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 Extended Power Uprates Subcommittee

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6 UNITED STATES NUCLEAR REGULATORY COMMISSION'S
7 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
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10 The contents of this transcript of the
11 proceeding of the United States Nuclear Regulatory
12 Commission Advisory Committee on Reactor Safeguards,
13 as reported herein, is a record of the discussions
14 recorded at the meeting.

15
16 This transcript has not been reviewed,
17 corrected, and edited, and it may contain
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2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

5 + + + + +

6 SUBCOMMITTEE ON EXTENDED POWER UPRATES

7 + + + + +

8 FRIDAY,

9 APRIL 23, 2008

10 + + + + +

11 ROCKVILLE, MARYLAND

12 + + + + +

13 The Subcommittee met at the Nuclear
14 Regulatory Commission, Two White Flint North, Room
15 T2B1, 11545 Rockville Pike, at 8:30 a.m., DR. WILLIAM
16 J. SHACK, Chairman, presiding.

17 MEMBERS PRESENT:

18 WILLIAM J. SHACK, Chairman

19 SAID ABDEL-KHALIK

20 J. SAM ARMIJO

21 SANJOY BANERJEE

22 DENNIS C. BLEY

23 MARIO V. BONACA

24 CHARLES H. BROWN, JR.

25 HAROLD B. RAY

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1 MEMBERS PRESENT (Continued):

2 MICHAEL T. RYAN

3 JOHN D. SIEBER

4 JOHN W. STETKAR

5 NRC STAFF PRESENT:

6 ZENA ABDULLAHI, Cognizant Staff Engineer

7 and Designated Federal Official

8 BOB DENNIG

9 RICHARD LOBEL

10 AHSAN SALLMAN

11 WILLIAM RULAND

12 MARTY STUTZKE

13 EDWIN HACKETT

14 ALSO PRESENT:

15 MIKE CROWTHERS

16 ALAN WOJCHOUSKI

17 GUANGJAN LI

18 ALLEN BUDRIS

19

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TABLE OF CONTENTS

2 AGENDA ITEM	PAGE
3 1. Opening Remarks	4
4 Chairman Shack	
5 2. BWROG - NEDC-33347P	6
6 (Xcel Energy)- Wojchouski	
7 3. NRC - NEDC33347P	91
8 Sallman, NRR	
9 4. NRC- Introduction	130
10 Ruland, NRR	
11 5. NRC - Staff Guidance on CAP	187
12 Ruland/Lobel/Sallman, NRR	
13 Adjourn	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	

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

2 (8:28 a.m.)

3 1. OPENING REMARKS

4 CHAIR SHACK: The meeting will now come to
5 order. This is a meeting of the Power Uprate
6 Subcommittee. I am William Shack, the Chairman of
7 this Subcommittee meeting.

8 ACRS members in attendance are Said
9 Abdel-Khalik, Sam Armijo, Sanjoy Banerjee, Mario
10 Bonaca, Charlie Brown, Jack Sieber, Dennis Bley, Mike
11 Ryan, and Harold Ray.

12 We have a consultant to help us today with
13 this review: Dr. Graham Wallis. Zena Abdullahi is
14 the ACRS staff, designated federal official for this
15 meeting.

16 In this meeting, we will cover two related
17 topics. The first topic is the proposed BWR licensing
18 methodology and calculation technique for addressing
19 the containment overpressure credit. The second topic
20 is the NRC draft guidance to the industry for the use
21 of containment accident pressure.

22 ACRS has expressed its views in crediting
23 containment accident pressure in a series of letters
24 dating back to a development of RG 1.1. Recently ACRS
25 has issued a March 18th, 2009 letter which delineated

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1 the Committee's concerns and proposed some approaches.

2 We look forward to hearing about the BWR
3 Owners' Group technique for quantifying the
4 conservatisms and the containment analysis that factor
5 into the available net-positive suction calculations.

6 We're also very interested in the staff's
7 guidelines for crediting containment accident pressure
8 needed for operation of the emergency core cooling
9 system and heat removal system.

10 We have received no requests from the
11 public to make a statement at today's meeting.

12 Portions of the meeting will be closed
13 because details of GEH's proprietary information may
14 be discussed. The Subcommittee agenda that is
15 available in this meeting room delineates which
16 segments of the meeting will be closed.

17 The rules for participation in today's
18 meeting have been announced as part of the notice of
19 this meeting previously published in the Federal
20 Register. A transcript of the meeting is being kept
21 and will be made available as stated in the Federal
22 Register notice.

