14 CONSULTANT WALLIS: Right.

15 MR. TILLS: And you can see basically--

16 CONSULTANT WALLIS: Well, what's  
17 important to know is how much of the steam is  
18 condensed and if all of it's condensed, you still  
19 have the problem. But a tiny bit is not -- some of  
20 it is not condensed, you're probably all right.

21 MR. TILLS: It's a very high  
22 concentration and a lower condenser of hydrogen.

23 CONSULTANT WALLIS: What is the  
24 concentration when it comes out of the condenser?

25 MEMBER BANERJEE: That is the local issue

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1 that -- that's why you need a map of LFL.

2 CONSULTANT WALLIS: Right.

3 CHAIR CORRADINI: You can go back to your  
4 normal presentation. We just wanted to get clear  
5 coming in.

6 MEMBER BANERJEE: Excuse me. That's an  
7 interesting plot. Can you go back to it? What is  
8 that now?

9 MR. TILLS: That's a steam Mole fraction  
10 in the condenser that the fans are tied to. And this  
11 is just showing the lower plenum in the lower region  
12 of the condenser's steam Mole fraction. And this is  
13 what happens when you turn the fans on, it jumps up.

14 CONSULTANT WALLIS: So what is the  
15 hydrogen Mole fraction?

16 MR. TILLS: The ---

17 MR. McKIRGAN: I'm sorry, this is John  
18 McKirgan.

19 Jack, before we get into too many details  
20 on this point, I mean we're very early in this review  
21 and I'm a little sensitive to these slides. This is  
22 an issue, the staff's captured it and we're going to  
23 take this back and look at this very seriously.

24 CHAIR CORRADINI: Okay. So now that  
25 we've gone blue, go back to your normal presentation.

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1                   CONSULTANT WALLIS: So we're not supposed  
2 to see that?

3                   CHAIR CORRADINI: This is proprietary to  
4 the members.

5                   CONSULTANT WALLIS: It does show that you  
6 have these figures. Can we see that or not? Are we  
7 allowed to take that away with us or not?

8                   MS. BERRIOS: No, you can see these ones.

9                   CHAIR CORRADINI: We're joking. I was  
10 just saying that I want to go back. I think what  
11 staff is saying they're early in the evaluation --

12                   CONSULTANT WALLIS: I understand that.

13                   CHAIR CORRADINI: -- of hydrogen. So I'd  
14 rather at least we get through their presentation and  
15 bring up the hydrogen part.

16                   CONSULTANT WALLIS: Okay. What I would  
17 like to know is are we going to have a meeting on  
18 this hydrogen/oxygen issue and is it going to be  
19 comprehensive? If it is, and this is so preliminary,  
20 we probably don't need to discuss it today at all as  
21 long as we know it's really being worked on.

22                   CHAIR CORRADINI: There's uniform nodding  
23 behind you.

24                   MR. McKIRGAN: The staff is going to take  
25 this back and we're going to look at this very

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1 seriously.

2 CONSULTANT WALLIS: Okay. Because until  
3 today I had no idea that anybody was working on the  
4 issue.

5 CHAIR CORRADINI: They are.

6 MR. McKIRGAN: They are.

7 MEMBER BANERJEE: Neither did I,  
8 actually.

9 CONSULTANT WALLIS: No. Not better  
10 informed.

11 MEMBER BANERJEE: Not than you.

12 MEMBER ABDEL-KHALIK: Okay. Back to the  
13 question about the fans. If you look at this diagram  
14 and trace the flow path of the fans where the suction  
15 is coming in and where the discharge is leaving can  
16 this fan ever operate if you have ten inches of water  
17 in the pan? Ever?

18 MR. TILLS: Yes. It is operating. You  
19 know we model with it operating. You know --

20 CONSULTANT WALLIS: Because the rho that  
21 you have to put in this diagram is the density of  
22 steam at three bars. If you put in something lower  
23 than that, you find it never works at all.

24 MR. MARQUINO: That's right. The rho is  
25 representative of the containment conditions at 72

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1 hours and its an input to the code. And it's used by  
2 both GEH and the staff.

3 CONSULTANT WALLIS: Because it could mean  
4 something like 14 inches instead of eight.

5 MEMBER ABDEL-KHALIK: So when you buy  
6 this fan the manufacturer gives you a characteristic  
7 curve, what did you do to that characteristic curve  
8 to get these numbers in the table?

9 MR. MARQUINO: We took that data out of  
10 the TRAC output, that specific table, and that  
11 implies a rho value. I also have the data in  
12 kilopsacals versus cubic meters per second. That I  
13 can bring over and show you. Maybe at a break we can  
14 do that.

15 MEMBER ABDEL-KHALIK: I think it would be  
16 a very good idea to do that. Because there might be  
17 an issue with this characteristic curve. All along I  
18 assumed that this is what the manufacturer would give  
19 you, which you know if the manufacturer has no idea  
20 that you're going to use this for steam at three  
21 bars, they may give you --

22 MR. MARQUINO: They need to know the rho  
23 value.

24 MEMBER ABDEL-KHALIK: -- a different  
25 characteristic curve depending on whatever density is

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1 it; air at standard temperature and pressure, most  
2 likely. So we need to get the details, the raw data  
3 of what the characteristic curve of the fan is to  
4 show whether or not this would actually work at all.

5 CHAIR CORRADINI: But you see where Dr.  
6 Abdel-Khalik's question is? Ten inches of water is  
7 2400 so you're always in shutoff mode.

8 MEMBER ABDEL-KHALIK: Right.

9 CHAIR CORRADINI: That's what's bothering  
10 him. You're on the same page now, right?

11 MR. MARQUINO: yes.

12 CONSULTANT WALLIS: IT is 2400 pascals,  
13 but it's actually now this 2400 times the density of  
14 steam at three bars, which gives you I think about 14  
15 or 15 inches of water. It's still not very much.

16 Anybody, this is all going to be cleared  
17 up?

18 CHAIR CORRADINI: Yes, it will.

19 MEMBER BANERJEE: Well, I think you said  
20 that you guys did the calculations, right, and you  
21 found that --

22 MEMBER ABDEL-KHALIK: But they did the  
23 calculations using the wrong density.

24 MR. TILLS: What may be the wrong  
25 density.

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1 MEMBER BANERJEE: In the characteristic  
2 curve.

3 MR. TILLS: We used what General Electric  
4 gave us as what their characteristic fan curve is. I  
5 mean there's been a considerable amount of back and  
6 forth on this. But that's what we were using.

7 MR. MARQUINO: So the flow goes to zero  
8 when the head is about 0.9 psi, and that's consistent  
9 with what Henry said relative to the 10 inches of  
10 submergence.

11 CONSULTANT WALLIS: Yes. Yes. I think  
12 that this is probably okay. I just when I looked at  
13 one of your RAIs it says 2400 pascals at 300 cfm.  
14 Well what you really meant was 2400 delta P over rho.

15 MR. MARQUINO: Right.

16 CONSULTANT WALLIS: And I think there was  
17 a mistake, and there's a mistake in that RAI. A  
18 typo.

19 MEMBER BANERJEE: Now they put the right  
20 units.

21 CONSULTANT WALLIS: Now I think we got  
22 the right units and it probably it work.

23 MEMBER ABDEL-KHALIK: But I think it  
24 would be a good idea to confirm that this is indeed  
25 what the manufacturer's characteristic curve would

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1 be.

2 CONSULTANT WALLIS: Or they can --

3 MEMBER ABDEL-KHALIK: It depends on what  
4 kind of fan.

5 CHAIR CORRADINI: So just for the sake of  
6 SI units, that's 6,000 pascals?

7 CONSULTANT WALLIS: Rho is hydrogen.

8 MEMBER BANERJEE: I mean, I'm still  
9 puzzling about what Graham is. Why operate a fan in  
10 this regime? I mean it seems -- with a tiny redesign  
11 of the fan, you have a completely flat regime the  
12 other way. You know, initially when we talked about  
13 this I thought it was flat the other way. This is  
14 flat this way, right? I mean you change a little bit  
15 of the -- you got a huge change in your flow.  
16 Whereas normally you change the delta P a little bit,  
17 you know the flow stays, more or less, the same.

18 MR. MARQUINO: We are using the default  
19 homologous curves in the code. So we have not  
20 adjusted those head flow characteristic particular to  
21 the fan that we might procure. And as I said, that is  
22 kind of putting a penalty on us because it'll be over  
23 capacity at some performance points.

24 MEMBER BANERJEE: So what you're saying  
25 is this is not a real fan?

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1 MR. MARQUINO: No. This is an analytical  
2 fan.

3 MEMBER BANERJEE: This is an analytical  
4 fan?

5 CHAIR CORRADINI: This is what they need,  
6 now they're going to buy it.

7 MEMBER BANERJEE: All right. Okay. Got  
8 it.

9 MR. TILLS: And this is just showing the  
10 fan curve as we're calculating it along with -- and  
11 you can see the issues that you've been raising on  
12 the figure here shows shutting off early time.

13 MEMBER BANERJEE: Right.

14 MR. TILLS: And that's why we didn't want  
15 to spend a whole lot of time on this transient  
16 response at the time when you first turn the fans on.  
17 Because this thing is going to zero flow and then it  
18 hits and goes back. You know, we're just really not  
19 tracking that.

20 CONSULTANT WALLIS: The thing that we  
21 would like to see, I think, is it self-correcting?  
22 That it doesn't sort of go to zero and bounce around  
23 all over the place, but it tends to when you get to  
24 any noncondensibles it tends to clear them out.

25 MR. TILLS: Right. Right. And that would

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1 be very difficult to zero in on.

2 CHAIR CORRADINI: You're not going to buy  
3 anything like this, I hope.

4 MEMBER BANERJEE: Would you really need  
5 the fan if it's doing that?

6 MR. TILLS: Yes.

7 MEMBER BANERJEE: That's the issue. I  
8 mean, what's the fan doing?

9 MR. TILLS: Okay. So let me see, let's  
10 back up just a little bit. Yes. We had already  
11 covered the issue of comparing MELCOR and TRAC. This  
12 is going on to DBA. Again, this was showing the  
13 three areas that we understand is DBA fan with this  
14 type of characteristic. They're using the semiscale  
15 pump model in TRAC, but we're putting in that same  
16 model via a fan characteristics in MELCOR.

17 The tray, we understand, has a ten inch  
18 submergence fixed through the period of intervention.

19 And the fill flow has got no level management.

20 I just wanted to go down here. This is,  
21 for instance, the intervention period with the flow.

22 And I'm showing here just the PCCS tank level, both  
23 TRAC and MELCOR. And you can see this is level  
24 control in TRAC, the dots. And then MELCOR, this was  
25 the comparison, confirmatory. And this is DBA.

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1 Okay.

2 This is the initial flood level at times  
3 zero. And you can see we're not really overflowing.  
4 It's going back into the storage tank. So there  
5 really isn't any intervention required here from what  
6 we understand.

7 CHAIR CORRADINI: But just so I'm clear  
8 of the effect of all of this. The effect of all this  
9 one and a half meters is they're essentially in a  
10 large amount of their pool -- a large amount of their  
11 rod bundle or their heat exchanger bundle surface is  
12 boiling which gives them a bigger -- which gives them  
13 a better performance which takes on the pressure a  
14 little bit?

15 MR. TILLS: Right. You could also say,  
16 you know, their saturation temperature is slightly  
17 than hours.

18 CHAIR CORRADINI: Slightly, right.

19 MR. TILLS: A few degrees different than  
20 ours at some level of the PCCS.

21 CHAIR CORRADINI: Yes. Okay. Okay.  
22 Thank you very much. And this is just showing that.  
23 Here's a saturation temperature with time as you're  
24 going, you know, through this different level pool.

25 Okay. So now we're in the DBA.

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1                   CONSULTANT WALLIS: So this is the  
2 anomaly that you put more water in and it actually  
3 cools worse?

4                   MR. TILLS: Yes, that's it.

5                   CONSULTANT WALLIS: Yes, right.

6                   MR. TILLS: So now we're in the DBA  
7 regime here mode. And now instead of tracking going  
8 down in time because our fan flow is slightly less,  
9 and also our refill is a little bit different.  
10 Instead of going and tracking the trend, we're back  
11 again to a flat, basically a flat curve. Okay. With  
12 these assumptions.

13                   So what does this mean in terms of what  
14 General Electric has said? I think their conclusion  
15 was is that we both show a constant trend going down,  
16 confirmatory, okay. But if we go back to DBA  
17 calculation, that's not necessarily the conclusion  
18 here. The conclusion is that we'll be a little bit  
19 higher. And in this case we're back to a fairly flat  
20 profile. Okay.

21                   Now this calculation, admittedly, is  
22 somewhat conservative. The ten percent conservative  
23 model, the PCCS was the ten percent.

24                   Also mention that single tube tests on  
25 the heat transfer is typically admitted to be, you

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1 know, in the 10 or 20 percent accuracy. It's almost  
2 like wall heat transfer. How accurate can you model  
3 that or measure that? You know, 10 or 15 percent is  
4 probably about it on measurement.

5 So, we believe that this is a reasonable  
6 approach to take a conservative model for the PCCS.

7 CONSULTANT WALLIS: But it looks as if it  
8 never comes down.

9 MR. TILLS: No, it does not.

10 CONSULTANT WALLIS: That's rather far  
11 from reducing rapidly or reducing it.

12 MR. TILLS: It does not. Well, initially  
13 it reduces it rapidly.

14 CONSULTANT WALLIS: Yes.

15 MR. TILLS: And I think what General  
16 Electric's conclusion was is that, hey, you know even  
17 MELCOR will reduce the pressure from around 400  
18 kilopascals to something less than 350 in a few 100  
19 hours, or in a 100 hours. That was I think their  
20 statement here today. And I think that's confirmed  
21 by this calculation.

22 CONSULTANT WALLIS: That is an effect on  
23 leakage from the containment because the pressure's  
24 up high for longer.

25 MR. TILLS: Right. And I think that goes

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1 to the staff's reason why you want to reduce pressure  
2 fast.

3 MS. CUBBAGE: There's no credit for  
4 pressure reduction in the dose calculations.

5 CONSULTANT WALLIS: No. I'm just saying  
6 they're leaking stuff from the containment, you have  
7 to put this into our dose calculations or something?

8 MS. CUBBAGE: Right. They did not take  
9 any credit for reduction in pressure in their dose  
10 calculations.

11 CHAIR CORRADINI: For both the control  
12 room and the external release, Amy?

13 MS. CUBBAGE: That's right.

14 CHAIR CORRADINI: Okay. So can I just  
15 get back to that, because I want to make sure I'm  
16 clear?

17 So two things. One is both stabilize,  
18 they just stabilize at different values?

19 MR. TILLS: Yes.

20 CHAIR CORRADINI: And in terms of the  
21 assumed, and I'll use your black line, they assumed  
22 you as they, uses this radiolytic decomposition which  
23 nothing turns on because it's a RTNSS system until 72  
24 hours?

25 MR. TILLS: That's correct.

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1 CHAIR CORRADINI: And then once the  
2 system turns on, is it overwhelming the production,  
3 matching the production or not keeping up with the  
4 production of radiolytic gases that are assumed to be  
5 produced? I'm trying to decide am I taking  
6 noncondensable out of the atmosphere because of --

7 MR. TILLS: There is no PARS, no assumed  
8 PARS to be operated for first --

9 CHAIR CORRADINI: 72 hours?

10 MR. TILLS: -- three days.

11 CHAIR CORRADINI: Right.

12 MR. TILLS: Then miraculously at this  
13 point, in reality all of a sudden the PARS start  
14 working.

15 CHAIR CORRADINI: Right.

16 MR. TILLS: Okay. And so the PARS would  
17 be both in the wetwell as in the drywell.

18 CHAIR CORRADINI: Right.

19 MR. TILLS: And at this point it's an  
20 interesting deal because what happens is in this  
21 calculation those are going to be shutoff generation  
22 rate.

23 CHAIR CORRADINI: Right. But you do not  
24 catch up? Because what I heard was the PARS  
25 capability is such that it's going to remove the

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1 amount of noncondensable. But in your audit  
2 calculation the black line you simply kill it?

3 MR. TILLS: That's right. You kill the  
4 generation.

5 CHAIR CORRADINI: Okay. Thank you.

6 MR. MARQUINO: So it matches production  
7 at 72 hours and there's no net additional  
8 noncondensibles added.

9 CONSULTANT WALLIS: Well since you're  
10 pumping noncondensibles into the GDCS pool region all  
11 the time from the PCCS, then there's no pause in  
12 there, is there? You're --

13 MR. MARQUINO: In the PCCS? That's  
14 outside of the primary containment. So there's no  
15 hydrogen --

16 MS. CUBBAGE: It's in the GDCS.

17 CONSULTANT WALLIS: The exhaust from the  
18 PCCS goes into the GDCS pool area, which just has a  
19 little bit of a grid at the ceiling. And so you're  
20 pumping noncondensibles, which are hydrogen and  
21 oxygen this time, into that GDCS pool volume --

22 CHAIR CORRADINI: You're still assuming a  
23 100 percent behavior of the PCCS. I don't know --

24 CONSULTANT WALLIS: I know. Anything  
25 that comes in that's a noncondensable goes out.

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1 CHAIR CORRADINI: Right.

2 CONSULTANT WALLIS: So you're pumping  
3 them into that region?

4 CHAIR CORRADINI: No. But you're not  
5 hearing me. I'm saying steam, hydrogen and oxygen are  
6 coming out of the PCCS and they're bubbling out of  
7 the GDCS pool.

8 CONSULTANT WALLIS: Yes.

9 CHAIR CORRADINI: And steam is. So it's  
10 not just hydrogen and oxygen that's coming out of the  
11 pool.

12 CONSULTANT WALLIS: Well someone's going  
13 to tell us about condensation --

14 CHAIR CORRADINI: But I wanted to correct  
15 what you're saying.

16 CONSULTANT WALLIS: So you're saying that  
17 the steam then sweeps and goes back into the  
18 containment again?

19 CHAIR CORRADINI: Well, whatever's coming  
20 out of the PCCS isn't going to get trapped there.  
21 It's going to go out to maintain pressure  
22 equilibrium.

23 CONSULTANT WALLIS: That's right. So  
24 you're going to say it's going to come out with  
25 enough steam in it, but it's okay.

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1 CHAIR CORRADINI: I don't know. I'm just  
2 saying there's some steam there. That's all i'm  
3 saving.

4 MEMBER ABDEL-KHALIK: Aside from whether  
5 these fans are safety grade or not, what guidance  
6 would you give the operator in terms of when they  
7 should start these fans based on these results?

8 MR. McKIRGAN: I think that question is  
9 probably more for GE to answer.

10 CHAIR CORRADINI: You're asking GE.  
11 Back to Wayne.

12 MR. MARQUINO: We haven't finalized the  
13 emergency procedures for ESBWR, but we don't intend  
14 to restrict the time that the operator could turn the  
15 fans on to 72 hours. The pool drain would be a  
16 factor, so we wouldn't direct the operator to turn  
17 the fans on unless the GDCS head is initiated and  
18 drained the pool.

19 MEMBER ABDEL-KHALIK: I guess we'll have  
20 to wait then until we can see what the PORVs look  
21 like.

22 MR. MARQUINO: Yes.

23 MS. CUBBAGE: Well we're not going to see  
24 those as part of the certification. I just wanted to  
25 make sure that they're conservatively not crediting

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1 them or based on the design basis not crediting them  
2 until 72 hours. But what we're hearing is nothing  
3 would prevent them if they were available from  
4 turning them on early.

5 MEMBER ABDEL-KHALIK: Well, that's my  
6 concern also that if they were to attempt -- unless  
7 we see what the characteristics that those fans are,  
8 they may not get --

9 MR. TILLS: And I'll just give you the  
10 summary here. It just says basically, you know for  
11 the intervention period we did go back to General  
12 Electric for clarification and design and operation.  
13 We've had those discussions with them.

14 We did confirmatory calculations to  
15 match, to try and match what they were modeling in  
16 their TRAC code. And we got reasonable agreement in  
17 terms of trends.

18 We also looked at the transient deal and  
19 with the exception of the transient deal, you know  
20 our calculation has shown an offset of about .4 which  
21 we understand at the late time equilibrium.

22 The added calculation if we follow design  
23 in operation, we're not decreasing with time, but  
24 we're essentially flat with about a 24 percent margin  
25 at 30 days.

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1           So, you know, we've tried to follow the  
2 guidance of the Committee to go back and look and see  
3 where the differences are. We did find some  
4 differences in PCCS modeling that seemed to explain  
5 these offsets. And yet we do see a difference between  
6 confirmatory and DBA calculations at this point.

7           CHAIR CORRADINI: Questions by the  
8 Committee.

9           CONSULTANT WALLIS: Well that was very  
10 helpful. Thank you.

11          CHAIR CORRADINI: I think it was.

12          MEMBER BANERJEE: Yes, just a question.  
13 The fact that you have a one dimensional model with a  
14 lot of mixing, is it likely -- I know this is loaded;  
15 to give you a conservative answer or a  
16 nonconservative answer in terms of pressure?

17          MR. TILLS: We believe its conservative.

18          MEMBER BANERJEE: Why?

19          MR. TILLS: Because what drives this  
20 system is how much gas goes into the wetwell. And if  
21 you are well mixed, we've looked at integral tests,  
22 PANDA -- or not PANDA. Yes, PANDA tests. Not  
23 PANTHERS, but PANDA tests. We always were well  
24 mixed. We modeled those experiments. Always get a  
25 higher pressure when we well mixed.

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1 MEMBER BANERJEE: Okay.

2 MR. TILLS: In fact, in the Standard  
3 Review Procedures for the NRC for BWR, drywells are  
4 always indicated to be modeled as a single cell well  
5 mixed.

6 MEMBER BANERJEE: And is there a physical  
7 reason for it?

8 MR. TILLS: Well, there's no trapping  
9 when you have well mixed. So there's no trapping  
10 volumes. And in fact, when we look at the comparison  
11 between TRACG and MELCOR for blowdown when it was  
12 MELCOR mixed, we see that we're about half -- or even  
13 greater higher pressure than they are in TRACG  
14 because they have trapping. The trap in the lower  
15 regions of the drywell below the source injection.

16 So like anytime you have a -- you know,  
17 80 percent of the volume in this drywell is in the  
18 upper drywell region. A very small amount in the  
19 lower drywell. So unless you're trapping all of that  
20 noncondensibles is going get blown to the wetwell.  
21 And that's where the pressure increases is going to  
22 occur.

23 So, you know, everything that we have  
24 that we looked at indicates we're conservative by  
25 doing well mixed.

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1                   And these sources, blowdown is more  
2 obvious it's going to be well mixed. But the  
3 injections late time, okay, for the first days is  
4 still significant. You're boiling this RPV. It's  
5 not like a quiescent, you know, plume-type  
6 environment. That's not the environment here.

7                   MEMBER BANERJEE: So do you have an  
8 estimate of the velocities?

9                   CHAIR CORRADINI: You used the words he  
10 doesn't want you to use.

11                  MR. TILLS: Yes, I don't have. But we'll  
12 back to you and tell you what they are.

13                  MEMBER BANERJEE: Okay.

14                  MR. TILLS: The injection rate coming out  
15 of the break pipe is somewhere around ten, a little  
16 bit less than ten kilograms per seconds coming out of  
17 the break pipe.

18                  CHAIR CORRADINI: Yes, that would make  
19 sense. Because you got essentially two megajoules  
20 per kilogram for boiling --

21                  MR. TILLS: That's right.

22                  CHAIR CORRADINI: -- delay heat. And  
23 that's about 20 megawatts of decay heat.

24                  MR. TILLS: Basically the boiling source.

25                  CHAIR CORRADINI: So you can calculate

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1 based on the break size what the velocity. It's a  
2 pretty substantial velocity even just to get the  
3 decay coming out.

4 MR. TILLS: Right.

5 MEMBER BANERJEE: Well, the densities  
6 were about three kilograms per meter cubed? So it's  
7 about three meters cubed per second.

8 CHAIR CORRADINI: I don't know how big  
9 the pipe is. I think Jack's point about on the order  
10 of ten kilograms per second sounds about right.

11 MR. TILLS: Right.

12 MEMBER BANERJEE: Yes.

13 MR. TILLS: And of course it isn't coming  
14 as a non-interacting plume. It's coming out hitting  
15 other parts, hitting other structures which the CFD  
16 code probably was going to have just as much trouble  
17 modeling as any other code.

18 MEMBER BANERJEE: Right. Okay.

19 CHAIR CORRADINI: Any other questions  
20 from the Committee?

21 Shall we have lunch. Okay. Let's recess  
22 until 1:15.

23 (Whereupon, at 12:20 p.m. the hearing was  
24 adjourned, to reconvene at 1:16 p.m. this same day.)  
25

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1 A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

2 1:20 p.m.

3 CHAIR CORRADINI: Why don't we get  
4 started?

5 I think the staff will begin this  
6 afternoon's discussion. Is Bruce or Jay going to  
7 lead us off?

8 MR. BAVOL: I'll start things off. My  
9 name is Bruce Bavol. I'm the Chapter 15 Project  
10 Manager for radiological analysis. And we'll get  
11 right to. I'm going to turn this over to Jay Lee and  
12 we'll star moving through the presentation.

13 MR. LEE: Okay. Good afternoon. I'm Jay  
14 Lee. I'm with NRO and I do the radiological  
15 analysis.

16 The purpose for today's presentation is  
17 to brief you all, Subcommittee, on completion of  
18 fission transport and the removal evaluation done by  
19 Sandia National Laboratory.

20 We feel that the ESBWR containment has a  
21 unique design. It has passive containment cooling  
22 water system and its heat exchanger also create the  
23 drain cooling system. So how this effect the fission  
24 product removal and ESBWR is uniquely different from  
25 current operating BWR or even somewhat different from

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1 AP1000 as well. So we will be presenting the work  
2 completed by Sandia on the fission product removal  
3 and transport inside the ESBWR containment.

4 We did brief you last year, I believe, it  
5 was January. So it was like a year and a half ago  
6 about this issue. And at that time Sandia did not  
7 complete some of the study they were doing. At that  
8 time we presented preliminary result and the  
9 preliminary evaluation. So we are back here today to  
10 present you the work completed by Sandia regarding  
11 the fission product behavior and the removal inside  
12 the ESBWR containment through this PCCS and gravity-  
13 driven cooling system. And then, of course, we're  
14 going to answer your questions.

15 The three issues we like to discuss or we  
16 like to present today is:

17 (1) Natural fission product deposition  
18 in the main steam line and the main condenser. This  
19 is really the aerosol fission product, fission  
20 product in aerosol form. We present aerosol  
21 behavior and it producing inside containment last  
22 year. So today's presentation is aerosol deposition  
23 in the main steam line and in the main condenser.

24 The second bullet item here we like to  
25 present to you today is iodine removal by passive

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1 containment cooling water system, in other words  
2 iodine behavior in containment and the reactor  
3 pressure vessel. That's the second item.

4 The third item we'd like to present to  
5 you is control of pH of water in containment and  
6 reactor pressure vessel pools to prevent iodine re-  
7 evolution.

8 Now bullet item number two and number  
9 three was also, I believe, Dr. Kress raised this  
10 issue during last meeting. Also in his report he  
11 pointed out that we should complete this study and  
12 present at a later time, which is today. So we are  
13 responding to your concern, Dr. Kress, by presenting  
14 this bullet item number two and number three.

15 With that, then I'm going to let Sandia  
16 start their work they have done for us. Don Kalinich  
17 is Sandia National Lab. And he did most of our  
18 study, along with Randy. So, Don, would you please go  
19 ahead and start?

20 MR. KALINICH: Sure. My name's Don  
21 Kalinich. I'm with Sandia National Laboratories.  
22 And I'm going to walk you through details on those  
23 three bullets that Jay just discussed. The first one  
24 is going to be concerning the fission product  
25 deposition in the main steam lines and the main

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1 condenser, specifically here aerosol deposition.

2 The main steam lines and the condenser  
3 are designed to meet the SSE criteria. There's a 200  
4 cfm leakage rate that's specified in the tech spec  
5 for the valves. That leakage rate is assumed to be  
6 there for the entire duration of the accident, 30  
7 days. And there was an independent RADTRAD  
8 confirmatory calculation that's been performed by the  
9 staff using information that I'm going to present  
10 here in order to compare with the GEH results in  
11 their Chapter 15 analysis.

12 Next slide.

13 So the way that analysis was done was  
14 results the ESBWR MELCOR model were used to establish  
15 thermal-hydraulic boundary conditions so that we  
16 could estimate aerosol removal coefficients. This is  
17 equivalent to what we presented last year when we  
18 were looking at just the containment removal  
19 coefficients. Subsequent to doing that work, the  
20 request came in to look at the main steam lines. So  
21 we extended the model to consider that part of the  
22 system and reran it so we could get main steam line  
23 results.

24 For that part of the model we have a  
25 containment main steam line only ESBWR MELCOR model.

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1 And we used that to perform quantitative analysis of  
2 uncertainties and aerosol physic parameters and their  
3 influence on the aerosol removal coefficient. We do  
4 a Monte Carlo analysis here. We define, we sample  
5 them and then statistically present the results. In  
6 this particular case we're using a 150 realizations  
7 in the statistical analysis.

8 CHAIR CORRADINI: So just to refresh my  
9 memory.

10 MR. KALINICH: Yes, sir.

11 CHAIR CORRADINI: This is using  
12 essentially the DBA source term specified as the  
13 source that's going to be leaking through the value,  
14 the closed main steam isolation valve, is that  
15 correct?

16 MR. KALINICH: We used the NUREG-1465--

17 CHAIR CORRADINI: I should have said the  
18 alternate source term.

19 MR. KALINICH: Yes, we used that.

20 CHAIR CORRADINI: But essentially that  
21 timing source term for DBA application?

22 MR. KALINICH: Yes.

23 CHAIR CORRADINI: Okay.

24 MR. KALINICH: That's correct.

25 CHAIR CORRADINI: Thank you.

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1 MR. KALINICH: And that's the same thing  
2 that was done for the containment, just to be no  
3 worries.

4 CHAIR CORRADINI: Thank you.

5 MR. KALINICH: Next slide, please.

6 So these are results. What we're looking  
7 at here is a 150 realizations on each graph, and  
8 there are four graphs. If you follow along from left  
9 to right and then top to bottom, you've got the in-  
10 board main steam line piping, the piping between the  
11 two valves, the piping out-board of the second valve,  
12 and then the condenser. And what we're looking at  
13 here is time on the X-axis 24 hours. And then you've  
14 got the removal coefficient in units of inverse hour.

15 And so what you've got here each of the multi-  
16 colored lines, there's a 150 on there.

17 The black lines, the top one represents  
18 the 95th percentile. The bottom one represents the  
19 fifth percentile. And then the red line in the red  
20 line in the middle represents the 50th percentile,  
21 the median value.

22 CHAIR CORRADINI: And so just again to  
23 refresh my memory, so you used a sampling technique  
24 and you used a normal distribution on the removal  
25 rate and sampled within that or were there more

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1 parameters than just that?

2 MR. KALINICH: I'd have to pull the  
3 report up. But we looked at things like particle  
4 slip coefficient --

5 CHAIR CORRADINI: Okay. So a whole range  
6 of things?

7 MR. KALINICH: A whole range of aerosol  
8 physics parameters, and I can provide that list and  
9 the distributions.

10 CHAIR CORRADINI: That's fine. That's  
11 fine.

12 MR. KALINICH: They're in the  
13 documentation.

14 CHAIR CORRADINI: But so the ranges,  
15 they're all normal distributions or --

16 MR. KALINICH: No, sir.

17 CHAIR CORRADINI: They're all various  
18 distributions and --

19 MR. KALINICH: It depends on the  
20 parameter that you're looking. Some would be  
21 uniform, some would be -- I can tell you that they  
22 all fixed upper and lower bounds because you want to  
23 do that for this type of analysis. But depending on  
24 what the parameter is and what the dataset are that  
25 support the definition of the distribution, and

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1 there's an explanation for each one in the report.

2 MEMBER STETKAR: And it's pretty clear  
3 that they are not all normal distributions?

4 MR. KALINICH: No, sir. They're not.

5 CONSULTANT KRESS: What did you do about  
6 the particle size?

7 MR. KALINICH: Particles? I'd have to  
8 look at that. I know we look at variation on the  
9 aerosol mass median diameter and on it's on the  
10 geometric standard deviation. And I'd have to go  
11 pull the report, which I have sitting in my backpack  
12 if you're interested, even an hour later and I can  
13 tell you specifically what we did.

14 I know that Dana has looked at it because  
15 I know that in the early analysis we were using old  
16 information and we were corrected and we reran our  
17 work. I think we chose -- we ran into a triangular  
18 distribution from -- but that's too much detail for  
19 right now, I can give you the specifics offline. But  
20 they're not all normals and there is a basis. I just  
21 didn't think that you all wanted to go through a  
22 dozen different parameters in great detail.

23 MEMBER POWERS: Maybe I can help. We  
24 used a triangular distribution for the mean of the  
25 particle sized distribution. That triangular came

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1 from our results of the PHEBUS FPT 1 and FPT 2 tests.

2 And we used a uniformed distribution per the  
3 geometric standard deviation of the distribution.

4 Again, we looked at the range that was plausible down  
5 to about 1.6 for the geometric standard deviation and  
6 up to about 3.2. That upper bound was again based on  
7 things that have been observed in the PHEBUS FPT 1  
8 and 2 tests.

9 CONSULTANT KRESS: That's about as good  
10 as you can do.

11 MEMBER POWERS: That's a fair way to  
12 think of doing --

13 CONSULTANT KRESS: What was the physical  
14 size of this, Dana? I mean submicrons?

15 MEMBER POWERS: The physical size? Well,  
16 there are, of course, the particle distribution in  
17 principle goes up to the size of boulders because its  
18 live normal, but in fact the mean is down around, a  
19 little better than a micron.

20 CONSULTANT KRESS: Okay.

21 MEMBER POWERS: And that's probably been  
22 the most important evolution of our understanding  
23 coming out of the PHEBUS tests is the radionuclide  
24 particles in the piping system are relatively small.

25 And that once they go into the containment you get

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1 growth up to the 2 and 3 microns. We never get up  
2 into the 10 and 25 micron sizes that have been  
3 hypothesized back in the NUREG-1150 days.

4 MEMBER BANERJEE: Now are these dendritic  
5 particles or --

6 MEMBER POWERS: Not typically. The  
7 problem is that by the time you actually sample them  
8 on a stage, any of the details of the structure. Our  
9 current understanding of how particles grow in these  
10 environments is they initially form chains, branch  
11 chains and once they've reached critical limit they  
12 fold over into something I call a dust bunny. It's  
13 highly porous material that has a roughly spherical  
14 envelop, but a relatively large shaped factor because  
15 of the high pilosity. Once you take it into the  
16 containment, you then get what amounts to a centering  
17 not really there's so much centering as water  
18 condensing in the crevices and then pulling them  
19 together a little tightly. By the time you put them  
20 on a stage that you can look at, they look more  
21 compact than they probably are when they're suspended  
22 but they're still manifestly high porosity to them.

23 CONSULTANT KRESS: You took care of those  
24 shape factor variation?

25 MEMBER POWERS: Yes. Shape factor, I

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1 believe, is -- and we're relatively generous on that  
2 because as you go from chains down to dust bunnies,  
3 you go over a fairly large range. The upper bounds  
4 on that range were actually fixed by some experiments  
5 in which exploding wires were used to form the  
6 primary particles and those used uranium dioxide,  
7 iron oxide and things like that. A fairly consistent  
8 pattern. And in those experiments they observed  
9 shaped factors up as high as 18.

10 CONSULTANT KRESS: Eighteen? Wow.

11 MEMBER POWERS: And, of course, more  
12 typically you drop down to 2 and 3s, especially after  
13 you get this collapsed to my dust bunny. And that's  
14 really what it very much looks like, is the dust  
15 bunnies that collect under furniture and things like  
16 that.

17 MEMBER BANERJEE: The shape factor being  
18 defined as surface area per volume ratio?

19 CONSULTANT KRESS: You count them,  
20 they're two spheres with the density of the material  
21 shaped like-- aerosol models think they're still  
22 spheres.

23 MEMBER POWERS: Our aerosol models think  
24 they're spheres with unit density.

25 CONSULTANT KRESS: Yes.

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1 MEMBER POWERS: And there are two ways to  
2 handle the shape factor. One is based on the envelop  
3 and the other one is both the envelop and the  
4 porosity effect on density.

5 MEMBER BANERJEE: So to follow this do  
6 you normally use some form of Boltzmann equation  
7 probably with the density function --

8 MEMBER POWERS: You're looking at  
9 integrating the evolution of the aerosol dynamic  
10 equation, which is a distribution. And what we do--

11 MEMBER BANERJEE: A density function.

12 MEMBER POWERS: What we do is we break  
13 that up into size bins. Because these distributions  
14 are not unimodal, typically. Because you have a  
15 source coming in to an aging aerosol, so you  
16 typically get multimodal. So rather than prescribing  
17 a distribution, you're integrating over a size bin.  
18 What we feed into it is this distribution we've been  
19 discussing with Tom where we have an uncertainty and  
20 its mean and an uncertainty and its geometric  
21 standard deviation.

22 MEMBER BANERJEE: It has to two log-  
23 normal shapes?

24 MEMBER POWERS: But we assume the input,  
25 aerosol, the source of aerosol is coming in as a log-

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1 normal and then the integration is done by setting up  
2 size bands so we don't prescribe the evolved  
3 distribution. But in truth, by the time they get to  
4 the containment and things like that, they look like  
5 log-normals.

6 MEMBER BANERJEE: Do you have collision  
7 events and coalescents so there is actually a change?

8 MR. KALINICH: Yes. But I think the  
9 short answer would be is MELCOR uses MAEROS as is  
10 kernel for its aerosol physics. So if that means  
11 anything, the MAEROS can. So I don't generally  
12 describe what's in that, but I was hoping that that  
13 would be sufficient to -- because there's many pieces  
14 of physics in there.

15 MEMBER POWERS: MAEROS is a reasonably  
16 sophisticated aerosol code. What do I say? It's  
17 been validated for containment aerosols against a  
18 huge number of experiments. It seems to be fairly  
19 reliability. That's not to say there aren't still  
20 issues that we wrestle with. And when I was  
21 especially going to piping systems, some of these  
22 subtleties of shape factors as a function of size and  
23 things like that, are areas of ongoing research. But  
24 for routine analysis, MAEROS is probably the standard  
25 of the state-of-the-art.

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1 MEMBER BANERJEE: But from a physical  
2 point of view these are so small that they would be  
3 basically be carried by the fluid.

4 MEMBER POWERS: Absolutely. There is no  
5 backward coupling, that is the fluid effects the  
6 aerosol, the aerosol does not effect the fluid at  
7 these concentrations.

8 MEMBER BANERJEE: So the primary unknowns  
9 are the coalescents of the breakup rates.

10 CHAIR CORRADINI: And the deposition.

11 MEMBER BANERJEE: And the deposition.

12 MR. KALINICH: I guess, going ahead back  
13 to that one just so -- what we provide after we  
14 provide the 150 realizations is we provide numeric  
15 values for the median which is what is then put into  
16 the RADTRAD code in order for it to do its  
17 calculation that's then compared to the Chapter 15  
18 results. So that's what you get out of all this here  
19 on this figure.

20 Next slide.

21 So this basically is going to try to lay  
22 out in very short form what was done by GEH and what  
23 was done by the staff so you can kind of have an idea  
24 of how they got what they got and we got what we got.

25 GEH calculated containment removal

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1 coefficients. They calculated removal coefficients  
2 for an elemental iodine based on SRP 6.5.2.

3 CONSULTANT KRESS: Is that what's  
4 normally called a lambda?

5 MR. KALINICH: Yes, sir. Lambda.

6 CHAIR CORRADINI: Normally what, Tom?  
7 I'm sorry.

8 CONSULTANT KRESS: It's called a lambda  
9 in the vernacular.

10 MR. KALINICH: Yes. In the parlance you  
11 would see that as a lambda because most of the time  
12 that's put into an exponential decay equation for  
13 deposition. That's basically what you're doing is  
14 you're fitting all the physics into some simple model  
15 that you can do quick and fast calculations on.

16 MEMBER BANERJEE: So these particles  
17 don't pick up a charge?

18 MR. KALINICH: Physically, yes, but in  
19 the models --

20 MEMBER POWERS: They definitely give  
21 inherent assumption here is Boltzmann distribution of  
22 charge that there's a unipolar bias. Now whether  
23 that's true or not is another question.

24 What I can say is that the only time that  
25 you can test whether they get charging is when you

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1 have a radiation field is the charging is not due to  
2 decay, it's due to the differential bombardment of  
3 atmospheric ions. In general, negatively charged  
4 ions have a higher mobility than positively charged  
5 ions and so you could develop a unimodel and charge  
6 distribution.

7 What I can say is that we're able to  
8 model experiments like the PHEBUS experiments without  
9 invoking charge. And what we think is happening is  
10 structures and discharging events are vast enough  
11 that we're not seeing big deviations from this  
12 Boltzmann charged distribution.

13 CHAIR CORRADINI: So you get charge  
14 exchange?

15 MEMBER POWERS: Yes, you get a charge  
16 exchange and we're just not seeing this huge  
17 differential mobility. But if I had a radiation  
18 field in this room and put aerosol particles up here,  
19 they would develop a negative charge because the  
20 oxygen ions would just be much more mobile, the  
21 anions would be much more mobile than the cations and  
22 you would see distortion especially for particles  
23 that are larger than about two microns. Small ones  
24 would be more like Boltzmann distribution. I can say  
25 we're not seeing that effect in the experiments and

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1 we can model those experiments quite well without  
2 invoking charge. They're always charged, but not  
3 invoking a bias charge one direction or another.

4 CONSULTANT KRESS: I'm not even sure how  
5 you would do that in the models anyway.

6 MEMBER POWERS: We have actually tried to  
7 set up models on that. And it's doable at the  
8 expense of an enormous amount of --

9 CONSULTANT KRESS: Yes.

10 MR. KALINICH: Okay. No credit was taken  
11 for removal in the main steam lines. Credit was  
12 taken for deposition, aerosols and elemental iodine,  
13 in the main condenser based on BWROG methodology.  
14 And this is consistent with the ABWR DCD.

15 No credit is taken for removal of iodine.

16 For the staff calculation. Containment  
17 aerosol removal coefficients were also calculated,  
18 albeit in a different fashion.

19 We also calculated main steam line and  
20 main condenser aerosol removal coefficients. In the  
21 staff calculation no credit was taken for removal of  
22 elemental or organic iodine.

23 And then the results of the staff  
24 calculation independently confirm that -- let me  
25 rephrase this. The staff calculation binds the GEH

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1 calculation in the sense that the GEH calculation has  
2 a higher -- right, Jay?

3 MR. LEE: Yes, compared to our lambda  
4 calculation. In other words, GEH lambda was somewhat  
5 higher than our lambda. In that sense it is bounded.

6 CONSULTANT KRESS: That is  
7 nonconservative, though, isn't it?

8 MR. LEE: No. GEH is more conservative  
9 in terms of lambda calculation.

10 MR. KALINICH: No, you mean it the other  
11 way around, Jay.

12 CONSULTANT KRESS: The other way around.

13 MR. KALINICH: Our lambdas were bigger  
14 than their lambdas.

15 MR. LEE: Okay. That's right.

16 CHAIR CORRADINI: Whose lambdas were  
17 bigger than whose lambdas?

18 MR. KALINICH: The staff's lambdas were  
19 bigger and no deposition.

20 MEMBER ARMIJO: Which is less  
21 conservative.

22 CONSULTANT KRESS: Yes, now I'm with you.

23 MR. KALINICH: Next slide, please.

24 Okay. The next topic I'm going to talk  
25 about is fission product removal, and here in this

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1 case we're talking about iodine vapor specifically.  
2 And the question is: Does iodine vapor removed by  
3 the PCCS stay removed? The idea being that if you do  
4 remove it, that vapor goes into a liquid phase that  
5 then goes into pools and other parts of the system.  
6 And the question is: Well, does that iodine then  
7 come back out? And if you're in your steady state  
8 for your system, maybe all you're doing is you're  
9 just moving iodine out of the vapor, into pools, back  
10 into the vapor and it doesn't provide any sort of  
11 sequestering of the material.

12 So there was a rate analysis of iodine  
13 transport between the PCCS, the GDCS, the RPV, the  
14 drywell and the wetwell to confirm what GEH has done  
15 on this topic.

16 Next slide, please.

17 So here's a picture of the ESBWR  
18 containment. I'm just going to talk real quick about  
19 this.

20 Basically, we looked at a bottom drain  
21 line accident so you can imagine that there's a pool  
22 down there underneath the RPV where the systems drain  
23 when the line is broke and then aerosol or vapor is  
24 taken in through the PCCS. What gets pulled out,  
25 then gets put into the GDCS pool, which once that

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1 system is brought on line goes into the RPV where the  
2 liquid there is boiled and there's a potential for  
3 iodine vapor to come back into the drywell through  
4 the DPVs that have opened as part of the accident  
5 sequence.

6 CHAIR CORRADINI: I just want to make  
7 sure I understand.

8 MR. KALINICH: Yes, sir.

9 CHAIR CORRADINI: So you're looking at  
10 what would be the equilibrium concentration reached  
11 after we get to some point in time? Is that the  
12 point of this?

13 MR. KALINICH: Actually, what I choose to  
14 look at was the mass of iodine vapor in the drywell.  
15 Because that's really the -- but you could look at it  
16 either way you want.

17 Next slide, please.

18 And this is just another figure that have  
19 some mechanisms on it. We can go on ahead and move  
20 on through this though due to the interest of time  
21 unless someone has questions.

22 So what we did, is we did a calculation  
23 performed with a simplified MELCOR ESBWR model. The  
24 iodine pool model was implemented in three places; in  
25 the RPV, in the drywell and in the wetwell.

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1                   There's actually no model currently  
2 available either in MELCOR that I'm aware of from  
3 talking with Dana that's going to model the  
4 diffusiopheric deposition of iodine vapor in the  
5 PCCS. So what we did instead is we said well what if  
6 we specify it. We'll just make a parametric model  
7 and we're say well if it occurs at a certain rate,  
8 what response do we get in the MELCOR model? That  
9 would at least give us an idea of how that effects it  
10 parametrically.

11                   So the next slide.

12                   CONSULTANT KRESS: Couldn't you just tie  
13 it to the condensation rate?

14                   MR. KALINICH: I suppose you could, but  
15 given that this model already takes a long time to  
16 run, I thought it was just cleaner to just do  
17 something simple than try to do something complicated  
18 for something I really didn't know. You know, in  
19 theory once you go down that primrose path if you're  
20 going to spend the time, you might as well actually  
21 get someone who knows what they're doing to actually  
22 build you a real model. From what I understand,  
23 there's just not information available. And given  
24 the time constraints, it wasn't an tractable thing to  
25 do. So this was our best foot forward, if you will,

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1 to try to at least get a handle on the problem.

2 So just to give you sign of what the  
3 iodine pool model is. It's in the MELCOR code it's  
4 based on work that was done by Dana. Basically it  
5 looks at acid generation and transfer to walls and  
6 pools. You're looking at radiolysis of air which  
7 produces nitric acid. And you have radiolysis of  
8 cable insulation that produces hydrochloric acid.

9 There's a pool pH calculation that's  
10 performed and we account it for the fact that you do  
11 have sodium pentaborate buffering in the pools. It  
12 accounts for iodine aqueous pool chemistry, pool-  
13 atmosphere mass transfer, iodine atmosphere  
14 radiolysis and recombination and iodine atmosphere to  
15 wall deposition.

16 MEMBER BANERJEE: Is for PWIs, right?

17 MR. KALINICH: The sodium pentaborate is  
18 for ESBWR.

19 MEMBER ARMIJO: That's typical BWR.

20 MEMBER BANERJEE: I see.

21 MS. CUBBAGE: In this situation they  
22 inject a slick on every LOCA signal.

23 MEMBER BANERJEE: Okay. Right. Got it.  
24 It's really meant to serve as a buffer then, is it?

25 MS. CUBBAGE: No.

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1 MEMBER POWERS: It was an accident that  
2 the neutronics coincided with chemistry here. Of  
3 course the really important thing is that the  
4 buffering capacity, the neutronics business is very  
5 obscure. We don't understand it.

6 MR. KALINICH: So this function is the  
7 result of four calculations times on the x-axis after  
8 seven days and on the y-axis you have the drywall  
9 airborne iodine vapor mass in kilograms. And what  
10 you're seeing here is the black curve is you have --  
11 basically what we did is we put on a lambda. We said  
12 it removes material at a particular rate per hour.  
13 The black -- and the PCCS. It's MELCOR so we put in  
14 there a set of control functions that said based the  
15 math we're going to remove a certain amount of it per  
16 hour using a lambda coefficient.

17 Yes, sir?

18 CHAIR CORRADINI: Maybe you said it and I  
19 didn't catch it. So it's being removed by  
20 essentially going into solution of the condensate and  
21 then drained --

22 MR. KALINICH: That's right. And we're  
23 forcing it to do that. There's no First Principle  
24 physics. We're just saying here's a rate that we're  
25 going to take out iodine out of the vapor as it comes

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1 through the PCCS. And we're going to put it into the  
2 liquid phase. And then liquid would drain into the  
3 GDCS and then on into the RPV and into the drywell  
4 because we've got a bottom drain line break.

5 MEMBER ARMIJO: You don't have any  
6 experimental basis --

7 CHAIR CORRADINI: Right, that's what I  
8 was going --

9 MEMBER ARMIJO: -- to say that this sort  
10 of makes sense or --

11 MR. KALINICH: Dana?

12 MEMBER POWERS: It fits. I mean, yes, we  
13 know that this is exactly what happens that it does  
14 go into solution readily. Again, I harken to the  
15 PHEBUS experiments where we have a wetwell condenser  
16 and we put -- the gaseous iodine comes from the RCS.  
17 Of course it does defuse over. And  
18 dffusiopherically condenses on the condenser and it  
19 does stop. Okay. To come to the end of that gets me  
20 into details that are the product of research right  
21 now.

22 What Don's described is he needs to do a  
23 calculation before, and we've completed our research,  
24 and so he's taken a fairly ad hoc but it serves his  
25 purposes here. The physics he's doing is well

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1 established.

2 CONSULTANT KRESS: These lambdas come  
3 from a very small value to a very high value. They  
4 fall somewhere in the middle.

5 MR. KALINICH: Right. By accident if  
6 there was something out there that we could get our  
7 hands on that would work, and we start talking about,  
8 you know, primary and odd diffusion equations and all  
9 that interesting stuff, but nothing that was going to  
10 help even quickly or-- remember, this work was being  
11 done a year and a half ago. And so PHEBUS was even  
12 further back than it was now.

13 Basically what I did is I said well I've  
14 got the base case where we don't have any removal,  
15 which is the black line. And then I started saying  
16 well let me just start putting in lambdas and see  
17 where you get so at least you can have an idea.  
18 Well, yes, if you have a really high lambda, you're  
19 going to basically knock all the -- which makes  
20 physical sense. But where do you need to be? Is it  
21 a lambda of one? Is it a lambda of ten? Lambda of  
22 100? A lot of it depends on long you're going.

23 Obviously, the red line is not going to  
24 get you to nothing anytime soon.

25 The blue line, which is a lambda of ten,

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1 if you're going out for another factor of four, out  
2 to 28 days, you've got a good trend there. And if it  
3 turns out that you have a very aggressive system in  
4 terms of the physics here, you're going to get the  
5 stuff out in about four or five days.

6 I just don't have an idea of where the  
7 actual system would truly lie until we get data in a  
8 model that we can put together and then run --

9 MEMBER BANERJEE: This is a point of  
10 reference: If you made the assumptions and still  
11 wrong that it was lambda that corresponded to some  
12 sort of condensation rate and made it the same, what  
13 lambda would that be?

14 MR. KALINICH: I don't have an answer. I  
15 could go back and look at something, but I don't have  
16 the results.

17 MEMBER BANERJEE: But you have MELCOR  
18 calculated some condensation rates?

19 MR. KALINICH: Yes, we have. Yes.

20 MEMBER BANERJEE: I'm not saying its  
21 going to be that, but it will at least give you a  
22 reference line of some sort.

23 MR. LEE: You know, of course the  
24 condensation rate is one of input in MELCOR code.

25 MEMBER BANERJEE: You have a longer rate-

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-  
MR. KALINICH: I think the key thing that we get from this, and let me go to the next bullet to explain why this -- what we think we're getting out of this slide.

MEMBER BANERJEE: It doesn't matter.

MR. KALINICH: So the first thing that you see is that higher removal rates result in lower iodine vapor mass in the drywell which would seem to be obvious but what really is important is the second bullet. And this results are indicative of that we're removing iodine vapor and its remaining in pools rather than being re-evolved. Because if it was re-evolving, then I would expect to see that, you know if that lambda of 100, that green curve looked like a black curve, then what that would tell you is that the stuff's staying in the pool. So I really don't care at that point what's going on with the PCCS. In the large, it's not being effective in removing iodine vapor.

CONSULTANT KRESS: Does the code calculate the pH --

MR. KALINICH: Yes, it does. And that probably -- hit the third bullet that we'll talk about.

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1 CONSULTANT KRESS: Okay.

2 MR. KALINICH: Yes. Obviously if the  
3 pool -- that's the other half of the story is that if  
4 you're doing this calculation, you have to make sure  
5 why are the pools sequestering. And there's  
6 sequestering because they remain basic.

7 CONSULTANT KRESS: That was the question.

8 MR. KALINICH: That's the quick and  
9 dirty.

10 And so the third bullet on this is, is  
11 that this supports the staff's assumption that iodine  
12 in elemental form remains in the water pools.

13 Yes, sir.

14 CHAIR CORRADINI: So if I might just back  
15 up. These are all calculations that again are  
16 looking at where reality might sit based on the DBA.

17 For the DBA analysis specifies a rate of removal or  
18 assumes there is no removal? That's what I don't  
19 remember, or don't know.

20 MR. KALINICH: The analysis that was done  
21 by the staff RADTRAD assumes no removal of iodine  
22 vapor from the system.

23 CHAIR CORRADINI: So this is looking, if  
24 I might say, margin based away from the DBA  
25 requirement? I'm trying to understand that.

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1 MEMBER ARMIJO: Yes. Yes. Yes, you are  
2 right.

3 CHAIR CORRADINI: Okay. Okay.

4 MR. KALINICH: It also confirms what was  
5 being reported by GEH in their calculations.

6 CHAIR CORRADINI: Okay. Thank you.

7 MR. LEE: You know, you also clarify  
8 whenever we say "iodine vapor," we meant the iodine  
9 in elemental form.

10 CHAIR CORRADINI: Yes, I understood that.

11 MEMBER ARMIJO: Okay.

12 CONSULTANT KRESS: But you did end up  
13 with a steady state level of iodine in the drywell?  
14 I mean, it didn't go to zero?

15 MR. KALINICH: No. No.

16 MEMBER ARMIJO: No.

17 MR. KALINICH: Especially if you're not  
18 removing any of the vapor through the PCCS. You can  
19 see that blackline. It just kind of sits there.

20 CHAIR CORRADINI: Well, that was the  
21 source of his original question, is your concern,  
22 wasn't it?

23 CONSULTANT KRESS: Right. Even if you  
24 got some removal, you could end up with a steady  
25 state?

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1 CHAIR CORRADINI: Correct.

2 MR. KALINICH: Right.

3 CONSULTANT KRESS: Because it doesn't  
4 remove all of it?

5 CHAIR CORRADINI: Right.

6 MR. KALINICH: And you can see the left  
7 curve which was a lambda of one per hour. Its steam  
8 doesn't really go down all that, we're just not  
9 removing all that much.

10 CONSULTANT KRESS: Yes.

11 MR. KALINICH: Next slide.

12 So now we're getting onto the follow line  
13 here, which is control the pH and not only the  
14 containment pools, but also the RVP pool to prevent  
15 iodine re-evolution.

16 So iodine in the pool will not  
17 significantly partition to the atmosphere if the pool  
18 pH is greater than 7, roughly.

19 Formation of cesium hydroxide and the  
20 addition of buffer, sodium pentaborate, results in an  
21 initial pool pHs between 8 to 8.5.

22 Acid formation in the system will  
23 eventually result in a reduction of the pool pH. And  
24 once again, we're accounting for radiolysis of air  
25 producing nitric acid and radiolysis of cable

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1 insulation producing hydrochloric acid.

2 CONSULTANT KRESS: Now where does the  
3 radioactive elements come from when the radiolysis  
4 are there?

5 MR. KALINICH: It would be --

6 CONSULTANT KRESS: In the pool?

7 MR. KALINICH: They form in the  
8 atmosphere.

9 CONSULTANT KRESS: So you did cap the  
10 atmosphere?

11 MR. KALINICH: Yes, sir.

12 CONSULTANT KRESS: Okay. That was my  
13 question.

14 MR. KALINICH: So in this model basically  
15 we've introduced the NUREG-1465 source term for the  
16 ESBWR into the system, and it done goes to where it  
17 wants to go based on the intercell deposition  
18 physics. So it all starts in the atmosphere and  
19 it'll deposit on heat structures and in the pools and  
20 the like.

21 CONSULTANT KRESS: So this is creating  
22 nitric acid in the air?

23 MR. KALINICH: Yes, sir.

24 CONSULTANT KRESS: And then that's going  
25 into the pools?

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1 MR. KALINICH: Yes, sir.

2 CONSULTANT KRESS: You have a mass  
3 transfer coefficient for that? And how does it get  
4 into the pool?

5 MR. KALINICH: Well, it can be -- I'd  
6 have to actually look at the -- I know that we use  
7 the -- let me see if I can try another shorthand  
8 here.

9 The pool model that's in MELCOR is the  
10 end spec model with modifications that were made by  
11 Dana. So I would have to actually go back and look  
12 at that model to see exactly what the mass transfers  
13 are. Maybe Dana can help me out here. I know  
14 there's a figure and about 13 pages in the reference  
15 model, I just don't have them all committed to  
16 memory. I apologize. There is a mechanism for  
17 moving the materials from vapors to pools.

18 MEMBER POWERS: The mass transport is  
19 based on the model described in the document by Kress  
20 and others. And in that --

21 CHAIR CORRADINI: Oh God.

22 MEMBER POWERS: -- document they describe  
23 the class of model, one in the liquid phase, one in  
24 the gas phase. To calculate the boundary distances  
25 that have to have diffusion across we use MACKey and

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1 Ewing, and they're experimental studies of the  
2 transport of organic pollutants from water.

3 We have the model for -- if the pool is  
4 evaporating, you have a resistance to the things  
5 going into solution. If it's condensing, you get an  
6 augmentation. So we do -- gaseous diffusion across  
7 the gas phase. In the liquid phase we just use  
8 molecular diffusion, which isn't quite right for  
9 iodine but it's what we can do right now.

10 CONSULTANT KRESS: But you did not find  
11 the cause of that vapor?

12 MEMBER POWERS: That's right. It does  
13 account for the effects of pool evaporation or  
14 condensation due to augment. And it's kind of  
15 interesting because as you condense -- evaporate, you  
16 still get some iodine transport across that  
17 evaporation front until you get to very close to  
18 boiling, actually, before you stop it completely.

19 But, yes, you have to do it in a -- sense  
20 where you've got a flux of water vapor and whatever  
21 is going into solution plus a stagnant gas that's in  
22 the background.

23 CONSULTANT KRESS: My concern was that  
24 you always keep the nitric acid from actually going  
25 into the pool.

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1 MEMBER POWERS: Yes, it does not resist  
2 it if the pool is boiling completely. It interferes,  
3 but it doesn't stop it.

4 Where the dominant resistance to mass  
5 transport is depends a little bit on how fast your  
6 conductive currents are over the top. The pool  
7 itself is assumed to be relatively well mixed, but it  
8 can become right limiting for the diffusion of irons  
9 across --

10 MEMBER BANERJEE: So how do you estimate  
11 the --

12 MEMBER POWERS: We use the correlation  
13 from Mackey and Ewing. They did experiments on water  
14 pools. And they were looking at organics,  
15 partitioning out of water. And they looked at them  
16 in, you know, a classic wind tunnel experiment where  
17 they get flow over the top. The reason you have to  
18 do this is there's a tendency to want to do these as  
19 a flat plate. But in fact, you get these capillary  
20 effects that ping your mass transport across both the  
21 gas phase and the liquid phase. As you go to higher  
22 flow rates, then you get actual gravity waves forming  
23 that effect it.

24 So they give you correlations for both  
25 the gas phase mass transport which we turn into a

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1 boundary layer effect -- because we had a different  
2 diffusion coefficient as a function of Reynolds and  
3 Schmidt numbers. And they're kind of predictable  
4 form --

5 MEMBER BANERJEE: This is on the liquid  
6 side it's a very high Schmidt number, right?

7 MEMBER POWERS: Yes. Yes.

8 MEMBER BANERJEE: So is the primary  
9 resistance on the liquid side or --

10 MEMBER POWERS: It depends on the Henry's  
11 Law coefficient

12 MEMBER BANERJEE: Okay.

13 MEMBER POWERS: If you have relatively  
14 large Henry's Laws everything's on the liquid side  
15 and relatively low, then you'd get into --

16 MEMBER BANERJEE: It depends on the  
17 solubility?

18 MEMBER POWERS: Yes. Exactly. Yes. It  
19 just depends where you are --

20 MEMBER BANERJEE: It's comparing the  
21 solubility to be on the liquid side.

22 MEMBER POWERS: And we don't want to make  
23 the judgment. We let the computer make that  
24 judgment. Do them both using the brilliantly deduced  
25 model from the esteemed Kress and colleagues.

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1 CHAIR CORRADINI: Let's move on.

2 CONSULTANT KRESS: I have a question,  
3 though.

4 CHAIR CORRADINI: You are in conflict.  
5 I'm sorry.

6 CONSULTANT KRESS: Where did you come up  
7 with the amount of cable insulation?

8 MR. KALINICH: It's from the GEH -- I  
9 believe it's both in the DCD and the licensing  
10 topical report.

11 MR. LEE: GE has a DCD type of a cable  
12 insulation as well as the amount of a cable  
13 insulation used. And that is classified as  
14 proprietary information.

15 CONSULTANT KRESS: Does the blowdown have  
16 any effect on that?

17 MR. KALINICH: On the amount of cable?

18 CONSULTANT KRESS: Yes, or the amount of  
19 acid producing material?

20 MR. LEE: It so happened that amount and  
21 the type of cables that the applicant used, GE used,  
22 is pretty same as amount used in ABWR design.

23 MEMBER ARMIJO: What fraction of this  
24 insulation gets turned into hydrochloric acid? All  
25 of it?

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1 MEMBER POWERS: No. It is a function of  
2 the dose rate and time. And we use for that -- ladle  
3 of hydrochloric acid production we use a  
4 recommendation from Beahm and coworkers at the  
5 exalted Oak Ridge National Laboratory in their  
6 studies.

7 There's been some subsequent work done on  
8 that at BTT in Finland where they say it's not a  
9 constant rate that we assume that in fact there's an  
10 exponential rate. It depends a little bit on the  
11 loading of the insulation, loading of additives,  
12 magnesium oxide, iron oxide into the insulation  
13 you're doing. But the number we use is one  
14 recommended by Beahm, et. al, for unloaded  
15 insulation. And, quite frankly, I can't remember  
16 what it is. It's so many kilograms per megarad of  
17 dose. And we just use that. Remember, the code  
18 calculate how much gets turned in. So it's a  
19 function of what your atmospheric dose rate is and  
20 the amount of insulation that you have exposed to  
21 that dose rate. If you don't, it does not require  
22 that that insulation be swept into the sump.  
23 Everything's getting that dose.

24 MR. LEE: Yes. I think that Oak Ridge  
25 developed the G factor.

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1 MR. MARQUINO: Wayne Marquino at GE.

2 There was a question about whether the  
3 blowdown effects the mass of insulation. We spec any  
4 unprotected insulation that's not within conduit is  
5 that mass value. So it's all participating.

6 MR. KALINICH: So there's a slide  
7 question comes when does the pool pH drop below 7 is  
8 what you'd like to know. And the GEH calculation  
9 predicts that the drywell pool pH goes below 7  
10 between 20 to 29 days in a normal scenario they were  
11 looking at and how much credit they took for cesium  
12 hydroxide formation.

13 The staff calculation confirms the GEH  
14 results out to 7 days.

15 Next slide.

16 MEMBER ARMIJO: I want to make sure I  
17 understand what that means. Does that mean after 7  
18 days its below 7?

19 MR. KALINICH: No. It means that we ran  
20 our calculation out to seven days and we still have  
21 pH between 8 and 8.5.

22 MEMBER ARMIJO: So you don't actually  
23 have a time at which it actually goes below pH 7?

24 MR. KALINICH: We don't. We don't.

25 Just to give you an idea, this

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1 calculation took about two to three weeks to run.

2 MEMBER ABDEL-KHALIK: Why?

3 MR. KALINICH: The iodine model is very  
4 CPU intensive.

5 CHAIR CORRADINI: Clearly an appropriate  
6 modeler didn't do it.

7 MR. KALINICH: There's a lot of chemistry  
8 being calculated. I took a look at it when I started  
9 running it to try to figure out if there was  
10 something I could do -- I mean, and we went through  
11 and simplified the model in a number of places to try  
12 to speed it up. But ultimately, you know, there's --

13 MEMBER BANERJEE: These are ODEs.

14 MEMBER POWERS: Yes, the model actually  
15 takes the in spec set of equations which are about, I  
16 would -- as I recall, 212 rate equation. But we take  
17 the steady state limits on those because it gets  
18 ready state pretty quickly. And its looking at both  
19 the radiolysis of water as well as these iodine  
20 reactions as well as the effect of iron impurities as  
21 well as the effect of CO<sub>2</sub> and hangs like that going  
22 into solution. Calculates the aqueous iodine  
23 concentration and the calculates the partitioning of  
24 that iodine across.

25 And the model developer is not what I

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1 would call computationally adept and I wouldn't  
2 vouchsafe the speed with which the calculation.

3 It hones finely, it may not hone fastly.

4 MEMBER BANERJEE: You didn't try a  
5 reduced order model?

6 MEMBER POWERS: We have a variety of ways  
7 to reduced the order of the model, but they've never  
8 been implemented in the MELCOR.

9 CHAIR CORRADINI: Okay. Moving.

10 MEMBER BANERJEE: It's interesting.

11 MR. KALINICH: Sorry to interrupt you,  
12 Dana.

13 Just to give you an idea of the  
14 differences between the GEH calculation and the staff  
15 calculation, the GEH calculation is based on a MELCOR  
16 ESBWR model that's run out for 24 hours to provide 24  
17 hours to provide thermal-hydraulic information and  
18 the cesium hydroxide and cesium iodine formation  
19 rates.

20 A code called ChemSheet is then used to  
21 take that output, extrapolated out to 30 days, in  
22 conjunction with acid generation rates to calculate  
23 the evolution of the pool chemistry for those 30  
24 days. So that's how the GEH calculation was done.

25 The staff calculation is a simplified

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1 MELCOR ESBWR model with Iodine Pool Model implemented  
2 in the RPV, drywell and wetwell. And we ran ours out  
3 seven days.

4 And our conclusion after looking at these  
5 is that iodine trapped in pools doesn't re-evolve all  
6 but it confirms what GEH has.

7 And I thought I actually had a plot, but  
8 there's a nice plot that shows that the pHs are  
9 constant for seven days. Imagine that, if you will.

10 So I believe the next slide, that's it.

11 MR. LEE: After seven days we expect  
12 iodine to decay, Iodine-131 decays almost half. And  
13 also chi over q factors by then is fairly low. So  
14 the dose will be less significant.

15 MR. KALINICH: So seven days was a  
16 sufficient of time to run to provide confidence that  
17 we can confirm what GEH does.

18 MR. LEE: So the regulatory review issues  
19 becomes really does ESBWR design provide adequate  
20 mitigation of radiological consequences in an event  
21 of a major reactor accident to protect public health  
22 and safety, meeting the dose acceptance criteria  
23 specified in 10 CFR 100, which is a citing criteria  
24 and also 10 CFR 52.47? Mainly 24 rem -- 24 rem at  
25 the LPG and five rem in the control. That's really

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1 the question.

2 So staff's final conclusion after  
3 reviewing all this lambdas we've been calculating  
4 inside the containment and main steam line and the  
5 condenser, the pH and all that, we conclude that an  
6 independent confirmatory calculation by the staff  
7 confirmed GEH calculations or GEH analysis as we've  
8 shown in the previous slides. Therefore, staff  
9 concludes that ESBWR design meets relevant dose  
10 acceptance criteria.

11 We do not have any open issues or open  
12 items. And this closes our Chapter 15 radiological  
13 analyses review.

14 CHAIR CORRADINI: Questions by the  
15 members?

16 CONSULTANT KRESS: This conclusion is  
17 kind of dependent on your assumed lambda values for  
18 the --

19 MR. LEE: Yes. Certainly we used the  
20 lambda value, with the GE lambda, also our GE  
21 lambdas.

22 CONSULTANT KRESS: I mean the lambda  
23 value for the PCCS.

24 MR. KALINICH: No. We took no credit for  
25 iodine removal in the calculations.

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1 CONSULTANT KRESS: Okay.

2 MR. KALINICH: So the real purpose of  
3 that was to see if you put iodine in the pools, does  
4 it stay there, does it come back out.

5 MEMBER ARMIJO: So you used a lambda  
6 zero, is that --

7 MR. KALINICH: That's right. Yes. For  
8 the RADTRAD calculations that were done by the staff  
9 there was no credit taken for iodine removal in the  
10 system.

11 CONSULTANT KRESS: Yes. I guess I missed  
12 that.

13 MR. KALINICH: It was in one of the  
14 comparative cites between the GEH calculation and the  
15 staff calculation.

16 CHAIR CORRADINI: So I guess to follow on  
17 Tom's question just for my understanding, is that  
18 required by the DBA assumptions that you take no  
19 credit for that? That's what I didn't understand.

20 MR. LEE: No, there's no requirement or  
21 anywhere in the SRP that we have to give a credit or  
22 not give a credit for such --

23 CHAIR CORRADINI: But historically no  
24 credit is taken?

25 CONSULTANT KRESS: Oh no. All it says is

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1 if you take credit, you have to justify that.

2 CHAIR CORRADINI: Okay. Fine. That's  
3 fine. I understand. Thank you.

4 MR. LEE: If you have any questions?

5 CHAIR CORRADINI: Other questions?

6 Thank you.

7 We'll move onto the GEH, who is going to  
8 give us a presentation, is that correct?

9 MR. BARRETT: All right. So in order to  
10 make the day flow a little bit better, I think I can  
11 bond two presentations in one, but the RB mixing  
12 holdup just moved ahead of the control room stuff.  
13 So we're going to be starting on page 16

14 CHAIR CORRADINI: Mr. Barrett, are you  
15 going to lead us off?

16 MR. BARRETT: I am.

17 CHAIR CORRADINI: Okay.

18 MR. BARRETT: And we're going to cover  
19 the reactor building mixing holdup.

20 CHAIR CORRADINI: Page 16.

21 MR. BARRETT: Yes, there should be a nice  
22 little --

23 CHAIR CORRADINI: Yep. Go ahead.

24 MR. BARRETT: Okay. The ESBWR reactor  
25 building provides a holdup volume and delays the

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1 transport of radionuclides from the containment to  
2 the environment. That's the overall concept of our  
3 secondary confinement, which is our reactor building.

4 And we did a detailed the  
5 holdup/transport analysis of the ESBWR reactor  
6 building using the code GOTHIC 7.2a.

7 And the purpose of this analysis is to  
8 show that we confirmed that the reactor building is a  
9 conservative characterization of what was used in the  
10 dose consequence model for the holdup and transport  
11 of delay of radionuclides.

12 You guys want to go to the next slide.

13 And so what we modeled is the whole  
14 entire reactor building. The clean ventilation  
15 system areas and the contaminated area ventilation  
16 system area. And the contaminated ventilation system  
17 area completely encompasses the entire containment  
18 and the clean area is around that. We didn't,  
19 however, do the -- model. And our reactor building  
20 is a highly compartmentalized building where the  
21 radionuclides would have to disperse to many  
22 different rooms through doors, HVAC duct, et cetera.

23 And the model is based off of the General  
24 Arrangements drawings located in the DCD which where  
25 we include all HVAC and door pathways that connect

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1 all the different areas in between each other.

2 CHAIR CORRADINI: So I have a question  
3 just out of curiosity?

4 MR. BARRETT: Yes.

5 CHAIR CORRADINI: So you switched to  
6 GOTHIC instead of MELCOR. I'm sorry TRACG, I'm sorry.  
7 I've had everything all screwed up. And the logic  
8 being that this essentially you're modeling this as  
9 essentially a series of air volumes connected by  
10 orifices?

11 MR. BARRETT: Yes, more or less. Yes.

12 CHAIR CORRADINI: Okay.

13 MR. BARRETT: And we've always used  
14 GOTHIC. We didn't use MELCOR or TRACG. This is  
15 basically -- well, I'll get into it a little bit  
16 more.

17 CHAIR CORRADINI: That's fine. I just  
18 wanted to make sure I understood. That's fine.

19 MR. BARRETT: Okay. So right now --

20 CHAIR CORRADINI: On page?

21 MR. BARRETT: -- we're the model  
22 description page, I apologize.

23 CHAIR CORRADINI: So you're on page 20?

24 MS. CUBBAGE: Slide 18.

25 MR. BARRETT: Unfortunately, the copy I

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1 have is not numbered th same as yours. I apologize  
2 for that.

3 MR. BARRETT: We're on Major Assumptions?

4 MR. BARRETT: So for the major  
5 assumptions of the analysis, it's LOCA concurrent  
6 with fuel damage, loss of offsite power and HVAC  
7 systems are not available. The leakage from the  
8 reactor building occurs at the closest point to the  
9 control building, which is the most conservative from  
10 a dose standpoint to the operators and the control  
11 room.

12 The reactor building is pressurized  
13 through a quarter inch water gauge on the windward  
14 and leeward sides of the building. And the reactor  
15 exfiltration rate was tuned to be 300 cfm.

16 CONSULTANT WALLIS: Now that corresponds  
17 to what kind of wind speed?

18 MR. BARRETT: Well, a quarter inch --  
19 it'll be somewhere in the 20s you'll around a quarter  
20 inch, I believe. Somewhere in the --

21 CONSULTANT WALLIS: That's right. That's  
22 what I have. Twenty miles per hour or something like  
23 that?

24 MR. BARRETT: Yes, somewhere in the 20s.

25 CONSULTANT WALLIS: Why is that good

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1 enough?

2 MR. BARRETT: Well, a dose analysis was  
3 done at calm wind speeds. So at higher wind speeds  
4 the dose would be lot less. So that's why we used the  
5 quarter inch.

6 CONSULTANT WALLIS: Well why not less?

7 MR. BARRETT: Well, I guess for  
8 conservatism.

9 So our dose was done considering low --  
10 like a high exfiltration or wind loading, but still  
11 it was done at --

12 CONSULTANT WALLIS: It seems there's sort  
13 of of an optimum place where it's worse. I mean,  
14 there's no wind then nothing happens. If it's too  
15 high a wind, it just blows everything away.

16 MR. BARRETT: Right.

17 CONSULTANT WALLIS: Somewhere in between  
18 in the worst condition. IS this the worst condition  
19 or --

20 MR. BARRETT: Well, the dose analysis was  
21 done at two things that can't happen at the same  
22 time: At calm conditions and high exfiltration rate.  
23 So both of those can't happen at the same time, but  
24 the dose analysis was done both together  
25 concurrently.

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1           Okay. If you go down to the next slide  
2 "Containment Release," most of the mass inside the  
3 containment during an accident is nitrogen and steam,  
4 any of which can carry the radioactive releases out  
5 to the environment assuming that those radionuclides  
6 would be attached to either steam or nitrogen to  
7 traverse to the reactor building. And the ESBWR  
8 containment is noted with nitrogen gas. And the  
9 steam that comes from the pipe break is where the  
10 steam would come from.

11           And the radioactive releases reach the  
12 environment through either the nitrogen and steam.

13           And for the GOTHIC model that we used in  
14 order to track these radionuclides is we used nothing  
15 but nitrogen because it won't condense, unlike the  
16 steam will. So we only tracked the nitrogen and  
17 assumed that all of it is traversing to the reactor  
18 building on nitrogen.

19           And comparing the releases of --

20           CONSULTANT WALLIS: This is radioactive  
21 nitrogen?

22           MR. BARRETT: Well, it's not radioactive  
23 nitrogen, but what we're saying is is in the model  
24 we're going to release nitrogen into the reactor  
25 building --

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1                   CONSULTANT WALLIS: That carries the  
2 radioactivity?

3                   MR. BARRETT: Right, right. Which could  
4 carry it.

5                   CONSULTANT WALLIS: Yes.

6                   MR. BARRETT: Okay. And comparing the  
7 releases is how we're going to do a comparison  
8 between the GOTHIC analysis and the dose calculation,  
9 which I'll get into in in a minute.

10                   Go to the next slide.

11                   CONSULTANT KRESS: Now in addressing the  
12 NUREG-1465 source term --

13                   MR. BARRETT: Yes. In dose calculation  
14 that was used for the source term.

15                   CONSULTANT KRESS: That has a time  
16 associated with it. Now GOTHIC's going to calculate  
17 flow rates which have a time associated with it due  
18 to the blowdown and stuff. How do you put those two  
19 times together?

20                   MR. BARRETT: So the nitrogen is not  
21 going to carry or anything, so it would have flow  
22 rate in and it's going to come out. So what we did  
23 was in the dose calculation we tracked a -- we used  
24 an isotope that -- long-lived isotopes so that it  
25 will be basically constant throughout the whole

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1 entire period. And we tracked that.

2 And what we do is a --

3 CONSULTANT KRESS: I guess my question is  
4 you have the blowdown is driving the GOTHIC behavior,  
5 which is of course the time from start of load in.

6 CONSULTANT KRESS: And you have a source  
7 term which starts when?

8 MR. BARRETT: Okay.

9 CONSULTANT KRESS: That's my question.

10 MR. MARQUINO: In a GOTHIC analysis we  
11 don't have varying pressure in the containment versus  
12 time. We have a constant rate out of the containment  
13 inside the reactor building that's based on the  
14 primary containment design pressure.

15 In the dose analysis we capture time  
16 released from the 1565 source term and time varying  
17 chi over q values. The match up is in the dose  
18 calculation we also don't change the primary  
19 containment release. So that allows us to compare  
20 the dose calculation to this GOTHIC analysis where  
21 nitrogen is like a tracer gas.

22 MR. BARRETT: Going onto slide 21. Here  
23 I talk more about what the quarter inch pressure,  
24 water gauge pressure that was assumed on the windward  
25 side and the leeward side and that how what we did to

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1 model it, one of the modeling assumptions we did is  
2 we had 300 cfm coming into one side and 300 cfm  
3 coming out of the other side. And we used a  
4 conservative containment release locations closest to  
5 areas where it can get out to the environment, or  
6 closest to the control building. And we funneled it  
7 out towards that area so that it can get out to the  
8 control building with the least path of resistance.

9 Go to the next slide.

10 All right. For the results what we did  
11 is after 72 hours we took the ratio of the amount of  
12 nitrogen that reaches in the environment and put that  
13 ratio over what was getting into the reactor building  
14 from containment. And that value is approximately 48  
15 percent.

16 In the dose calculation, as Wayne was  
17 discussing earlier, we did the same type of ratio.  
18 And we got a ratio of approximately 70 percent when  
19 you assume a mixing volume in the dose calculation of  
20 50 percent.

21 You can go to the next slide.

22 So as you can see, this a figure of  
23 merit. It just shows the different ratios.

24 The top line is our dose calculation  
25 line, which has about approximately a 70 percent. And

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1 the bottom line is the GOTHIC line, which is about 48  
2 percent. And the line that's right next to the  
3 GOTHIC line is the equivalent dose calculation line  
4 if you were to use a mixing volume of approximately  
5 90 percent.

6 So, as you can see, the GOTHIC line i s  
7 always below what would be predicted to get out into  
8 the environment that was used in the dose  
9 calculation.

10 Go to the next slide.

11 All right. So we did several sets of  
12 sensitivity analyses requested by the staff in order  
13 to show that our model was to determine some of the  
14 uncertainties and to quantify some of those  
15 uncertainties. And so what we ended up doing is  
16 making a best estimate type leakage model where we  
17 used like multiple leakage points, varying  
18 temperatures and some of those things in order to  
19 just get like a best estimate model. And what we did  
20 then is then we perturbed a bunch of different  
21 parameters to see how it was going to behave after  
22 that. And we quantified all those. And what we  
23 found is that the CONAVS boundary or the tested  
24 boundary that we have right now is the most important  
25 parameter. And that that is what's going to really

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1 drive how much is being held up inside of the reactor  
2 building.

3 And so in order to qualify how  
4 conservative our referenced case was that I used  
5 earlier, we took that nominal best estimate case and  
6 matched the 300 cfm leakage when it leaked out of  
7 wherever it could, and that line is below the  
8 referenced case that I used earlier. So there's some  
9 conservativeness in how we distributed leakage and  
10 how we allowed it to get out into the environment.

11 Additionally, we did a 30 day  
12 calculation. We ran out both the RADTRAD or dose  
13 calculation model and the GOTHIC model after 30 days  
14 to show that the GOTHIC model is always below the  
15 dose calculation model or ratio.

16 And then the staff also asked us to put  
17 it in terms of dose consequence and consequences of  
18 additional holdup, and which we did an equivalent  
19 dose for what the operators would see from the  
20 different perturbations that we used in the nominal  
21 case.

22 And then we also did some dose analysis  
23 for what would happen during the holdup, if you got a  
24 lot of holdup. And, obviously, the dose to the  
25 outside public would be a lot less. The dose to the

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1 operators would be a lot less. And the equipment  
2 inside is still within our EQ limits and we have  
3 ITAACs to confirm all that.

4 CONSULTANT WALLIS: With this constant  
5 leakage rate --

6 MR. BARRETT: Excuse me.

7 CONSULTANT WALLIS: With the constant  
8 leakage rate that you have, 300 cfm, I would think  
9 you could do a very simple hand calculation sort of  
10 an exponential approach to equilibrium which would  
11 come pretty close to some of these code.

12 MR. MARQUINO: For the RADTRAD  
13 calculation, yes, it has a pretty simple model. The  
14 GOTHIC model is a set of lumps and orifices. So it's  
15 a 1D model of --

16 CONSULTANT WALLIS: That they have  
17 combined into some pseudo lump and pseudo orifice.

18 CHAIR CORRADINI: There would be an array  
19 of exponentials?

20 CONSULTANT WALLIS: Yes.

21 CHAIR CORRADINI: Yes. Right.

22 MR. BARRETT: Go on to the next slide.

23 And these are just a summary of the ITAAC  
24 and surveillance requirements that we have in place  
25 right now that specifies when we're testing the

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1 reactor building and to ensure that the as built  
2 design will match what was done in the analyses.

3 Go on to the next slide. Okay.

4 This is the conclusions, and the basic  
5 conclusion is that the analyses of the reactor  
6 building confirms that the mixing volume assumed in  
7 the ESBWR dose analysis is a conservative  
8 characterization of the multi-volume reactor building  
9 that we have and provides the holdup and transport  
10 delay of the radionuclides.

11 CONSULTANT WALLIS: Where does this 300  
12 cfm come from? Is there assumed that all the doors  
13 are closed or all the doors are open, or all the  
14 seals work, or whatever it is --

15 MR. BARRETT: Right. Right. What we  
16 have is a test on our reactor building contaminated  
17 area where we pressurize it and we don't allow it to  
18 go past a certain --

19 CONSULTANT WALLIS: It hasn't been built  
20 yet, so how do you know what 300 cfm -- is 300 cfm a  
21 specification?

22 MR. BARRETT: Yes. It's in ITAAC.

23 CONSULTANT WALLIS: Oh, it's an ITAAC.  
24 Okay.

25 MR. BARRETT: Yes. That's the conclusion

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1 of the presentation. Do you have anymore questions?

2 CHAIR CORRADINI: Now we're going to go  
3 back in space, I'm not sure what, to another topic,  
4 is that correct?

5 MR. BARRETT: Yes. We're going to go to  
6 the control room habitability heat-up analysis

7 CHAIR CORRADINI: All right.

8 MR. BARRETT: We're going to skip the  
9 agenda slide. It kind of tells about, sort of things  
10 like -- we'll just start from the beginning of the  
11 control room heat-analysis.

12 So we did a detailed analysis using  
13 CONTAIN 2.0 of the entire control building, in  
14 particular --

15 CHAIR CORRADINI: So I have a question  
16 immediately.

17 MR. BARRETT: Yes, go ahead.

18 CHAIR CORRADINI: So we've now gone  
19 through MELCOR and now we've gone through GOTHIC and  
20 now we're at CONTAIN. Can you give me some insight?

21 Do you just feel like you want to diverse in all  
22 your applications? What's going on here?

23 Wayne, I'll let you make that answer.

24 MR. MARQUINO: Is your only tool in your  
25 toolbox a home a hammer?

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1 CHAIR CORRADINI: Well if I've got a red  
2 hammer and a green hammer and a blue hammer, unless I  
3 enjoy my color diversity, yes. I mean CONTAIN is no  
4 different, and MELCOR is no different than GOTHIC.  
5 Unless I misunderstand there's some feature. That's  
6 what I was trying to get at. Is there a feature  
7 you're trying to use here that --

8 MR. BARRETT: Well, for the reactor  
9 building mixing issue we used -- GOTHIC has the  
10 ability to do 3D modeling, 2D, 1D and  
11 multidimensional type. It has a more kind of mesh.  
12 And we used some of that for the larger volumes and  
13 for the traversing of the nitrogen throughout the  
14 reactor building.

15 And for this particular analysis when we  
16 first set out, it was an NRC code. We felt like it  
17 was a pretty good code. So we decide to go with it.

18 CHAIR CORRADINI: Okay.

19 MR. BARRETT: And so then we wanted to go  
20 with the simplicity model, so it allowed us to do  
21 that.

22 CHAIR CORRADINI: Okay. Fine.

23 MR. BARRETT: So like I was saying, these  
24 contain 2.0, it includes an entire control building  
25 with emphasis on the control and habitability area.

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1 And so all the rooms are connected to each other.

2 And so all the room-to-room interactions can be seen.

3 And the considerations we used were a loss of off-  
4 site power where normal HVAC is unavailable for  
5 cooling. We have safety related heat loads are always  
6 going. Some of the nonsafety-related heat loads, most  
7 of the major ones, have been de-energized. There's  
8 people, lighting and there's an operation of an  
9 emergency filter unit which supplies unfiltered  
10 outside air -- I mean filtered outside air into the  
11 control room.

12 MEMBER STETKAR: What assumptions did you  
13 make on the nonsafety-related heat loads.

14 MR. BARRETT: Well, we basically came up  
15 with something we might like to have. Like  
16 nonsafety, we don't any unsafety-related.

17 MEMBER STETKAR: No, I understand that.  
18 But in the real world there will be a finite amount  
19 of nonsafety-related heat loads in that building.  
20 And the question I was getting to is are you assuming  
21 that the operators are going to actively shut off any  
22 nonsafety-related heat loads --

23 MR. BARRETT: No. They de-energize  
24 automatically once you get to a certain -- under  
25 certain conditions.

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1 MR. ARCARO: Yes. There's a safety-  
2 related trip on the nonsafety-related heat loads that  
3 are in excess of what's in the heat up analysis.

4 MEMBER STETKAR: You took credit for that  
5 term probably, but you took credit for the full two  
6 hour duration of the nominal life of nonsafety-  
7 related batteries and equipment that will be powered  
8 from it?

9 MR. BARRETT: Yes.

10 MEMBER STETKAR: Okay.

11 MR. ARCARO: And then what's left was,  
12 you know what we need for alarm indication and  
13 running three or four via fuse

14 MR. BARRETT: Right.

15 MEMBER STETKAR: Yes, I just wanted to  
16 make sure you weren't shutting things off that  
17 actively --

18 MR. BARRETT: No. Further what we did  
19 also, like there's a nonsafety room above the control  
20 room habitability area. We actually took that up to  
21 like -- I can't -- something like 60 C and let that  
22 go throughout the entire duration assuming that it's  
23 going to be working some how in order to run those  
24 nonsafety screens in the control room. So that was  
25 an additional conservatism.