23 Therefore, we request that participants in
24 this meeting use microphones located throughout the
25 meeting room in addressing the Subcommittee. The

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1 participants should first identify themselves and
2 speak with sufficient clarity and volume so that they
3 may be readily heard.

4 We did receive a request for telephone
5 participation. We ask that the telephone participants
6 identify themselves before the start of the meeting.
7 Is anybody on the line?

8 (No response.)

9 CHAIR SHACK: Okay. I just wanted to make
10 sure that when they come on, they come listen-in only
11 mode.

12 MS. ABDULLAHI: This is Zena Abdullahi. I
13 think they are all on. Can you please all identify
14 yourselves? Hello?

15 (No response.)

16 MS. ABDULLAHI: The light is open.

17 CHAIR SHACK: We will now proceed with the
18 meeting. I will call upon Alan Wojchouski of Xcel
19 Energy, which is also representing the BWR Owners'
20 Group, to begin.

21 2. BWROG - NEDC-33347P

22 MR. CROWTHERS: Before Alan gets started,
23 my name is Mike Crowthers. I am with PPL Susquehanna.
24 I am the Owners' Group Vice Chairman. I appreciate
25 the opportunity to come and talk to ACRS today. As

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1 you recall, we were here back in 2008, when we
2 provided presentation prior to submittal of the
3 Topical to the staff.

4 We over the last couple of years have been
5 addressing RAIs and working with the staff to resolve
6 questions and concerns. We think we are at the point
7 where the Topical is pretty much ready to be approved.
8 And so we are here again to make that presentation.

9 We will be revising the Topical once the
10 staff has finalized their review to incorporate the
11 staff's feedback that we have received through the RAI
12 process.

13 There is no proprietary information in our
14 prepared slide. So unless we have to go there, we
15 shouldn't have to use that. But if we do have to go
16 to proprietary information, we'll let you know. And
17 then we'll just have to hold those questions and
18 comments to that point in the agenda where we have the
19 time slotted.

20 I am going to turn it over to Alan. Alan
21 is going to lead us through the presentation here.
22 Alan has been the lead for the Owners' Group since the
23 inception of this effort. Again, Alan is from
24 Montecello.

25 Alan, all yours.

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1 MR. WOJCHOUSKI: Take it off from there.
2 Alan Wojchouski from Xcel Energy. I work at
3 Montecello Nuclear Generating Plant. I have degrees
4 in mathematics, physics, and computer science minor.
5 I went on to Virginia Tech and got a Master's degree
6 in nuclear engineering.

7 My career started off with Exxon Nuclear
8 doing redesigns for Prairie Island's unit I and II and
9 then went off to Montecello for the last 30 years. So
10 at Montecello, I have been system engineer and in
11 management chain, supervisor over those years and have
12 also previously held a senior reactor operator's
13 license.

With that, we'll start off with the presentation. The purpose of the presentation is to provide an overview of the Topical report. The Topical report was basically put together to provide a standardized predictable approach for the utilities to request containment accident pressure.

It goes ahead and outlines a deterministic method to calculate NPSHa and statistical method to demonstrate the margin inherent in the deterministic methodology. As I go through the presentation, each one of these different terms will be defined for you a little bit better.

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1 Brief history of the Topical report. Late
2 in 2005, the NRC requested the BWR Owners' Group to
3 participate in trying to address several concerns that
4 were raised by the ACRS.

5 So we sat down, formed a Committee, the
6 Containment Accident Pressure Committee, and started
7 work on putting together the licensing Topical report
8 to address certain of those issues.

9 In February, we were here in front of the
10 ACRS to go ahead and present the draft licensing
11 Topical report. I gave a very similar presentation at
12 that time. That was one week before we actually
13 submitted the Topical report to the NRC staff for
14 their review.

15 Since that time, we received numerous
16 requests for additional information and provided the
17 responses. The staff went ahead and provided a draft
18 SE. We went ahead and commented on it. And right now
19 they have a revised draft SE. And we'll hopefully
20 shortly release that. That is where the current
21 status is of the Topical report.

22 Basically the high-level overview of the
23 Topical report has different sections. Each one of
24 the different sections is listed in front of you.
25 Basically the overview of the NPSH evaluation, how

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1 available NPSH evaluation is done for the BWR or for
2 design basis LOCA, also NPSH considerations for
3 special events, ATWS, station blackouts, appendix R
4 type of events.