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1           They probably -- for whatever reason it  
2 got that hot in those rooms it probably wouldn't work  
3 and we wouldn't have the additional heat load. But  
4 we included that in the model.

5           MEMBER STETKAR: It would be interesting  
6 to see what would happen when whatever is there  
7 doesn't work.

8           MR. MARQUINO: No. But we did make a  
9 revision about a year ago based I&C and Operations  
10 input to accommodate additional nonsafety heat loads  
11 so that they wouldn't have to be shed at times zero.  
12 And that's been factored into the analysis.

13           MEMBER STETKAR: That has? Okay. Good.  
14 Good. Than you.

15           CONSULTANT WALLIS: Now, you talk about  
16 heat loads and there's a lot about heat loads in the  
17 answers to the RAIs. How about water loads? I mean,  
18 you've got 11 people in there at 93 degrees  
19 Fahrenheit.

20           MR. BARRETT: Yes.

21           CONSULTANT WALLIS: Presumably producing  
22 quite a moisture to paper.

23           MR. BARRETT: That's in the analysis as  
24 well.

25           CONSULTANT WALLIS: I didn't see any kind

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1 of water balance in any of your RAI responses.

2 MR. BARRETT: They might not have been in  
3 the RAI responses. Maybe because they didn't request  
4 specifically for what the values were. But they in  
5 fact in the analysis to match up with what the ASHRAE  
6 Fundamentals has suggested for latent and sensible  
7 loads.

8 CONSULTANT WALLIS: And then the outside  
9 conditions, the air which is coming in.

10 MR. BARRETT: Yes.

11 CONSULTANT WALLIS: You seem to have very  
12 low humidity in that air?

13 MR. BARRETT: Right. The outside air  
14 temperature was based off of the worst temperature  
15 ever for all the potential ESBWR sites. And at that  
16 worst temperature --

17 CONSULTANT WALLIS: 117 degrees  
18 Fahrenheit?

19 MR. BARRETT: 117 degrees, we took the  
20 coincidence wet-bulb temperature and figured out what  
21 its corresponding humidity to be.

22 CONSULTANT WALLIS: You took it to be 20  
23 percent humidity.

24 MR. BARRETT: Right.

25 CONSULTANT WALLIS: A wet-bulb

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1 temperature of 63 degrees Fahrenheit. Now that seems  
2 to be awful low for the worst case.

3 MR. BARRETT: It's the worse case --

4 CONSULTANT WALLIS: When we're looking at  
5 cooling towers for another application, they're  
6 assuming the worst case is 86 degrees wet-bulb  
7 temperature. You know, 63 degrees Fahrenheit, 20  
8 percent humidity seems to be very low for a worst  
9 condition, doesn't it?

10 MR. ARCARO: Well, there was some  
11 sensitivity runs, too.

12 MR. BARRETT: Right. We also did an  
13 additional sensitivity run where we did take --

14 CONSULTANT WALLIS: But why did you take  
15 such an optimistic initial case before you'd done any  
16 sensitivity at all?

17 MR. BARRETT: Because, well our  
18 acceptance criteria for heat up was 93 degrees  
19 Fahrenheit. A final temperature of 93 degrees  
20 Fahrenheit. And to get the worst case for getting to  
21 93 degrees Fahrenheit is to have the highest dry-bulb  
22 temperature.

23 CONSULTANT WALLIS: 17 degrees  
24 Fahrenheit?

25 MR. BARRETT: Yes.

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1                   CONSULTANT WALLIS: But that has a  
2 relative humidity of 20 percent.

3                   MR. BARRETT: Right. That's it's  
4 coincidence -- I mean it would be --

5                   CONSULTANT WALLIS: A wet-bulb  
6 temperature of 63 degrees Fahrenheit. That seems to  
7 me to be much too low for a bad humid day in the  
8 worst parts of the nation.

9                   MR. MARQUINO: Antonio explained one  
10 point, which it is a factual temperature, the highest  
11 temperature and a corresponding humidity. And --

12                   CONSULTANT WALLIS: The humidity is just  
13 20 percent?

14                   MR. BARRETT: Yes. Well, as you get to  
15 higher and higher temperature it's harder and harder  
16 to get higher and higher humidity.

17                   CONSULTANT WALLIS: I know. But that's a  
18 wet-bulb temperature of 63 degree Fahrenheit.

19                   MR. BARRETT: Yes, that's based off of  
20 actual data.

21                   CONSULTANT WALLIS: The highest recorded?

22                   MR. BARRETT: Yes.

23                   CONSULTANT WALLIS: It doesn't make  
24 sense.

25                   MR. BARRETT: That's not the highest

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1 recorded humidity or the highest recorded wet-bulb  
2 temperature, but that is the highest recorded  
3 temperature for all the sites, which is the most  
4 limiting for the highest temperature in the control  
5 room.

6 CONSULTANT WALLIS: Okay. Okay. So you  
7 were saying the temperature limits. I was worried  
8 about humidity limit. I think you want to look at  
9 the worst case where they're all evaporating and  
10 there's 90 degrees and they've uncomfortable, how  
11 humidity does it get. And I didn't see that in the--

12 CHAIR CORRADINI: So let me Dr. Wallis'  
13 question differently. So you didn't find it being  
14 limiting to have a lower temperature but a much  
15 higher humidity? That's what I think what he's  
16 asking in a reverse way.

17 MR. BARRETT: Okay. From a maximum  
18 temperature standpoint it's not more limiting. From  
19 a humidity standpoint, obviously to have higher  
20 humidities it would be more limiting. So what we did  
21 do was a sensitivity analysis where we used the zero  
22 percent exceedance wet-bulb temperature at a 100  
23 percent humidity and we did a calculation. And the  
24 temperature was nowhere near as high, however it did  
25 have a high humidity, the temperature was nowhere

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1 near the 93 degree limit.

2 MEMBER STETKAR: How high was it?

3 MR. ARCARO: One of the earlier runs, 96  
4 degree dry-bulb, 100 percent humidity gives 89  
5 degrees at 72 hours.

6 CONSULTANT WALLIS: Well, I am still  
7 puzzled. I'm still puzzled. Because you said the  
8 limit is going to be comfortable is 86 degrees at  
9 wet-bulb temperature.

10 MR. BARRETT: Yes.

11 CONSULTANT WALLIS: Now that can happen  
12 outside.

13 CHAIR CORRADINI: But I think the answer  
14 to your question, his sensitivity they got within a  
15 few degrees of their limit on the same manner.

16 CONSULTANT WALLIS: Oh, you see, if their  
17 limit is 86 degrees Fahrenheit in the control room,  
18 it can be 86 degrees Fahrenheit wet-bulb outside.  
19 And then it comes in, and they evaporate into it, so  
20 it's got to go up. I don't see how you can ever get  
21 down to 86 if it's 786 outside.

22 MR. BARRETT: Get down to it?

23 CONSULTANT WALLIS: It comes in, and they  
24 evaporate into it.

25 MR. BARRETT: Get dow to 86, I'd not

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1 following you.

2 CONSULTANT WALLIS: It doesn't make  
3 sense.

4 MR. McLAMB: I think to clarify here what  
5 you're asking is how can you take hotter air from  
6 outside and at 72 hours after forcing it through the  
7 control room, how is the temperature going to be any  
8 lower than --

9 CONSULTANT WALLIS: How can you take  
10 humidity air from outside and have it come into the  
11 control room and leave no more humidity than it was  
12 when it came in? That doesn't

13 MR. BARRETT: Well, first of all, the  
14 initial conditions of the control room is not going  
15 to be 86/86. It's going to be like 74 max 60  
16 percent.

17 CONSULTANT WALLIS: But after a while --

18 MR. BARRETT: After a while it should  
19 start to come up. But at the end of it, you're not  
20 going to be high. It's not 86 already in the control  
21 room and you're adding more 86, or something like  
22 that.

23 CONSULTANT WALLIS: Well when we analyze  
24 cooling towers we assume it 86 degrees Fahrenheit  
25 wet-bulb temperature in the air outside.

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1 MR. BARRETT: Yes.

2 CONSULTANT WALLIS: And if that comes  
3 into the control room --

4 MR. BARRETT: Yes.

5 CONSULTANT WALLIS: -- the humidity in  
6 there has got to be higher than that because people  
7 are evaporating.

8 MR. BARRETT: The humidity will start to  
9 rise.

10 CONSULTANT WALLIS: Well, it does rise.  
11 It's higher. I think a transient is less important,  
12 after while it's equilibrium. So I couldn't  
13 understand how you get the humidity down to the  
14 desired value. I still don't understand that. But  
15 anyway, go on.

16 CHAIR CORRADINI: But let's just make  
17 sure. You said something in your question that I  
18 want to make sure they agree with.

19 So do you reach an equilibrium quick  
20 enough or are you still coming up into a transient?

21 MR. BARRETT: We're still coming up.  
22 We're still coming up.

23 CHAIR CORRADINI: Anyway, Graham, I think  
24 that's what he's trying to tell you.

25 CONSULTANT WALLIS: Very close, doesn't

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1 it?

2 MR. MARQUINO: Well, we've got a plat  
3 later that shows the daily cycles of temperatures and  
4 how the ---

5 CONSULTANT WALLIS: Like humidity?  
6 Humidity equalizes pretty quickly. Water comes in  
7 and water goes out. It doesn't build up. There's no  
8 walls soaking up humidity. Humidity happens very  
9 quickly.

10 MR. BARRETT: Yes, humidity will be going  
11 up. But it doesn't start -- humidity doesn't start  
12 at 86 percent, 100 percent. I mean, it's going to be  
13 somewhere around I think normal for a ESBWR is 20 to  
14 60 percent. So it will be building up, but it's not  
15 going to get up that high.

16 CONSULTANT WALLIS: Yes. I didn't see a  
17 corresponding build up of humidity, which seemed to  
18 me would happen much quicker. Because the walls are  
19 a heat sink --

20 MR. BARRETT: There is a humidity plot in  
21 the -- well, that one is that the 20 to 40 percent so  
22 it's not going to show you what you want.

23 CONSULTANT WALLIS: Do you know much  
24 people give off in water vapor when they're as  
25 uncomfortable as this in a stress situation?

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1 MR. BARRETT: Could you say that one more  
2 time?

3 MR. MARQUINO: What's the acceptance  
4 criteria --

5 CONSULTANT WALLIS: The heat source,  
6 what's the water source for 11 people in a stress  
7 situation at 93 degrees Fahrenheit? I'd made an  
8 estimate and it seemed to me that it was worth about  
9 10 percent in humidity, but maybe I was wrong.

10 MR. BARRETT: What we use is what ASHRAE  
11 recommended us to use for people giving off moisture.

12 MR. ARCARO: Yes. So a sensible heat of  
13 75 watts and latent heat of 55 watts per person.

14 CONSULTANT WALLIS: That's not water.  
15 Okay. So I won't ask any more questions. I just  
16 didn't see the answer to my question to what I read  
17 about how did they reach buildup, what were the  
18 sources and so on.

19 MR. BARRETT: All right. Go to the next  
20 slide.

21 All right. The rooms of the control  
22 building are modeled as single nodes connected by  
23 concrete. So all the interactions between all the  
24 different rooms can be seen from the nonsafety room  
25 above. Safety room below. All the different heat

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1 transferred.

2 MEMBER ABDEL-KHALIK: How many of these  
3 walls are below grade?

4 MR. BARRETT: The whole entire control  
5 room habitability area is actually below grade.

6 MEMBER ABDEL-KHALIK: How many of those  
7 walls are in contact with the outside world?

8 MR. BARRETT: The outside world, like the  
9 ground? The actual soil?

10 MEMBER ABDEL-KHALIK: Right.

11 MR. BARRETT: The whole back wall is  
12 contact and part of the side walls. So maybe half of  
13 the outside barrier, then we also have some walls  
14 inside as well.

15 MEMBER ABDEL-KHALIK: Is the condition at  
16 that boundary taken in the analysis at all as a  
17 boundary condition?

18 MR. BARRETT: It is. It is on the  
19 outside. But we took a conservative number. We  
20 estimate it to be 86 degrees, although it will be a  
21 lot less than that. The further down you get, the  
22 cooler the ground will be.

23 MEMBER ABDEL-KHALIK: Well, we'll listen  
24 to what you have to say.

25 MR. BARRETT: I see. Okay.

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1 Our design goal for the summer conditions  
2 is a bulk average temperature of 93 degrees  
3 Fahrenheit at the end of 72 hours.

4 Go to the next slide.

5 For major assumptions:

6 The total heat load is 9630 watts which  
7 encompasses all of the heat loads, including a 15  
8 percent margin;

9 The outside air supply -- the outside  
10 temperature is 117 degrees Fahrenheit with a day and  
11 night temperature profile.

12 CONSULTANT WALLIS: At 20 percent  
13 humidity?

14 MR. BARRETT: At 20 percent humidity at  
15 117 degrees and at the lower end I think it's 40 --  
16 40 something percent.

17 CONSULTANT WALLIS: It's not a lot.

18 MR. BARRETT: Right. If the humidity is  
19 higher, the temperature will be lower. Like if you  
20 took the same amount of moisture --

21 CONSULTANT WALLIS: Well I couldn't find  
22 it, because I'm so stupid with a computer, I just try  
23 to see the records for Washington, D.C I think in  
24 Washington, D.C. you get temperatures in the 90s and  
25 wet-bulb temperatures well above what you say you

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1 have here.

2 MR. BARRETT: Right.

3 CONSULTANT WALLIS: So I'd like somebody  
4 to check that. And the staff check it, or somebody  
5 who is smart with a computer can get onto it and  
6 figure what the humidity records are for some humid  
7 places.

8 MEMBER BANERJEE: But what's the issue?  
9 I mean --

10 CONSULTANT WALLIS: My issue is that he's  
11 got a very low humidity air coming in and people are  
12 evaporating. I'm more concerned about the humidity  
13 in the control room. It seems to me --

14 MR. BARRETT: The real question is how  
15 much heat is being added to the overall calculation  
16 from the 117 degree air coming in versus the actual  
17 heat loads in the area.

18 MEMBER STETKAR: And he said well it's  
19 conservative to assume 117 degree dry air coming in  
20 from temperature. But they said it only really makes  
21 like three degrees temperature difference.

22 CONSULTANT WALLIS: But it's the humidity  
23 difference I'm worried about.

24 MEMBER STETKAR: And humidity is a real  
25 concern.

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1                   CONSULTANT WALLIS: It is, yes. So  
2 you're concerned, too?

3                   MEMBER STETKAR: Oh, yes. Well, I'm not  
4 concerned not only for the human beings, but also the  
5 equipment in there that has to operate at a --

6                   CHAIR CORRADINI: John doesn't care about  
7 the human beings. He cares about the equipment.

8                   MEMBER STETKAR: No, I do. I do. Let  
9 them sweat in the dark for 72 hours.

10                  MEMBER BANERJEE: But even in Karachi,  
11 isn't it warm --

12                  CHAIR CORRADINI: Let's keep on going. I  
13 want to get through this. Let's go.

14                  MR. BARRETT: All right. So the concrete  
15 thermal conductivity is listed here. So all the  
16 concrete thermal properties including the density,  
17 thermal conductivity, specific heat are lower than  
18 what the actual design values are.

19                         For, for example, like the concrete  
20 density is about 1900 kilograms per meter cubed when  
21 it's really going to be around 2400 or so. The  
22 initial humidity is 60 percent max and the EFU flow  
23 rate is a flow rate of 508 cfm maximum. The lower  
24 end is 466 cfm.

25                  CHAIR CORRADINI: And just to clarify,

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1 just so that Professor Wallis hears it again, you  
2 suggested that there was another sensitivity you did  
3 which was -- and I don't remember. It was something  
4 0100 percent humidity and an incoming temperature of  
5 what?

6 MR. BARRETT: 88 degrees.

7 CHAIR CORRADINI: Okay. So that's a  
8 sensitivity that essentially takes much lower  
9 temperature but a 100 percent humidity?

10 MR. BARRETT: Right.

11 CHAIR CORRADINI: Okay.

12 CONSULTANT WALLIS: Well, how does it  
13 ever get to a lower humidity than 100 percent?  
14 Because -- how does it get to a lower wet-bulb  
15 temperature than 88 if it's a 100 percent humidity--

16 MR. BARRETT: It's 88 drywell and 100  
17 percent humidity --

18 CONSULTANT WALLIS: How does it ever get  
19 down to 86?

20 MR. BARRETT: What was that?

21  
22 CONSULTANT WALLIS: How was it a 100  
23 percent humidity at 88 degrees and you want a wet-  
24 bulb temperature of 86 degrees for OSHA --

25 MR. BARRETT: When it starts --

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1                   CONSULTANT WALLIS: How do you ever get  
2 the water out to get it down to that lower humidity?

3                   MR. BARRETT: Well, at the end of the 72  
4 hour period it's not up to the 86.

5                   CONSULTANT WALLIS: Humidity transient is  
6 very quick.

7                   MR. MARQUINO: It's mixing in the control  
8 room habitability area.

9                   CONSULTANT WALLIS: The transient is  
10 about the -- just with the air in the control room.  
11 There's no sink in the walls or anything. It's a  
12 very quick transient. And there's no --

13                   MR. BARRETT: You're putting 509 cfm into  
14 a control room that is --

15                   CONSULTANT WALLIS: I figured that out.  
16 Yes. And I figured out how much people would sweat.  
17 And it actually contributes a significant of  
18 moisture to that 500 cfm.

19                   CHAIR CORRADINI: So let's hold the  
20 question. Let them go through the analysis. I just  
21 want to make sure that you have another analysis as a  
22 sensitivity that we can ask about. But let's let you  
23 at least let you go through your basic analysis.

24                   MR. BARRETT: Okay.

25                   MEMBER ABDEL-KHALIK: Now tell me about

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1 the next to last bullet.

2 MR. BARRETT: Okay. The control room  
3 habitability area concrete has been exposed to an air  
4 temperature of 85 degrees F for 8 hours before the  
5 initiation of the transient.

6 MEMBER ABDEL-KHALIK: Now prior to that  
7 point what was the temperature of the concrete across  
8 the entire thickness?

9 MR. BARRETT: 74. It's 74 degrees at the  
10 wall at the surface in the control room habitability  
11 area. And depending upon the temperature on the  
12 opposite side, there's a linear temperature  
13 distribution. And --

14 MEMBER ABDEL-KHALIK: And what was that  
15 temperature?

16 MR. BARRETT: -- for example on the  
17 opposite side, in most cases I think it was 78  
18 degrees.

19 MEMBER ABDEL-KHALIK: The one larger was,  
20 roughly, 74/75 degrees across the entire concrete  
21 wall thickness?

22 MR. BARRETT: Yes.

23 MEMBER ABDEL-KHALIK: Is that a  
24 reasonable thing to assume when there is direct  
25 contact with the outside?

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1 MR. BARRETT: Okay. One other thing that  
2 we did is so we went and we actually set all of the  
3 initial temperatures so if a control room  
4 habitability area is 74 degrees, corridor and normal  
5 conditions are whatever to whatever. So we cited  
6 that one at 78 degrees. We cited it at 78 degrees.  
7 And then we ran the whole entire model for 72 hours,  
8 allowed everything to come into equilibrium including  
9 stuff that's in contact with the outside world, the  
10 outside world being 86 for the soil. So it came to  
11 same equilibrium. And then at that point we exposed  
12 the control room habitability area inside to an 85  
13 degree -- we set all the air temperature to 85  
14 degrees Fahrenheit, exposed it there for eight hours.  
15 And then whatever the resulting concrete  
16 temperatures were at that point, we then started our  
17 transient analysis.

18 MEMBER ABDEL-KHALIK: Well, what's the  
19 logic?

20 MR. MARQUINO: Going back to your  
21 question about the outside temperature and --

22 MEMBER ABDEL-KHALIK: Yes.

23 MR. MARQUINO: -- the ground temperature,  
24 we've also provided the technical specification on  
25 the average concrete temperature so that it will be

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1 monitored and that heat sink will be viable  
2 consistent with our analysis.

3 MR. BARRETT: Right. So if you go  
4 outside of that, you can go into like an LCO for an  
5 eight hour period, so you have eight hours to get the  
6 temperature down. But if you go over 85 degrees,  
7 then the nonsafety systems will start -- everything  
8 will start shutting down. So --

9 MEMBER ABDEL-KHALIK: There is actually a  
10 tech spec on the average concrete wall temperature  
11 for the --

12 MR. BARRETT: Well, it's on the  
13 temperature of the air. So --

14 MEMBER ABDEL-KHALIK: Well, you just said  
15 "the concrete temperature."

16 MR. BARRETT: Yes. It's on the  
17 temperature of the air first, and then once the  
18 temperature of the air -- if the temperature of the  
19 air goes above, say it goes to 75, you then in an  
20 action and then you must get the temperature down  
21 below. And then you must check the concrete barrier  
22 -- the concrete temperatures. Because what you want  
23 to make sure is that you're not over 74 degrees for  
24 the concrete.

25 MEMBER ABDEL-KHALIK: How do people

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1 assure compliance with that tech spec on the concrete  
2 wall temperature? Do you have embedded thermal  
3 couples within the concrete walls to measure concrete  
4 temperature?

5 MR. MARQUINO: Well, there's multiple  
6 ways. We could provide embedded temperatures, as  
7 Antonio said. This is in response to the air  
8 temperature being out of spec. It usually would not  
9 have to be monitored. So it could be simply  
10 temperature -- local temperature measurements that an  
11 auxiliary operator takes in that tech spec condition.

12 MEMBER ABDEL-KHALIK: I'm sorry. How  
13 would an auxiliary operator measure the concrete wall  
14 temperature if part of it was below grade?

15 MR. MARQUINO: They can measure the  
16 interior wall temperature.

17 MEMBER ABDEL-KHALIK: Well, okay. But is  
18 that really our concern in terms of providing  
19 adequate heat sink?

20 MR. ARCARO: I guess that is one method  
21 you could do. But the tech spec basis talks about if  
22 the average of the control room habitability air  
23 temperature exceeds the specified limit, restoration  
24 of the heat sink is verified by administrative  
25 evaluation considering the length in time and extent

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1 of the heat sink average air temperature exclusion,  
2 or by direct measurement of the heat sink material,  
3 structural material temperatures.

4 So based on analysis, based on evaluation  
5 you know how long it takes for the heat sink to heat  
6 up. So that would be your operability. You know, if  
7 you exceed a certain time, then you're outside of  
8 that window.

9 You know, the option is you could  
10 actually go measure the structure and verify that the  
11 concrete temperature is a certain temperature.

12 CHAIR CORRADINI: But when you say  
13 measuring, just to make sure I understand. When you  
14 say measure the concrete temperature, you're implying  
15 measuring the inside temperature? You got a lot of  
16 feet of concrete. You're talking about the inside  
17 wall temperature?

18 MR. WACHOWIAK: This is Rick Wachowiak  
19 from GEH.

20 So your concern seems to be that we  
21 haven't assumed outside temperature of the wall  
22 that's in contact with the ground.

23 MEMBER ABDEL-KHALIK: Well, my concern is  
24 that you're assuming that you have a huge a huge  
25 sink.

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1 MR. WACHOWIAK: Yes.

2 MEMBER ABDEL-KHALIK: And, you know if  
3 this thing is located at a hot location, the ground  
4 temperature may be very high. You have a long summer  
5 period that the below ground part of the concrete may  
6 actually be a lot higher than the assumed 74 to 78  
7 degrees F that you're using in your analysis.

8 MR. WACHOWIAK: Right. So you understand  
9 the question. In our calculation we looked at what  
10 the ground temperature would be so many feet, meters  
11 below ground.

12 MEMBER ABDEL-KHALIK: Right.

13 MR. WACHOWIAK: And then assumed that  
14 that was the outside temperature of the wall. And I  
15 think what your question is, and not about the inside  
16 temperature and those things, is how robust is that  
17 calculation that we did to ensure that that's what  
18 the outside temperature is.

19 MEMBER ABDEL-KHALIK: It's been there for  
20 months.

21 MR. BARRETT: And I guess the -- I looked  
22 at the ASHRAE book for Phoenix at 22 feet, so that  
23 would be the underground portion, and you would be 73  
24 degrees, so it's 86 degrees soil temperature. You  
25 know, the temperature kind of does a thing like that

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1 as you go down in depth. So I'm thinking you got  
2 margins on your 86 degrees.

3 MEMBER ABDEL-KHALIK: What is the ceiling  
4 of the control room relative to grade?

5 MR. ARCARO: It's about grade.

6 MR. BARRETT: Yes, it's about grade.

7 MEMBER ABDEL-KHALIK: Okay. So if you're  
8 taking the value at 22 feet --

9 MR. BARRETT: So you'd be somewhere less  
10 than that.

11 MR. BARRETT: Yes, but we've done 86 for  
12 the entire thing.

13 MEMBER ABDEL-KHALIK: I'm sorry?

14 MR. BARRETT: The soil temperature is  
15 assumed to be 86 degrees.

16 CONSULTANT WALLIS: That's very high for  
17 soil temperature.

18 MR. WACHOWIAK: This is Rick again.

19 So what you're saying is that the value  
20 that we used is robust for the sites that we're  
21 planning on using this plan. The average wall  
22 temperature over that control room habitability area  
23 should be less than what we assumed in the analysis?

24 CONSULTANT WALLIS: Could you clarify  
25 something about the walls? I thought I read in some

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1 of these RAIs that you made some assumption about  
2 half the walls cool down or something or heated up.

3 MR. BARRETT: I did a hand calculation--

4 CONSULTANT WALLIS: That's a hand  
5 calculation. But really it's a transient, isn't it.  
6 And your computer actually does a heat diffusion  
7 through the walls, does it? Does it do that  
8 calculation?

9 MR. BARRETT: Yes. There's like a really  
10 fine mesh. The mesh is finer closer towards the air.

11 CONSULTANT WALLIS: I thought it did,  
12 yes. And you just a check with this half of the wall  
13 thing?

14 MR. BARRETT: Yes, exactly.

15 CONSULTANT KRESS: What does the computer  
16 use for the outside surface of the concrete?

17 MR. WACHOWIAK: What we were just talking  
18 about. In contact with the ground. It's the  
19 boundary condition.

20 MR. BARRETT: We used a boundary  
21 condition that's 86 degrees. It's a huge boundary  
22 condition. It's 86. It's not going to change.

23 MEMBER STETKAR: Antonio, I was just  
24 searching through drawings and I'm coming up empty,  
25 and I have to admit ignorance. Is the control room

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1 habitability area itself in contact with the exterior  
2 soil or is surrounded by other areas of the control  
3 building that contains other equipment and spaces?

4 MR. BARRETT: Yes. Part of it --

5 MEMBER STETKAR: I'm talking laterally.

6 MR. BARRETT: Yes. Yes. So here's the  
7 hallway corridor. So there's no equipment or  
8 anything out there. So it's contained on that side.  
9 And the other side is a thick concrete with soil on  
10 the other side.

11 MEMBER STETKAR: Okay.

12 CHAIR CORRADINI: Okay. So that explains  
13 your answer when you said "half is and half isn't."  
14 So half of it is exposed to a hallway, the other half  
15 is directly onto the soil?

16 MR. BARRETT: Right.

17 CHAIR CORRADINI: Okay. Got it. Thank  
18 you.

19 MEMBER ABDEL-KHALIK: Now, at the end of  
20 that 72 hour when the temperature reaches -- or still  
21 hasn't reached the 93 degree F limit, what is the  
22 average temperature of the concrete?

23 MR. BARRETT: It's less than 93. I don'[t  
24 recall off the top of my head. I would have to get  
25 back to you on that. It's less than 93.

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1 MEMBER ABDEL-KHALIK: I mean, it has to  
2 be. IT's still absorbing heat, I'm guessing that's  
3 what your question is?

4 MEMBER ABDEL-KHALIK: Well, I'm trying to  
5 find out what it is.

6 MR. BARRETT: Well, I would have to get  
7 back to you on that.

8 Next slide.

9 So this is a picture out of DCD. I  
10 didn't include the humidity chart on here. But this  
11 shows the heat up at the control room. The blue line  
12 is the outside air temperature and the red line going  
13 across is the acceptance criteria of 93 degrees  
14 Fahrenheit. And then the other line is the profile  
15 of the heat up of the control rooms.

16 The second note I have down here is that  
17 that corresponds to a maximum wet-bulb temperature of  
18 about 75 degrees Fahrenheit. And the NIOSH  
19 recommendation is about 86 degrees Fahrenheit. So  
20 it's quite lower than that.

21 CONSULTANT WALLIS: Now the external wet-  
22 bulb temperature is higher than that, as it can be.  
23 How can it possibly get down to 75?

24 MR. BARRETT: In this particular case the  
25 outside wet-bulb temperature is not. It's lower than

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1 what's already in the control room.

2 CHAIR CORRADINI: So the next logical  
3 question would be for the sensitivity you quoted, I  
4 guess we'd be interested to see a similar sort of  
5 plot.

6 CONSULTANT WALLIS: For the 88 --

7 CHAIR CORRADINI: For the low temperature  
8 but a 100 percent humidity case. I think that's  
9 where --

10 MR. BARRETT: Okay. So you want to see  
11 something like the wet-bulb temperature --

12 CONSULTANT WALLIS: So 88 degrees  
13 Fahrenheit, 100 percent humidity.

14 MR. BARRETT: That's what the sensitivity  
15 -- I'm not presenting -- that is not --

16 CHAIR CORRADINI: Yes, I understand. But  
17 you have that?

18 MR. BARRETT: We have done that analysis,  
19 yes.

20 CHAIR CORRADINI: Okay.

21 CONSULTANT WALLIS: I would be very  
22 interested to see what you get for a humidity in the  
23 control room.

24 MEMBER ABDEL-KHALIK: Now this graph  
25 shows -- it is not very obvious, but it shows an

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1 initial reduction in the air temperature for a very  
2 short period of time.

3 MR. BARRETT: Yes.

4 MEMBER ABDEL-KHALIK: Where does that  
5 come from?

6 MR. BARRETT: That comes from earlier I  
7 mentioned how I artificially held the control room  
8 habitability area at 85 degrees Fahrenheit for a  
9 period of time, at which the corresponding  
10 temperature of the concrete was at 74 degrees and  
11 started to heat up slowly. So once I stopped  
12 artificially holding the temperature at 85 degrees,  
13 it had a dip of when it starting to absorb that heat,  
14 which is also I did a hand calculation which is also  
15 present in that hand calculation as well. So the  
16 concrete is still much lower.

17 MR. WACHOWIAK: And this is Rick.

18 So the physical phenomena that's  
19 happening there is that if we lose some sort of  
20 cooling in the control room, the temperature can go  
21 up and as we go past 72, that's when we go into the  
22 tech spec action. But the next automatic action that  
23 happens is later at what temperature?

24 MR. ARCARO: Eight-five degrees is where  
25 you trip it.

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1 MR. WACHOWIAK: At 85 degrees we trip off  
2 nonessential or nonnecessary nonsafety-related loads.

3 So the physical phenomena there that happens is we  
4 actually do lose load so that the artificial increase  
5 in temperature is no longer a valid assumption.

6 MR. BARRETT: Right.

7 MR. WACHOWIAK: So there is a physical  
8 meaning to that.

9 MR. ARCARO: At 74 you got a tech spec  
10 limit, 78 you got an alarm, 85 you trip off your  
11 MDCIS to stay within the heat loads of the  
12 calculation.

13 MEMBER STETKAR: So all the MDCIS goes  
14 away?

15 MR. ARCARO: Just your essential,  
16 nonessential MDCIS. You've still got enough to see  
17 your panels.

18 MR. WACHOWIAK: This is Rick again.

19 What we've done in that case is we've  
20 given the I&C system a budget of how many watts are  
21 allowed to be used in the control room following this  
22 limit. And between the I&C group and the HFE group  
23 they're going to decide best to use that budget of  
24 heat load for nonsafety-related equipment that stays  
25 on.

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1                   CONSULTANT WALLIS: These 11 people are  
2 in this room for three days?

3                   MS. CUBBAGE: It's eight hours. They  
4 have shifts.

5                   CONSULTANT WALLIS: They're coming out?

6                   CHAIR CORRADINI: They're allowed to go  
7 out and get another group.

8                   MS. CUBBAGE: Oh.

9                   MR. BARRETT: Go to the next slide.

10                   And the staff also requested that we did  
11 do a winter conditions analysis. So we did an  
12 evaluation of that analysis. And we used the code  
13 ECOSIM. And the ECOSIM --

14                   CHAIR CORRADINI: I'm not going to ask  
15 that question.

16                   MR. BARRETT: Yes.

17                   CHAIR CORRADINI: Go ahead. I just think  
18 you guys are equal opportunity employers.  
19 Everybody's doing -- you're using everybody's tools.

20                   MEMBER ARMIJO: Was there something  
21 special about ECOSIM compared to --

22                   MR. BARRETT: Yes. The CONTAIN code had  
23 some limitations as far as going down to as low as we  
24 wanted to go, the negative 40 degrees. So we used  
25 ECOSIM. And in order to validate ECOSIM what we did

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1 is we reproduced the CONTAIN model and did the exact  
2 same model and got the same results, so we used --

3 MEMBER ABDEL-KHALIK: For the high  
4 temperature.

5 MR. BARRETT: Yes, for the high  
6 temperature.

7 CONSULTANT WALLIS: For the winter you  
8 have very cold air coming in?

9 MR. BARRETT: That's correct.

10 CONSULTANT WALLIS: How about snow and  
11 ice, doesn't that -- and ice formation would block  
12 off the air flow, or what happens to ice crystals  
13 that come in the filter and so on?

14 MR. ARCARO: For RTNSS and safety systems  
15 you have defectors and --

16 CONSULTANT WALLIS: But the filters,  
17 don't it just snow. The air intakes, don't it just  
18 snow?

19 MR. ARCARO: They're protected from snow.

20 CONSULTANT WALLIS: But the snow is in  
21 suspension. Small snow particles blow about and  
22 they're often -- you know, they get around obstacles.

23 MR. MARQUINO: So your concern is that  
24 the snow will come in and then melt and then --

25 CONSULTANT WALLIS: I don't know. It

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1 might block up the filters at the inlet, don't you?

2 MR. ARCARO: Well, you have a fan and  
3 then you got a prefilter. You've got a stage of  
4 filters.

5 CONSULTANT WALLIS: I know that the Army  
6 put filters on people who were going out in the snow  
7 exercising. And some of them had very bad effects  
8 because filters clogged up with ice. And they  
9 couldn't breath.

10 MS. CUBBAGE: This issue wouldn't be  
11 unique to ESBWR, would it?

12 CONSULTANT WALLIS: No, it wouldn't be  
13 unique. But I just wondered what they do with the--

14 MS. CUBBAGE: So I think plants are out  
15 there operating with snow.

16 CONSULTANT WALLIS: Yes.

17 MR. BARRETT: Okay.

18 MEMBER ABDEL-KHALIK: If I may just go  
19 back to the summer analysis, if you don't mind?

20 MR. BARRETT: Yes.

21 MEMBER ABDEL-KHALIK: You have a heat  
22 load of roughly 9.6 kilowatts.

23 MR. BARRETT: Yes.

24 MEMBER ABDEL-KHALIK: And the temperature  
25 of the air is continually increasing over a 72 hour

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1 period. That sort of tells me that the heat transfer  
2 rate from the control room to the containment is less  
3 than 9.6 kilowatts. Is that true or is the increase  
4 primarily because of infiltration of hot air?

5 MR. BARRETT: It comes from both. So  
6 it's less than both combined.

7 MEMBER ABDEL-KHALIK: So roughly what is  
8 the heat transfer rate -- what is the relative  
9 contribution to this increase? Can you tell me what  
10 the heat transfer from the control room air to the  
11 containment is at the beginning and end of this  
12 period?

13 MR. BARRETT: I could tell you --

14 MEMBER ABDEL-KHALIK: Probably at the end  
15 of this period would be the highest value?

16 MR. BARRETT: I think the highest value  
17 would probably be at the beginning. Because well,  
18 number one, the outside air temperature difference  
19 between the outside air temperature and the control  
20 room temperature is the highest. And then you have  
21 the additional heat load.

22 MEMBER ABDEL-KHALIK: But if you're  
23 starting with room temperature roughly 74 and the  
24 wall temperature is roughly 74?

25 MR. BARRETT: Well, it's not. The air

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1 temperature is starting at 84.

2 MEMBER ABDEL-KHALIK: Okay. Okay. So  
3 what is the highest heat transfer rate from the  
4 control room air to the containment wall?

5 MR. BARRETT: I'm not sure. I'll have to  
6 get back to you on that. I'd have to look it up in  
7 the analysis. But I could let you know later.

8 MEMBER ABDEL-KHALIK: All right. Thank  
9 you.

10 MR. BARRETT: Okay. Our design  
11 temperature for the bulk average air temperature if  
12 55 degrees Fahrenheit for the winter conditions.

13 You can go to the next slide.

14 And the winter conditions model is  
15 similar to the summer conditions models except that  
16 it has much lower heat loads, much lower initial  
17 temperatures and a lower EFU air supply temperature,  
18 which is the negative 40 degrees. All the concrete  
19 dimensions and thermal properties are the same.

20 CONSULTANT WALLIS: And the initial  
21 temperature of the ground?

22 MR. BARRETT: In this particular model  
23 the initial temperature ground is much lower. We  
24 actually didn't use the ground as any sort of heat--

25 CONSULTANT WALLIS: And the initial

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1 temperature of the concrete, though, is the --  
2 something in between the temperature of the control  
3 room and the ground, isn't it? A gradient wind stay  
4 state?

5 MR. BARRETT: Yes, that's correct.

6 And for this analysis I'm trying -- yes,  
7 we used 65 degrees for the temperature of what the  
8 ground would be. But the ground is actually not  
9 going to provide any additional heating.

10 CONSULTANT WALLIS: The ground is a lot  
11 colder than that?

12 MR. BARRETT: Yes.

13 MR. ARCARO: Yes, 60 degrees.

14 MR. BARRETT: About 60 degrees. Thank  
15 you.

16 CONSULTANT WALLIS: In northern New  
17 England the ground temperature pretty well year round  
18 when you get down a few feet is around 45 degrees.

19 MR. BARRETT: Right. So, I mean, it  
20 would act as a heat source at 60.

21 CONSULTANT WALLIS: A cold source.

22 MR. BARRETT: Yes. A cold source. Yes.

23 So, at the end of the analysis it was  
24 above, it remained above 55 degrees.

25 Can we go to the next slide.

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1                   So we did several alternate calculations  
2 at the request of the staff for the containment  
3 analysis.

4                   We used GOTHIC 7.2a to get a more  
5 detailed analysis, 3D modeling of the control room  
6 habitability area.

7                   CHAIR CORRADINI: What do you mean by  
8 that? You used the lump parameter version of GOTHIC?  
9 You didn't use the distributive parameter version?

10                  MR. BARRETT: We used the lump parameter  
11 version of CONTAIN for the heat up analysis.

12                  CHAIR CORRADINI: Okay.

13                  MR. BARRETT: And then we used the 3D  
14 modeling for an alternate calculation where we  
15 subdivided the control room into multiple nodes.

16                  CHAIR CORRADINI: But when you say  
17 multiple nodes, I'm just to make sure I understand.  
18 GOTHIC has two methods of application. One is to  
19 essentially solve the Navier-Stokes and one  
20 essentially just break up volumes into subvolumes but  
21 it's still lumps.

22                  MR. BARRETT: Yes, it breaks up the  
23 volumes and the subvolumes.

24                  CHAIR CORRADINI: Okay. Fine. All  
25 right. Thank you.

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1 MR. BARRETT: So where you get to see all  
2 the different flows and all the different aspects  
3 that are going inside the model.

4 CHAIR CORRADINI: Okay.

5 MR. BARRETT: And we did this model, and  
6 it confirms the CONTAIN model that was done where the  
7 operators are in the subdivided nodes, where the  
8 operators were it remained below 93 degrees. I think  
9 below six foot six. But there is a temperature  
10 gradient within the main control room and the other  
11 rooms.

12 Second, as I mentioned earlier, we did  
13 the ECOSIM model where we took the exact same model,  
14 modeling it again in ECOSIM and the numbers were the  
15 same. So that gives us a higher confidence that the  
16 modeling was done correcting.

17 MEMBER ABDEL-KHALIK: So in this sort of  
18 3D modeling do you know the locations of the heat  
19 sources within the control room?

20 MR. BARRETT: We didn't know the actual  
21 specific locations, but we made some assumptions  
22 based off of, like, where panels are, where panels  
23 are located and we used, like, okay this is  
24 particular position is where the wide display panel  
25 would be. So we're going to use that as a primary

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1 where most of it would come from. Then a BEU may be  
2 down in this particular part of the control room. So  
3 we'll use that particular node for additional heat  
4 loading.

5 MEMBER ABDEL-KHALIK: So this sort of  
6 just allows you to live with higher temperatures due  
7 to stratification?

8 MR. MARQUINO: The operators are assumed  
9 to be standing on the floor. So we established this  
10 two meter elevation as where we were monitoring the  
11 temperatures against the 93 F criteria. And we  
12 didn't look at temperatures in the false ceiling at  
13 the top, which would be higher.

14 MEMBER ABDEL-KHALIK: You did or did not?

15 MR. MARQUINO: Well, the code calculates  
16 those temperatures, but we don't have any acceptance  
17 criteria for them.

18 CHAIR CORRADINI: He's saying that --

19 MEMBER ABDEL-KHALIK: I mean, is it  
20 really reasonable to assume that the air in the  
21 control room will be stratified in these nice layers  
22 and you don't have to worry about anything above two  
23 meters?

24 MR. BARRETT: Well, yes. Well, there's a  
25 temperature gradient, but it's not like if you go up

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1 an extra foot it's going to be, you know, a 100 and  
2 some degrees. It's only going to be like 93.1  
3 degrees or something like that.

4 MEMBER ABDEL-KHALIK: I mean, don't you  
5 think with people moving around that there's enough  
6 mixing that any assumptions you make about  
7 stratification would be sort of just assumptions?

8 MR. BARRETT: Yes. Well, I mean, we're  
9 going by what the code calculated as far as its  
10 temperature gradient. We didn't artificially make it  
11 have this stratification. So, I mean, if you have a  
12 room and you have stratification, there's going to be  
13 higher temperatures at the top and cooler  
14 temperatures at the bottom.

15 MEMBER ABDEL-KHALIK: Provided you don't  
16 have people walking around all over the place mixing  
17 it up.

18 MR. BARRETT: Right, right.

19 Our criteria is an average temperature.  
20 We're not -- it was not like a point temperature at  
21 this point or at that point. It's supposed to be an  
22 average temperature rise over the entire thermal  
23 area. So by that respect, I mean it seems to be well  
24 within what we've looked at.

25 MEMBER STETKAR: Antonio --

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1 MR. BARRETT: Yes.

2 MEMBER STETKAR: -- on that point,  
3 eventually we're going to get to this picture, I  
4 hope.

5 But since you brought up the average  
6 temperature, did you do anything about trying to  
7 calculate temperatures inside those cabinets where  
8 equipment lives, specifically solid state electronic  
9 digital equipment that really doesn't like to get  
10 warm and not a primary heat source for this room?

11 MR. BARRETT: Right. We did not look for  
12 that specifically. And I think it's going to be  
13 handled separately from this particular evaluation.

14 MR. WACHOWIAK: This is Rick --

15 MEMBER STETKAR: How is it going to be  
16 handled separately from this particular evaluation?

17 MR. McLAMB: You're talking about  
18 equipment qualification. And this evaluation can be  
19 used to provide temperatures outside of the cabinets.

20 The purpose was not to calculate temperatures inside  
21 the cabinets.

22 MEMBER STETKAR: This can be used to  
23 calculate a bulk fluid temperature in the room which  
24 doesn't necessarily even mean the temperature  
25 immediately outside the cabinets, does it?

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1 CHAIR CORRADINI: No, I think that would  
2 be -- at least that's the way I interpreted what you  
3 just said, is you're going to use this as a boundary  
4 condition for the bulk, but you're going to do a  
5 separate analysis for the equipment qualification?

6 MR. McLAMB: Right. This goes beyond the  
7 level of detail that Antonio performed in his  
8 analysis. He's worried about people being  
9 overheated.

10 CHAIR CORRADINI: Okay.

11 MR. WACHOWIAK: This is Rick Wachowiak,  
12 GEH.

13 So just to be clear on this, our  
14 equipment is subject to -- digital equipment in a  
15 mild environment, it's subject to an EQ program. The  
16 components inside the cabinet will be tested as a  
17 unit as part of the EQ program with ambient  
18 temperatures outside the cabinet much higher than  
19 what we're allowing in the control room. So the  
20 equipment inside the cabinet will be tested as part  
21 of the -- qualified as part of the EQ program to much  
22 higher temperatures than what we'll see in the  
23 control room.

24 There are other rooms where we challenge  
25 that limit more closely. But the control room is not

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1 one of them.

2 CHAIR CORRADINI: Okay.

3 MR. McKIRGAN: I'm sorry, if I could just  
4 -- this is John McKirgan.

5 The staff has also issued an RAI on this.  
6 So I think we'll be seeing additional information on  
7 that.

8 CHAIR CORRADINI: Okay.

9 MR. BARRETT: And so additionally, our  
10 First Principles hand calculation was performed, as I  
11 mentioned earlier where we took into account heat  
12 transfer, heat transfer from the air, equipment and  
13 into the concrete walls. And it is relatively close  
14 to what was calculated in the CONTAIN analysis with  
15 being below 93 degrees.

16 Go to the next slide.

17 CONSULTANT KRESS: Is that a transient  
18 calculation?

19 MR. BARRETT: Yes. There was a --

20 CONSULTANT WALLIS: The hand calculation  
21 isn't a transient, is it?

22 MR. BARRETT: It is a transient  
23 calculation.

24 CONSULTANT WALLIS: And you have all  
25 sorts of little nodes in the wall?

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1 MR. BARRETT: Yes. Well, no, no --

2 CONSULTANT WALLIS: To an average or--

3 MR. BARRETT: Yes. I think Thomas  
4 alluded to it earlier. I used like half the -- yes.  
5 Because that would have been a lot of --

6 CONSULTANT WALLIS: Just the same as the  
7 transient where the normal way it penetrates the  
8 wall.

9 MR. BARRETT: Okay. And some of the  
10 sensitivity analysis that we did were the zero  
11 percent Exceedance Wet-bulb, EFU outside air  
12 temperature. That was the 100 percent humidity case  
13 and where we do get a temperature, I think, around 89  
14 degrees which is much lower than the 90 degree limit.  
15 Possibly higher humidity.

16 Lower EFU air temperature where we went  
17 out and ran case where one day at 117 degrees and the  
18 next day at the one percent exceedance, which I think  
19 was around 100 degrees. And we got like a two degree  
20 additional margin from doing that.

21 And we varied the EFU flow rate which we  
22 saw almost no sensitivity, a very, very small  
23 sensitivity.

24 We varied the heat load, and I think it  
25 was approximately 700 watts. We'll get an extra

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1 degree.

2 And then we varied the temperature  
3 profile where we saw a small sensitivity to that.

4 CHAIR CORRADINI: So all of these  
5 sensitivities, which one -- I'm trying to get a  
6 feeling for which one challenged the --

7 MR. BARRETT: The main ones, I would say,  
8 was like the heat load. So I mean if we put twice as  
9 much equipment in there, it's not going to be that  
10 great.

11 The outside air temperature if you  
12 increase it much past 117, if you put like 10 extra  
13 degrees, that's going to have a large effect.

14 Other than that, the rest of them didn't  
15 show too much sensitivity.

16 MR. ARCARO: Well, the other side of the  
17 outside air temperature, we assumed a continuous  
18 cycle at 117 degrees, whereas you know ultimate heat  
19 sink sort of calculations allows you to use that as a  
20 historic peak. So if you do one cycle at 117 and  
21 then you use your one percent exceedance for the  
22 other values, you get quite a reduction in  
23 temperature.

24 CHAIR CORRADINI: So I guess that was  
25 something -- right. I guess that was something I

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1 didn't understand when you did this. So in assuming  
2 the external value you are directed by ASHRAE to once  
3 you have that maximum, to continue the cycle at that  
4 maximum?

5 MR. BARRETT: No, no. We did that as a  
6 level of conservatism.

7 CHAIR CORRADINI: Okay. So the ASHRAE  
8 guidance would be to essentially look at one really  
9 bad day and other days around it closer to the  
10 average day in that location, in that geographic  
11 location? That's what I'm trying to understand?

12 MR. BARRETT: Yes. Well, yes, you would  
13 have the one peak. After that I'm not sure -- I don't  
14 think it says that you're supposed to use average for  
15 those days.

16 CHAIR CORRADINI: I understand. But you  
17 don't use the same cyclical peak?

18 MR. BARRETT: Right. You don't use that  
19 same peak.

20 MR. ARCARO: I think we're using the  
21 worst case, URD ASHRAE temperature that we'll find in  
22 combination of dry-bulb/wet-bulb and we're using it,  
23 you know, for three cycles. So there's certainly  
24 margin there.

25 CHAIR CORRADINI: Okay. Thank you.

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1                   CONSULTANT WALLIS: Now these air  
2 supplies produce a pressure of about an eighth of an  
3 inch of water or something like that?

4                   MR. BARRETT: Yes.

5                   CONSULTANT WALLIS: What happens if  
6 there's a strong wind blowing outside? I mean you  
7 had another analysis for another building. Does that  
8 affect the flow of the air that's ventilating this  
9 control room?

10                  MR. BARRETT: Well, the EFU supplies a  
11 particular volumetric flow rate into the control  
12 room, so --

13                  CONSULTANT WALLIS: But I'm saying if the  
14 wind is blowing so that it comes in on one side and  
15 goes out the other, or does it come in? Does it come  
16 in -- the wind is blowing in an adverse direction,  
17 does it change the flow rate through the ventilation  
18 system?

19                  MR. BARRETT: The way that the analysis  
20 was done is that e did it at a constant flow rate in  
21 and a constant flow rate out.

22                  CONSULTANT WALLIS: But then when you did  
23 a building in your previous talk you said that the  
24 wind wa causing a flow through the building. And I  
25 just wonder if --

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1 MR. BARRETT: Yes, we have like a fan.  
2 We have a fan. In the building we don't have  
3 anything that's --

4 CONSULTANT WALLIS: Yes, but the wind's  
5 the fan in the building?

6 MR. BARRETT: Right.

7 CONSULTANT WALLIS: In this case there is  
8 not a fan.

9 MR. BARRETT: And so therefore it would  
10 be changing with the wind.

11 CONSULTANT WALLIS: The wind is not a  
12 fan?

13 MR. BARRETT: Right, it is a fan.

14 CHAIR CORRADINI: I think we're talking  
15 about two different buildings. Let's make sure we're  
16 clear.

17 CONSULTANT WALLIS: Yes, I know that.

18 CHAIR CORRADINI: Okay.

19 CONSULTANT WALLIS: I'm just saying in  
20 one case you consider the wind to be a fan, and this  
21 case the wind oppose the fan if its blowing the wrong  
22 way, couldn't it?

23 MR. ARCARO: Well, I guess the basic  
24 model is you take outside air, it's got a deflector,  
25 a missile shield, it's going to take outside air.

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1 It's going to run it through the control room using  
2 the EFUs. It's going to discharge through an orifice  
3 device inside the building. I guess you could get  
4 perturbations in pressure due to wind.

5 CONSULTANT WALLIS: If the wind is  
6 driving flow rate -- if the first building --

7 MR. BARRETT: I guess, what is your  
8 overall question?

9 CONSULTANT WALLIS: Well, when you did  
10 the first building, the reactor building, you said  
11 the wind creates flows through the rooms in the  
12 building, right, because it changed the pressure  
13 between the rooms and causes flow.

14 If the wind does the same thing with the  
15 control room, and that presumably is superimposed on  
16 whatever your fan is doing.

17 CHAIR CORRADINI: So to ask the question  
18 differently, is have you looked at a pressure  
19 variation about the supply of the fan and how that  
20 would change the flow? I think that's what Graham is  
21 asking.

22 MR. BARRETT: Yes, it has a very small  
23 impact on the analysis variation on the pressure.

24 CONSULTANT WALLIS: That is pretty weak.  
25 It's only an eighth of an inch water gauge that you

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1 were talking about. And in the case of -- that's  
2 only 20 feet a second. If you had a wind outside of  
3 60 miles an hour.

4 MR. BARRETT: When we looked at varying  
5 the pressure in the control room, it had very little  
6 sensitivity on the heat up analysis.

7 MR. WACHOWIAK: This is Rick Wachowiak  
8 from GEH.

9 I had a talk with our HVAC engineer about  
10 this particular question. And he said that during  
11 the detailed design we can place the exhaust orifice  
12 and the intakes for the fans in such a way that it  
13 would minimize the effect of wind coming at the  
14 building from different directions deriving flow  
15 through that.

16 So for example if we had the exhaust and  
17 the fans both on the same side of the building, then  
18 effect cancels itself out. But that's a detail  
19 design consideration and he's already considering it.

20 CONSULTANT WALLIS: But then, as we have  
21 discussed many times, the devil is always in the  
22 details.

23 MR. WACHOWIAK: Right. And once again,  
24 we have to remember with this control room that the  
25 500 or so cfm, it is the normal flow into the control

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1 room through the HVAC system. There's recirculation  
2 fans within the control room, but the normal supply  
3 and exhaust is still through this same orifice and  
4 it's still the same amount. So, if that was going to  
5 be a consideration, we would see it during normal  
6 operation too. So it's something that would be  
7 continuously monitored, if you will. But that's the  
8 intent is to minimize that effect.

9 CONSULTANT WALLIS: It's designed in a  
10 way so that the wind does not affect the ventilation?

11 MR. WACHOWIAK: That's correct.

12 MEMBER ABDEL-KHALIK: Now in this  
13 sensitivity analysis what was the parameter range for  
14 this flow rate?

15 MR. BARRETT: 466 to 509.

16 MEMBER ABDEL-KHALIK: 466 to 509?

17 MR. BARRETT: 466 being the minimum, 509  
18 being the max.

19 MEMBER ABDEL-KHALIK: That's a very  
20 narrow range even for a sensitivity analysis.

21 MR. BARRETT: Well, that's the range of  
22 what we expect the fan to be.

23 CHAIR CORRADINI: Based on fan  
24 performance, is that what you're saying?

25 MR. BARRETT: I believe that's right.

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1 MR. ARCARO: Yes, and nominal minimal  
2 value for the fan is 466. And the analysis was done  
3 higher than that because of the effects of, you know,  
4 the high temperature.

5 MR. BARRETT: Next slide.

6 All right. This shows some of ITAAC and  
7 surveillance requirements that we have in place right  
8 now.

9 CONSULTANT WALLIS: Excuse me. Cfm is a  
10 bit difficult for an air fan because the density of  
11 the air just for barometric pressure variation can  
12 vary, not in extreme cases, something like 10  
13 percent. So the mass of air that's involved depends  
14 upon barometric pressures. Cfm is a funny variable.  
15 I mean, other than to do with maps or something like  
16 that.

17 This is a cfm at some condition. Some  
18 barometric condition which is unspecified.

19 MR. ARCARO: I think that there's an  
20 ITAAC for performance that talks about the flow rate  
21 at a pressure.

22 CONSULTANT WALLIS: A given barometric  
23 condition, yes. Must be.

24 MR. ARCARO: Yes, tested air and filtered  
25 air supply shall be reduced below the required 466

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1 cfm when the control room habitability area is  
2 isolated and being maintained at a positive pressure  
3 of .125 inches water gauge with respect to the  
4 surrounding areas.

5 CONSULTANT WALLIS: Yes, but I'm saying  
6 466 cfm if the air is at 40 degrees Fahrenheit and  
7 the barometric pressure is high, then you can get a  
8 ten percent difference in density than if it's a hot  
9 day with a low pressure.

10 So this difference between 466 and 500 is  
11 about in the uncertainty and what you mean by 1 cfm.

12 MR. ARCARO: And I think that the way the  
13 existing plants do surveillance is they normalize it.

14 They do the standard cubic feet and they take into  
15 account the --

16 CONSULTANT WALLIS: The standard cubic  
17 feet or 20 degrees --

18 MR. TILLS:

19 MR. ARCARO: The STP, right.

20 CONSULTANT WALLIS: It's never clear to  
21 me what you mean by a cfm.

22 MEMBER ABDEL-KHALIK: IS the 409 a SDP or  
23 is at the actual conditions?

24 MR. BARRETT: It's at the actual  
25 conditions.

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1 MEMBER ABDEL-KHALIK: Okay.

2 CONSULTANT WALLIS: The coming in  
3 conditions, yes.

4 MR. BARRETT: It's set at 509, 117, 100,  
5 whatever it is.

6 Okay. And we've gotten some RAIs from  
7 the staff discussing different clarifications or  
8 descriptions into the surveillance requirements  
9 required.

10 CONSULTANT WALLIS: Eighty feet a second  
11 was clarified. Eighty feet a second was clarified.

12 MR. BARRETT: Yes, it was.

13 CONSULTANT WALLIS: And it now seems to  
14 be something more like 20 feet a second? If I'm  
15 right on that one eighth water gauge is.

16 MR. ARCARO: We had a typo in one of the  
17 responses, one of the RAI responses. It was coming  
18 in at 80 feet a second.

19 CONSULTANT WALLIS: But now it's  
20 something like 20 feet a second, is that right?

21 MR. ARCARO: I'm thinking that -- was  
22 asking about the distribution inside the control  
23 room. So how do you get through --

24 CONSULTANT WALLIS: But you claimed its  
25 well mixed because you got 80 feet per second going

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1 in.

2 MR. ARCARO: Well, and we increased that  
3 to 800 feet per second or some value that is more  
4 reflective of the ASHRAE requirements for a defuser.

5 CONSULTANT WALLIS: 800 feet per minute,  
6 15 feet a second. Okay.

7 So 13 feet a second, this amount of air,  
8 is much more stirring than just people walking  
9 around?

10 MR. BARRETT: Right.

11 CONSULTANT WALLIS: And you say the  
12 location and configuration of supply registers will  
13 be optimized to distribute and mix the air. So is  
14 someone going to check then that it does do that? Is  
15 there an ITAAC?

16 MR. ARCARO: There is ITAACs for heat  
17 removal.

18 CONSULTANT WALLIS: So again, I've  
19 learned there's always a devil in the details. And  
20 is somebody going to check that you really do mix the  
21 air? Is there some sort of an ITAAC?

22 MR. ARCARO: There is an ITAAC.

23 MR. MARQUINO: Well, the staff has  
24 requested us to reflect some additional details of  
25 these analyses in the DCD or in LTR so that the as-

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1 built design can be checked against it and to clarify

2 --

3 CONSULTANT WALLIS: You aren't going to  
4 build a louver just behind a piece of equipment so  
5 that it doesn't mix? Or blow the air in just behind  
6 a piece of equipment, all that?

7 MR. MARQUINO: No. And they've also  
8 asked how we'll assure that people don't put up wall  
9 hangings in the offices that prevent heat transfer to  
10 the --

11 CONSULTANT WALLIS: Or the carpet on top  
12 of a floor register or something?

13 MR. MARQUINO: Yes.

14 MR. WACHOWIAK: This is Rick again.

15 So to try to get it back into this  
16 question about some of the mixing, on slide 14 you  
17 show the flow rates

18 CHAIR CORRADINI: Are we at that slide?

19 MR. WACHOWIAK: Can you describe the  
20 magnitude of the flow through the floor versus the  
21 magnitude of the flow through the in-registers,  
22 supply registers?

23 CHAIR CORRADINI: Are we at this slide  
24 naturally? Because I was waiting to get to this one.

25 MR. McLAMB: We skipped a couple.

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1                   CONSULTANT WALLIS:  So it goes out  
2 through that little hole near the floor?  The air  
3 goes out through that little white hole in the floor.

4                   MEMBER STETKAR:  Why don't we just to  
5 that slide.  Because otherwise we're not going to get  
6 to -- all they have is presentations of what they're  
7 going to do.  This is the key of the whole analysis.

8                   Let me ask it, from what I read, you're  
9 taking credit for the fact that those exterior  
10 surrounding rooms are unoccupied and have zero heat  
11 sources in them, right?  Those rooms -- the control  
12 room is the thing where you have the little  
13 mannequins seated and the exterior rooms are rooms  
14 like offices and toilets and a hallway, and things  
15 like that that have no heat sources in them, is that  
16 correct?

17                   MR. BARRETT:  That's correct.

18                   MEMBER STETKAR:  Okay.  So you get a good  
19 convective heat flow.  Without that convective hat  
20 flow you lose.  The walls that you show between the  
21 control room and those exterior rooms on this cartoon  
22 seem to end at the raised floor.  So you get a good  
23 convective heat flow below that raised floor?

24                   MR. BARRETT:  No, they --

25                   MEMBER STETKAR:  They don't really do

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1 that, do they?

2 MR. BARRETT: No. They continue --

3 MEMBER STETKAR: They're solid concrete  
4 walls?

5 MR. BARRETT: Right.

6 MEMBER STETKAR: How do you get the heat  
7 flow through those -- the convective air flow through  
8 those walls?

9 MR. BARRETT: There's openings in between  
10 all the walls.

11 CHAIR CORRADINI: I'm not sure what  
12 you're talking about.

13 MEMBER STETKAR: On the drawing here if  
14 you look, there's a big concrete slab to the left.  
15 You move to the right of that, you see a vertical  
16 line.

17 CHAIR CORRADINI: Right.

18 MEMBER STETKAR: That's a wall.

19 CHAIR CORRADINI: Right.

20 MEMBER STETKAR: Now that wall on the  
21 drawing here ends at that dashed line that's a raised  
22 floor.

23 CHAIR CORRADINI: Oh, I see your point.

24 MEMBER STETKAR: So there's a good flow  
25 coming -- circulating very, very well.

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1 CHAIR CORRADINI: So there's vents or  
2 connections even though the wall goes on through --

3 MEMBER STETKAR: Sold concrete walls.

4 MR. BARRETT: So, yes, it should have  
5 like a line continuing with some holes in it. There  
6 are holes within. So that all the rooms can  
7 communicate with each other.

8 MEMBER STETKAR: Is there confidence that  
9 those holes are big enough?

10 CHAIR CORRADINI: What are you asking?  
11 Are you asking --

12 MEMBER STETKAR: I'm asking if there's  
13 good confidence that the holes are big enough?

14 CHAIR CORRADINI: They haven't designed  
15 it yet.

16 MEMBER STETKAR: Okay.

17 CHAIR CORRADINI: Is that a fair guess?

18 MR. BARRETT: Yes, I would say it's fair.

19 CHAIR CORRADINI: Okay.

20 CONSULTANT WALLIS: Well I guess what  
21 we're getting here is what we've had throughout this  
22 while ESBWR review is until you look at the details,  
23 like where does the wall really go assumptions about  
24 mixing and circulation and so on are just very  
25 theoretical. And you have to really look at the

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1 details and see if it will do what you modeled. And  
2 I've had trouble with so many things. You know,  
3 until we know the details of the drain pan or  
4 something, we don't really know what happens in it.  
5 So I think we may need to go further than just a  
6 cartoon and have something like a real drawing of  
7 what it's going to be like.

8           Maybe in the DCD, is there a real drawing  
9 of this that we can use?

10           MEMBER STETKAR: Not very well.

11           CONSULTANT WALLIS: Not very well, no.

12           MR. BARRETT: I think we've been  
13 requested to put a drawing into the DCD and I think  
14 we've agreed to do that. So we're going to look at  
15 putting some more of those details into the DCD.

16           CHAIR CORRADINI: So this is a work in  
17 progress relative to open our eyes? I guess that's  
18 what I wanted to end with on this. This is going to  
19 end up a design drawing from the control room  
20 envelop? That's what I thought I heard you just say.

21           MR. ARCARO: Yes. We do have an RAI  
22 that's specifically asked to put this level of detail  
23 in the DCD.

24           CHAIR CORRADINI: Okay.

25           MEMBER ARMIJO: I had a question. Is

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1 there a significant heat load in this Q-DCIS room  
2 that are beneath the control room, and have you taken  
3 that into account in order to calculate?

4 MR. BARRETT: Yes. Yes. We have taken  
5 that heat load into account. So that room-to-room  
6 interaction, the heat coming up from the floor, is  
7 taken into account.

8 MEMBER STETKAR: Do you have any idea  
9 what the temperatures are in those Q-DCIS rooms?  
10 Because they're a separate ventilation --

11 MR. BARRETT: Yes, it's in the DCD. I  
12 can't remember the value off the top of my head, but  
13 it is in there.

14 MR. WACHOWIAK: So in the GOTHIC model  
15 did we model a flow resistance in the subfloor area  
16 between the office areas.

17 MR. BARRETT: Yes.

18 MR. WACHOWIAK: And it's not zero?

19 MR. BARRETT: No, it's not zero.

20 MR. WACHOWIAK: So what you're asking  
21 about a minute ago is taken account in the model and  
22 the flows that we depict here qualitatively and would  
23 confirm our other calculations, our flows that are  
24 based on not a open area, but a wall with holes?

25 MR. BARRETT: Right. That's correct.

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1 MR. ARCARO: And the whole control room  
2 habitability area is modeled as it built in a GE  
3 drawing. So you have all the walls, all the heat  
4 sinks, the raised floors, the dropped roof. You've  
5 got the communication between the different areas.  
6 You got the doors going to the shift sup office. So  
7 it's a true model of what the configuration is.

8 MEMBER STETKAR: When you run the  
9 analyses, do you find that the Q-DCIS rooms are a net  
10 heat input to the control room habitability area? I  
11 mean, right now this drawing just shows a nice blue  
12 line along the floor there. I was curious whether it  
13 was a sort of a yellow line along the floor.

14 MR. BARRETT: Yes. I mean, what it really  
15 does is it raises part of that gradient, temperature  
16 gradient so it really doesn't have too much of an  
17 effect, but it does effect the gradient slightly  
18 within that mesh nodding of the floor.

19 MEMBER STETKAR: Right.

20 CONSULTANT WALLIS: So the habitability  
21 area is probably well mixed by the fans. I can  
22 believe that. The adjacent rooms don't have any  
23 obvious mixing mechanism except for natural  
24 convection of some sort?

25 MR. BARRETT: That's correct. So as the

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1 EFU flow goes into the main control room, it's going  
2 to be displacing that air throughout the rest of the  
3 area.

4 MR. ARCARO: The idea was that we would  
5 direct the flow to the occupied areas. So the  
6 personnel are going to be in the main control room,  
7 the areas outside of there, the offices not be  
8 supplied with the same air flow. But, you know, those  
9 areas aren't also going to have the habitability and  
10 the CO<sub>2</sub> concerns that you'd have in the central  
11 location.

12 And I think we did see, you know based on  
13 the GOTHIC analysis, which was done to ensure that we  
14 did have mixing, adequate mixing. The GOTHIC  
15 analysis if you look at the flow vectors and the  
16 distribution shows that you have about seven to nine  
17 times the EFU flow circulation through the area. So  
18 you're getting a lot of internal circulation through  
19 that area that's mixing that's minimizing the  
20 temperature gradients and maintaining the temperature  
21 in the occupied area, the OSHA required or the ASHRAE  
22 required area for people, you know, within the  
23 limits.

24 CONSULTANT WALLIS: Is the adjacent room  
25 significantly different in temperature from the

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1 habitability area?

2 MR. BARRETT: Well, what do you consider  
3 to be significant?

4 CONSULTANT WALLIS: Well, I'm just  
5 thinking about my house. If I'd heat one room in the  
6 house, th adjacent rooms --

7 MR. BARRETT: We get enough flows. Like,  
8 for example, if this occupied area is between, let's  
9 say 88 and 93, and the adjacent rooms would be  
10 somewhere around 85 or so.

11 CONSULTANT WALLIS: That's because  
12 there's good circulation or natural circulation  
13 that's shown here?

14 MR. BARRETT: Right. That's correct.

15 CONSULTANT WALLIS: Because there's a  
16 cold wall in there.

17 MR. BARRETT: Yes.

18 CHAIR CORRADINI: Are you done?

19 CONSULTANT WALLIS: Did you calculate any  
20 of these things in this cartoon or is it just a  
21 cartoon?

22 MR. BARRETT: IT was calculated.

23 CONSULTANT WALLIS: No numbers on  
24 anything here.

25 MR. BARRETT: Yes. The numbers, we looked

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1 at the numbers inside the calculation and we produced  
2 this cartoon with the insights that we gained from  
3 the calculations.

4 CONSULTANT WALLIS: Well, you could, you  
5 could sort of say the concrete temperature surface is  
6 75 and the temperature at the hottest part of the  
7 control room is 95 and an adjacent room is 83 or  
8 something. That would give some idea of what you're  
9 predicting.

10 MR. BARRETT: We could do that.

11 CHAIR CORRADINI: But before you  
12 volunteer to do anything, let me make sure I  
13 understand where we're going.

14 So is this your last slide?

15 MR. BARRETT: Yes.

16 CHAIR CORRADINI: Okay. All right. So  
17 we're kind in open, I thought what this was, and  
18 we're in open discussion.

19 CONSULTANT WALLIS: Well, it's a slide  
20 with no numbers.

21 CHAIR CORRADINI: But this was to give  
22 them a qualitative feel. I don't think they meant  
23 this to be a quantitative --

24 CONSULTANT WALLIS: It's interesting to  
25 see what it would be if it were quantitative.

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1 MR. BARRETT: In one of our RAI responses  
2 we actually showed the output of the GOTHIC that  
3 showed the temperature is isotherms.

4 CONSULTANT WALLIS: That would be good.

5 CHAIR CORRADINI: And is that something  
6 that has been submitted?

7 MR. BARRETT: Yes.

8 MR. SULVA: This is Mike Sulva on the  
9 phone.

10 RAI 94-29 supplement 3 submitted with  
11 this pictorial and it explains that the -- and that's  
12 why I guess you're asking a lot of questions about  
13 it. Because the tests describes the flows and it was  
14 an illustrative attached to that RAI. It works  
15 through the tests and explain the mixing as well.  
16 There's another pictorial in there which shows a  
17 cross section showing the temperature distribution as  
18 well.

19 CHAIR CORRADINI: Could you repeat the  
20 number? 94-29 supplement 3?

21 MR. SULVA: That's correct.

22 CHAIR CORRADINI: Thank you.

23 CONSULTANT WALLIS: Now I have supplement  
24 2; do you have supplement 3? Yes, I do. Okay.

25 CHAIR CORRADINI: Other questions?

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1 MEMBER ABDEL-KHALIK: Is there a tech  
2 spec limit on the temperature in the Q-DCIS room?

3 MR. ARCARO: Yes, there is.

4 MEMBER ABDEL-KHALIK: And what is that?

5 MR. ARCARO: All of the rooms that  
6 contribute to the analysis do have tech spec limits  
7 against them.

8 MEMBER STETKAR: That would get back to  
9 the same question about internal cabinet temperatures  
10 and things that they really haven't looked at yet.

11 MEMBER ABDEL-KHALIK: But I'm just trying  
12 to figure out how much heat load comes in from the  
13 floor vis-à-vis the 9.6 kilowatt.

14 MR. WACHOWIAK: Mike, this is Rick.

15 Do you have the tech spec? I think the  
16 way it describes the tech spec is that if the control  
17 room habitability area or any of the surrounding  
18 rooms, right?

19 MR. ARCARO: Well, there's a table in the  
20 basis. It's broken up into groups. So you got the  
21 control room habitability, heat sink group 1, heat  
22 sink group 2 that's the Q-DCIS room. The design  
23 temperature established, the design temperature is 78  
24 degrees. So the control room itself is 74. The  
25 surrounding rooms are 78 with the exception of the

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1 HVAC rooms, which are 104 degrees Fahrenheit. So  
2 those are the temperatures you need to maintain or  
3 you get into the actions for air temperature and then  
4 for concrete temperature.

5 CHAIR CORRADINI: Other questions?

6 MEMBER ARMIJO: Yes. Just we skipped over  
7 the CO<sub>2</sub> bullet on slide 12. You talk about an  
8 emergency filter system for the CO<sub>2</sub>. That's not  
9 really a filter, is it? It's just a --

10 CHAIR CORRADINI: An alarm.

11 MEMBER ARMIJO: Yes. Because you can't  
12 filter CO<sub>2</sub>, is that right?

13 MR. ARCARO: Okay. Yes. When you're  
14 running the EFUs, like that's what's providing your  
15 circulation. So based on previous RAIs there was  
16 some questions about the mixing in the control room.

17 So this bullet is saying that ESBWR control room  
18 will meet the requirements for CO<sub>2</sub>, which is an  
19 ASHRAE requirement for 5,000 PBM.

20 MEMBER ARMIJO: But it's just sweeping  
21 the gas out, it's not some chemical recombiner or --

22 MR. ARCARO: That's correct. Yes. You  
23 take fresh air in and you pump it out and --

24 MEMBER STETKAR: Your variable orifice is  
25 really maintaining the CO<sub>2</sub>?

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1 MR. ARCARO: That's correct. Yes.  
2 Actually that's good for 21 people. The heat up  
3 analysis for 11, the flow we have is enough to  
4 support habitability for much more.

5 MEMBER STETKAR: One last question. That  
6 variable orifice, I don't get into design, it really  
7 is something that is -- is there a design that people  
8 will adjust the size of that orifice on a real time  
9 basis or is set and fixed for all times once you  
10 actually get the thing designed and know what the  
11 heat loads and air distributions are? In other  
12 words, is a balanced damper and an HVAC system that's  
13 set and that's it, or is it something that actually  
14 is a you can put your hands on it and move it type of  
15 device?

16 MR. ARCARO: Yes. And again, we have a  
17 supplemental RAI on that particular device.

18 Big picture, the idea is you wouldn't  
19 have to adjust it. We did some sensitivity analysis  
20 and runs. And the idea is that we could actually go  
21 back to one of those slides that show the ventilation  
22 system. Yes, this guy here.

23 When you're in normal operation you're  
24 running on outside air, right? So your EFUs are  
25 secure. You've got an outside air handling unit

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1 that's putting fresh air into the control room. You  
2 got a recirc air handling unit that's recircing the  
3 air in the control room.

4 You also in normal operation up on the  
5 right hand side up on the top of the roof you've got  
6 the bathroom ventilation.

7 If you add up the flows for the outside  
8 air and the bathroom, that equals the flow for the  
9 EFU. So the idea is radiation condition, you shut  
10 off your normal flow, you start up your EFUs, it's  
11 going to be a seamless transfer. Because it's the  
12 same flow coming from the EFU that you were coming in  
13 from the normal airflow and adding the bathroom  
14 exhaust.

15 So if you were maintaining an eighth of  
16 an inch pressure before, you should be maintaining  
17 that eighth of an inch pressure afterwards.

18 We looked at I think an earlier response  
19 to the RAI we said it would take minimal operator  
20 action, you know. For 72 hours you should be able to  
21 maintain that pressure.

22 We did do some analysis and I think the  
23 response for the follow up RAI is it's going to be  
24 that for the first 72 hours it will require no  
25 operator action. And it can take the differences in

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1 pressure due to the temperature swings both daily and  
2 over the 72 hour period going from 70 degrees up to  
3 90 degrees.

4 So the orifice itself shouldn't be  
5 adjustable. It could be as simple as a piece of pipe,  
6 eight inch pipe that just provides you an area to  
7 ensure you got circulation and get rid of the flow.

8 CHAIR CORRADINI: Other questions?

9 Okay. Let's take a break until 4:00 and  
10 we'll come back with our final presentation on the  
11 staff's control room ventilation.

12 (Whereupon, at 3:42 p.m. a recess until  
13 4:01 p.m.)

14 CHAIR CORRADINI: Dennis, go ahead.

15 MR. GALVIN: So this afternoon the  
16 staff's going to present on the control room  
17 habitability system. It's covered by section 9.4 of  
18 the SOP and section 6.4. Jim O'Driscoll will present  
19 it.

20 MR. O'DRISCOLL: Hello, everybody.

21 Next slide.

22 I just want to give you a brief on the  
23 status of our review, Chapter 6.4 and 9.4 control  
24 room habitability and ventilation issues.

25 The previous briefing to ACRS was on

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1 November 15th, and the other purpose of the brief is  
2 to answer the Subcommittee's questions on the review.

3 Next slide.

4 These are lead reviewers.

5 Next slide.

6 The staff focus on two things. First  
7 objective is the expected performance of the passive  
8 cooling in the control room habitability area and the  
9 reactor building. Basically the ability to maintain  
10 the habitability and operability of equipment for 72  
11 hours following an accident.

12 The other focus area right now we're  
13 looking at is the post-accident EFU operation: The  
14 quality of air supply; air distribution; air quality  
15 issues essentially.

16 CONSULTANT WALLIS: Are you looking at  
17 humidity, too? Humidity?

18 MR. O'DRISCOLL: We are looking at  
19 humidity.

20 Next slide.

21 This is status of the RAIs. We have five  
22 open for 9.4 and three open for 6.4.

23 Next slide.

24 The first question the staff is asking  
25 itself is can the passive cooling of the control room

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1 habitability area and reactor building maintain  
2 habitability and operability of equipment for 72  
3 hours following an accident. These are the questions  
4 we have to ask and answer ourselves. We first need  
5 to determine reasonable habitability acceptance  
6 criteria for the control room habitability area  
7 temperature.

8 We need also to get an idea of the -- to  
9 determine the required level of detail for supporting  
10 heat up analysis. How much detailed analysis do you  
11 need to be confident that you're going to achieve  
12 your goal.

13 And then going forward, the appropriate  
14 level of configuration control to maintain the  
15 assumptions that you have observed in those analyses.

16 Next slide.

17 The review approach for temperature.  
18 What we're doing is we reviewed the proposed  
19 performance goal the applicant proposed, the input  
20 assumptions and their design basis calculation.  
21 We're looking at the alternate means or alternate  
22 ways of figuring out that temperature at the end of  
23 72 hours. And then take all those analyses, identify  
24 insights and compare to what's the design basis  
25 information and to assure that we've got those

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1 insights captured correctly.

2 We also need to identify sensitivities to  
3 understand the relative importance of these insights  
4 and address uncertainties.

5 Next slide.

6 The applicant's actions that we've  
7 completed is they submitted to us a CONTAIN 2.0  
8 analysis as their design basis calculation for the  
9 habitability area.

10 They also submitted a control room  
11 habitability a GOTHIC analysis is supposed to be used  
12 for the demonstration of convection mixing in the  
13 area only, not really to be used to determine the  
14 heat up of the control room.

15 They also submitted a First Principles  
16 calculation around September to demonstrate an  
17 alternate means of calculating the heat up of the  
18 room. They've also added ITAAC to update and  
19 validate the design basis calculation with as-built  
20 dimensions.

21 Those actions are the actions that were  
22 done since the last time the ACRS was briefed.

23 What the staff has done. We've reviewed  
24 the CONTAIN 2.0 analysis of the control room  
25 habitability area. We're still looking at it as we

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1 gain insights from other analyses methods, but we've  
2 done an initial review of what they provided us.

3 We've also reviewed the CONTAIN 2.0  
4 analysis of the reactor building. What's going on  
5 right now is we're reviewing the GOTHIC analyses that  
6 was submitted to the staff which is an older analysis  
7 with different initial conditions than what was  
8 provided in CONTAIN. So what we're trying to do is  
9 match those initial conditions to what's CONTAIN and  
10 observe any differences.

11 We're also reviewing the applicant's  
12 First Principle calculation. And we're reviewing the  
13 RAI responses when they come that. We've issued RAIs  
14 about three weeks ago.

15 MEMBER STETKAR: I'm not familiar with  
16 either of the codes. I understand the modeling  
17 principles are different. But are you looking at the  
18 details analyses and comparing the two to look at  
19 differences in models, differences in --

20 MR. O'DRISCOLL: We've got the input and  
21 output decks for CONTAIN. And we're checking how  
22 those were built. And we also have the input and  
23 output files for the GOTHIC analysis that was used to  
24 support the mixing RAI response. And that's what  
25 we're working with. We're not just looking at a

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1 report, we're actually looking at the data files.

2 MR. GALVIN: We have a couple of slides  
3 on that.

4 MEMBER STETKAR: Okay. No problem.

5 MR. O'DRISCOLL: Yes. The applicant's  
6 control room habitability maximum temperature  
7 criteria. This is what was proposed to us. It was  
8 based on EPRI's Utility Requirements Document  
9 guidance. Essentially what the URD says is that you  
10 can be allowed a 15 degree rise in main control  
11 temperature for a main control room that's normally  
12 maintained between 73 and 78 degrees. And what the  
13 applicant has done is they're controlling their  
14 control room at 74 degrees per tech spec and they're  
15 allowing themselves a 19 degree rise to get to less  
16 than or equal to 93 degrees.

17 We're also looking at their outside  
18 environmental input assumptions. They're using 117  
19 degrees Fahrenheit with 80 degree wet-bulb, that's in  
20 Chapter 2. That's the site condition.

21 CONSULTANT WALLIS: I want to ask you  
22 about that. Because I looked at a response to RAI  
23 6.4-21 and there they have 117 degrees Fahrenheit and  
24 20 percent relative humidity.

25 MR. O'DRISCOLL: Right.

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1                   CONSULTANT WALLIS: And that didn't make  
2 sense to me. That's much too low. You have 80  
3 degrees F. Well 20 percent humidity is something  
4 like a 63 degrees F wet-bulb. So something doesn't  
5 seem consistent here.

6                   MR. O'DRISCOLL: Right. We're looking at-  
7 -

8                   CONSULTANT WALLIS: So are you looking at  
9 that?

10                  MR. O'DRISCOLL: Yes. We didn't ask an  
11 RAI on that, but we are looking at the initial  
12 conditions that they've assumed.

13                  CONSULTANT WALLIS: Then I had real  
14 problems seeing if it were this wet, how they could  
15 get that moisture out. Because there's no mechanism  
16 for taking moisture out in the control room.

17                  MR. O'DRISCOLL: That's right.

18                  CONSULTANT WALLIS: There's only  
19 mechanism for putting it in.

20                  MR. O'DRISCOLL: Right.

21                  CONSULTANT WALLIS: Unless its condensing  
22 on the walls.

23                  MR. O'DRISCOLL: The URD requires that the  
24 applicant use -- or actually it doesn't. It  
25 recommends. The guidance is is that you use the zero

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1 percent exceeds the value. That's all it really says  
2 about your initial conditions.

3           You're supposed to take the coincident--  
4 the dry-bulb coincident with wet-bulb and use zero  
5 percent exceedance. But the applicant chose the 27  
6 degree cycle from ASHRAE's Fundamentals Handbook.  
7 That magnitude of that swing is from a representative  
8 site. So that's what they've used for input  
9 criteria.

10           Next slide.

11           CHAIR CORRADINI: So I guess -- I'm  
12 listening. Can you go back a slide?

13           MR. O'DRISCOLL: Sure.

14           CHAIR CORRADINI: So that's their  
15 assumption and their analysis is not matching their  
16 assumption? I'm confused.

17           MR. O'DRISCOLL: No. The message is is  
18 this what they're using. What they put into their  
19 analysis does match these assumptions. But what we  
20 have to do as a staff is to determine if those  
21 assumptions are valid or in the --

22           CHAIR CORRADINI: Well, I misunderstood  
23 then. I'm sorry. Excuse me.

24           MR. O'DRISCOLL: Yes. Excuse me.

25           MR. O'DRISCOLL: The next slide.

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1           For operator functionality criteria the  
2 applicant is proposing they use a wet-bulb globe  
3 temperature of less than or equal to 86 degrees which  
4 allows an unlimited stay time for light work for  
5 numerous standards. And that's essentially a heat  
6 stress value. It tasks about physiological conditions  
7 on the body. It doesn't --

8           MR. GALVIN: We had our HFE staff here  
9 to, I guess -- they're getting ready to leave. But  
10 if they could just speak to that for a moment and if  
11 the ACRS had any question, we'd like to throw that  
12 out.

13           CHAIR CORRADINI: Yes.

14           MR. GALVIN: So PAula Pieringer is going  
15 to speak.

16           MR. PIERINGER: I'm Paul Pieringer. I'm  
17 technical reviews in the human factors area.

18           The applicants are committed to NUREG-  
19 0700, which is the HFE program, which in turn  
20 reference NUREG-0700 which has various design  
21 requirements, one section of which addresses heat  
22 stress.

23           There's the classic curve that plots wet-  
24 bulb globe temperature against stay times. And using  
25 standard work clothing dress for the control room

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1 with a low metabolism, the stay time for 90 degree is  
2 unlimited. There's no stay time limits.

3 Now that's the NUREG-0700. We went back,  
4 did a literature search, talked to the primary author  
5 for NUREG-0700 which took us back to a document  
6 called DR INP-4493, an EPRI document. That document  
7 basically develops the system of curves which, as you  
8 might expect, show short stay times at high  
9 temperatures and basically they plateau at 85 to 86  
10 degrees depending on which set you take and which  
11 researcher's information you use.

12 So from a conservative standpoint all the  
13 literature points to 85 to 86 degrees being the  
14 maximum limit for no stay time requirements. If you  
15 go above 86 degrees you start entering and requiring  
16 additional controls to make sure that the people can  
17 perform. And it's physiological, it's also mental.  
18 In fact, 85/86 is specifically addressed by NIOSH  
19 under a mental performance codes is the  
20 characterization they give to it. So we're  
21 specifically looking at the operator's cognitive  
22 capabilities in this setting.

23 CHAIR CORRADINI: So you concur with the  
24 applicant's criteria?

25 MR. PIERINGER: Yes, sir. We concur with

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1 86 degrees wet-bulb temperature. Right? I want to  
2 make sure that's clear. It is always wet-bulb  
3 temperatures that are correct for humidity.

4 MR. GALVIN: Did anyone want to ask  
5 questions? Otherwise, I would like to have them  
6 leave.

7 CHAIR CORRADINI: You'd like to let him  
8 leave.

9 MR. GALVIN: Okay. Thank you very much,  
10 Paul.

11 MR. O'DRISCOLL: The second part of this  
12 slide is, again, what's driving that is the  
13 applicant's outside environmental assumptions, a 117  
14 degree coincident with 80 degree wet-bulb. They're  
15 allowing an average daily temperature cycle which  
16 result in outside relative humidity from 20 to 45  
17 percent.

18 CONSULTANT WALLIS: So this 20 percent is  
19 supposed to cause to the 80 degrees F?

20 MR. O'DRISCOLL: My understanding is, is  
21 that that's what they're -- they're saying if you go  
22 to a psychometric chart --

23 CONSULTANT WALLIS: But didn't you check  
24 that?

25 MR. O'DRISCOLL: We are checking that.

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1 And, yes. If you go to a psychometric chart -- and  
2 what they're doing is they're allowing the humidity  
3 to remain the air and let the air cool and you'd get  
4 45 percent.

5 They've also put the control room --

6 CONSULTANT WALLIS: At night, it went up  
7 at night to 45 percent?

8 MR. O'DRISCOLL: That's correct.

9 They're also allowing the maximum range  
10 starting for a control room habitability of a  
11 humidity being at 60 percent at the beginning of the  
12 observed period.

13 Next slide.

14 CONSULTANT WALLIS: Do you recall how  
15 much they assume a person emits of water vapor at  
16 these hot conditions per day?

17 MR. O'DRISCOLL: It's in the NIOSH  
18 standard. There's actual a number, you can liters  
19 per person.

20 CONSULTANT WALLIS: I couldn't find that  
21 anywhere.

22 MR. O'DRISCOLL: Yes. I can give you  
23 that. That's in Part 8 of the NIOSH standard. We've  
24 actually referenced the NIOSH standard in the DC, but  
25 there's a number as far as the --

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1                   CONSULTANT WALLIS: Could you just let me  
2 have that sometime?

3                   MR. O'DRISCOLL: Absolutely.

4                   CONSULTANT WALLIS: All right. Thank  
5 you. Of these conditions, you know, the worst  
6 conditions.

7                   MR. O'DRISCOLL: Okay.

8                   CONSULTANT WALLIS: I think it depends a  
9 bit on how active you are, as well?

10                  MR. O'DRISCOLL: Right. And the way we're  
11 looking at, is we're accepting light work as what the  
12 -- even though they'll be under, I'm sure, a lot of  
13 stress. But they're not chopping wood or anything.  
14 Okay.