5 The safety basis for requesting
6 containment accident pressure is also included in
7 section number 5. We also on the technical type of a
8 basis went ahead and proposed what from the technical
9 input should be included in the licensing basis
10 methodology. So also the elements of the license
11 amendment request were discussed within the Topical
12 report.

13 I am showing a slide of a BWR Mark I
14 containment. The reason why I chose this is for BWRs,
15 the Mark I containments are the ones that have been
16 asking for containment accident pressure and have
17 received them in the past.

18 To kind of go ahead and give you the main
19 elements of it, I'll use my pointer. A large portion
20 of it is the drywell, which poses -- houses, actually,
21 the reactor vessel and the core and its auxiliary
22 equipment, but you also notice coming off from the
23 sides there are eight bent lines, which connect the
24 drywell to the suppression chamber. The suppression
25 chamber is in the lower part of the screen, which

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1 happens to be in the shape of a torus.

2 I will probably call the suppression
3 chamber suppression chamber torus. Also, I will be
4 calling the airspace above it the wetwell airspace.
5 And also the water underneath it contains many
6 thousands of gallons of water. That will be the torus
7 temperature of the water into that that we'll be
8 discussing.

9 The main purpose --

10 DR. WALLIS: What you don't show here is
11 where the pumps are for the NPSH.

12 MR. WOJCHOUSKI: I don't.

13 DR. WALLIS: In some plants, they are very
14 conveniently put down in holes so that they have a lot
15 of head on them.

16 MR. WOJCHOUSKI: At Montecello, a lot of
17 the Mark 1's, what we have is off of the torus is
18 where we actually pull the section for the ECCS pumps.
19 The ECCS pumps are generally in the corner of the
20 rooms, this nice square building, right adjacent to
21 the level of the torus. So you --

22 DR. WALLIS: Those are the ones that need
23 more help.

24 MR. WOJCHOUSKI: That's correct.

25 DR. WALLIS: There is some literature in

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1 holes, which --

2 MR. WOJCHOUSKI: If you have a deep --

3 DR. WALLIS: Right.

4 MR. WOJCHOUSKI: -- well pump, those are
5 the ones that typically do not ask for containment
6 accident pressure.

7 DR. WALLIS: So whether or nor you will
8 need this overpressure depends a lot on where the
9 pumps are and what kind of pumps they are.

10 MR. WOJCHOUSKI: That's correct. That's
11 correct.

12 MEMBER BANERJEE: Are there any plants
13 that need this without the uprates, the overpressure
14 credit?

15 MR. WOJCHOUSKI: Yes. Montecello was one
16 of those, even before we did a first uprate. We had
17 within our tech spec basis that we needed containment
18 accident pressure for certain periods of that.

19 MEMBER BANERJEE: How long was that?

20 MR. WOJCHOUSKI: Are you asking the
21 duration of how long we actually need it? To tell you
22 the truth, I do not know.

23 MEMBER BANERJEE: Is it short? That's
24 what I wondered.

25 MR. WOJCHOUSKI: Shorter. When we

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1 originally licensed, we were at 1,675
2 megawatts-thermal. And our current license is at
3 1,775. So when we went to transition, we went ahead
4 and actually increased it.

5 For Montecello, our original design was
6 that we put it in a our tech spec basis that we needed
7 containment accident pressure, saying that for small
8 periods of time you would need that. It was not
9 quantified. I never did see the analysis from the
10 late '60s that specified that.

11 In 1997, when we put in our suction
12 strainers, we went ahead and also requested review and
13 approval for containment accident pressure at
14 Montecello. That was a time when we formally did the
15 calculations and submitted them to the staff. They
16 got reviewed and approved at that time. So that was
17 the basis of that 1,775.

18 Prior to that, it was noted that we had
19 needed it within our basis. I'm not sure if all BWRs
20 are in the same situation, but I am sure all of the
21 designs are similar. And they would probably have
22 needed it based on what their peak suppression pool
23 temperature at the time was calculated to become.

24 MEMBER BANERJEE: But these are Montecello
25 was at -- the pump's not that deep in --

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1 MR. WOJCHOUSKI: Right. The single-stage
2 pumps, they're in corner rooms off of the torus main
3 room. They are not in pits. They are not
4 multi-stage.