15                  Next slide.

16                  These are the results that were passed to  
17 the staff on the three analyses. These are the take  
18 aways.

19                  Bulk room temperature from CONTAIN was 92  
20 degrees with a 43 percent relative humidity at the  
21 end of the 72 hour period.

22                  GOTHIC demonstrates mixing.

23                  And the First Principles calculation,  
24 bulk room temperature is 91.3 degrees.

25                  We've got these results, some of these

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1 results as late as September. And we're looking at  
2 them.

3 Next slide.

4 MEMBER ABDEL-KHALIK: 93 percent relative  
5 humidity with 92 degree F dry-bulb temperature.

6 What's the wet-bulb temperature?

7 MR. O'DRISCOLL: The wet-bulb is -- I'm  
8 sorry. Dry-bulb of --

9 MEMBER ABDEL-KHALIK: 92.

10 MR. O'DRISCOLL: I think it's around 75  
11 percent. And it's below. And that's the basis for  
12 someone to meet the --

13 MEMBER ABDEL-KHALIK: 86 degree wet-bulb  
14 temperature?

15 MR. O'DRISCOLL: Yes. Yes. But, you know,  
16 if you look a psychometric chart and you look at the  
17 range of the control room, you know below 90 you can  
18 exceed 86 degrees wet-bulb globe temperature but  
19 still be below 93 degrees.

20 MEMBER ABDEL-KHALIK: Right.

21 CHAIR CORRADINI: I don't think I  
22 understand your explanation. Can you just say it  
23 again slower?

24 MR. O'DRISCOLL: Sure. I'm sorry. Okay.

25 The bulk room temperature value of 92

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1 degrees is a dry-bulb temperature.

2 CHAIR CORRADINI: Yes.

3 MR. O'DRISCOLL: It's coincident with the  
4 43 percent relative humidity.

5 CHAIR CORRADINI: Right.

6 MR. O'DRISCOLL: The corresponding wet-  
7 bulb temperature using just the psychometric chart,  
8 the corresponding wet-bulb temperature at that is on  
9 the order of about 71 or 72 degrees.

10 CHAIR CORRADINI: Okay. Okay. So  
11 they're in their limit?

12 MR. O'DRISCOLL: They're under the  
13 acceptance criteria for human performance, the 86  
14 wet-bulb globe temperature.

15 MR. PARKS: Ed Parks for the staff.

16 The wet-bulb globe temperature here is an  
17 index. It's not really a temperature itself. It's  
18 made up of about 70 percent of the wet-bulb  
19 temperature plus 30 percent of the dry-bulb  
20 temperature, roughly. And it turns out that a 93  
21 degree control room at about 75 percent relative  
22 humidity gives you something on the order of an 86  
23 degree wet-bulb globe temperature index. And that  
24 index is used to measure heat stress on the body.

25 MR. O'DRISCOLL: Right. That's correct.

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1 The wet-bulb globe temperature, it's an index and the  
2 actual corresponding wet-bulb temperature is 71, but  
3 the index you're getting, it's actually higher. But  
4 it's below their acceptance criteria.

5 CHAIR CORRADINI: I'm sorry to sound like  
6 I don't understand this.

7 MR. O'DRISCOLL: Sure.

8 CHAIR CORRADINI: But we're throwing a  
9 few things around here.

10 MR. O'DRISCOLL: Yes.

11 CHAIR CORRADINI: So is the acceptance  
12 criteria a 100 percent relative humidity at 86  
13 degrees or is the acceptance criteria this index?  
14 That's what I'm still not clear --

15 MR. O'DRISCOLL: The acceptance criteria  
16 is the index. The wet-bulb globe temperature index  
17 of 86 degrees.

18 CHAIR CORRADINI: Which is not a  
19 temperature, it's a --

20 MR. O'DRISCOLL: It's an index.

21 CHAIR CORRADINI: -- stylized average?

22 MR. O'DRISCOLL: That's right. As Ed  
23 said, it's 70 percent of the --

24 MEMBER STETKAR: That index, that  
25 acceptance index, as I understand it, at 92 or 93

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1 degrees would correspond to 75 percent relative  
2 humidity?

3 MR. O'DRISCOLL: Yes.

4 MEMBER STETKAR: Something that I can  
5 think about.

6 MR. O'DRISCOLL: Yes.

7 MEMBER STETKAR: Is that right?

8 MR. O'DRISCOLL: Yes. And they're getting  
9 71 percent wet-bulb temperature, so they're below the  
10 75 -- they're getting 71 degrees wet-bulb  
11 temperature. And that corresponds to less than the  
12 WBGT.

13 In other words, if they use --

14 CHAIR CORRADINI: That's all right. I  
15 just wanted to make sure that -- I'm trying to  
16 determine between a real temperature and an average  
17 index. And so this is an index comparison?

18 MR. O'DRISCOLL: Yes.

19 CHAIR CORRADINI: Okay. I'm happy.  
20 Thank you.

21 MEMBER ARMIJO: I have a question. I  
22 guess I'm really confused.

23 MR. O'DRISCOLL: Sure.

24 MEMBER ARMIJO: If you built this plant  
25 in the deep south, Wilmington, North Carolina or

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1 something like that, the humidity is 100 percent, no  
2 problem.

3 MR. O'DRISCOLL: Yes.

4 MEMBER ARMIJO: Now you're going to be  
5 pumping that into the control room at that site?

6 MR. O'DRISCOLL: Yes. Yes.

7 MEMBER ARMIJO: Will they still meet  
8 their habitability?

9 MR. O'DRISCOLL: That is yet to be  
10 determined. We're looking at that. I cannot  
11 categorically say that they would based on what they  
12 gave me.

13 MEMBER ARMIJO: Where does the water go?  
14 The humidity is going in, there's nothing going out  
15 as far as moisture?

16 CONSULTANT WALLIS: Right. Where does  
17 the water go?

18 MEMBER ARMIJO: They have a lot of  
19 wallboard.

20 MR. BARRETT: So Ed stated earlier that  
21 92 degrees -- Ed states earlier that if you have a  
22 control room that's at 92 degrees and it will take  
23 about 75 percent humidity to get to an 86 degree wet-  
24 bulb temperature. And from the sensitivity  
25 calculations that we did earlier where we used a 100

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1 percent, we were getting around 89 degrees. So its  
2 corresponding humidity would have to be almost 100  
3 percent or probably more than 100 percent to get you  
4 over the limit. So that should help to give you an  
5 idea of where we are.

6 MEMBER ABDEL-KHALIK: Do you actually do  
7 a lot of balance calculation?

8 MR. BARRETT: No.

9 MEMBER ABDEL-KHALIK: So how do you  
10 figure out the final relative humidity?

11 MR. BARRETT: The code calculates it.

12 MEMBER ABDEL-KHALIK: I mean --

13 CONSULTANT WALLIS: But just common  
14 sense. If it comes in a 100 percent humidity, it  
15 doesn't get cooled down, the water must still be  
16 there.

17 MEMBER ABDEL-KHALIK: I mean just because  
18 the code calculates it, do you know what's in the  
19 code? How does it do a water balance?

20 MR. BARRETT: Yes. Well, we have flow  
21 coming in and flow coming out. So there's a  
22 volumetric flow coming in and a volumetric flow  
23 coming out. So when that humidity, when all the  
24 humidity and stuff goes into the room, there is some  
25 coming out.

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1 MEMBER ABDEL-KHALIK: But there are  
2 people there also.

3 MR. BARRETT: And there is actually -- we  
4 have, I guess you would call it, like a boundary  
5 condition or a flow boundary condition where we're  
6 placing more moisture due to people into the volume.

7 CHAIR CORRADINI: So can I ask one  
8 clarification at this point? So you have sources,  
9 you have no sinks? You're not counting for any  
10 condensation on the walls and drainage?

11 MR. BARRETT: We do account for a  
12 condensation on the walls.

13 CHAIR CORRADINI: You do?

14 MR. BARRETT: Yes.

15 CHAIR CORRADINI: Okay.

16 CONSULTANT WALLIS: Oh, you do?

17 MR. BARRETT: Yes.

18 CHAIR CORRADINI: That's why I wanted to  
19 ask. So there is a sink?

20 MR. BARRETT: Yes.

21 CONSULTANT WALLIS: Maybe that's how you  
22 manage to get the water out.

23 MEMBER ABDEL-KHALIK: So does the code  
24 tell you at the end of 72 hours you have a puddle of  
25 water on the concrete floor?

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1 MR. BARRETT: It tells you how much  
2 moisture is on the wall. But in the low moisture  
3 case, there is none. In the 100 percent humidity  
4 case, there is.

5 MR. MCKIRGAN: This is John McKirgan  
6 again.

7 This is something the staff is looking  
8 at: The humidity, the water balance, this is  
9 something that is part of our ongoing review.

10 CONSULTANT WALLIS: But if there's water  
11 on the wall, then you must be below -- you must be  
12 supersaturated. It must be 100 percent humid.

13 CHAIR CORRADINI: On the wall. The  
14 wall's cooler. The wall's always cool.

15 MS. CUBBAGE: But you're not at 93  
16 degrees.

17 CONSULTANT WALLIS: There's a transient  
18 in the wall. The wall has got a lot of resistance  
19 back there. The wall temperature is probably fairly  
20 close to the --

21 CHAIR CORRADINI: We established early on  
22 when we were questioning Antonio that the wall's  
23 always cooler. So the wall is a sink.

24 MR. O'DRISCOLL: Right.

25 CHAIR CORRADINI: So you're losing some

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1 and you're gaining some.

2 CONSULTANT WALLIS: So that's where the  
3 water went. It went on the wall.

4 CHAIR CORRADINI: So you guys are still  
5 looking at it?

6 MR. O'DRISCOLL: Yes, we are.

7 CHAIR CORRADINI: Good.

8 MR. O'DRISCOLL: The next slide talks  
9 about what we're doing with CONTAIN. We reviewed the  
10 heat up calc report and the data files with no issues  
11 at this time with the data that they provided us as  
12 far as its accuracy, as far as the math in it.

13 The sensitivities on CONTAIN we've done.  
14 We've changed concrete density, specific heat,  
15 humidity of the outside air, the heat transfer area,  
16 outside air temperature and the EFU fan flow rate.

17 What we find here is that the take away  
18 is that there is some sensitivity with concrete  
19 densities, sensitivity being you can get some --  
20 there's some performance improvement if you increase  
21 concrete density. But others are relatively  
22 insensitive.

23 When I wrote this I didn't -- you know,  
24 if you have humidity you're going to get some  
25 movements too. But what we did is we forced humidity

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1 and ran it, I think, on one run in CONTAIN and got  
2 the percentage of what we got there.

3 MEMBER ABDEL-KHALIK: How about concrete  
4 conductivity?

5 MR. O'DRISCOLL: We also did that as well.

6 CONSULTANT WALLIS: That's influenced by  
7 the rebar, isn't it?

8 MR. O'DRISCOLL: Yes. What the applicant  
9 provided us was the aggregate values for those  
10 because the wall was an aggregate of rebar and  
11 concrete. The concrete that they have in, they put  
12 in for their analysis, is 120 pound concrete as  
13 opposed to a more denser concrete. And when you put  
14 those extra, you get some improved performance.

15 CONSULTANT KRESS: And then you do the  
16 CONTAIN calculation. The concrete is divided up in  
17 little nodes so you can find the transient through--

18 MR. O'DRISCOLL: Yes. There's I think at  
19 least five nodes in the wall, I believe.

20 CONSULTANT WALLIS: Your hand calculation  
21 will show that it comes not quite to equilibrium, but  
22 significantly towards equilibrium in three days the  
23 concrete, I think.

24 MR. O'DRISCOLL: Right. I mean it's got  
25 more potential to cool at the end of 72 hours. I

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1 mean --

2 CONSULTANT WALLIS: But the thermal wall  
3 has penetrated right through the concrete, I think,  
4 by three days if you look at the square root of alpha  
5 T and all that stuff, transient conduction has gone  
6 through significantly into the concrete and probably  
7 reached the other side.

8 MR. O'DRISCOLL: What we're doing, I don't  
9 want to jump too far ahead. But we're doing a First  
10 Principles calculation of our own.

11 CONSULTANT WALLIS: Okay. Good. So  
12 you've got it all under control?

13 MR. O'DRISCOLL: Yes.

14 CONSULTANT WALLIS: Okay.

15 MR. O'DRISCOLL: It makes it easier  
16 because it's quicker to get answers instead of going  
17 back to the applicant every time we want to --

18 CONSULTANT WALLIS: So I don't need to do  
19 it? You'll do it.

20 MR. O'DRISCOLL: Okay. GOTHIC. What we  
21 got here is that the applicant's analyses that we've  
22 looked is different than CONTAIN. It uses 20 percent  
23 sensible heat loads, lower EFU fan flow rate and it  
24 uses a higher initial heat sink temperature, which is  
25 an opposite effect. So what we have to do here is we

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1 have to get those initial conditions to match the  
2 CONTAIN initial conditions in order for us to really  
3 compare apples-to-apples with GOTHIC.

4 So we're going to do basically two cases.

5 One case is just to verify their model with no  
6 changes. And then we're going to match the input  
7 assumptions and see what we get.

8 The First Principles calc, next slide.

9 They've provided us on or about September, September  
10 4th I believe, a First Principles calc. Essentially  
11 is a conductive heat model. It's a single mode calc.

12 It's pretty simple.

13 We looked at that and we're trying to  
14 build a model that you can -- a little bit more  
15 sophisticated that works from First Principles. It's  
16 essentially a math cad with First Principles' point  
17 of view. And we just got it. We're close to being  
18 able to get answers from that.

19 CHAIR CORRADINI: So what is this First  
20 Principles calculation that you're checking?

21 MR. O'DRISCOLL: They provided in a  
22 teleconference, telepresence meeting a First  
23 Principles calc on September 4th. It was a letter.  
24 It wasn't in response to an RAI.

25 CHAIR CORRADINI: But a calculation of

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1 what?

2 MR. O'DRISCOLL: Of the heat removal,  
3 passive heat removal as an alternate means of  
4 demonstrating the CONTAIN analysis.

5 CHAIR CORRADINI: Okay.

6 CONSULTANT KRESS: You have to get the  
7 rates right because it's a race between the rate of  
8 heat coming in and rates going into the concrete.

9 MR. O'DRISCOLL: I don't want to go into  
10 too much detail, but what we want to do is the  
11 convection, the heat transfer coefficient for  
12 convection needs to be modeled.

13 CONSULTANT KRESS: Yes, that wasn't in  
14 the hand calculation.

15 MR. O'DRISCOLL: That's correct. So we  
16 want to see what that does for us.

17 CONSULTANT KRESS: Yes. It may be that  
18 the concrete conductivity controls, so that may  
19 happen too. But I think you do need to have that in  
20 there.

21 MR. O'DRISCOLL: It was their confidence  
22 in --

23 CONSULTANT KRESS: It will slow down the  
24 rate in which you're going into the concrete.

25 MR. O'DRISCOLL: Yes.

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1                   CONSULTANT KRESS:  And it's this rate  
2                   that --

3                   MR. O'DRISCOLL:  And it could result in a  
4                   high room temperature.  So if we did that, we would  
5                   get a higher confidence in the proposed model.

6                   CONSULTANT WALLIS:  Now were you looking  
7                   at some sort of condensation coefficient for the  
8                   wall, too?

9                   MR. O'DRISCOLL:  No.

10                  CONSULTANT WALLIS:  So how do you know  
11                  the rate of condensation on the wall, which seems to  
12                  be important for humidity control.

13                  MR. O'DRISCOLL:  We'll have to look at  
14                  that more.

15                  CONSULTANT WALLIS:  That one, okay.

16                  MEMBER STETKAR:  Are you also modeling  
17                  heat input from surrounding areas?

18                  MR. O'DRISCOLL:  Yes.

19                  MEMBER STETKAR:  You are?

20                  MR. O'DRISCOLL:  Yes.  We're looking at  
21                  the heat input.  Basically the heat input from the  
22                  EFU fan, the sensible heat load that's in the room  
23                  and I believe we're doing solar load as well.

24                  MEMBER STETKAR:  I was thinking more the  
25                  Q-DCIS rooms down below.

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1 MR. O'DRISCOLL: We'll have to look at  
2 that.

3 CONSULTANT KRESS: Can you use your First  
4 Principles calculations you're talking, and the input  
5 will be the room temperature that you get from  
6 CONTAIN, you don't calculate actually all the heat  
7 losses and the inputs and stuff with your hand  
8 calculation?

9 MR. O'DRISCOLL: Right. We're going to  
10 take, basically, their input assumptions from  
11 CONTAIN, the 85 degree room, the heat sink  
12 temperatures at the end of the eight hour period of  
13 time of loss, you know which is all our output from  
14 the CONTAIN step 2. They call it CONTAIN step 2. We  
15 can plug that in and come up with a number.

16 CONSULTANT KRESS: Now the question I  
17 wanted to ask you about that is that already has the  
18 concrete heat sink in it. If you look at the  
19 temperature of the control room as a function of  
20 time, it already has this concrete sink in it. I was  
21 wondering how you were going to take that out of the  
22 CONTAIN to give you your boundary condition for your  
23 hand calculation. Do you understand --

24 MR. O'DRISCOLL: No, I don't understand  
25 your question.

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1 CHAIR CORRADINI: He's basically saying  
2 you're already biased the calculation by the sink so  
3 you can't use a forcing function that already has the  
4 answer in it.

5 CONSULTANT KRESS: Right. That's  
6 basically it.

7 CONSULTANT WALLIS: Well, you can check  
8 compatibility, though. You can use it to calculate  
9 whether he went and see if its compatible with the  
10 CONTAIN. He can CONTAIN to calculate how much heat  
11 went into the wall and then he can go back and see if  
12 that's consistent with what CONTAIN says.

13 MR. McKIRGAN: If I could, yes, I think  
14 that's really the intent of the First Principles calc  
15 is as an independent check, somewhat confirmatory of  
16 the CONTAIN analysis.

17 It's really not our intent to try to add  
18 back all the physics of CONTAIN or GOTHIC in the  
19 First Principles calc. It's we're trying to do  
20 something fairly basic and simple that we can run  
21 very quickly with just a few parameters.

22 Syed? I've got Syed Haider here. He's  
23 on our staff. He's been looking and developing this  
24 First Principles. Do you want to try and address  
25 that issue?

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1 MR. HAIDER: Yes. This is Syed Haider.  
2 I'm working on the First Principles analysis.

3 The analysis is pretty flexible. So we  
4 can change the initial conditions and we can account  
5 for sensitivity to turbulent correlation that we are  
6 using for convective heat transfers.

7 So essentially the model is pretty  
8 flexible and we can model different phases. So we  
9 can take out the impact, the effect of CONTAIN  
10 analysis from the heat sink.

11 MR. MCKIRGAN: But again, the purpose of  
12 the First Principles is for the staff to develop  
13 confidence. It's the CONTAIN analysis that the  
14 applicant has submitted that will be the design basis  
15 for the plant.

16 CONSULTANT WALLIS: For the wall, you  
17 could do things like, say, well we know the solution  
18 to a step function because it's in all the books. We  
19 can take the step function to the worst one we can  
20 assume and so it jumps to the highest temperature.  
21 We can assume the other extreme, which it jumps to  
22 the lowest temperature it jumps to. And you can sort  
23 of bracket the heat transfer to the wall and see if  
24 it's reasonable. You can do all kinds of little  
25 checks like that.

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1 MR. HAIDER: This is Syed Haider.

2 CONSULTANT WALLIS: That's how it's going  
3 to work out. And if you do it, it's going to work  
4 out. It's just that we haven't heard all the details  
5 yet. But it should work out.

6 MEMBER ABDEL-KHALIK: Now when you do the  
7 condensation on the wall, how do you account for  
8 latent heat? Or is that considered the part of the  
9 latent load that people put out?

10 MR. O'DRISCOLL: Well, we haven't modeled  
11 the condensation in this model yet, so we don't have  
12 it. I can't answer that question. We haven't model  
13 condensation in our First Principles calc yet. But I  
14 can get you that answer.

15 MR. McKIRGAN: I'm sorry, Jim. So not to  
16 belabor that, but this is an area of review. The  
17 staff is going to look at condensation and the water  
18 balance. It may not be in the form of the First  
19 Principles calc. So this is an area that is still  
20 under staff review. And so I'm trying to keep the  
21 First Principles calc very clean. And it's not our  
22 intent, again, to add back every piece of physics.

23 MEMBER ABDEL-KHALIK: I understand. But  
24 I think it would be important to look at what the  
25 applicant has done to make sure that the calculation

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1 is internally consistent.

2 MR. McKIRGAN: Absolutely. And we  
3 continue to review the GOTHIC analysis and the  
4 applicant's First Principles calculation. Those are  
5 still under staff review.

6 MEMBER ABDEL-KHALIK: Do you understand  
7 my question?

8 MR. O'DRISCOLL: Yes. You want to  
9 basically know how we're going to model that, if we  
10 can model that in our First Principle calc.

11 MEMBER ABDEL-KHALIK: Well, not  
12 necessarily, but to make sure that the applicant  
13 claims to have done a lot of balanced calculation  
14 which results in condensation on the walls. Well,  
15 how do you handle the latent heated vaporization that  
16 results in this energy exchange?

17 CONSULTANT WALLIS: I think it's just a  
18 few hundred watts when I was looking at it.

19 MEMBER ABDEL-KHALIK: Is it?

20 CONSULTANT WALLIS: I've already got  
21 eight times 25 watts from just the heat from there  
22 generating. And then the vapor they're generating if  
23 it's condensed, it adds up maybe another 50 percent  
24 to that, which has to be taken away on the wall. But  
25 it's not that big a proportion of the total --

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1 MEMBER ABDEL-KHALIK: I'm just wondering  
2 if it's counted twice.

3 MR. O'DRISCOLL: CONTAIN has two numbers  
4 for heat load for -- they have latent sensible for a  
5 human being. And that was used as an input into the  
6 CONTAIN model. So we make sure that we're not double  
7 dipping there with that.

8 CONSULTANT WALLIS: Right. In fact,  
9 you're helping us a lot because you're revealing more  
10 about what was in CONTAIN than we heard from GEH.  
11 That's very helpful.

12 CHAIR CORRADINI: Just think of CONTAIN  
13 as MELCOR without meltdown. That's all it is. It's  
14 the same code.

15 CONSULTANT WALLIS: The same code?

16 CHAIR CORRADINI: It's exactly the same  
17 code.

18 MR. O'DRISCOLL: Yes. Next slide.

19 Okay. Some of the insights we can talk  
20 to you about already from the staff analysis is that  
21 CONTAIN model has some conservatism in it by a  
22 demonstration of this low density concrete.

23 GOTHIC has demonstrated convective mixing  
24 would be expected in the room.

25 The highest temperatures we observed of

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1 these analyses are actually in GOTHIC. So we're  
2 still looking at that calc.

3 The impact of those is that it primarily  
4 impacts equipment qualification assumptions. And the  
5 closer agreement between all these calcs would add  
6 confidence to their proposed design basis calculation  
7 model.

8 The open items to these insights is we're  
9 asking for more specific definition and references in  
10 the design basis heat up cal required in tier 2.  
11 Basically tier 2 doesn't really mention what the  
12 actual calc is in the reference. So we're asking for  
13 more specificity in the design certification.

14 We're also asking for more specific ITAAC  
15 description. In other words, what is the actual calc  
16 by name that you're going to update at the end of the  
17 day? What is the methodologies? Is it going to stay  
18 the same? Is it going to be different? So that's an  
19 RAI that's out to the applicant.

20 Next slide.

21 MR. GALVIN: Just if I could elaborate  
22 briefly?

23 We've asked them to a tier 2 star which  
24 would lock them in and so they couldn't change. And  
25 I think in principle they're considering that idea.

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1 So, I mean, we're going to have another report with  
2 just some sort of actual calculation that you'd be  
3 able to see it.

4 CHAIR CORRADINI: What are considering  
5 again?

6 MR. GALVIN: Make A tier 2 star which  
7 requires staff approval prior to changing. There  
8 would be certain variables that we would lock in and  
9 then certain variables we know would change based on  
10 as-built conditions.

11 CHAIR CORRADINI: Oh, I see. Okay.  
12 Thank you.

13 MR. O'DRISCOLL: An additional insight was  
14 the applicant's CONTAIN and First Principles results  
15 are close to the acceptance criteria 93 degrees  
16 Fahrenheit at the end of 72 hours. So that  
17 essentially maintenance of margin here is important  
18 to us. Configuration control is important, you know  
19 in order to be confident that we're not going to  
20 exceed 93 degrees, the acceptance criteria.

21 So the related open items. There's an  
22 RAI out from the EQ Branch that talks more about how  
23 the EQ service temperatures will be to explain. That  
24 basically you're taking this 93 degree bulk room  
25 temperature and translating it into what's going

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1 inside these electrical cabinets. And an explanation  
2 of why it would be bounding, you know the outside air  
3 would be bounding, air temperature would be bounding.

4 MEMBER STETKAR: Jim, let me interrupt  
5 you there because I'll do the broken record thing  
6 here again.

7 We focused all this afternoon on the  
8 control room habitability area. Does the EQ Branch  
9 have a similar question out for the control building  
10 general ventilation area?

11 MR. O'DRISCOLL: Yes. It's the same RAIs.

12 MEMBER STETKAR: Same RAI?

13 MR. O'DRISCOLL: Yes.

14 MEMBER STETKAR: Okay. Because there we  
15 don't have external air flow and it's a different  
16 reactor.

17 MR. O'DRISCOLL: It covers the reactor  
18 building.

19 MEMBER STETKAR: It covers the reactor  
20 building also?

21 MR. O'DRISCOLL: Well the RAI has to do  
22 with the reactor building and the control room  
23 habitability area.

24 MEMBER STETKAR: Yes, but there are areas  
25 inside the control building that the control building

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1 general ventilation area that contain the Q-DCIS  
2 rooms and other equipment in the control building.  
3 It's a separate ventilation area. So the three that  
4 I was concerned about was the reactor building  
5 because there's stuff -- again, I'm an equipment guy.  
6 I don't care about the people. Yes, I'm an  
7 insensitive -- you know.

8 But the three areas that contain  
9 important equipment, there are the rooms in the  
10 reactor building, clean air and ventilation system  
11 rooms. There are general areas in the control  
12 building outside of the control room habitability  
13 area. And then the control room habitability area.  
14 Sort of those three areas are --

15 MR. O'DRISCOLL: I need to check the RAI.

16 MEMBER STETKAR: -- of concern because  
17 they all take credit for completely passive heat  
18 removals for the full 72 hours.

19 MR. O'DRISCOLL: I'll need to check the  
20 RAI to make sure that we didn't --

21 MEMBER STETKAR: Because there are areas,  
22 the reactor building, the clean area ventilation  
23 system area areas contain big heat sources. All the  
24 inverters and things are out there. They're putting  
25 out a lot of heat.

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1                   Again, that's not -- I don't care about  
2 radiation for those things and there's no people out  
3 there, but they're kind of important stuff.

4                   MR. PAL: This is Amar Pal. And the lead  
5 for the EQ.

6                   When we asked the question about  
7 additional details on the -- temperature on  
8 electrical equipment including computer I&C  
9 equipment, will be determined for the ESBWR.

10                  MEMBER STETKAR: Okay. So it's a general  
11 --

12                  MR. PAL: It's a general question. So  
13 should that cover the --

14                  MEMBER STETKAR: As long as they cover  
15 the equipment located in those three --

16                  MR. PAL: Areas.

17                  MEMBER STETKAR: -- areas, that's  
18 important.

19                  MR. PAL: Yes.

20                  MEMBER STETKAR: Okay. Thanks.

21                  MR. O'DRISCOLL: Okay. Moving to the  
22 second bullet. Another open issue is a description  
23 of the controls used to maintain the passive heat  
24 sink configuration and the heat load assumptions  
25 during life of the plant. So moving forward how do

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1 you control these walls?

2 ITAAC needed to update and validate the  
3 design basis calc with as-built dimensions for the  
4 reactor building. There is no ITAAC right now, so we  
5 need to have a similar type of ITAAC.

6 The next issue we're looking at is the  
7 post-accident control room habitability area air  
8 quality. And what the staff is asking is will the  
9 air quality be acceptable in the control room  
10 habitability area at the end of the end of a 72 hour  
11 cooling period? And again, the key question the  
12 staff asked itself for this feature is to determine  
13 reasonable habitability acceptance criteria for air  
14 quality: Quality of air, quantity of air supply that  
15 should be used, the carbon dioxide levels that should  
16 be used.

17 Determine if there is assurance of air  
18 distribution and mixing.

19 Determine if the required levels of  
20 detail -- when the required level of detail is  
21 required in the DC and related to the design features  
22 that are proposed.

23 And determine level of configuration  
24 control needed if you need to put the room in a  
25 certain configuration to maintain your assumptions.

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1           The staff review, again, approach was to  
2 review the proposed performance goal and review the  
3 performance design features to assure that goal was  
4 met and identify insights in the analyses versus  
5 design basis information and ITAAC. And assure that  
6 that information in the design for certification  
7 document.

8           The applicant actions completed thus far  
9 are:

10           For air supply, distribution and mixing  
11 they stated in tier 2 that the air quality adheres to  
12 ASHRAE 62.1 air quality. And that's for 21 people in  
13 the control room;

14           They've added a remove exhaust below the  
15 occupied zone in the control room habitability area.

16           And what that does it serves to assure that there  
17 will be -- the air flow will be guaranteed. From the  
18 EFU will actually get down and go out through the  
19 room;

20           The EFU air delivery will be optimized to  
21 deliver air to occupied zones of the control room  
22 habitability area. They made that commitment in tier  
23 2.

24           They've also since the last time you were  
25 briefed they made the power supply RTNSS for the

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1 post-72 hour period for the EFUs. That was an open  
2 issue the last time you were briefed. It was a  
3 portable battery system was proposed at that time and  
4 now it's a RTNSS diesel.

5 CONSULTANT WALLIS: This is a dedicated  
6 diesel that does nothing except power these --

7 MR. O'DRISCOLL: No. It's the ancillary  
8 diesel -- I believe it's the ancillary diesel  
9 generator. It's a load now on the ancillary diesel  
10 generator.

11 CONSULTANT WALLIS: Okay.

12 MR. O'DRISCOLL: The open items associated  
13 with these items are:

14 We need more design and instrumentation  
15 requirements for the remote exhaust path. As you've  
16 seen before, it's illustrated as, more or less, a  
17 box. I'm not sure exactly what that is. We need to  
18 do an SRP 9.4.1 review on that equipment to make sure  
19 because it's going to be safety-related, I assume;

20 Other details or actions to promote  
21 convective mixing and prevent short cycling of supply  
22 air. Basically is there anything required as far as  
23 closing control room habitability area doors to make  
24 the air flow per their design intent?

25 And details of the design intent of the

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1 airflow, and also how are they going to optimize this  
2 airflow. Basically on that is that they got a lot of  
3 insights from GOTHIC. They've defined the control  
4 room as a occupied zone. In other words, they made a  
5 subset of the control room habitability area and  
6 called it the control room occupied zone, which is  
7 essentially the main control room from the raised  
8 floor six feet up. And they said that area would be  
9 the area of concern.

10 So the issue is is to get that  
11 information into tier 2 and to make sure the EFUs are  
12 optimized to served that area.

13 And that's all I have.

14 MEMBER STETKAR: Before you leave this  
15 one, you unfortunately hauled out the bullet on the  
16 power supply for the EFUs.

17 MR. O'DRISCOLL: Yes.

18 MEMBER STETKAR: And I'm now a bit  
19 confused. The EFUs right now are powered from the  
20 safety-related batteries. Is that correct? I don't  
21 know whether they're DC motors or AC motors, but  
22 they're powered from the safety-related batteries?

23 MR. WACHOWIAK: This is Rick Wachowiak,  
24 GEH.

25 Yes. they're powered by the batteries for

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1 the first 72 hours is the assumption. After 72 hours  
2 we have our ancillary diesel generators that we use  
3 to power various RTNSS class B loads for continuing  
4 things.

5 And so one of the loads that it powers is  
6 Q-DCIS. So when the safety-related batteries run  
7 out, the ancillary diesel generators can be turned on  
8 to continue to the operation at Q-DCIS which picks up  
9 the EFUs. And, in fact, it also picks up a small air  
10 conditioning unit on the roof to provide additional  
11 cooling for the control room.

12 MEMBER ARMIJO: Can you back to 17? You  
13 had a statement on a key question for your review is  
14 to determine reasonable habitability acceptance  
15 criteria. And my question is isn't this already  
16 defined what the reasonable acceptance criteria?

17 MR. O'DRISCOLL: Well, it's very defined.  
18 From a radiological point of view it is. But for  
19 air quality --

20 MEMBER ARMIJO: You don't have some other  
21 code or some other standard?

22 MR. O'DRISCOLL: No, it's not very easy to  
23 find. It's not all in one place.

24 MEMBER ARMIJO: What do we use for power  
25 plants today, nuclear plants? Do they have --

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1 MR. O'DRISCOLL: Well, they have inactive  
2 systems.

3 CHAIR CORRADINI: It's all safety-related  
4 active systems.

5 MEMBER ARMIJO: So they don't have any--

6 MR. O'DRISCOLL: Yes, it's not really a  
7 concern as opposed to here.

8 MEMBER ARMIJO: Okay. That answers my  
9 question.

10 CHAIR CORRADINI: Other questions by the  
11 Committee?

12 Okay. I want to thank the staff. I  
13 wanted to --

14 MR. GALVIN: I have one more  
15 presentation.

16 CHAIR CORRADINI: Oh, you do? I  
17 apologize.

18 MR. GALVIN: Yes.

19 CHAIR CORRADINI: I missed that.

20 MR. GALVIN: We're going to have a one  
21 page presentation, right?

22 CHAIR CORRADINI: Okay. Oh, I'm sorry. I  
23 missed it.

24 MR. FORREST: My name is Edwin Forrest.  
25 And I'm going to talk about reactor building mixing.

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1 And it's important because in the design basis  
2 analysis for a LOCA accident there's an assumption on  
3 the dilution that comes from the secondary  
4 containment. And the assumption that GE is proposing  
5 is 50 percent mixing. And the way that's achieved is  
6 by reducing the secondary containment volume to a  
7 volume of about 50 percent. So it goes from 806,000  
8 cubic feet down to 400 and something thousand cubic  
9 feet. And that's done in the design basis analysis.

10 Now to justify this we have to make some  
11 assumptions about what the dilution within the  
12 reactor building is. To do this we agreed in NUREG-  
13 1242 that as the staff's safety evaluation for the  
14 upper URD, that we would consider holdup in the  
15 reactor building and we would not require a standby  
16 gas treatment system that draws the reactor building  
17 down. But we did this for a price. We put a  
18 requirement that the building must be a concrete  
19 steel well built structural thing. It must be tested  
20 periodically at a quarter inch to an exfiltration  
21 rate. And that exfiltration rate should be no more  
22 than 25 percent of the volume of the reactor  
23 building.

24 In this case the reactor building is the  
25 contaminated portion of the reactor building. It

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1 does not include the clean area of the reactor  
2 building. It does not include the refueling pool area  
3 of the reactor building.

4 The staff noticed that GE requested  
5 essentially 50 percent volume per day exfiltration  
6 rate which translates to 300 cfm, which is the number  
7 they included in their design basis LOCA analysis.

8 Staff took this under consideration and  
9 realized that the contaminated area of the reactor  
10 building is almost entirely enclosed within the clean  
11 areas of the reactor building. So there's another  
12 barrier. And there's very little potential for wind  
13 loading on the contaminated portions of the reactor  
14 building.

15 So in essence, we have considered the 50  
16 percent volume per day, 300 cfm leakage as acceptable  
17 to the staff.

18 GE submitted a detailed comprehensive  
19 GOTHIC analysis of the reactor building and  
20 particularly the contaminated area. It's room-by-  
21 room, it's exhaustive. It looked, I think, at every  
22 penetration, doorjamb, door crack, HVAC duct that you  
23 can imagine.

24 It used generally more conservative areas  
25 for these gaps and things than really would exist,

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1 and this was part of their conservatism. And they  
2 applied the full 300 cfm leakage from the reactor  
3 building. And they used this GOTHIC analysis to  
4 determine the amount of holdup that could be  
5 anticipated.

6 We realize that there are a lot of  
7 assumptions that could be made in these type of  
8 things. There were assumptions made, like on where  
9 the leaks occur and the total leakage rate from the  
10 primary to the reactor building would be .35 mass per  
11 day of the primary containment.

12 What they did was they took this .35 mass  
13 per day and they divided it among every penetration  
14 based upon the size of the pipe and the penetrations  
15 are prorated. And they accepted essentially in each  
16 room.

17 One of our concerns is real life you  
18 might not get that nice proportional split. You  
19 might get a lot higher in one room than another room.

20 And we started looking at these things an we asked  
21 for some sensitivity studies. Sensitivity studies  
22 like if you had higher leakage in one of the rooms,  
23 how does this effect it? If you had different sizes  
24 on your door gaps or different release point, or  
25 multiple release points?

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1           And GE came back with a fairly detailed  
2 assessment based upon a nominal GOTHIC analysis which  
3 show that the sensitivities to these parameters were  
4 small and in no case would they violate the amount of  
5 holdup that they were predicting. And the amount of  
6 holdup that they were predicting was essentially  
7 translated to around 70 percent or more in terms of  
8 dilution effect.

9           The staff did its own simplified type of  
10 assessment. We looked at some multiple room type  
11 things. We got results that were very consistent  
12 with the GOTHIC analysis.

13           We then looked at its translation to the  
14 50 percent mixing assumption that was put into the  
15 RADTRAD. And we found that the 50 percent mixing  
16 assumption was conservative. It was also what we  
17 normally would give to a power plant that had a  
18 standby gas treatment system once it had drawn down  
19 the secondary containment.

20           So it's not a number that we haven't used  
21 before. It sort of accounts for the fact that maybe  
22 there's portions of the contaminated building that  
23 don't come into play for the dilution effect.

24           And so the end result is that we feel  
25 comfortable with the approach used by General

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1 Electric. That they do have a robust containment.  
2 It is tested.

3 They also have administrative controls  
4 that assure that the doors maintain control within  
5 the contaminated areas. There's alarms in the  
6 control room. There's, I imagine, operator walkdowns  
7 on a periodic basis to assure that it's maintained in  
8 the configuration that's within the analysis. And we  
9 believe that there's ample conservatism in the  
10 results.

11 Thank you.

12 CHAIR CORRADINI: There's a question.

13 MEMBER STETKAR: And this is a bit beyond  
14 me, so I want to make sure I understand.

15 I think I heard you say that basically  
16 the analysis now takes credit for the clean areas to  
17 help in the holdup in the dilution.

18 MR. FORREST: I don't think I said that,  
19 John.

20 MEMBER STETKAR: Okay.

21 MR. FORREST: I think what I said --

22 MEMBER STETKAR: If it doesn't, I need to  
23 understand that.

24 MR. FORREST: I think what I said was  
25 that in terms of exfiltration rate --

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1 MEMBER STETKAR: Okay.

2 MR. FORREST: -- exfiltration is really  
3 caused by wind loadings on surfaces. And since the  
4 contaminated area of the reactor building is almost  
5 entirely surrounded by the clean areas of the reactor  
6 building, the surfaces that are available to wind  
7 loading are very few and far between.

8 MEMBER STETKAR: On the contaminated  
9 area?

10 MR. FORREST: On the contaminated.

11 MEMBER STETKAR: Okay.

12 MR. FORREST: And thus, it's hard to  
13 really get a differential pressure that would push  
14 you to the tested value of 300 cfm.

15 MEMBER STETKAR: Okay. Thanks. I don't  
16 have any more questions then.

17 CHAIR CORRADINI: Okay. That was a very  
18 complete one side. I might recommend this would be a  
19 nice way to do it from now on.

20 Any other questions from the Committee?

21 CONSULTANT WALLIS: Well, I'm still a  
22 little puzzled. Because in NUREG-1242 requires an  
23 exfiltration less than 25 percent and yet they asked  
24 for 50 percent. And you had a long explanation of  
25 why that was acceptable, but it still leaves it twice

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1 what it's in NUREG-1242.

2 MR. FORREST: NUREG-1242 is not a  
3 regulatory requirement, it's guidance in this case.

4 CONSULTANT WALLIS: I see.

5 MR. FORREST: And if the applicant is  
6 able to convince us by whatever means he uses; his  
7 methods that his approach is acceptable to us, then  
8 we have the ability to consider it and accept it.  
9 And that's what we've done in this case.

10 CONSULTANT WALLIS: Okay.

11 CHAIR CORRADINI: Other questions?

12 Let me review some of the things that I  
13 wrote down, and I hope the Committee will help me if  
14 I've missed something in terms of side notes that I  
15 had that we asked for clarification.

16 One was we're going to, we just did, got  
17 a paper copy of supplement 05 that we're going to  
18 look at. And I assume the consultants will get us,  
19 since they seem to be very thorough, their look at  
20 supplement 05 relate to that.

21 Also, there's some sessions that Graham  
22 had about what's happening relative to oscillations  
23 that cause differences in noncondensibles. What I  
24 heard GEH say was they thought that had something to  
25 do with fan performance or addition of waters into

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1 the PCC pool, but they were going to check and get us  
2 an explanation.

3 CONSULTANT WALLIS: Well, I think that's  
4 also being superseded by --

5 CHAIR CORRADINI: Well, I'm sure another  
6 river will show up, but we'll at S05.

7 The second thing was is that they've  
8 committed to at least getting us more information on  
9 the details of the drain pan. And where's Wayne?

10 You had a pictured. You volunteered that  
11 you had a picture. Is this a good time to show it,  
12 or do you want to wait and maybe we'll start off  
13 tomorrow with that?

14 MR. MARQUINO: Okay.

15 CHAIR CORRADINI: Okay. Details of the  
16 drain pan. And we also wanted to get some idea about  
17 the energy balance, why do we not need that sort of  
18 modeling in TRACG.

19 And then we left with the final thing  
20 that we wanted to get some implication on combustion.

21 And what I heard from the staff is this is still a  
22 work in progress that they're doing analysis, and  
23 they'll get back to us.

24 And the final thing is, let's see here,  
25 we asked for some details on the base summer case in

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1 terms of wall temperatures and potentially for one of  
2 he wide sensitivities at 88 degrees and 100 percent  
3 humidity sensitivity to look at wall temperatures  
4 versus other things. And what I hear is staff is  
5 staff is still evaluating these calculations by the  
6 applicant.

7 Have I missed anything?

8 MEMBER ABDEL-KHALIK: Can I add something  
9 for the containment analysis?

10 CHAIR CORRADINI: Sure.

11 MEMBER ABDEL-KHALIK: We need to  
12 understand the characteristic curve of the fans.  
13 Particularly the details of the ITAAC that will  
14 specify those characteristics. Because you have to  
15 couple whatever table you gave us with a specific  
16 density. And the problem that I'm having is that the  
17 operators are to start those fans early, the fans  
18 will not work. Because if you start with the fluid  
19 density is a lot lower than what you're assuming,  
20 which it corresponds to three atmospheres, then the  
21 head produced by the fan is going to be a lot less,  
22 and it's possible that it may not be able to overcome  
23 the ten inches of water in that pan.

24 So we need to understand how the  
25 characteristic -- the characteristic curve of that

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1 fan will be specified and exactly how the ITAAC will  
2 sort of confirm that the fan performance is what we  
3 want it to be.

4 CHAIR CORRADINI: So I want to make sure  
5 I've captured this. So it's not just the fan curve,  
6 you want to understand how its eventually going to  
7 captured in ITAAC for testing purposes?

8 MEMBER ABDEL-KHALIK: Right. Because the  
9 data that was specified in the table is incomplete  
10 without specifying the fluid density to go with it.  
11 And what we understood --

12 MR. WACHOWIAK: This is Rick Wachowiak  
13 from GEH.

14 I believe the way the ITAAC reads now is  
15 that you test it at ambient room conditions and then  
16 an analysis is performed to translate that to  
17 accident conditions. So I think the ITAAC does what  
18 you want it do. You just may not be clear on what  
19 analysis needs to be done to do that. But it's best  
20 to provide by test and analysis.

21 MEMBER ABDEL-KHALIK: That's fine. I  
22 think the information that we have right now does not  
23 allow an independent assessment as to whether or not  
24 these things will actually work if the operator turns  
25 the fan on before you get to the 72 hour point when

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1 the density is relatively high.

2 MR. WACHOWIAK: Right.

3 CHAIR CORRADINI: Got it. I think I've  
4 got it.

5 Okay. Everything. Graham, you had --

6 CONSULTANT WALLIS: The vacuum break  
7 temperature measurement to tell when its leaking.  
8 There seem to be some odd things about the TRAC  
9 model. And I think eventually there's going to be  
10 test, but are we going to not know whether it will  
11 work until we see the results of some test which is  
12 going to be what? A year from now or something?

13 CHAIR CORRADINI: Are you asking?

14 CONSULTANT WALLIS: Can we do something  
15 to get more assurance that that temperature  
16 measurement will be successful?

17 CHAIR CORRADINI: I guess I might state  
18 it differently. I would look to the staff to  
19 identify for us what they're satisfied with and then  
20 explain it to us so that we understand what their  
21 review was. Because if they're asking for a test and  
22 GE will do it, then we'll hear that from the staff's  
23 evaluation.

24 CONSULTANT WALLIS: So we're going to  
25 wait and see what the test --

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1 CHAIR CORRADINI: I think it's best we  
2 hear what the staff -- I don't think I want to ask  
3 the applicant to anything. I want to hear what the  
4 staff --

5 CONSULTANT WALLIS: I want to hear  
6 something about that the next time or sometime in the  
7 future from the staff.

8 CHAIR CORRADINI: Yes, I think so.

9 MEMBER ABDEL-KHALIK: I guess my concern  
10 about that is just like all instruments, you would  
11 like the response of an instrument to be a unique  
12 function of the quality that you are trying to  
13 measure. And I'm not sure that that delta T that  
14 they're measuring will be a unique function of the  
15 leakage rate.

16 Does it have to linear; it can be a  
17 complicated function as long as a unique function.

18 CHAIR CORRADINI: Other comments?

19 CONSULTANT WALLIS: Well, yes. I think  
20 the staff is on the ball about control room  
21 habitability. They seem to be asking the same kind  
22 of questions that we're asking.

23 CHAIR CORRADINI: Right.

24 CONSULTANT WALLIS: So I'm thinking that  
25 they're going to resolve this without too much input

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1 from us. And when they come back and everything is  
2 resolved, presumably there are still some questions,  
3 then we may not have any questions because it's going  
4 to be so clear cut. That's what I'm hoping will  
5 happen. They seem to be getting there. And it's not  
6 that difficult a question.

7 What surprised me was it wasn't until  
8 4:30 that we learned there was condensation on the  
9 walls and that's where the water went. We've been  
10 asking all day --

11 CHAIR CORRADINI: I assumed it, but I  
12 just wanted to make sure everybody else was assuming  
13 what I was assuming.

14 CONSULTANT WALLIS: You assumed there was  
15 condensation on the walls?

16 CHAIR CORRADINI: Yes. The wall's cold.  
17 It's got to go somewhere.

18 MEMBER BANERJEE: He's a condensation  
19 man. That's what he did for a living before he  
20 became an administrator.

21 CHAIR CORRADINI: Do you have any other  
22 comments, Dr. Banerjee, now that you've joined us?

23 MEMBER BANERJEE: I think the point that  
24 I was interested in coming in was the difference  
25 between the MELCOR and the TRACG calculations. And

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1 as far as I'm concerned that's a done issue.

2 CHAIR CORRADINI: Well, I want to remind  
3 the Subcommittee that that's the one thing that's  
4 going to result in a letter in the December member,  
5 which is the long term cooling. We had to address  
6 long term cooling for -- all the new plants are going  
7 to have to address it per the SRM from the  
8 Commission, but we're the first ones up to do it. So  
9 that's the one thing I wanted to hear. I was hoping  
10 to hear that both the applicant and the staff had  
11 thought it through.

12 MEMBER BANERJEE: I think they told us a  
13 convincing story.

14 CHAIR CORRADINI: Yes.

15 MEMBER BANERJEE: And the differences  
16 that still existed could be explained. I mean I  
17 haven't looked into it in any detail.

18 The concern I still have, apparently the  
19 staff had it before, was what's happening to the  
20 various noncondensibles, what are their compositions  
21 and lower flammability limits and things like this.  
22 It may or may not be something of importance, but it  
23 will be important to get that data and see.

24 There could be local regions where it  
25 could be above LFL. If so, we should know.

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1 MEMBER ARMIJO: Mike, just another thing.

2 For the next letter I think we should include the  
3 resolution on Chapter 15 radiological analysis. That  
4 thing looks like it's been done very well.

5 CHAIR CORRADINI: Well, I wasn't planning  
6 to write, so just to make sure we're clear. I'm not  
7 planning to write an interim letter. I'm simply  
8 addressing the requirement by the Commission on long  
9 term cooling. Just that.

10 MEMBER ARMIJO: Okay.

11 CHAIR CORRADINI: Other than that, my  
12 thought is not to write interim letters until we're  
13 pass interim and we're near final.

14 CONSULTANT KRESS: Well, put this on your  
15 list.

16 CHAIR CORRADINI: Yes, sir. Okay.

17 If we don't have anything else, we'll  
18 adjourn until tomorrow.

19 CONSULTANT KRESS: I have --

20 CHAIR CORRADINI: Oh, I'm sorry. Tom, I  
21 didn't see you.

22 CONSULTANT KRESS: You know, I originally  
23 felt --

24 CHAIR CORRADINI: That I had adjourned.

25 CONSULTANT KRESS: -- that because the

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1 fan was needed to meet the GDC on rapid draining down  
2 the pressure, I don't think the GDC is for long term  
3 cooling. It doesn't specify it's 72 hours. And I  
4 still think it ought to be a safety component. But  
5 the staff doesn't seem to agree with me --

6 CHAIR CORRADINI: I think I sensed that  
7 when you asked the question earlier today. They're  
8 treating it as RTNSS since it's outside the 72 hour  
9 per the regulation.

10 CONSULTANT KRESS: But I don't see that  
11 in the GDC.

12 CHAIR CORRADINI: Maybe we should ask for  
13 the staff to explain. But my sense of it is this is  
14 based on the Commission's redefinition of what can be  
15 safety or does not have to be safety, or does not  
16 have be in terms of a safety system. But does any of  
17 the staff have --identify yourself with sufficient  
18 clarity and volume.

19 MR. QUEEN: I think in light of the  
20 Commission's policy on advanced reactors would  
21 encourage inherently passive designs and also in  
22 light of the police on the safety stable shutdown of  
23 being a hot condition rather than a cold condition,  
24 we've basically come to the conclusion that this  
25 system that they provided does meet GDC-38 by

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1 reducing the pressure and keeping it acceptably low.

2 CONSULTANT KRESS: Just a difference in-

3 -

4 MS. CUBBAGE: But as far as the timing on  
5 whether it's at 72 hours versus at time zero, our  
6 conclusion is that it's acceptable for it to be  
7 RTNSS.

8 CONSULTANT KRESS: The other thing I  
9 wanted to comment on was I'd raised the issue of  
10 iodine sequestering earlier.

11 CHAIR CORRADINI: Yes.

12 CONSULTANT KRESS: I particularly thought  
13 I was very positively impressed with the work done by  
14 Sandia and Jay Lee. I don't see how you could do  
15 that any better. And they put the issue to rest, I  
16 think.

17 CHAIR CORRADINI: Okay. Good. What I  
18 heard is the same kind of relative to what Sam had  
19 said.

20 CONSULTANT WALLIS: I say that Jack Tills  
21 is very helpful. It was worth saying at this point.

22 But even without that, I think we did have questions  
23 remaining from the GEH presentation.

24 CHAIR CORRADINI: Other comments? I  
25 didn't mean to cut you off. It got quiet, so I

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1 thought we were done.

2 Okay. So we'll adjourned until tomorrow.

3 And we'll talk about PRA.

4 (Whereupon, at 5:11 p.m. the Subcommittee  
5 meeting was adjourned, to reconvene tomorrow,  
6 November 18, 2009.)

7

8

9

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# ESBWR Containment

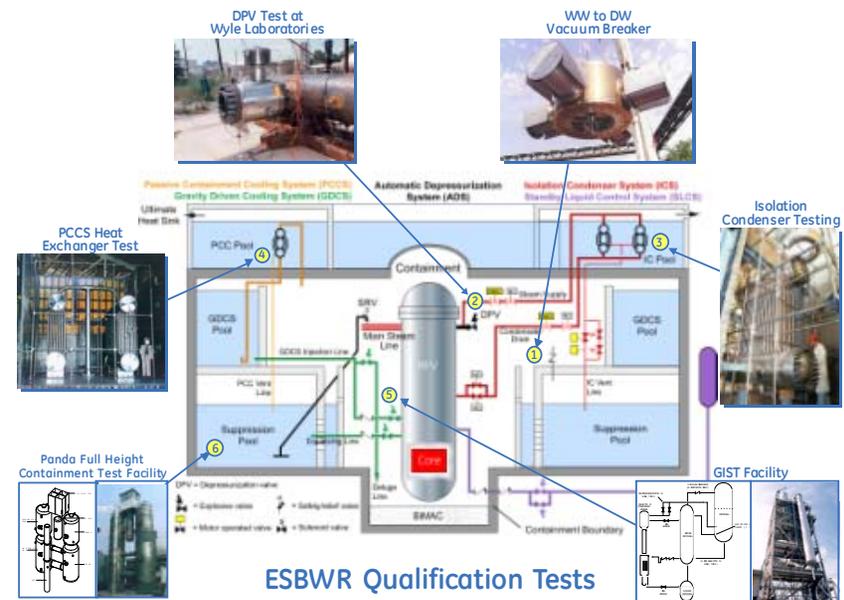
## ACRS Meeting

Wayne Marquino

Matt Solmos

November 17, 2009

GE-Hitachi Nuclear Energy



HITACHI

GEH Proprietary Information removed

# Agenda

- Staff & ACRS observations on TRACG model post 72 h, from June 2009
- Vacuum Breaker Leak Detection
- Design features for Radiolytic Gases in Piping & Heat Exchangers

# RAI 6.2-139 -Corrected

## Level 34, Ring 6 curve on Figure 9

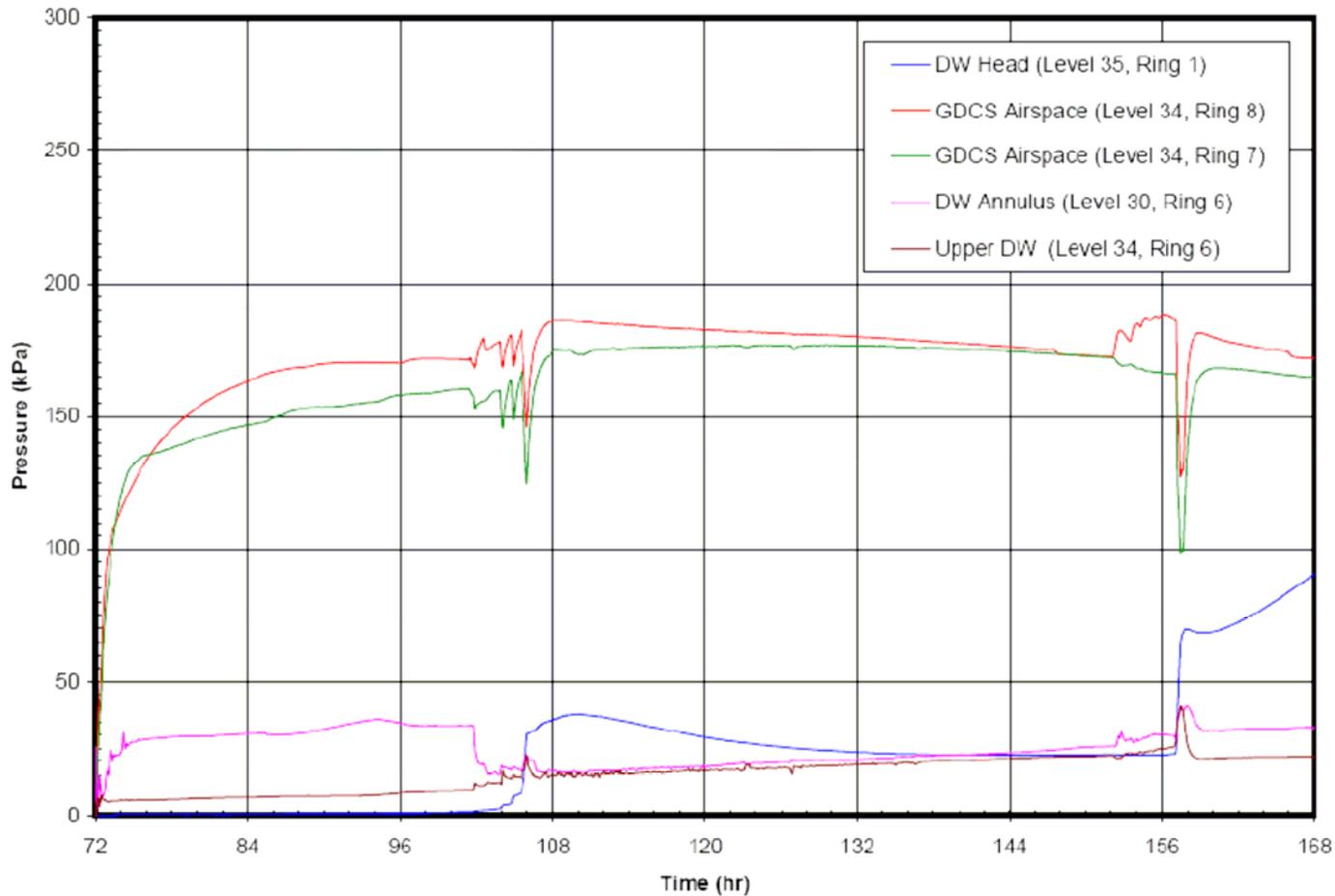


Figure 9. NC Gas Pressures in DW Annulus, DW Head and GDCS Gas Space

# TRACG/MELCOR comparison

## RAI 6.2-140 S5

- Defined Head/Flow characteristic for fan which envelopes analysis
- Updated detailed results for the post 72h depressurization for NRC staff review to DCD Rev 6, 4 of 6 fans operating

# Staff & ACRS observations on TRACG model post 72 h, from June 2009

- DW Head volume distribution & Elevation of top of DW
  - > Elevation of the bottom or Upper DW cells are above the top of DW
  - > TRACG volume fraction assigned to the top level Upper DW cells is small fraction of the geometric volume
  - > 10% of DW Head volume extends into ring 5 of TRACG model
  - > 0-72 h analysis contains bounding non-mechanistic features:  
Double pipe in GDCS airspace &  
All NC purged to WW @ 72 h

# Staff & ACRS observations on TRACG model post 72 h, from June 2009

- Renode upper DW & PCC inlet & GDC airspace to DW head connection > Smaller Reduction in DW pressure
- Move MSL break & DPV pipe exit to DW different Radial cells > No significant change
- Move GDCS airspace to lower DW > Larger reduction in DW pressure

# Evaluations to reconcile TRACG/MELCOR results

- PCC Power
  - > Slows reduction in DW pressure
- Fan Characteristic
  - > 10% Less Rated head
    - Slightly slowed reduction in DW pressure
  - > 10% Less Rated flow
    - No Sig. Effect
- TRACG Wetwell heat loss to Reactor building similar to MELCOR

# Summary

- Staff & ACRS observations on nodalization addressed
- TRACG and MELCOR use different models for PCC heat transfer
- Both predict the ESBWR containment pressure is reduced via PCC fan operation, and continues to reduce through the 30 day evaluation

# Detecting vacuum breaker leakage

Type tests will be conducted to determine the temperature setpoints at analytical limit.

- > DW & WW conditions over 72 hours will be tested
- > TRACG analysis demonstrates concept, doesn't establish setpoints
- > TRACG inputs provided to NRC staff

Extension of VB inlet into WW airspace cools low flowrate leakage and distinguishes temperatures from from high flow

Post 72 h PCC fan operation, or operation of RWCU/SDC will reduce DW pressure, and eliminate DW>WW leakage

# Hydrogen radiolytic accumulation chapter 1

## Generic Issue 195

- Review of Operating Experience is an integral part of ESBWR System Design, and GEH has already performed preliminary reviews on a system-by-system basis.
- The findings and recommendations from these reviews are being tracked and GEH procedures will ensure that they are dispositioned during the detailed design of the plant.
- Items such as hydrogen buildup in the PCCS have been identified as an issue to be addressed during detailed design. (See excerpts at left from GEH OER-SSR 07-0004.)

# Hydrogen radiolytic accumulation

## chapter 1 Generic Issue 195

- GEH has historical guidance on how combustible gas accumulation has been addressed in past designs.
- Schedule has reserved time for future design reviews to address (among other things) issues identified in the OE review.
- During the design review process, various potential solutions are evaluated to determine the most effective way to address the issue of combustible gas accumulation.
- Appropriate industry codes will be applied to the PCC fan to prevent it posing an ignition source



Presentation to the ACRS ESBWR Subcommittee

**ESBWR Design Certification Review  
MELCOR DBA Calculations**

Presented by

Harry A. Wagage, NRO/DSRA/SBCV  
Jack Tills, Sandia National Laboratories

November 17, 2009

# Project and Technical Review Team

- Project Managers
  - Ilka Berrios, Chapter 6 Project Manager
  - Amy Cubbage, ESBWR Lead Project Manager
- Technical Reviewers
  - Harry Wagage, NRO/DSRA/SBCV - Lead Technical Reviewer
  - Allen Notafrancesco, RES/DSA/FSTB
  - Hossein Esmaili, RES/DSA/FSTB
  - Jack Tills, Consultant, JTA Inc.

# Purpose

- To present comparison between TRACG and MELCOR for ESBWR containment long term heat removal
- Discuss remaining open issues

# Status

- Completed MELCOR Confirmatory Analyses
  - Gained understanding of differences in trend of TRACG and MELCOR long-term containment pressure
- Differences remain for the pressure drop at 72 hours
- Open RAI 6.2-140 Supplement 5
  - Based on insights from MELCOR Studies
  - Ensures that Design Basis is documented in DCD
  - GEH response pending

# Previous Containment Pressure Calculations

## [Comparison from 6/2009 for Rev 5 (RAI)]

6 Fans Operational: 1 Fan in each PCCS HX Loop  
 MELCOR TRACG

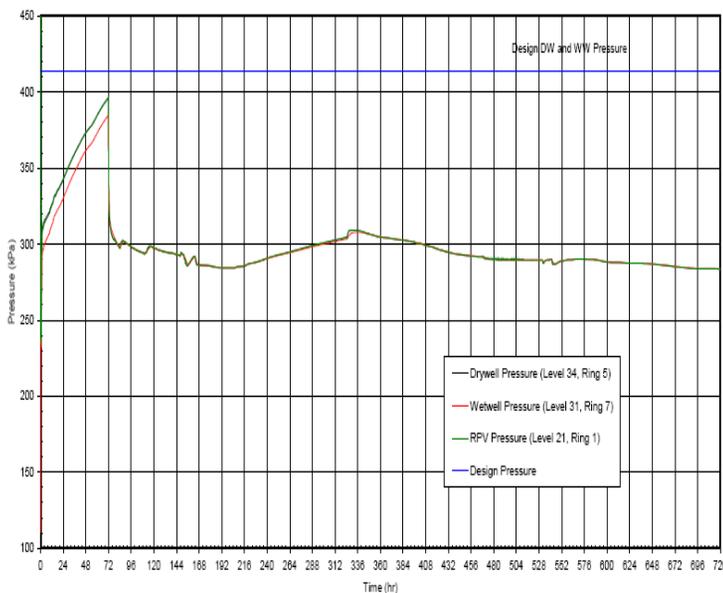
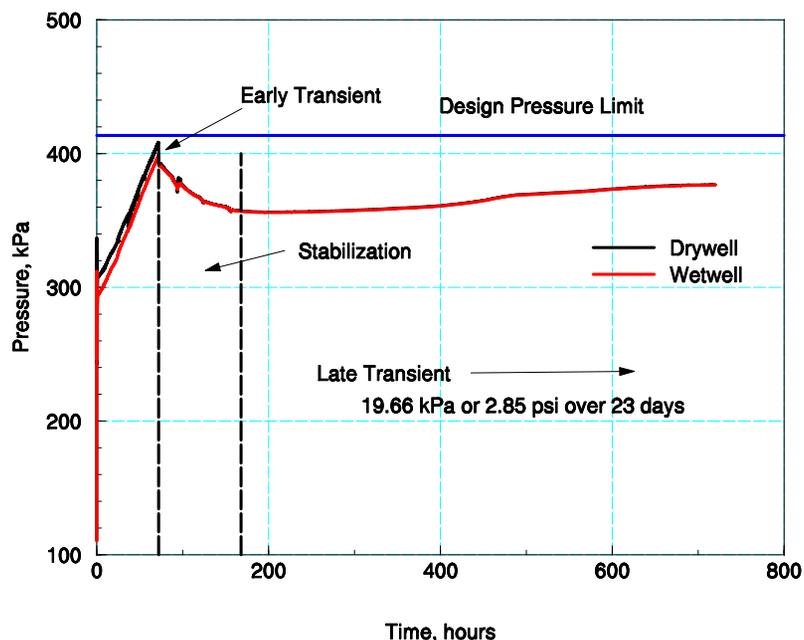


Figure 6.2-140 S04-C1 Main Steam Line Break, 1 DPV Failure (Bounding Case) – Containment Pressures (30 days)

Constant Upper Pool Refill @ 200 gpm  
 Fan flow fixed at 200 cfm  
 November 17, 2009

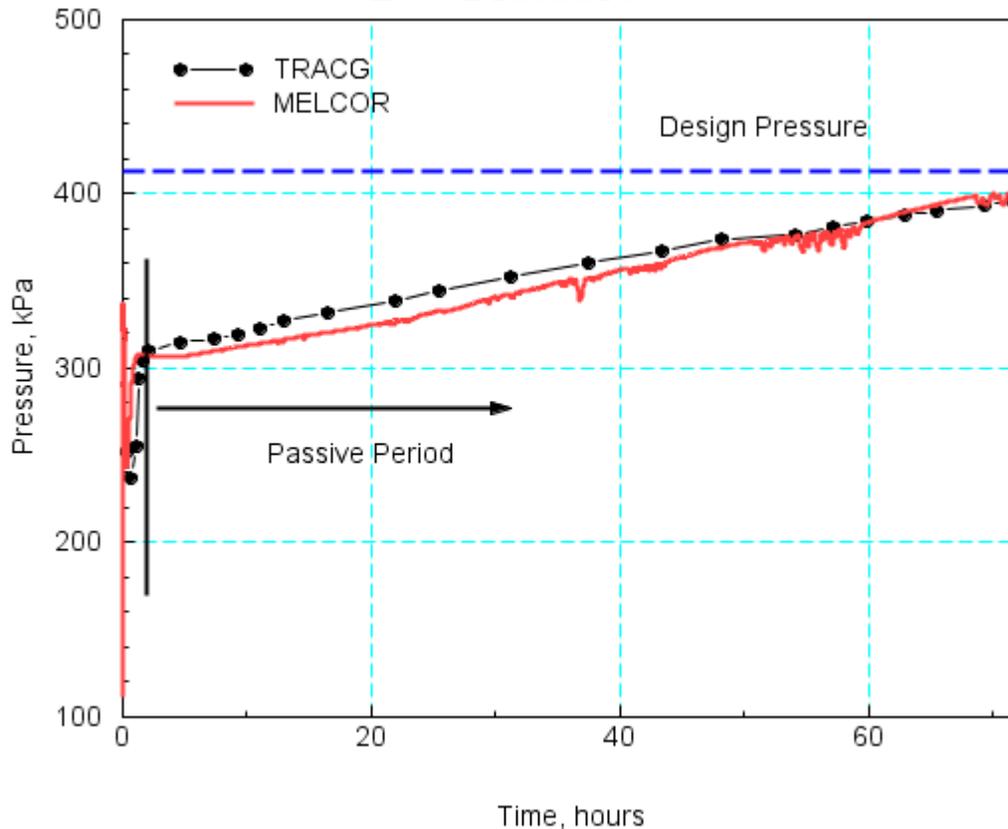
Refill Management  
 TRACG Semiscale Pump Option

# Presentation Outline

- MELCOR DBA calculation for ESBWR Long-term Passive Period (peak pressure)
  - Long-term cooling phase compares well with DCD TRACG results to 72 hours [DBA (audit) and confirmatory calculations are equivalent]
- Intervention Period Revised Plant Model (72 to 720 hours) for MELCOR/TRACG (DCD Rev 6) comparisons; i.e., confirmatory
  - Updated input for TRACG fan curve with variable fan outlet submergence / PCC pool refill management capability
  - PCC/IC pool with multi-laying to track saturation temperature with depth
  - Include a maximum rule for mixed/transition heat transfer correlations
- MELCOR Plant Model for Intervention Period
- Confirmatory calculation to compare MELCOR/TRACG results with 4 fans (upper pool refill management, without GDCS pool condensate trays)
- Calculations to investigate remaining differences between MELCOR and TRACG (DCD Rev 6)
- Bounding Intervention DBA Calculation (Audit) for Rev 6 with 4 fans (3 to 30 days) based on actual design and function

# Figures-of-Merit for DBA (audit) Bounding Calculation [Passive Period: 0 to 72 hours]

MSLB with 1 DPV failure  
DW Pressure



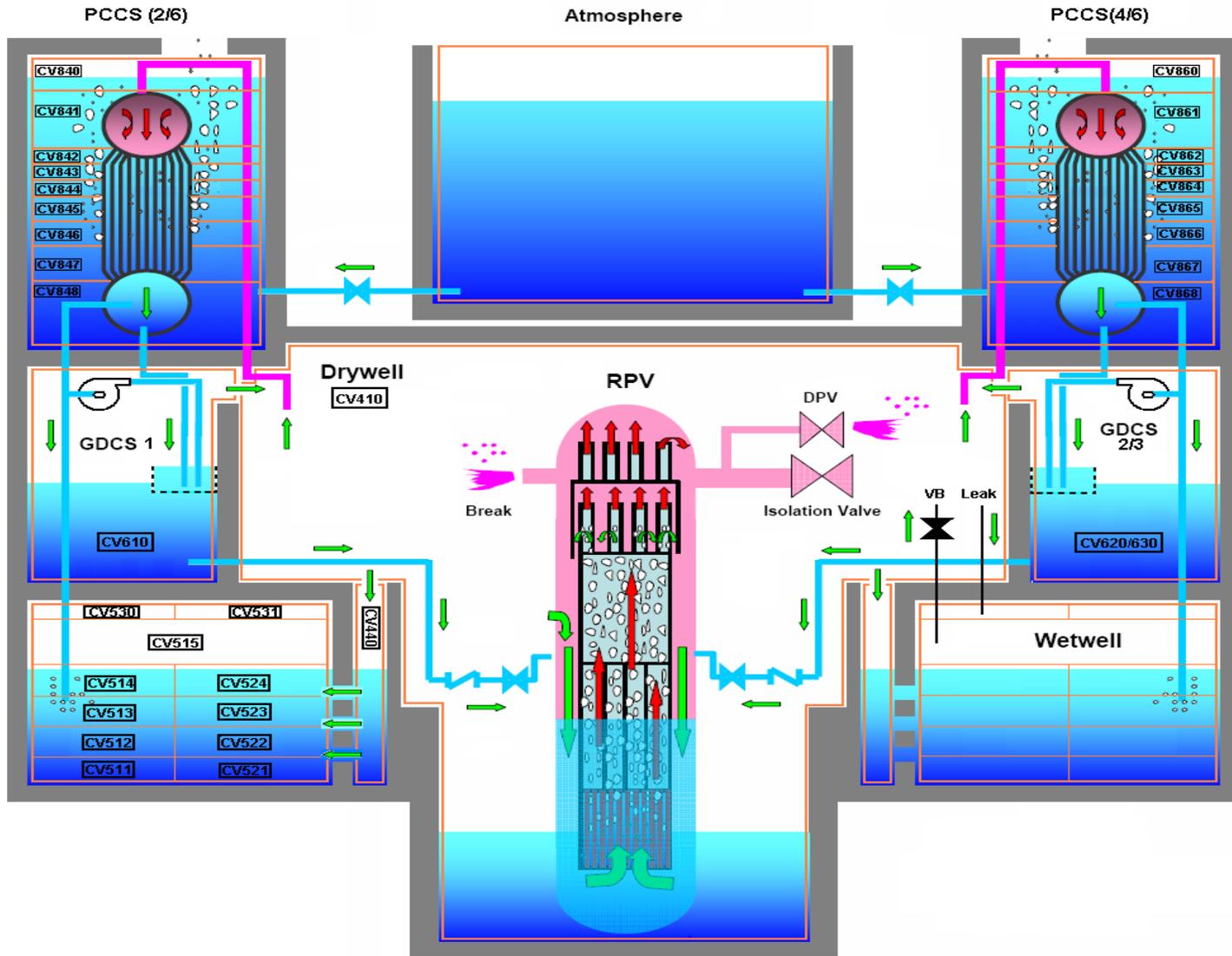
DCD Rev 6

Peak Pressure / Margin  
 396.25 kPa / 5% (TRACG)  
 400.03 kPa / 4% (NCG adjust)  
 Pressure trend at peak  
 Increasing

MELCOR DBA  
(audit/confirmatory)

Peak Pressure / Margin  
 400.65 kPa / 4%  
 Pressure trend at peak  
 Increasing

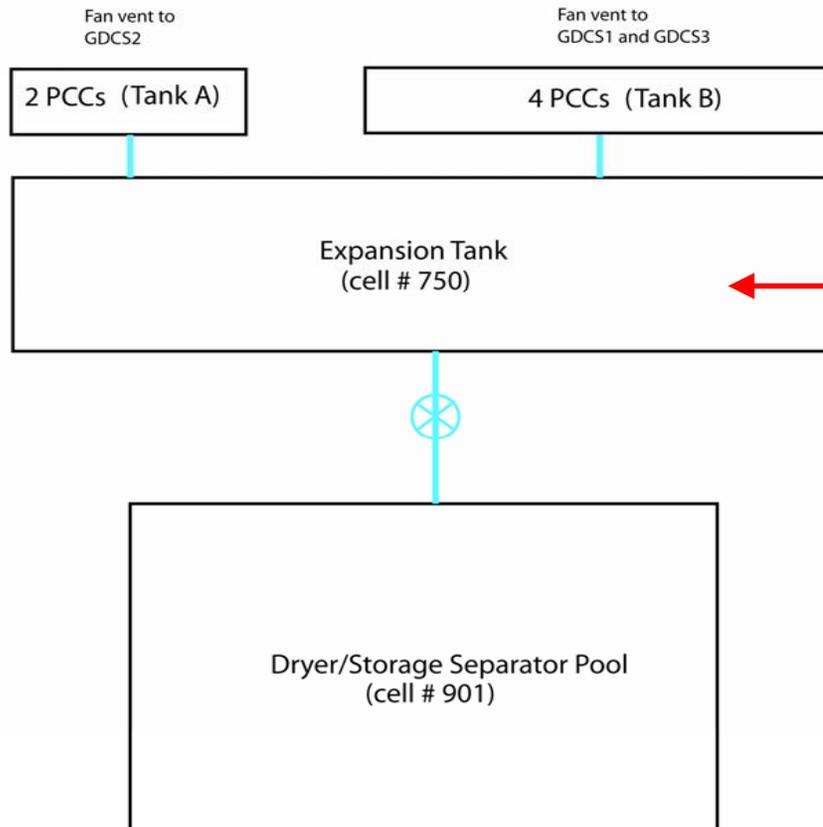
# MELCOR ESBWR Plant Model



# MELCOR ESBWR Plant Model (cont.)

## [External Pools]

### Water Tanks (Outside Containment)



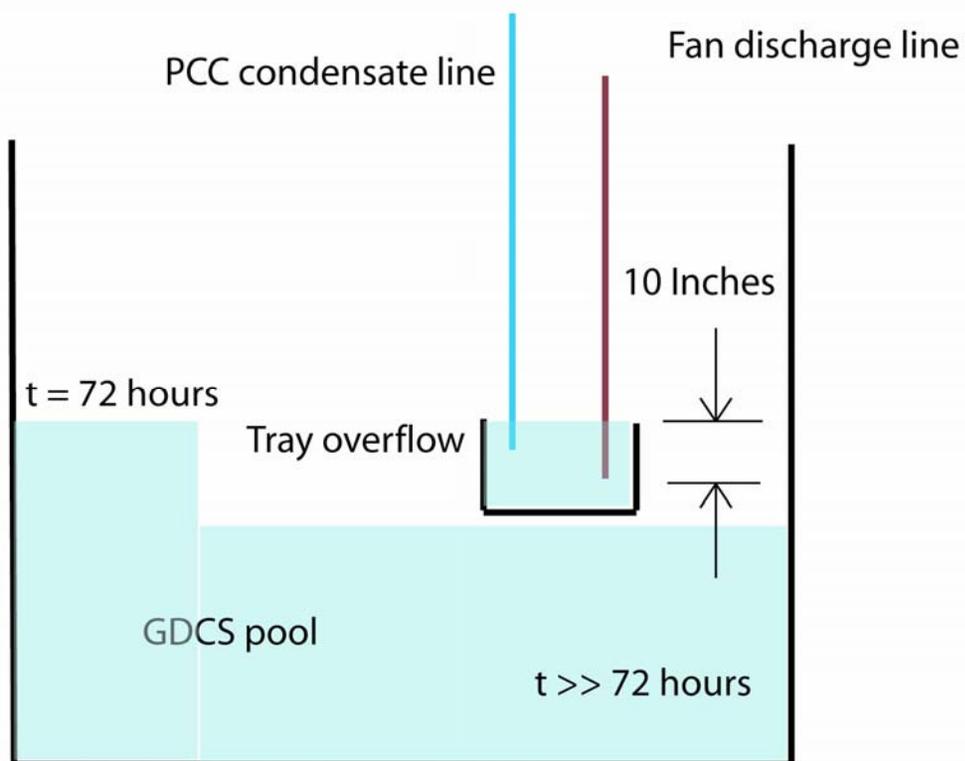
### DBA (audit) Basis

Refill @ 200 gpm post-3 days with no refill management

### Confirmatory Basis

Refill @ 200 gpm initially post-3 days followed by refill management (level at top of condenser tubes) consistent with TRACG simulation

# MELCOR ESBWR Plant Model (cont.) [GDCS Tanks]



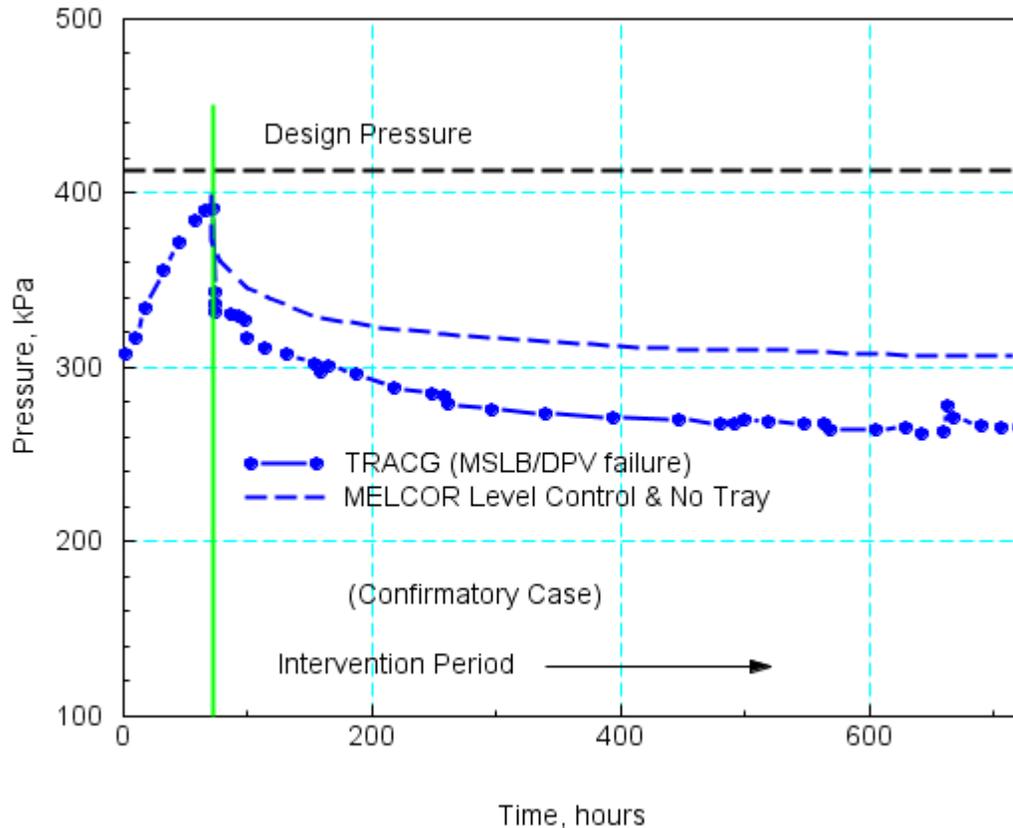
## DBA (audit) Basis

Fan vent elevation is actually directed to the GDCS air-space -- tray effect simulated with fixed 10 inch submergence for calculating fan flow (in TRACG, fan discharge enters the GDCS pool and affects the bulk pool temp.)

## Confirmatory Basis

Fan vent elevation set 10 inches below GDCS water Level at 72 hours – tray effect not simulated

# MELCOR Confirmatory Calculation (TRACG DCD Rev 6)



## DCD Rev 6 (TRACG)

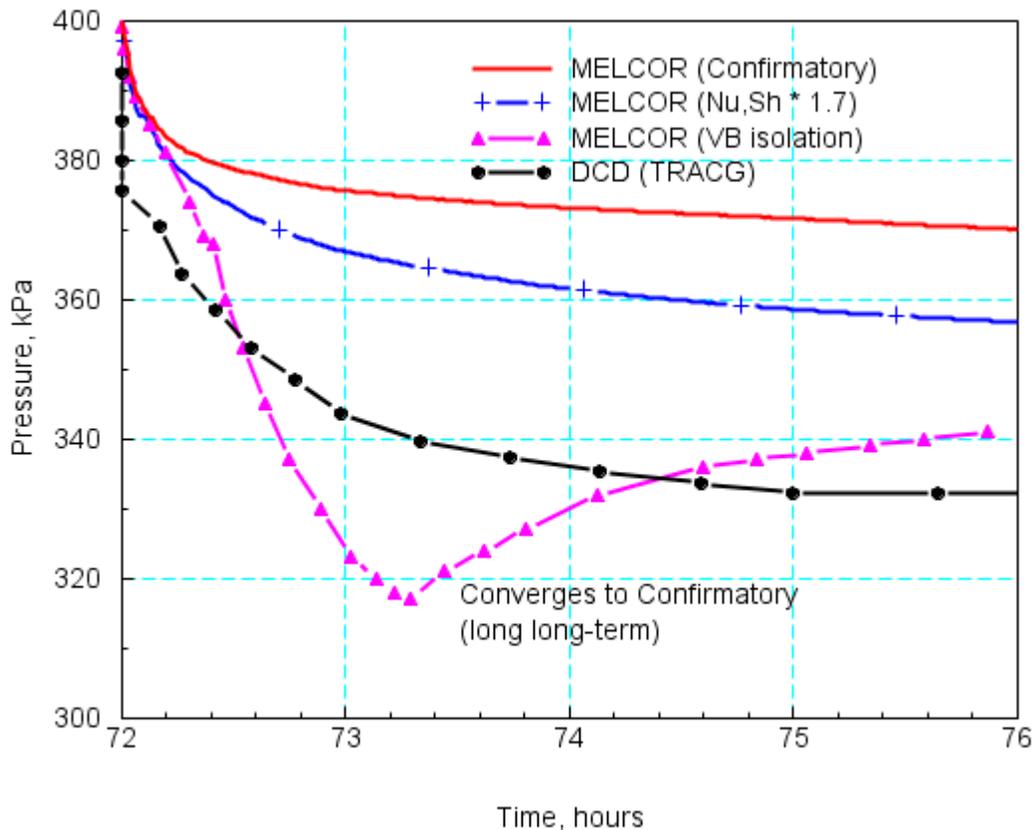
- pool level control (variant procedure)
- fan vent with varying submergence (variant design)

## Confirmatory Calculation

**MELCOR ESBWR plant  
with level control  
without GDCS pool tray**

- late time trends confirmed
- early transient “cliff” difference remains
- long long-term offset

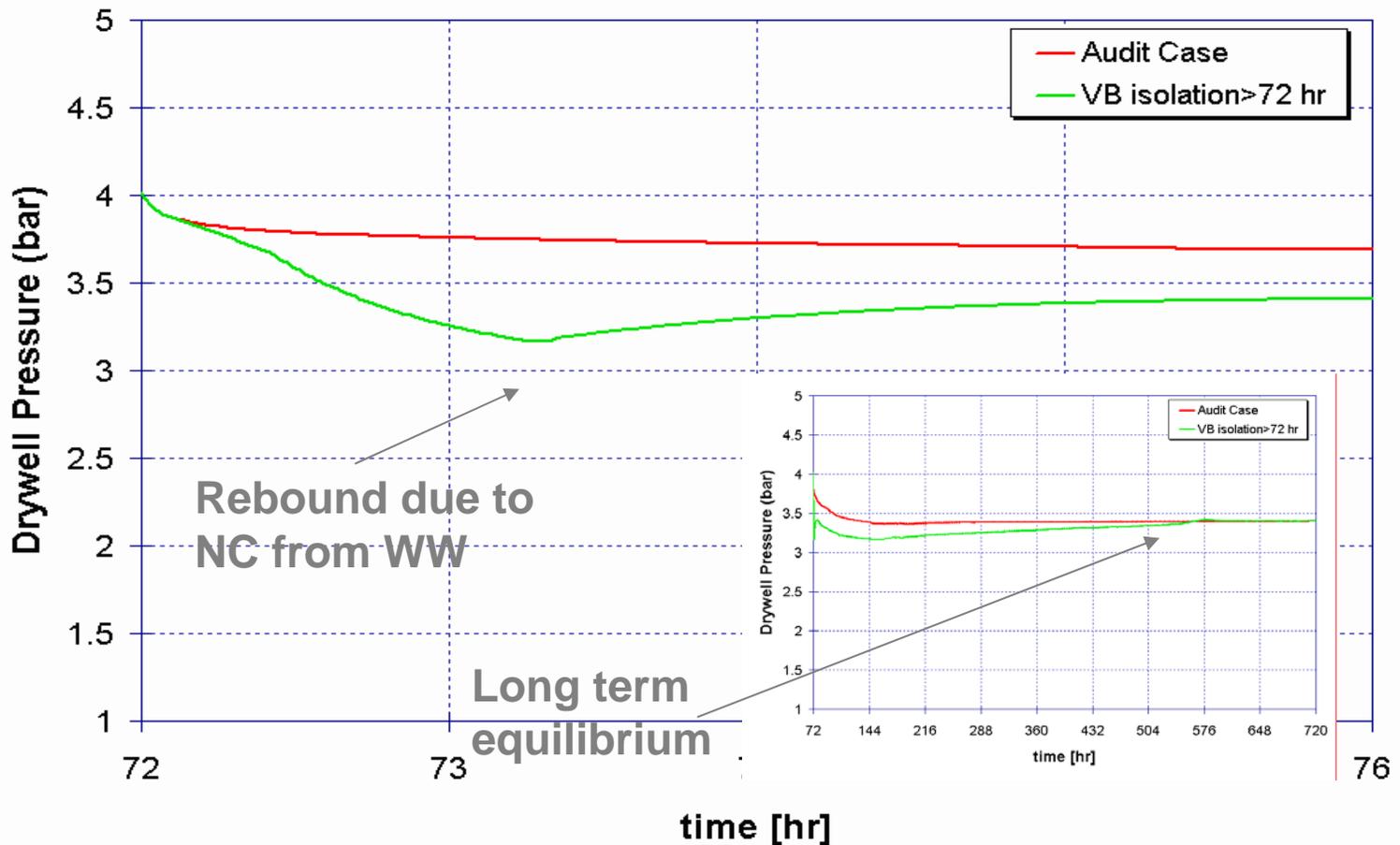
# MELCOR Calculations to Investigate “Pressure Cliff” Response