5 MEMBER BANERJEE: Thanks.

6 MR. WOJCHOUSKI: Vermont Yankee is the
7 same design. Duane Arnold is the same design. Many
8 of the Mark 1's are of that same design.

9 The main function of the primary
10 containment, as you know, is to be a barrier for the
11 release of fission products from the reactor to
12 secondary containment.

13 And the other function of it is to
14 reactively reduce the pressure inside the containment,
15 in which once you have a LOCA inside the drywell, it
16 will force the non-condensables and the steam down the
17 vent lines through the vent header and down the
18 downcomers.

19 Downcomers are submerged underneath water.
20 So as the condensables are forced through the water,
21 they'll condense, reducing the overall pressure of the
22 whole containment.

23 DR. WALLIS: Now, you said the containment
24 is a barrier. And the fuel cladding is also a barrier
25 and so on. And maybe this is a time to say that with

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1 CAP, you've got one barrier dependent on the other
2 barrier.

3 So this raises a question of defense in
4 depth and how you evaluate this independent barrier
5 idea. Sometime we're going to get to that, I guess,
6 with the --

7 MR. WOJCHOUSKI: We will get to that. We
8 have specific slides in which we went ahead and
9 analyzed what happens if your failure, single failure,
10 that you're doing is a containment itself. So that's
11 towards the very end of the presentation we'll be
12 covering that. And if you have additional questions
13 at that time, we would be happy to go ahead and
14 address them.

15 Methodology that's discussed within the
16 Topical report. Deterministic calculation of NPSHa
17 without containment accident pressure, it uses
18 conservative assumptions for DBA LOCA and normal
19 assumptions for special events. And it determines the
20 wetwell pressure comparing the NPSHa to NPSHr.

21 Statistical evaluation is NPSHa without
22 containment accident pressure. If NPSHa is lower than
23 NPSHr, then this goes and provides a realistic
24 evaluation of the event in support of containment
25 accident pressure requests based on the deterministic

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1 calculations.

2 MEMBER ABDEL-KHALIK: Now, why would you
3 need the wetwell pressure if you are not taking credit
4 for the containment accident pressure in this first
5 bullet?

6 MR. WOJCHOUSKI: What you normally do is
7 go ahead and do the calculation without crediting any
8 containment accident pressure on it. And you find out
9 if your NPSHa is above your NPSHr.

10 MEMBER ABDEL-KHALIK: Well --

11 MR. WOJCHOUSKI: If that's the case, then
12 you don't need any containment accident pressure.

13 MEMBER ABDEL-KHALIK: To calculate NPSHa
14 without taking credit for the containment accident
15 pressure, do you need the wetwell pressure or do you
16 just need the wetwell temperature?

17 MR. WOJCHOUSKI: For doing that, you go
18 ahead and assume that the wetwell pressure is
19 atmospheric.

20 MEMBER ABDEL-KHALIK: When you say,
21 "determine the wetwell pressure," what does that mean?

22 MR. WOJCHOUSKI: What you do for
23 determining the wetwell pressure is if you go ahead
24 and do your calculations and have NPSHa above NPSHr,
25 you don't need any -- if you find out that you're

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1 beneath NPSH_r, you go ahead and take some of the
2 credit of the wetwell pressure. And how much you use
3 is how much is needed to make NPSH_a equal NPSH_r.

4 MEMBER ABDEL-KHALIK: But we're not
5 converging.

6 MR. WOJCHOUSKI: Okay. Good.

7 MEMBER ABDEL-KHALIK: Go ahead and
8 continue. What also happens with the methodology?

9 MR. WOJCHOUSKI: What happens if you have
10 NPSH_a lower than NPSH_r, you go ahead and also
11 statistically go ahead and do some calculations with
12 it and find out more realistically what the needed
13 pressure would be.

14 If you find out that, even with
15 containment accident pressure, you do not have enough
16 NPSH_a to equal NPSH_r, then you need to go ahead and
17 evaluate alternate means, which basically means they
18 have to go ahead and start working with the pumps and
19 vendors and see what other things that you can
20 actually do to accommodate the pumps working for that.

21 MEMBER ABDEL-KHALIK: So in big picture
22 terms, you enter this last scenario if and only if the
23 entire totality of available accident pressure credit
24 to be taken is insufficient to provide what you need
25 in terms of NPSH?

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1 MR. WOJCHOUSKI: This is correct. And we
2 have never seen an example that we really need to go
3 that far yet, but we have a methodology in which if
4 that case comes up, that we can go ahead and continue
5 the dialogue.