- Vacuum breaker open at ~ 8 minutes following fan activation (MELCOR)
- Significant sensitivity to VB activation in short-term, with later convergence to confirmatory case
- Significant incremental increase in PCC HMTA model does not reproduce severe “pressure cliff” response
- Prediction of “pressure cliff” during this transient period extremely difficult to assess (due to integral effects and lack of data for fan activation impact on PCC performance during plant operation)

# MELCOR Sensitivity Calculation for Case Without VB after 72 hrs

[Variation of PCC Inlet NCG concentration]

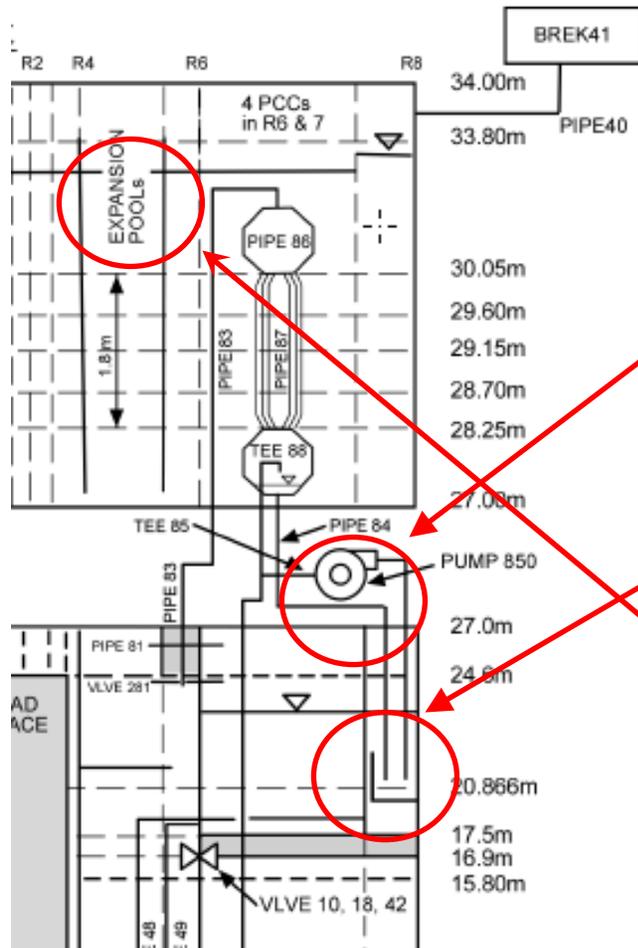


# Investigation to Resolve Long Long-term MELCOR/TRACG Pressure Offset

- Reviewed previous HTMA modeling for UCB/MIT single-tube tests to confirm accuracy of tube-side calculation
- Reviewed independent reports for HTMA/MELCOR modeling for 1) UCB single-tube tests and 2) PUMA test to confirm MELCOR PCC modeling basis
- Performed additional PANTHERS low flow calculations (ESBWR PCC nodalization) to show that MELCOR PCC prediction of heat removal is conservative by < 15% under plant conditions for long long-term application
- Applied the observed 10-15% conservatism in MELCOR PCC modeling to show this degree of conservatism can produce long long-term pressure offset of ~ 0.5 bar in DW pressure while removing all decay heat power

# Post-LOCA Containment Cooling and Recovery DBA (audit) Calculation Basis

DCD Rev6 TRACG Plant Model

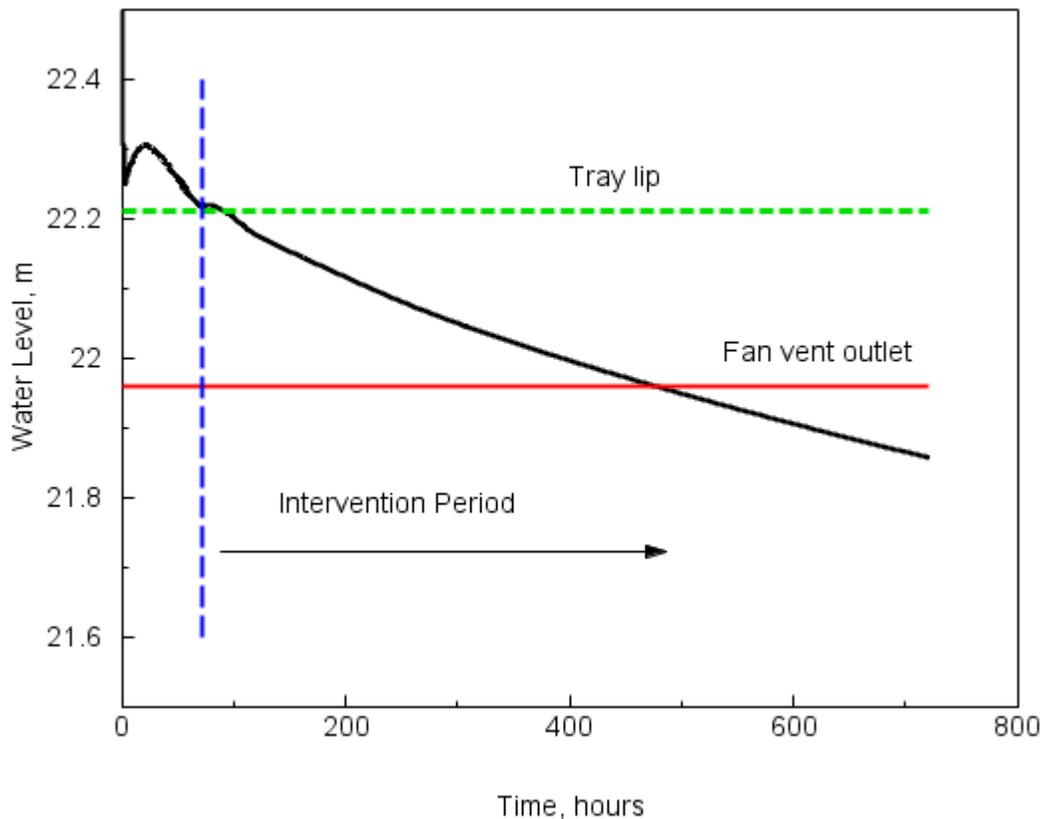


## Governing Conditions for Post-3day DBA (audit)

- Fan (TRACG Semiscale pump model)  
rated head =  $2000 \text{ m}^2/\text{s}^2$   
rated flow =  $0.5 \text{ m}^3/\text{s}$  per fan
- Tray in GDCS  
maintain vent submergence of 10 inches  
@ start of intervention period and  
throughout
- IC/PCC/Expansion pool refill  
refill at fixed rate = 200 gpm  
(with no level control anticipated, except  
for over-flow situation)

# MELCOR Calculated GDCS Water Level with Tray Simulation [DBA versus Confirmatory]

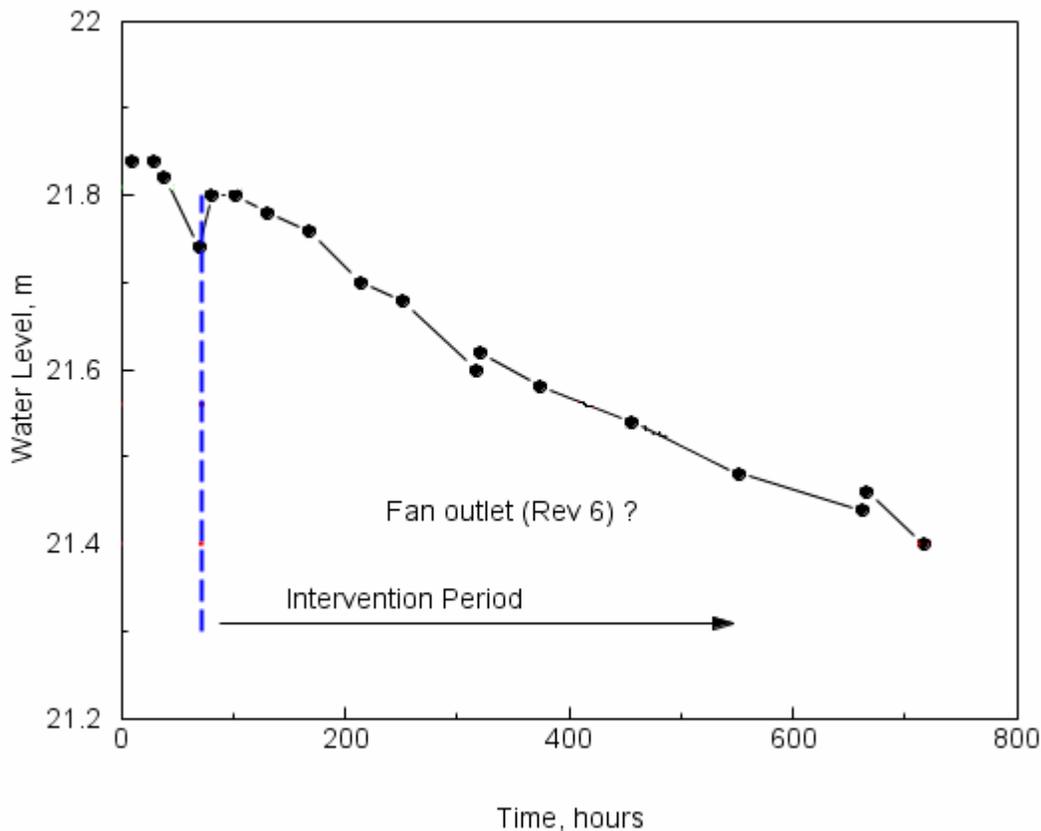
MSLB with 1 DPV failure  
GDCS Water Level



- Tray lip @ 10 inches (0.254 m) above fan vent outlet
- GDCS tank water level trends below fan vent outlet
- Recovery system design maintains fixed submergence
- MELCOR DBA simulates tray design by imposing a fixed 10 inch submergence during intervention period

# TRACG Calculated GDCS Water Level and Simulation of Vent Submergence

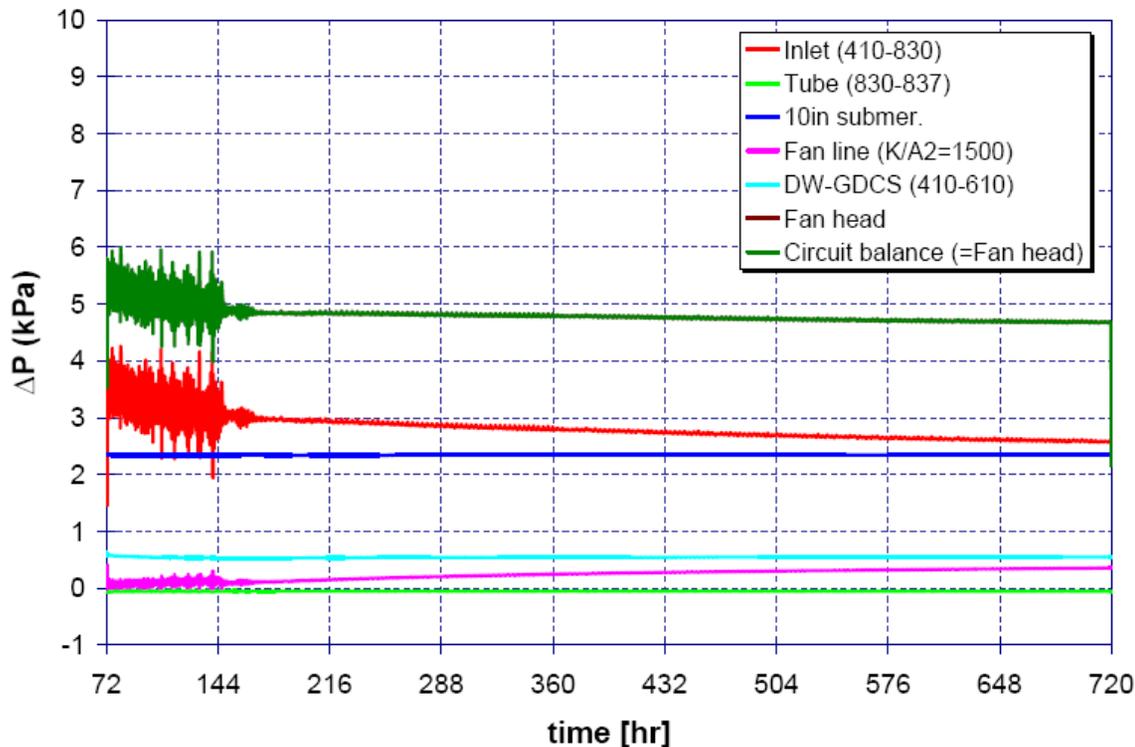
MSLB with 1 DPV failure  
GDCS Water Level



- Tray lip at GDCS level @ 72 hours not simulated (fan vent submergence variable)
- GDCS tank water level trends toward fan vent outlet
- Recovery system design maintains fixed submergence
- DCD Rev 6 (neglects tray lip design → fan vent modeled with varying submergence causing increased fan flow due to reduced head)

# Components of Fan Head Calculation

MELCOR Audit (MSLB with 1 DPV failure)



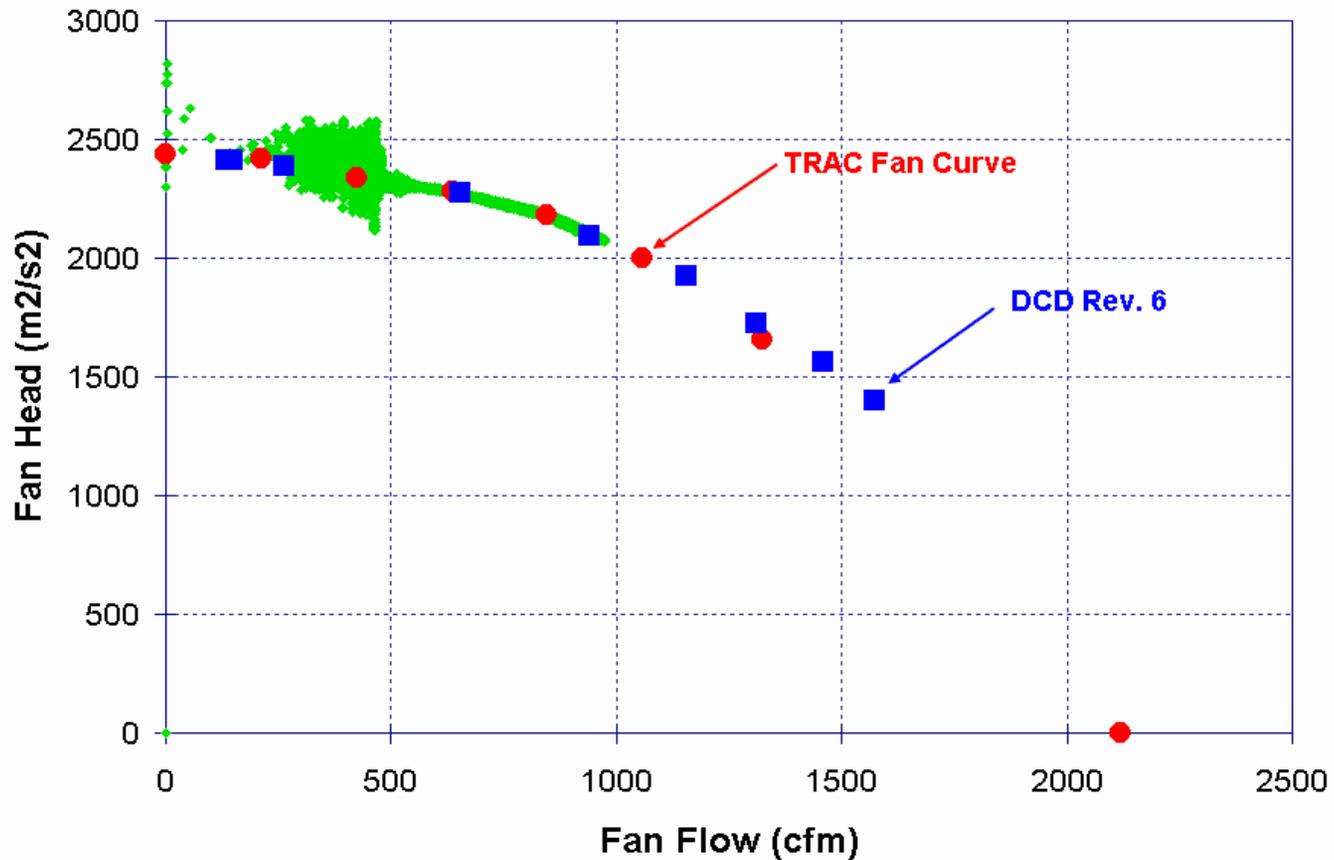
## Fan Head Calculation

PCC Inlet Line Loss  
+ Tube Loss  
+ Fan Line Loss  
+ Submergence Head  
- DW to GDCS Loss  
Fan Head (Circuit balance)

- Important contributors for head calculation (and flow)
  - PCC Inlet Line Loss
  - Submergence

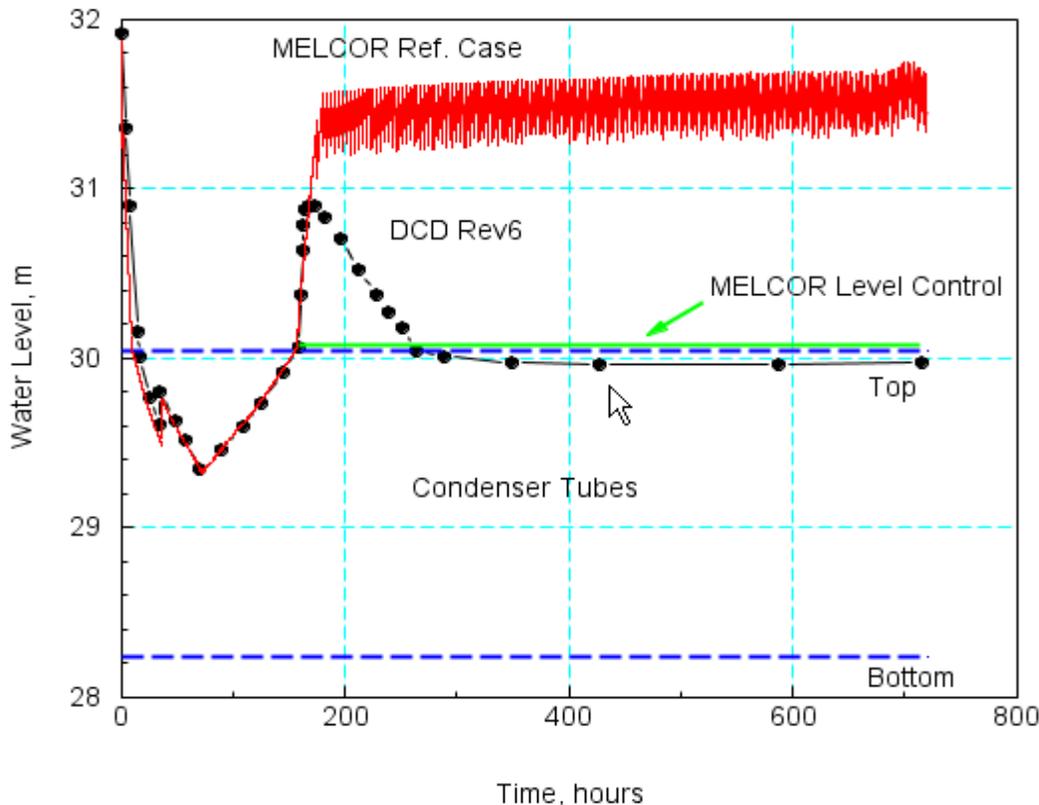
# MELCOR Calculated Fan Flow (Audit) [Intervention Period]

MSLB with 1 DPV failure



# Intervention Period Flood Profile

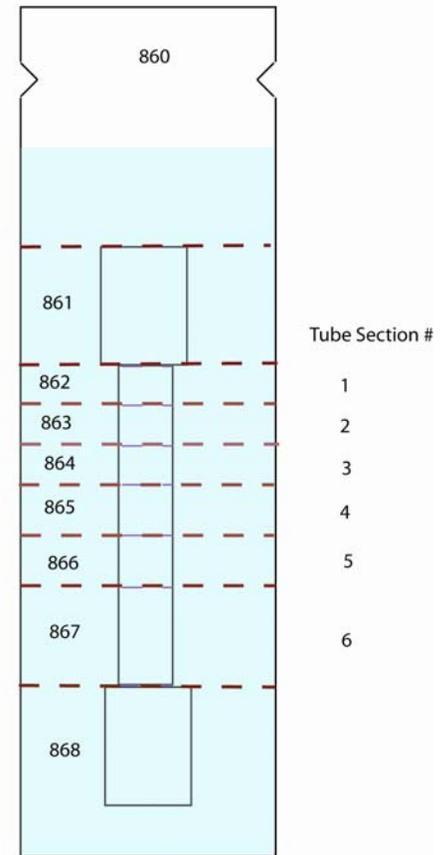
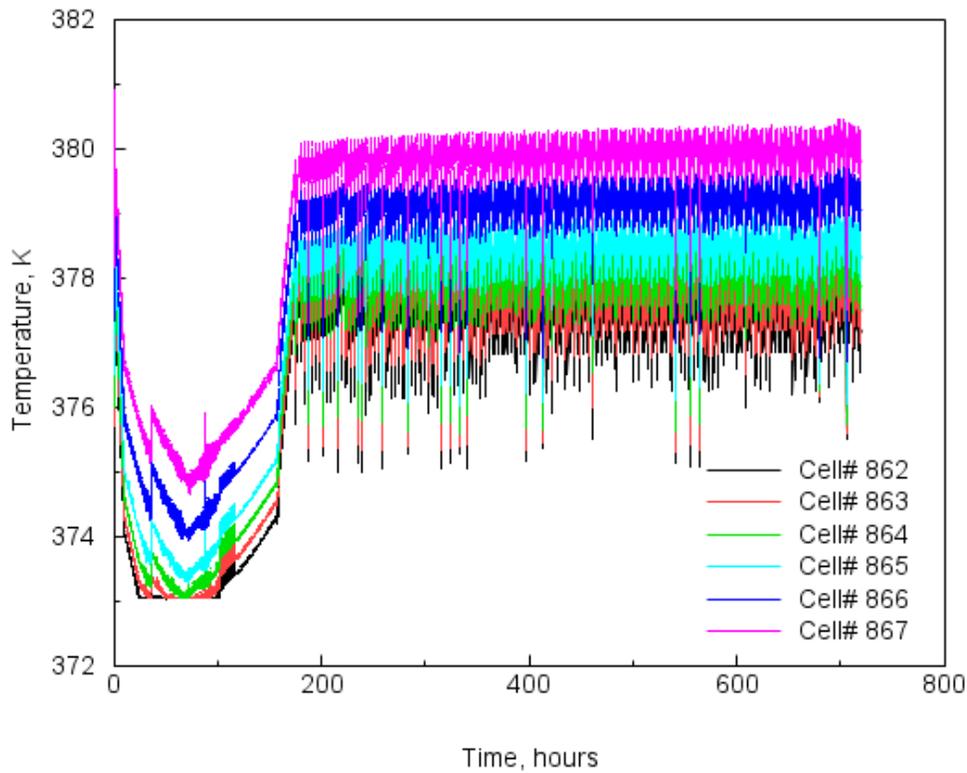
MSLB with 1 DPV failure  
Expansion/PCC/IC tank



- No water level control for MELCOR DBA (audit) -- based on NRC understanding of actual operation procedure
- MELCOR water level control assumed only for confirmatory calculation (@top of tubes)
- DCD Rev 6 assumed water level control

# MELCOR Calculated PCC/IC Pool Saturation Temperatures

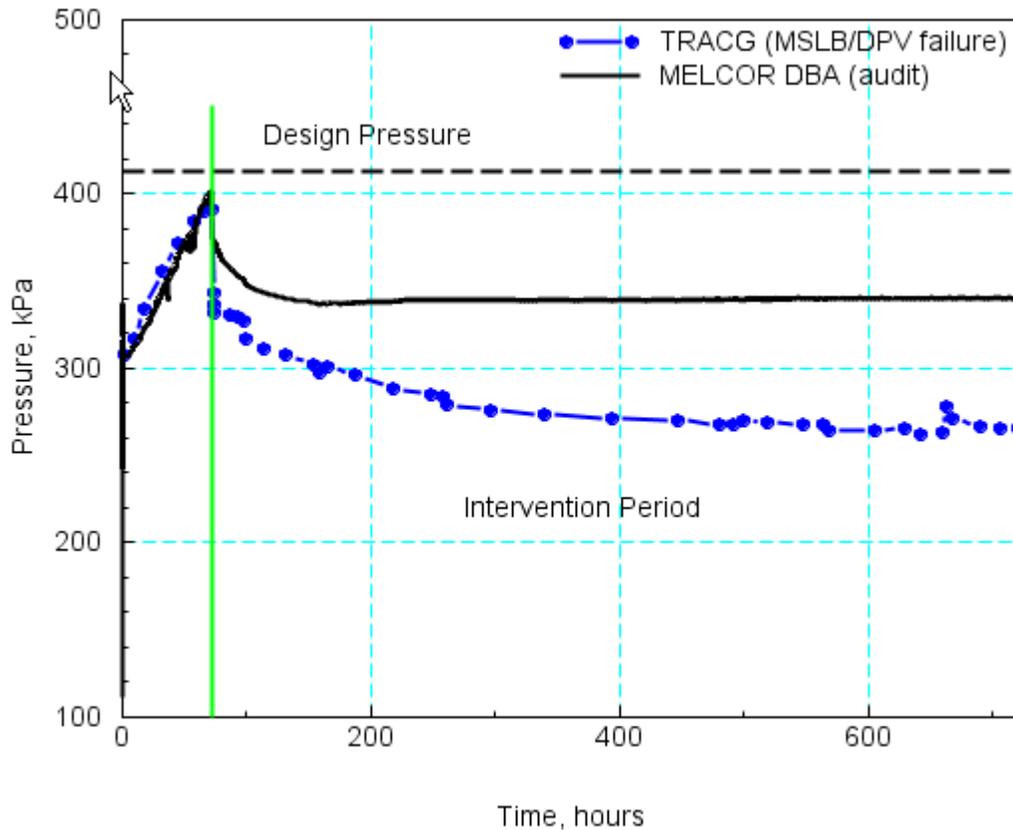
MSLB with 1 DPV failure



# MELCOR DBA (audit) Calculation

[Intervention Period: 72 to 720 hours]

MSLB with 1 DPV failure / 4 fans  
DW Pressure



## DCD Rev 6

- Margin @ 720 hours  
48% (TRACG)  
with level control  
without GDCS tray

## Audit Calculation

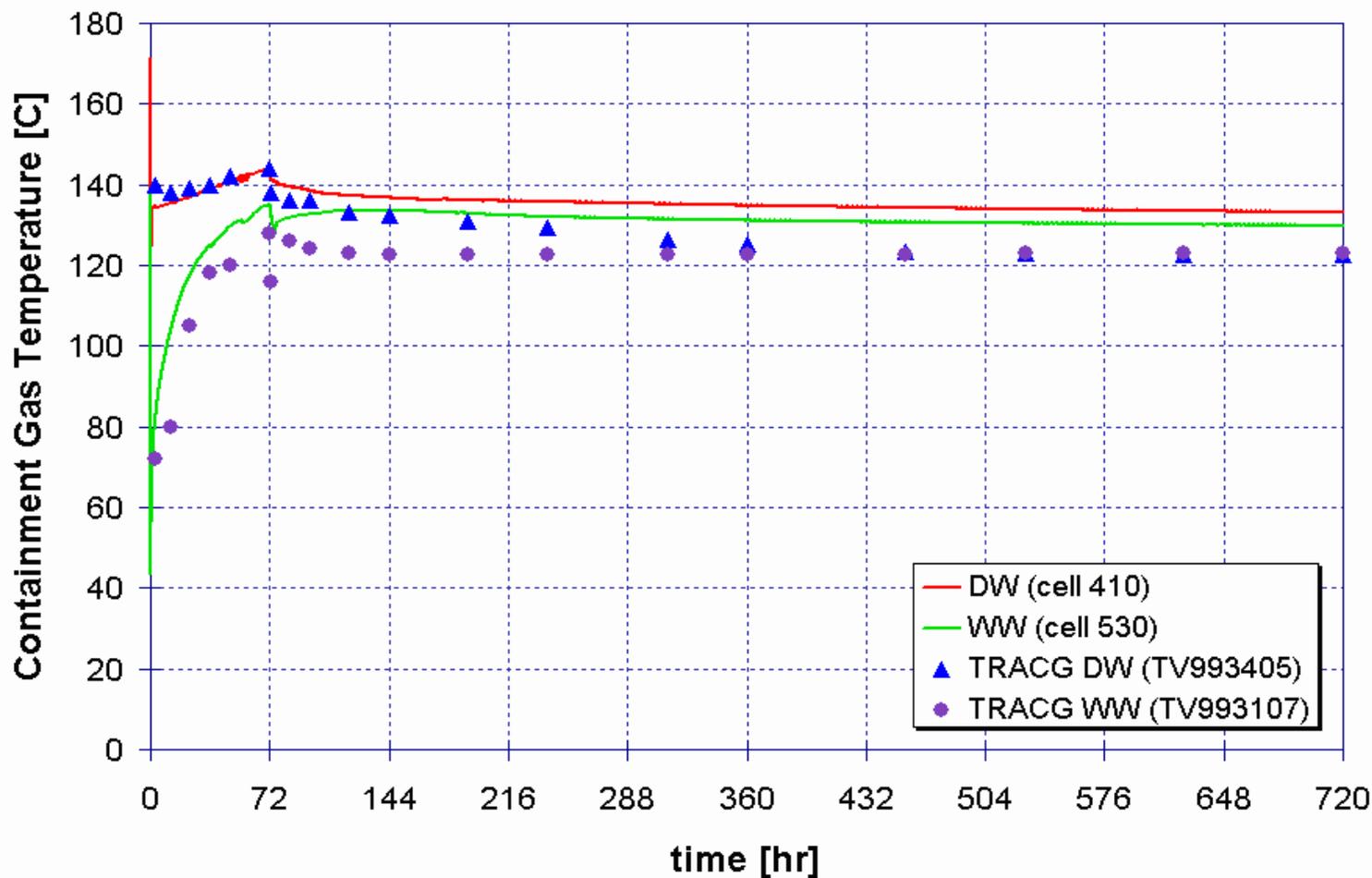
Margin @ 720 hours  
24%

no level control (procedure)  
flood @ 200 gpm fixed

fan vent covered (design)  
min coverage = 10 inches

# MELCOR Audit Calculation (MSLB Bounding)

[Intervention Period: 72 to 720 hours]



# MELCOR ESBWR DBA Calculation Summary for Intervention (post-3day) Period

- MELCOR Plant Model for Intervention Period Revised (guided by GEH clarifications of post-3 day design/operation)
- MELCOR confirmatory calculations confirm DCD Rev 6 results were performed without GDCS pool tray function and with PCC/IC/Expansion pool refill management (both tray neglect and refill management are shown to trend the containment pressure lower than the DBA (audit) calculation)
- With the exception of early intervention transient effect (i.e., pressure “cliff”), the MELCOR and TRACG post- 3 day pressure trends are similar when design/operation parameters are similarly modeled, with MELCOR results showing an offsetting increase of ~ 0.4 bar at 30 days
- MELCOR DBA (audit) pressure calculation, based on ESBWR design/operation, during the late intervention period is flat with ~ 24% margin @ 30 days (720 hours)



**Presentation to the ACRS Subcommittee**  
**ESBWR Design Certification Review**  
**Chapter 15, “Radiological Analysis”**

Presented by

Jay Lee - NRO/DSER/RSAC  
Donald Kalinich - Sandia National Laboratory  
Randy Gauntt - Sandia National Laboratory

November 17, 2009

# Purpose

- Brief the subcommittee on the completion of fission product transport and removal evaluation in the ESBWR containment.
  - Briefing on the preliminary evaluation was given to the subcommittee on January 17, 2008
- Answer the subcommittee's questions

# Technical Evaluation Completed

- Natural fission product deposition in main steam lines and main condenser.
- Iodine removal by passive containment cooling system - Iodine behavior in containment and reactor pressure vessel (RPV).
- Control of pH of water in containment and RPV pools to prevent iodine re-evolution.

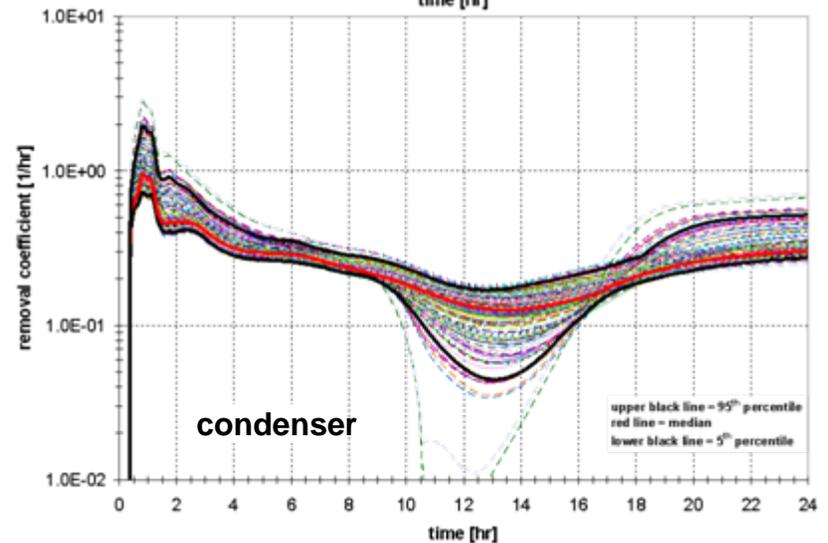
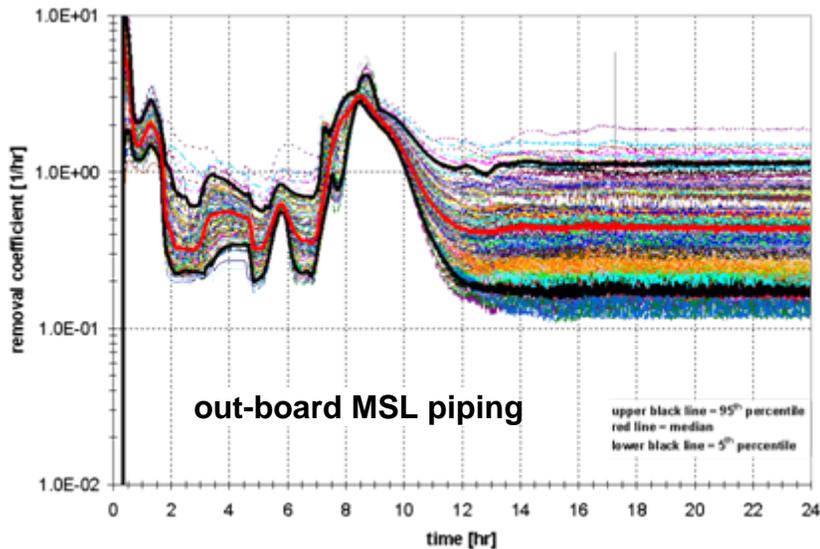
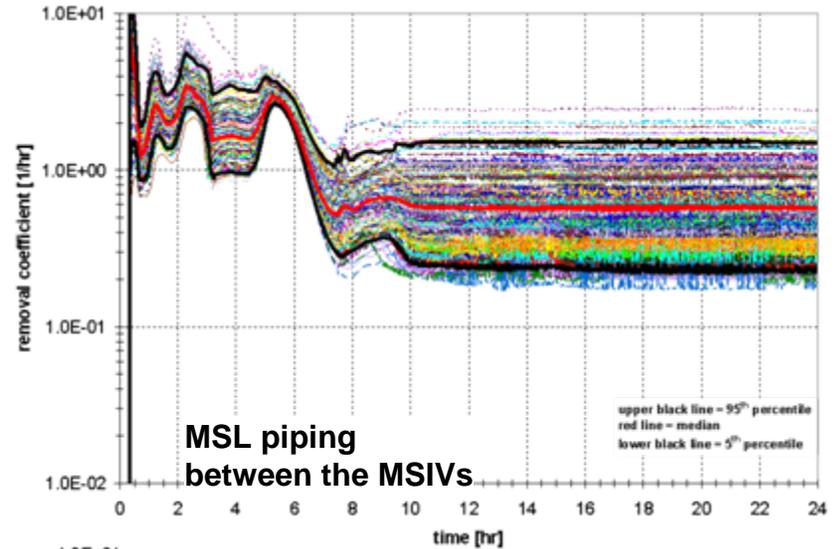
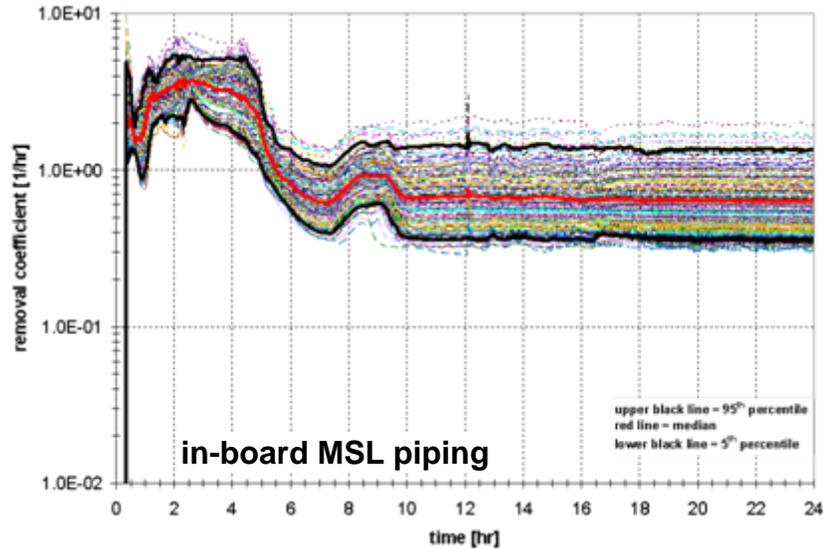
# Natural Fission Product Deposition in Main Steam Lines and Main Condenser

- Main steam lines, main steam line drain lines, and main condenser are designed to meet SSE criteria.
- Main steam isolation valve leak rate assumed (200 cfm) is specified in ESBWR technical specification.
- 200 cfm leak rate is assumed for the entire duration of accident (30 days).
- An independent RADTRAD confirmatory calculation has been performed by the staff.

# Natural Fission Product Deposition in Main Steam Lines and Main Condenser

- Results from ESBWR MELCOR model used to establish thermal-hydraulic boundary conditions to estimate aerosol removal coefficients.
- Containment/Main Steam Line - only ESBWR MELCOR model used to perform quantitative analyses of uncertainties in aerosol physics parameters on aerosol removal coefficients using Monte Carlo sampling (150 realizations).

# MSL and Condenser Aerosol Removal Rates



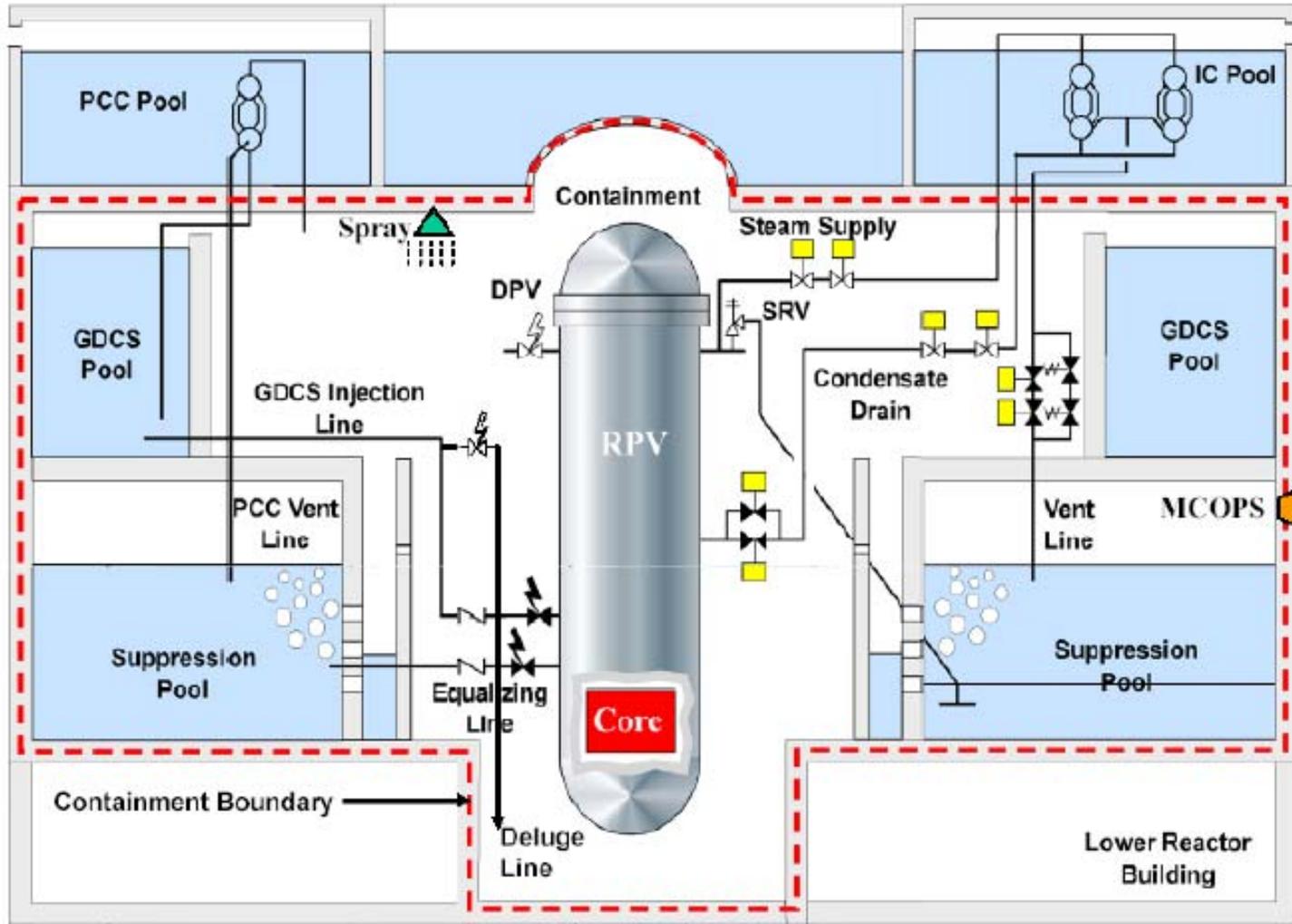
# Natural Fission Product Deposition in Main Steam Lines and Main Condenser

- GEH Evaluation
  - Calculated containment aerosol removal coefficients.
  - Elemental iodine removal coefficient based on SRP 6.5.2.
  - No credit taken for removal in the main steam lines.
  - Credit taken for deposition (aerosols and elemental iodine) in the main condenser based on BWROG methodology (consistent with certified ABWR DCD).
  - No credit taken for removal of organic iodine.
- Staff Evaluation
  - Calculated containment aerosol removal coefficients.
  - Calculated main steam line and main condenser aerosol removal coefficients.
  - No credit taken for removal of elemental or organic iodine.
- The results of staff independent confirmatory calculation bound the results of the GEH calculation.