6 MEMBER ABDEL-KHALIK: Okay. So you enter
7 bullet 3 or the third scenario when you have
8 absolutely no margin for NPSH, even when you use
9 realistic calculations?

10 MR. WOJCHOUSKI: This is true. So, even
11 if you're using realistic calculations and your NPSHa
12 is less than NPSHr, you go ahead and have to do
13 another method.

14 MEMBER ABDEL-KHALIK: Do you think this is
15 prudent?

16 MR. WOJCHOUSKI: If you can go ahead and
17 do a different methodology, like adding another heat
18 exchanger or something else --

19 MEMBER ABDEL-KHALIK: No. At point 2.
20 Before you enter point 3. If you are right at the
21 point where you are actually using up all available
22 containment accident pressure credit with no margin
23 left, do you think that's prudent?

24 MR. WOJCHOUSKI: That would be point 3.

25 MEMBER ABDEL-KHALIK: Just on the margin

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1 before you enter point 3, just on the boundary between
2 and 3.

3 MR. CROWTHERS: I think, if I may, when we
4 get into the statistical analysis description, you
5 will hear that there is some -- even though it is
6 statistical and it is more realistic, there is still
7 some conservatism built into that methodology.

8 Maybe we ought to wait to see how that
9 goes and then ask the questions.

10 MEMBER ARMIJO: I thought that after you
11 did your first step, conservative assumption DBA LOCA,
12 nominal assumptions, and all of that, after that first
13 step, you would do an evaluation of whether there were
14 some changes to the pumps or other systems and
15 determine whether it was practical or not.

16 So there must have been -- it bothers me
17 that you're not looking at the alternate of an
18 engineering fix to, let's say, pumps can't deliver
19 what is needed. You look at that as a last resort,
20 rather than as an initial look that says, "Hey, look.
21 We can do something to upgrade these pumps or if worse
22 comes to worst, we'll get some better pumps."

23 We have never heard, at least I haven't
24 heard, on this Subcommittee any kind of discussion of
25 the extent to which you would go to upgrade the plant

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1 so that it can deliver the power that you need without
2 compromising the safety system.

3 That is where I am at philosophically.
4 Your calculations may turn out that there is margin
5 all over the place. And that would change my mind.
6 But right now I just think you're doing things sort of
7 backwards.

8 MR. WOJCHOUSKI: In order to go ahead and
9 put together the licensing submittal to the NRC, one
10 of the things that you have to do within that is go
11 ahead and say why you cannot reasonably go ahead and
12 modify the plant. If it's small modifications, that
13 will be done by the utilities to go ahead and get the
14 extra margin.

15 If it comes out like for Montecello, we
16 were talking earlier about deep well pumps.
17 Montecello, we have several corner rooms in which we
18 have two RHR pumps and a core spray pump. It's got
19 approximately 12 feet of structural concrete with lots
20 of rebar underneath it.

21 In order to go ahead and replace existing
22 pumps with the deep well pumps, you're digging through
23 12 feet of concrete then beneath that. And you'd have
24 to analyze the structural impact on the building
25 itself if you're going to go ahead and try to perform

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1 --

2 MEMBER ARMIJO: I can understand there is
3 a cost and it could be a great cost, but then there is
4 also benefit. In a big power uprate, there is a big
5 benefit, too. So if it was a generator you had to
6 replace to get more power out of the plant, you
7 wouldn't hesitate.

8 But if it's this pump, it seems like it's
9 -- I don't know. It just seems like the sequence of
10 considerations is wrong. But that's prejudging. So
11 I'll just be --

12 MEMBER BANERJEE: Just to carry on Sam's
13 thoughts, you entered that thought right at the end.
14 You say, "Oh, now maybe we can add another heat
15 exchanger or something." Why do then? Why not
16 earlier? You're doing this uprate. You don't do this
17 without an uprate. So why don't you look at that
18 earlier?

19 MR. WOJCHOUSKI: You can do it. You can
20 be here asking for containment accident pressure
21 whether you have an uprate or not an uprate.

22 MEMBER BANERJEE: You said you entered
23 this last point where you stopped to look for another
24 heat exchanger or something. Unless I've got you
25 wrong, after you show that this --

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1 CHAIR SHACK: It's your last resort, not
2 your first resort.