# Fission Product Removal by Passive Containment Cooling System

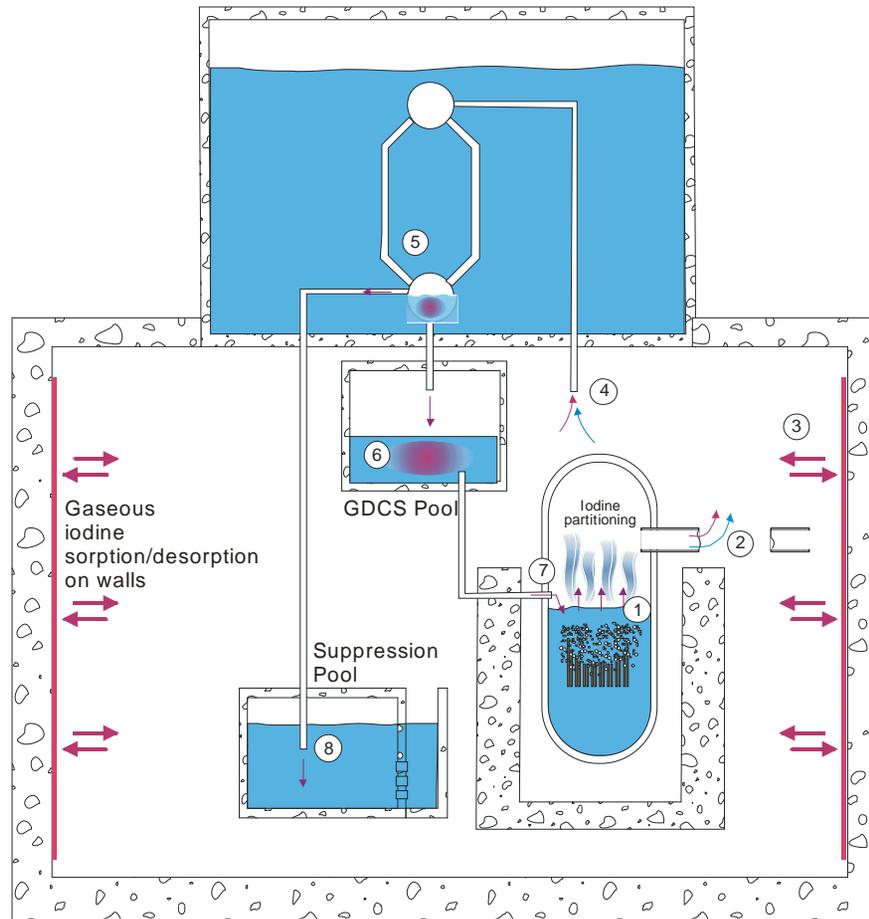
- Does iodine vapor removed by the PCCS stay removed?
- The staff completed a rate analysis of iodine transport between the PCCS, GDCCS, RPV, the drywell, and the wetwell to confirm the GEH analyses.

# Fission Product Removal by Passive Containment Cooling System



## ESBWR Containment

# Fission Product Removal by Passive Containment Cooling System



Simplified Schematic of ESBWR Containment Illustrating Iodine Transport and Deposition Pathways

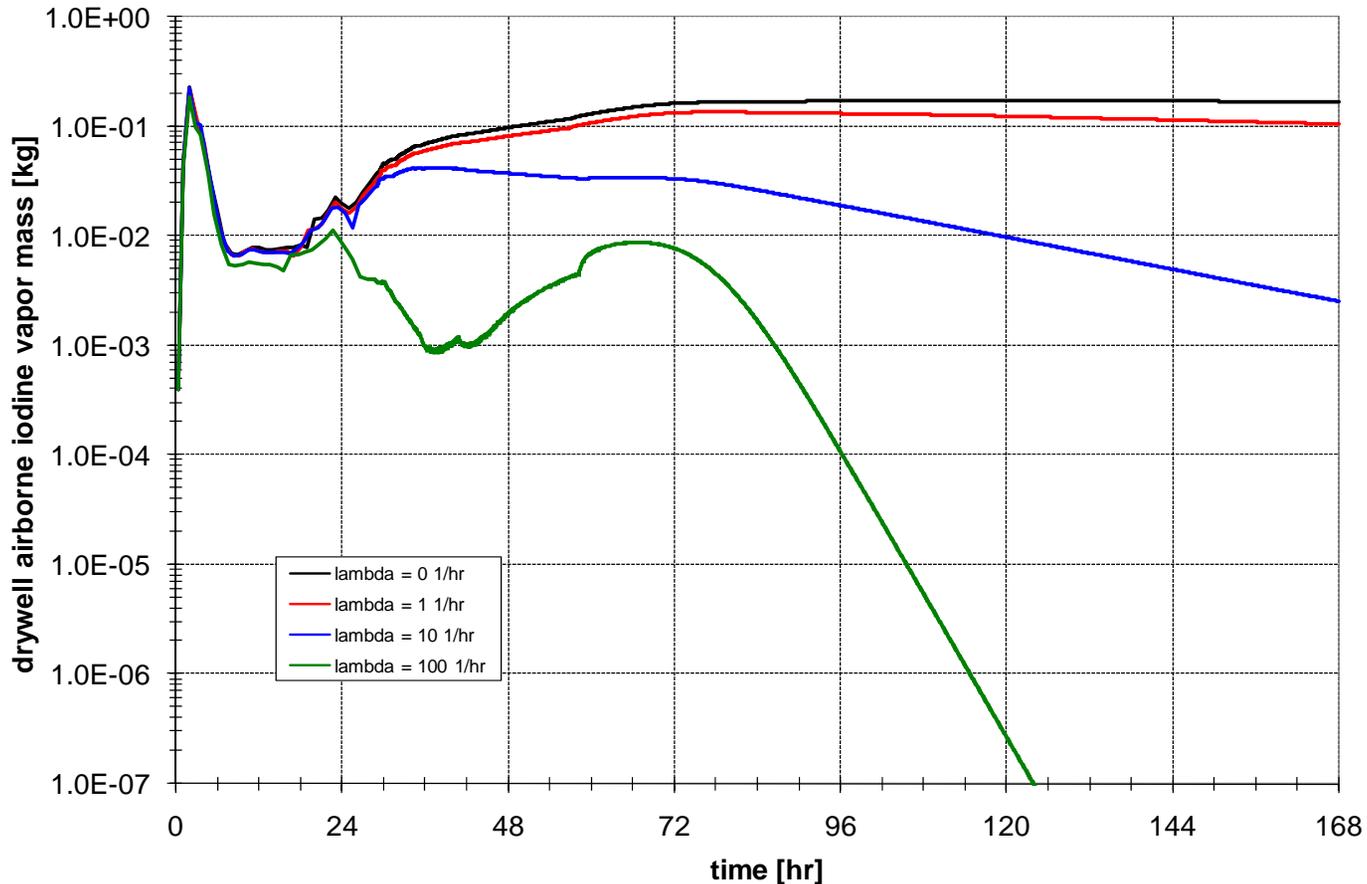
# Fission Product Removal by Passive Containment Cooling System

- Calculation performed with a simplified MELCOR ESBWR model.
- Iodine pool model implemented in the RPV, drywell, and wetwell.
- No model currently available for diffusiopheric deposition of iodine vapor.
- Deposition (i.e., removal) of iodine vapor in the PCCS was evaluated parametrically.

# Fission Product Removal by Passive Containment Cooling System

- Based on Iodine Pool Model in MELCOR code developed by Dana Powers
  - Acid generation and transfer to walls and pools
    - radiolysis of air produces nitric acid
    - radiolysis of cable insulation produces hydrochloric acid
  - Pool pH calculation
    - sodium pentaborate buffering accounted for
  - Iodine aqueous pool chemistry
  - Pool-atmosphere mass transfer
  - Iodine atmosphere radiolysis and recombination
  - Iodine atmosphere-wall deposition

# Fission Product Removal by Passive Containment Cooling System



Drywell Airborne Iodine Vapor Mass as a Function of PCCS Iodine Vapor Removal Coefficient (lambda)

# Fission Product Removal by Passive Containment Cooling System

- Results and conclusion
  - Higher PCCS iodine vapor removal rates result in lower iodine vapor mass in the drywell.
  - Results are indicative of removed iodine vapor remaining in pools rather than being re-evolved.
  - Supports the staff assumption that iodine in elemental form remains in water pools.

# Control of pH in Containment Pools to Prevent Iodine Re-evolution

- Iodine in a pool will not significantly partition to the atmosphere if the pool pH is greater than 7.
- Formation of CsOH and addition of buffer (sodium pentaborate) results in an initial pool pH of ~ 8.0 to 8.5.
- Acid formation will eventually result in a reduction in pool pH
  - radiolysis of air produces nitric acid
  - radiolysis of cable insulation produces hydrochloric acid
- When does the pool pH drop below 7?
  - GEH calculation predicts drywell pool pH < 7 between 20 to 29 days.
  - Staff calculation confirms GEH results out to 7 days.

# Control of pH in Containment Pools to Prevent Iodine Re-evolution

- GEH calculation
  - MELCOR ESBWR model run out to 24 hours provides
    - T-H information
    - CsOH and CsI formation rates
  - ChemSheet model uses MELCOR model output (extrapolated out to 30 days) in conjunction with acid generation rates to calculate evolution of pool chemistry out to 30 days.
- Staff calculation
  - Simplified MELCOR ESBWR model with Iodine Pool Model implemented in the RPV, drywell and wetwell.
  - Evolution of pool chemistry calculated out to 7 days.
- Staff Conclusion
  - iodine trapped in pools does not re-evolve and confirms GEH analysis

# Regulatory Review Issue

- Does the ESBWR design provide adequate mitigation of radiological consequences in an event of a major reactor accident to protect public health and safety, meeting the dose acceptance criteria specified in 10 CFR 100 and 10 CFR 52.47?

# Staff Conclusion

- An independent confirmatory calculation by the staff confirmed the GEH analysis.
- The staff concludes that ESBWR meets the relevant dose acceptance criteria.

# Discussion/Committee Questions

# Control Room Habitability and Reactor Building Mixing/Holdup Analysis

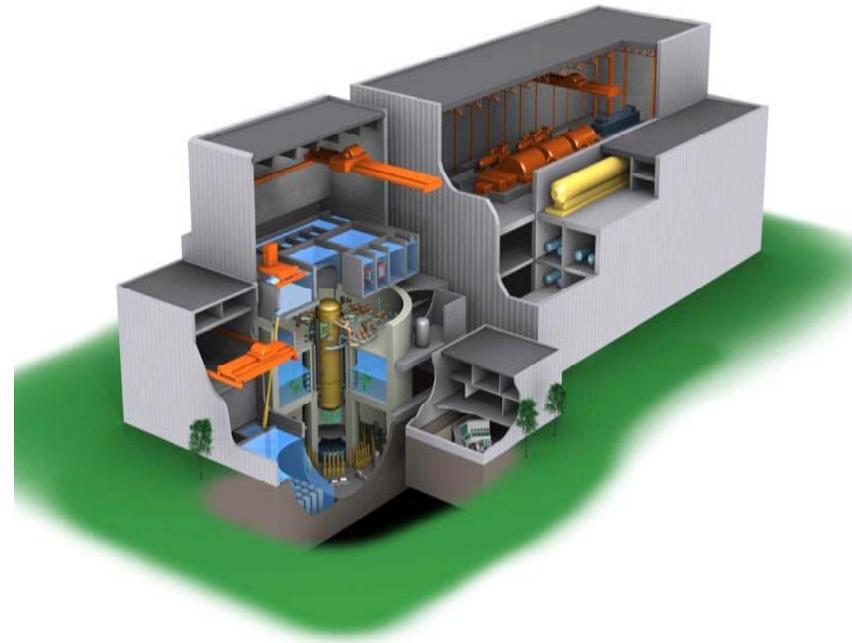
Advisory Committee on Reactor Safeguards

Antonio Barrett

Mike Arcaro

November 17, 2009

GE Hitachi Nuclear Energy



# Agenda

- Control Room Habitability Area (CRHA) Thermal Analysis Model Description / Assumptions / Results
- CRHA Thermal Analysis Alternate Calcs / Sensitivity
- CRHA GDC 19 Design Parameters
- CRHA Adequacy of EFU Supply and Circulation
- CRHA Design Validation / Surveillance Procedures
- Reactor Building (RB) Holdup / Confinement Model Description / Assumptions / Results
- Validation of RB Holdup / Confinement-Sensitivity
- Summary

# Introduction

A detailed thermal analysis of the ESBWR Control Room Habitability Area has been performed using the computer code CONTAIN 2.0.

The analysis includes the entire Control Building, which accounts for room-to-room interactions.

The analysis considers:

- (a) loss of offsite power where normal HVAC is unavailable
- (b) safety-related heat loads
- (c) some nonsafety-related heat loads
- (d) people
- (e) lighting
- (f) operation of an Emergency Filter Unit (EFU)

# Model Description

The rooms of the Control Building are modeled as single nodes connected by concrete.

The thermal mass of the concrete walls, floor, and ceiling act as passive heat sinks that maintain the CRHA temperature within design goal limits.

The summer design goal for the ESBWR CRHA is a bulk average temperature of 93°F at the end of the period of interest (72 hours).

# Summer Conditions Major Assumptions

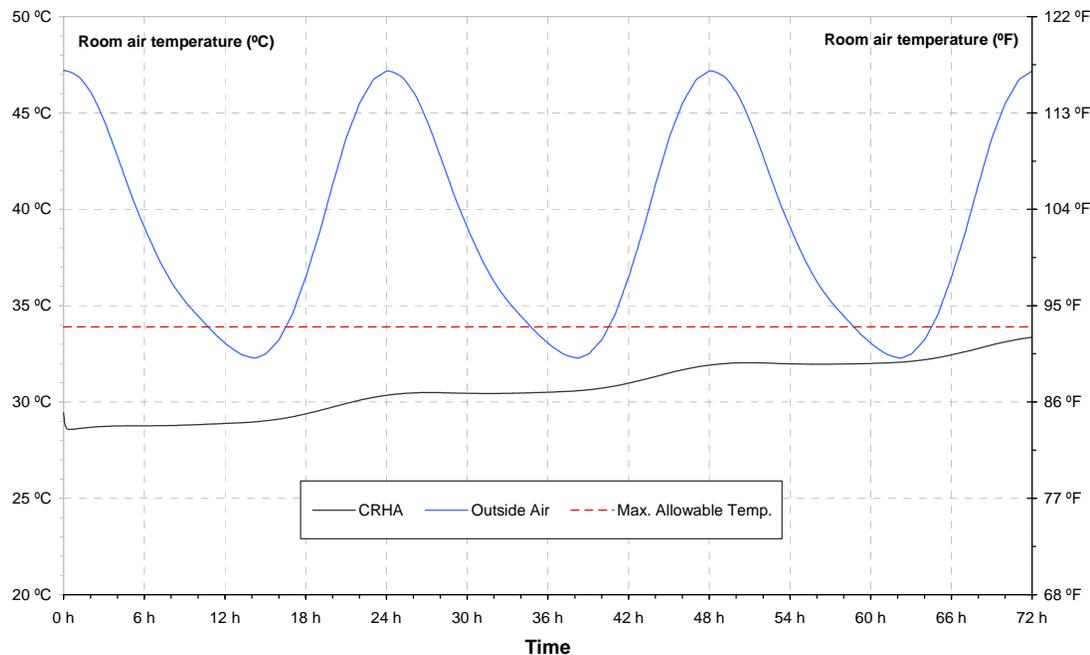
- Total Heat Load – 9630 Watts (max)
- EFU Air Supply Temperature – 117°F (max)
- CRHA Initial Temperature – 74°F (max)
- Concrete Thermal Conductivity – 0.865 W/m°C
- CRHA Initial Humidity – 60% (max)
- EFU Flow Rate – 509 cfm (max)
- CRHA concrete has been exposed to an air temperature of 85°F for 8 hours before initiation of the transient
- Some nonsafety-related equipment deenergized



# Summer Results

The analysis results show that the bulk average temperature in the CRHA at the end of the period of interest remains below 93°F.

The wetbulb temperature is below 75°F which is below the NIOSH recommendation of 86°F.



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# Winter Conditions

An analysis was also performed for winter conditions.

The winter conditions analysis was performed using the code ECOSIM. ECOSIM was validated against the the CONTAIN code.

The winter design goal for the ESBWR is a bulk average temperature of 55°F at the end of the period of interest.

# Winter Conditions Modeling/Results

The winter conditions model is similar to the summer conditions model except that it has lower heat loads, lower initial temperatures, and a lower EFU air supply temperature.

The concrete dimensions and thermal conductivity are the same.

The analysis results show that the bulk average temperature in the CRHA at the end of the period of interest remains above 55°F.

# Summer Conditions Alternate Calculations

- GOTHIC 7.2a

More detailed analysis using 3D modeling of the CRHA.

- ECOSIM

CONTAIN model reproduced using ECOSIM to validate winter conditions calculation.

- 1<sup>st</sup> Principles Hand Calculation

Heat transfer calculation to validate CONTAIN analysis.

# Sensitivity Analyses

- 0% Exceedance Wetbulb EFU Supply Air Temperature
- Lower EFU Supply Air Temperature
- EFU Flow Rate
- Heat Load
- EFU Supply Air Temperature Profile

# ITAAC/Surveillance Requirements

DCD Tier 1 ITAAC Table 2.16.2-4

DCD Tier 2 Chapter 16 Section 3.7.2

Additional clarifications/descriptions requested by NRC staff and will be included in DCD Rev 7.

# CRHA GDC 19 Design Parameters

*A control room shall be provided from which actions can be taken to operate the nuclear power unit safely under normal conditions and to maintain it in a safe condition under accident conditions, including loss-of-coolant accidents*

- CRHA provides adequate protection against radiation. For all events, the control room dose is within the dose acceptance limit of 5.0 rem (50 mSv) total effective dose equivalent (TEDE)
- The CRHA temperature / humidity values calculated during the 72 hours following a DBA equate to less than 30°C (86°F) wet bulb temperature
- The CRHA heatup analysis indicates that the average temperature the CRHA would not exceed the 93°F limit
- The Emergency Filter Unit System maintains CO<sub>2</sub> concentration in the CRHA to less than 5000 ppm

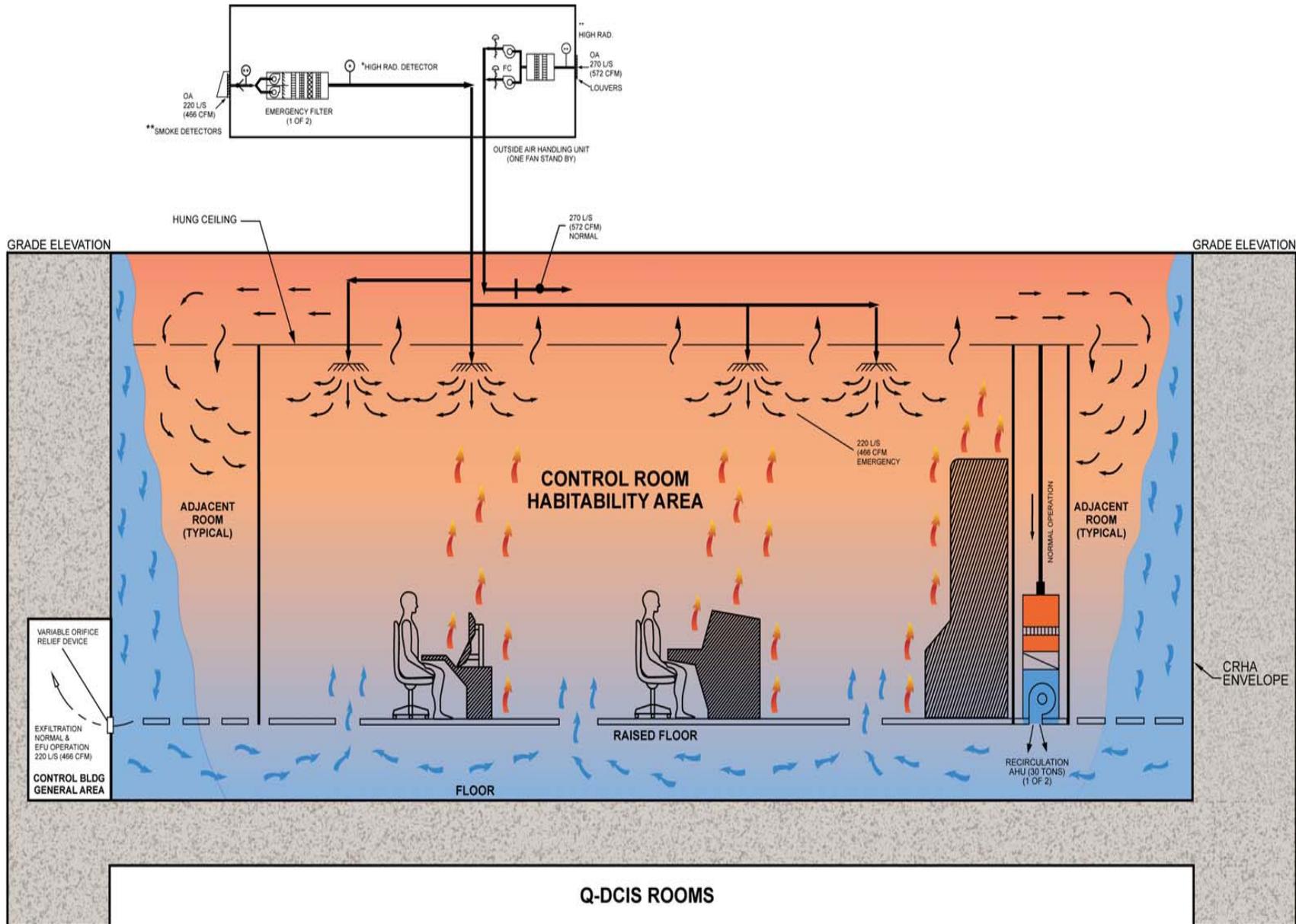


# CRHA Adequacy of EFU Supply and Circulation

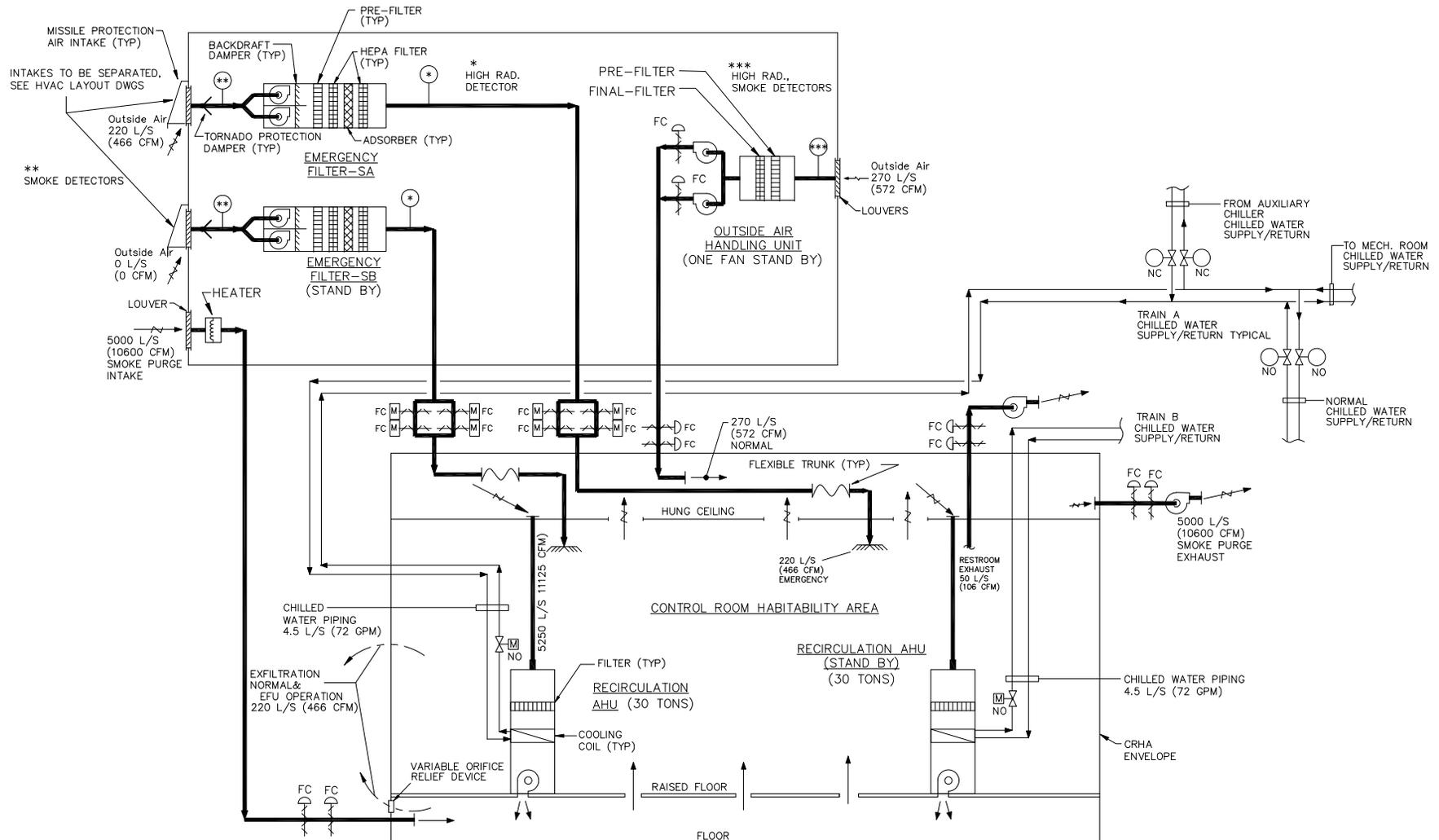
The CRHA accident HVAC design (mixing and displacement) in conjunction with the convective air currents (due to heat loads/sinks) and personnel movement ensures that temperature is within acceptable limits, buildup of contaminants (e.g., CO<sub>2</sub>) is minimal and a freshness of air is maintained.

The EFU provides a minimum of 466 cfm of outside air that maintains the freshness of air and provides a positive pressure in the CRHA.

# CRHA Adequacy of EFU Supply and Circulation



# Control Room Habitability Area HVAC



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# Reactor Building Mixing/Holdup

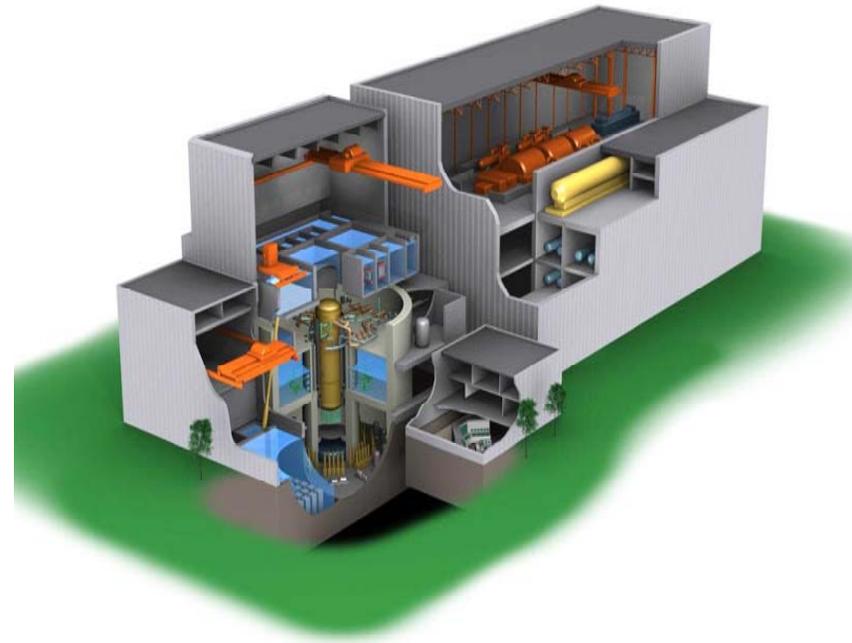
Advisory Committee on Reactor  
Safeguards

Antonio Barrett

Mike Arcaro

November 17, 2009

GE Hitachi Nuclear Energy



# Introduction

The ESBWR Reactor Building provides a holdup volume and delays the transport of radionuclides from the containment to the environment.

A detailed holdup/transport analysis of the ESBWR Reactor Building using the code GOTHIC 7.2a has been performed.

The analysis of the Reactor Building confirms that the mixing volume assumed in the ESBWR dose analysis is a conservative characterization of the Reactor Building holdup and transport delay of radionuclides.

# Model Description

The GOTHIC model includes the Reactor Building contaminated area ventilation system (CONAVS) area and the clean area ventilation system (CLAVS) area.

The rooms in these areas are modeled based on the General Arrangements drawings and considers the connections between the rooms through doors and HVAC ducts.

The GOTHIC model has the same Reactor Building exfiltration rate as the LOCA dose analysis model.

# Major Assumptions

- LOCA with fuel damage concurrent with a loss of offsite power and HVAC systems are unavailable
- Leakage from the Reactor Building occurs at the point closest to the Control Building
- The Reactor Building is pressurized to ¼" w.g. pressure due to wind loading
- Reactor Building exfiltration rate of 300 cfm
- Conservative containment leakage distribution location

# Containment Release

Most of the mass inside containment during the accident is nitrogen and steam, which carry the radioactive releases.

The ESBWR containment is inerted with nitrogen. The steam comes from the pipe break. Radioactive releases reach the environment via nitrogen or steam.

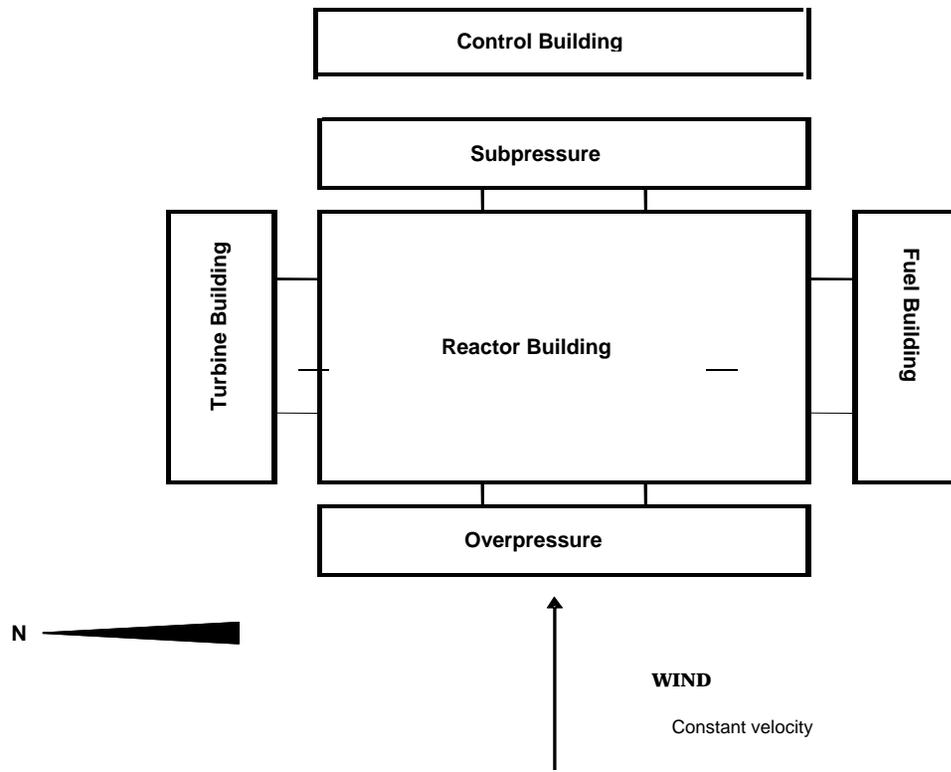
The GOTHIC model uses nitrogen to track holdup and transport of radionuclides, because it will not condense.

Comparing the representative containment releases and RB exfiltration rates allows for a comparison of the GOTHIC and dose calculation models.

# Reactor Building Leakage

The Reactor Building is assumed to be pressurized to  $\frac{1}{4}$ " w.g. due to wind loading.

A  $\frac{1}{4}$ " w.g. pressurization of the Reactor Building results from high wind conditions. The dose analysis assumes calm wind conditions.



# GOTHIC Results

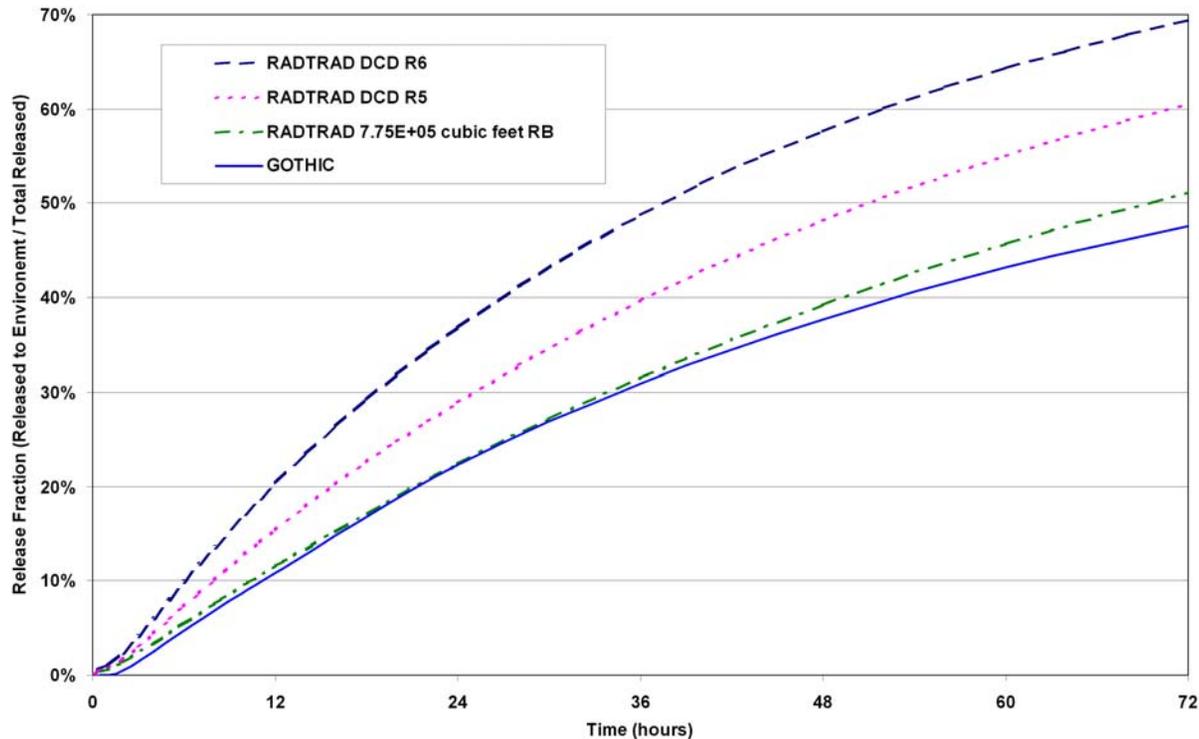
After 72 hours, the ratio of the amount of nitrogen that reaches the environment over the amount released into the RB is approximately 48%.

The dose calculation ratio is approximately 70% when assuming a Reactor Building mixing volume of 50%.



# GOTHIC vs Dose Calculation

A comparison between the GOTHIC ratio of release into the environment over the release into the Reactor Building shows that the GOTHIC ratio is always lower than the dose calculation ratio.



# Sensitivity Analysis

- Nominal Case (Best Estimate)– Sensitivities run to determine uncertainties; CONAVS boundary most important parameter
- Nominal Case with 300 cfm Leakage
- 30 Day Calculations
- Dose Consequences for Additional Hold up

Sensitivity analyses address NRC staff request to consider model uncertainties, conservatism and adverse effects. GEH concludes that the GOTHIC analysis accounts for these concerns.



# ITAAC/Surveillance Requirements

DCD Tier 1 ITAAC 2.16.5-2 Item 4

DCD Tier 2 Technical Specification (TS)  
Surveillance Requirement 3.6.3.1.5

# Conclusion

The ESBWR Reactor Building design has multiple volumes and flow resistances in the CONAVS area that provide holdup of radioactive releases from containment.

The GOTHIC analysis shows that adequate resistances exist in the ESBWR design when the Reactor Building boundary flows are equal to or less than the flow assumed in the dose analysis of 300 cfm.

The analysis of the Reactor Building confirms that the mixing volume assumed in the ESBWR dose analysis is a conservative characterization of the Reactor Building holdup and transport delay of radionuclides.

# Summary

- CRHA design meets GDC 19 habitability requirements
- EFU Supply and Circulation is adequate to support CRHA habitability
- CRHA Design Validation / Surveillance Procedures assure functions will be met
- The ESBWR RB provides a holdup volume and delays transport of radioactivity from the containment to the environment
- Periodic testing verifies the RB exfiltration rate is less than the limit assumed in the radiological analyses



Presentation to the ACRS Subcommittee

**ESBWR Design Certification Review  
Section 9.4, “HVAC,” and  
Section 6.4, “Control Room Habitability System”  
Ventilation Issues**

Presented by

James O’Driscoll, NRO/DSRA/SBCV

November 17, 2009

# Purpose

- Brief the Subcommittee on the staff's review of the ESBWR design certification application, Chapter 9.4, "HVAC," and Section 6.4, "Control Room Habitability System"; ventilation issues
  - Previous briefing on this issue was given to the subcommittee on November 15, 2007.
- Answer the Subcommittee's questions

# Project and Technical Review Team

- **Project Managers**
  - Dennis Galvin, Chapter 9 Project Manager
  - Ilka Berrios, Chapter 6 Project Manager
  - Amy Cubbage, ESBWR Lead Project Manager
- **Technical Reviewer**
  - Jim O'Driscoll, Lead Technical Reviewer
  - John McKirgan, Branch Chief, SBCV

# Staff Focus

- Expected performance of the Passive cooling of Control Room Habitability Area and Reactor Building
  - Ability to maintain habitability and operability of equipment for 72 hours following an accident.
- Post Accident EFU Operation
  - Quantity of Air Supply
  - Air distribution, mixing, flow paths, and temperature
  - Carbon Dioxide Levels
  - Power Supply

# RAI Status Summary

- Section 9.4
  - Issued RAIs = 58
  - Resolved = 53
  - Open Items = 5
- Section 6.4
  - Issued RAIs = 23
  - Resolved = 20
  - Open Items = 3

# RB and CRHA Temperature Control

- Can passive cooling of ESBWR CRHA and RB maintain habitability and operability of equipment for 72 hours following an accident?
- Key Questions for a review of this feature:
  - Determine reasonable habitability acceptance criteria for CRHA temperature
  - Determine required level of detail for a supporting heat up analysis
  - Determine appropriate level of configuration control

# Staff Review Approach – Temperature

- Review supporting heat up analyses of RB and CB
  - Review proposed performance goal
  - Review input assumptions in DB calc
  - Review alternate method calculations
  - Identify insights in analyses vs. DB information and ITAAC
  - Identify sensitivities
  - Address uncertainties

# Staff Review Approach – Temperature

## Applicant Actions completed

- CONTAIN 2.0 analysis submitted
  - as the DB calculation for the CRHA analysis
- CRHA GOTHIC analysis submitted
  - to demonstrate mixing in MCR
- First principle calculation submitted
  - as alternate method of demonstration of passive heat removal
- ITAAC added
  - to update and validate DB calc with as-built dimensions (CRHA only)

## Staff Actions Completed

- Staff review of CONTAIN 2.0 analysis of CRHA
- Staff review of CONTAIN 2.0 analysis of RB

## Staff Actions Ongoing

- Staff review of GOTHIC analysis
- Staff review of first principle calculation
- Review of RAI responses

# Staff Review Approach – Temperature

## Applicant's CHRA Maximum Temperature Criteria

- Based on EPRI Utility Requirements Document guidance: CRHA max temperature rise limited to 15°F for a MCR with a normal temp range of 73-78°F
  - Proposed ESBWR CRHA temp acceptance criteria: <93°F
    - ESBWR CRHA max temp limited to 74°F per TS; allowing a maximum rise of 19°F

## Applicant's Outside Environmental Input Assumptions

- 117°F coincident with 80°F wet bulb.
- 0% exceedance value; as per EPRI URD
- Temperature cycle 27°F: From ASHRAE Fundamentals Handbook
  - A representative site was chosen for this temperature swing

# Staff Review Approach – Temperature

## Applicant's Operator Functionality Criteria

- Widely used industry standards for heat stress
  - WBGT <86°F allows unlimited stay time for light work

## Applicant's Outside Environmental Input Assumptions

- 117°F coincident with 80°F wet bulb.
- Daily temperature cycle results in outside air relative humidity to cycle daily from 20% to 45%;
- Heat up analysis assumed a maximum normal CRHA humidity of 60%
  - Starting value equal to NUREG 0700 guidance for maximum normal CR humidity range.

# Summary of Submitted Analyses

## CRHA Temp at the end of 72 hour passive cooling

- Design Basis: CONTAIN single node model
  - Bulk room temp result: 92°F; 43% RH
- GOTHIC Multi-node model
  - Demonstrates Mixing
- First Principles Calculation
  - Bulk room temp shown to be 91.3°F

# CONTAIN Review Actions

- Reviewed CRHA heat up calc report and data files
  - No issues
- Sensitivity Studies
  - Concrete density
  - Concrete specific heat
  - Humidity of outside air
  - Heat transfer Area
  - Outside Air temp
  - EFU fan flow rate

Some sensitivity exists in concrete density;  
other parameters have less sensitivity

# GOTHIC Review Actions

- Applicants GOTHIC analysis was designed to demonstrate convective mixing in the MCR due to temperature differences
  - Different model than CONTAIN
  - Used 20% lower sensible heat loads than CONTAIN
  - Used lower EFU fan flow
  - Used higher initial heat sink temperature
- Staff will compare GOTHIC against the DB analysis
  - Case 1: Staff run of applicant's input file- no changes
  - Case 2: Match to CONTAIN input assumptions

**STAFF is still reviewing GOTHIC analysis**

# First Principles Calculation Review Actions

- Applicant submitted this analysis as an alternate demonstration of the CRHA passive cooling mechanism.

**Currently under review by Staff**

# Insights From Staff Analyses

- CONTAIN model has some conservatism
- GOTHIC has demonstrated convective mixing is expected
- Highest temperatures observed in GOTHIC model
  - Primarily impacts equipment qualification assumptions
  - Closer agreement would support use of the proposed DB model
- Related Open Items to these insights:
  - More Specific definitions and references to DB Heat up Calc required in Tier 2
  - More Specific ITAAC description and Tier 1 information required

# Insights From Review Of Analysis

Applicant's CONTAIN and First Principles results are close to the acceptance criteria of 93°F at end of 72 hours

- Maintenance of margin important. Configuration control is important

## Related Open Items:

- EQ Branch: more details on how EQ service temperature will be determined.
  - Explanation why bulk room temp would be bounding for equipment inside cabinets
  - Description of controls used ensure enclosures are designed correctly
- Description of controls used to maintain passive heat sink configuration and heat load assumptions during life of plant
- ITAAC needed to update and validate DB calc with as-built dimensions (RB)

# Post Accident CRHA Air Quality

- Will the air quality be acceptable in the CRHA at the end of the post 72 hour cooling period?
- Key questions for a review of this feature:
  - Determine reasonable habitability acceptance criteria- air quality
    - Quantity of air supply
    - Carbon dioxide levels
  - Determine if there is assurance of air distribution and mixing
  - Determine the required level of detail need in DCD for related design features
  - Determine the level of configuration control need

# Staff Review Approach – Air Quality

- Review supporting heat up analyses of RB and CB
  - Review proposed performance goal
  - Review CRHA design features to assure goal will be met
    - Identify insights in analyses vs. DB information and ITAAC

# Staff Review Approach – Air Quality

## Applicant Actions Completed

- Air supply, distribution and mixing
  - DCD states design adheres to ASHRAE 62.1-2007 air quality for 21 people
  - Remote exhaust added below occupied zone of CHRA
  - EFU air delivery will be optimized to deliver air to occupied zones of CHRA
- Power supply
  - EFUs now powered by RTNSS ancillary DG post-72 hours

## Open Items

- Design and instrumentation requirements for remote exhaust path
- Other details or actions to promote convective mixing / prevent short cycling of supply air
- Details of design intent of airflow and how CRHA air flow optimization will be accomplished

# Discussion/Subcommittee Questions



Presentation to the ACRS Subcommittee

**ESBWR Design Certification Review**  
**Section 6.2.3, “Reactor Building” Mixing Issues**

Presented by

Edwin Forrest, NRO/DSRA/SBCV

November 17, 2009

# Reactor Building Mixing

- NUREG – 1242 - allows hold up to be considered
  - Tested, Concrete Steel Safety Envelope - CONAVS
  - Exfiltration less than 25% volume per day
  - ESBWR exfiltration is ~ 50% volume per day
- GOTHIC Analysis demonstrates holdup
  - Comprehensive Assessment /Sensitivity Studies
  - Subject to assumptions, physical parameters
- Staff Evaluation
  - Simplified multiple room holdup assessment
  - Results consistent with GOTHIC analysis predictions
  - RADTRAD 50% mixing assumption is conservative