3 MEMBER BANERJEE: Yes, your last, not your
4 first.

5 MR. DENNIG: Alan, this is Bob Dennig,
6 Chief SCVP in NRR. In terms of the terminology and
7 when you do things and don't do things and what the
8 credit is, I think it might be useful to quickly go to
9 your slide 21 or 22 and talk about the relationship of
10 those plots to atmospheric and at what point or under
11 what circumstance do you do the statistical analysis
12 and so on and make it more concrete. Would that make
13 sense?

14 MR. WOJCHOUSKI: We can jump to the end of
15 the presentation.

16 CHAIR SHACK: Yes. I think the
17 terminology is a little bit twisted. And I think that
18 might help. If it doesn't help with that, the
19 guidance from the staff says it cannot be practically
20 altered. And there's no guidance in the BWR Owners'
21 Group document that really addresses that question.

22 MR. WOJCHOUSKI: I believe it is in there.
23 I believe it goes ahead and says that you're supposed
24 to go ahead and demonstrate that it's not practically
25 --

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1 CHAIR SHACK: A particular example, why
2 can't you replace the pumps with pumps that can pump
3 it to replace fluid?

4 MR. CROWTHERS: You could, but the Owners'
5 Group is not going to prescribe that, right? We're
6 trying to provide generic methodology to go through
7 and work your way through this issue. That's really
8 going to be up to each licensee to make those kinds of
9 decisions whether they do mods, what kind of mods they
10 might be, et cetera.

11 MR. WOJCHOUSKI: So this lays a
12 prescription on how to do your calculations, how to do
13 statistical calculations, and what to go ahead and
14 look at for possible modifications.

15 MEMBER ABDEL-KHALIK: But I think that the
16 basic underlying question is Reg Guide 1.82, rev. 3
17 position, 1.3.1.2 for PWRs, and position 2.1.1.2 for
18 BWRs state that for operating reactors for which the
19 design cannot be practicably altered, it is acceptable
20 to use containment accident pressure greater than a
21 containment pressure prior to the accident, greater
22 than atmospheric.

23 The question is, do you believe this
24 grandfathering clause remains applicable, regardless
25 of what changes the licensee may decide to make to the

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1 plant, including power uprates?

2 MR. WOJCHOUSKI: The plants were designed
3 and needed containment accident pressure before power
4 uprates. And there's no reason why they shouldn't be
5 allowed to have containment accident pressure after
6 uprates.

7 The main thing that you're doing with the
8 power uprates as you are changing the temperature of
9 the suppression pool water, as that goes up, your
10 vapor pressure goes up. And you need more --

11 MEMBER ABDEL-KHALIK: I think you gave
12 your answer. And I guess we'll ask the same question
13 for the staff, whether this grandfathering applies,
14 regardless of what changes the licensee may elect to
15 take or make to the plants. Thank you.

16 MR. WOJCHOUSKI: okay. I think we'll just
17 pop back to the slide again. Next. Okay.

18 So the methodology, do deterministic
19 calculations, do statistical calculations to go ahead
20 and show the margin in it.

21 MEMBER RAY: Okay. One more time. It's
22 been said, but I'm going to say it also. Why don't
23 you reverse the sequence of the last step and the
24 second step? Just if you can say that in simple terms
25 like he said, which is not the business of the Owners'

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1 Group to do that, if that's your answer, fine. Is
2 that your answer?

3 MR. WOJCHOUSKI: Yes.

4 MEMBER RAY: Okay. Fine. It's just not
5 the business of the Owners' Group to do it. It's the
6 business of our licensees to do it.

7 MR. WOJCHOUSKI: And that's part of the
8 methodology that they have to consider when they are
9 putting their application together.

10 MEMBER RAY: Yes. I hear you.

11 MR. WOJCHOUSKI: NPSH overview. How the
12 Topical report went ahead and calculating net positive
13 section had available is broken down for simplicity
14 into just two terms: H_{ww} and H_{pl}. Go ahead and look
15 at the parentheses underneath it. H_{ww} is basically
16 P_{ww}, which is a wetwell airspace pressure, minus the
17 vapor pressure, times 144 over the density of the
18 suppression pool water. That is basically H_{ww}. We
19 went ahead and organized it this way because those
20 terms are easy to get out of the containment analysis
21 that is normally performed by General Electric Hitachi
22 for us.

23 The other terms, the P_{ll} happens to be
24 with the height of the pump and the losses due to
25 suction strainers and due to suction piping. Those

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1 are typically gone ahead and calculated up by the
2 utilities themselves.

3 DR. WALLIS: Can I ask you about that
4 suction strainer loss?

5 MR. WOJCHOUSKI: Sure.

6 DR. WALLIS: I think in the document it
7 says you use NEDO-32686A, which is a document from
8 1998 about how to calculate suction strainer head
9 loss. And I thought we knew a lot more now about
10 suction strainer head loss than we did in 1998. We
11 knew a lot more about the uncertainties in calculating
12 it. I wonder if it's appropriate to use such an old
13 document for what could be an important element in the
14 head loss.

15 MR. WOJCHOUSKI: Right now that is our
16 licensing basis method of calculation. That's what
17 Montecello's license is based on.

18 DR. WALLIS: Is it realistic or
19 conservative or what? It calculates a head loss, but
20 there are big uncertainties about that head loss
21 presumably from our experience with head losses.

22 MR. WOJCHOUSKI: There is. And each
23 utility has gone ahead and addressed those on their
24 own basis. For Montecello, I'll give you a couple of
25 examples just to try to answer your question.

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1 Montecello, we went ahead and put in
2 suction strainers. In order to go ahead and add
3 additional conservatism when we were doing the
4 prototype heat exchangers, we took 15 square feet of
5 plastic and taped it on the outside of the strainer
6 before we went ahead and dumped all the debris, paint
7 chips, iron oxide, and NUCON insulation into the
8 slurry to come up with what our head losses would be
9 with the prototype testing.

10 We went ahead and also -- conservatively
11 the documentation says that if you have gone ahead and
12 measured how much accumulation of sludge basically,
13 iron oxide off your piping, if you have not gone ahead
14 and measured that, you are supposed to assume 300
15 pounds per year actual accumulation in your
16 calculations. It says that if you have gone ahead and
17 measured it, that you could probably go -- you could
18 use 150 pounds per year accumulation.

19 Montecello measured ours. And we had like
20 76 pounds. So there is a lot of conservatism in how
21 much debris is being generated and used on all the
22 suction strainers.

23 DR. WALLIS: So I think you're saying you
24 don't just rely on some old method. You actually do
25 new experiments?

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1 MR. WOJCHOUSKI: At the time that we went
2 ahead and installed the suction strainers, which was
3 in 1997, that methodology was new. We went ahead and
4 did our testing according to the methodology.

5 DR. WALLIS: Do you recommend that all
6 utilities do new testing, then, or do you recommend
7 they use this old document?

8 MR. WOJCHOUSKI: For NPSH, what we're
9 recommending in the licensing Topical report is that
10 you use your current licensing basis. If that changes
11 in the near future, that is going to be required to be
12 something different, that is what we will have to use.

13 But right now whatever their current
14 licensing basis is is how you go ahead and calculate
15 what your suction strainer --

16 MR. CROWTHERS: There is a separate
17 effort, separate committee, separate activity, looking
18 at BWR strainers based on what's been --

19 DR. WALLIS: And this might have an
20 influence on CAP.

21 MR. WOJCHOUSKI: And this is another
22 reason why if that changes significantly, that some
23 other utilities without going forward on power uprate
24 may have to come back in and ask the staff for some
25 additional containment accident pressure. And then

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1 they would be right into this methodology, as we
2 stated here.

3 So it's not just power uprates. It could
4 be outcome of suction strainer.

5 DR. WALLIS: So when you do your
6 statistical analysis, do you vary the Hloss from the
7 strainer in the statistical way?

8 MR. WOJCHOUSKI: No.

9 DR. WALLIS: No?

10 MR. WOJCHOUSKI: What is being changed on
11 the equation statistically is the containment
12 analysis.

13 MR. CROWTHERS: We'll get to that.

14 MR. WOJCHOUSKI: We'll be getting into
15 that.

16 DR. WALLIS: And the third point is if
17 this was a big term in your losses, this would be some
18 place where you could make changes to the design which
19 might be feasible and not too expensive compared with
20 boring through 12 feet of concrete. You could change
21 the strainers if that helped.

22 MR. WOJCHOUSKI: Strainers are as big as
23 you can get in the whole --

24 DR. WALLIS: They are now?

25 MR. WOJCHOUSKI: They are now.

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1 DR. WALLIS: They are now? Okay.

2 MR. WOJCHOUSKI: It's a huge term on the
3 loss anyway.

4 DR. WALLIS: That will be interesting to
5 know. Thank you.

6 MR. WOJCHOUSKI: Deterministic approach.
7 The traditional conservative analysis that is being
8 performed uses substantive inputs that are bounding
9 for the containment initial conditions.

10 The resulting pool temperature response is
11 maximized, and available head response is minimized.
12 This approach will give a conservative assessment of
13 NPSHa. This is what utilities have been using
14 already.

15 Statistical approach. This is new. It
16 takes credit for variabilities in the analysis inputs.
17 The order the statistical method is applied, the input
18 to variables is defined statistically and combined
19 through a Monte Carlo process. Fifty-nine random
20 draws are made from the corresponding probability
21 distributions.

22 Containment pressure and temperature time
23 histories are calculated for each of those 59 cases.
24 This allows for more realistic NPSHa values and which
25 can be used to quantify the conservatism in the

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1 deterministic analysis.

2 MEMBER BLEY: Why 59 cases?

3 MR. WOJCHOUSKI: Fifty-nine cases is the
4 minimum number of cases that you need to come up with
5 a 95 percent confidence level. If you did a lot more
6 cases, you could come up with a 96 or 98 confidence
7 level.

8 Ninety-five confidence level has been used
9 since all of that has been established in other --

10 MEMBER BANERJEE: It is their peak clad
11 temperature methodology.

12 MR. WOJCHOUSKI: For the deterministic
13 approach, you either the maximum or the minimum
14 values.

15 MEMBER BANERJEE: Excuse me. When you
16 apply it to other problems, that presumes that you
17 actually use a best estimate code to do the
18 calculations.

19 MR. WOJCHOUSKI: We're not using best
20 estimate code. SHEX is the code that has been used in
21 the analysis here.

22 MEMBER BANERJEE: So the analogy is not
23 exact, right, with what we do for other systems?

24 MR. CROWTHERS: We are not sure of the
25 answer. Do you have the answer, Guanjan?

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1 MR. LI: Yes. This is Guanjan Li from GE
2 Hitachi. So, actually, in one of the responses to the
3 NRC RAI we compare the CSAU methodology with our
4 methodology. So this is step three, basically the
5 phenomena identification and table. This is PIRT. We
6 call it PIRT table.

7 So, actually, we didn't do that step
8 because that one applies to the best estimate code.
9 And the SHEX is simply try the code and to maximize
10 temperature. So this is code. So we didn't do. And
11 this is code uncertainty.

12 We agree with the NRC, actually. If you
13 are going to use this best estimate code, like TRACG,
14 to do this, this methodology. You'll have to quantify
15 the code uncertainty.

16 MEMBER BANERJEE: I think that that's a
17 clear answer, but if you do that, then we know what
18 we're doing because you're using a CSAU methodology,
19 which we all have developed, know, and love. And what
20 you are doing here I don't really know.

21 So you have to clarify in detail what it
22 means. You are not using a best estimate code. You
23 haven't done a PIRT. So what are we doing?

24 MR. LI: The purpose of this LTR,
25 actually, is to use the statistical method to

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1 demonstrate margin. So you are going to see, even if
2 your own statistical methods, we still have a lot of
3 conservatism that remains there.

4 So basically the steps, step 11, actually,
5 inputs the parameters within that PIRT in the CSAU
6 methodology. So this statistical method is
7 demonstrating margin. If we remained some
8 conservatism in our methodology, we think it is
9 reasonable.

10 MEMBER BANERJEE: But we don't know. You
11 know, that is the problem. People keep saying,
12 "conservatism." We don't know what that means.

13 With the best estimate, could we know
14 precisely what we mean?

15 MR. LOBEL: This is Richard Lobel from the
16 staff. Could I address that?

17 MEMBER BANERJEE: Do you want to address
18 it now or do you want to --

19 MR. LOBEL: In my presentation, I am going
20 to show a comparison of the SHEX code, the code that
21 GEH uses, with the GOTHIC code, both using the same,
22 basically the same, input. And I can show you a
23 comparison of pressures and temperatures between a
24 more realistic code and the SHEX code.

25 MEMBER BANERJEE: Okay. We can defer that

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1 if you like.

2 MEMBER ABDEL-KHALIK: But, just for the
3 record, has SHEX ever been formally evaluated by the
4 staff?

5 MR. LOBEL: SHEX has been used for years
6 in licensing calculations, but we have never written a
7 formal SER approving it.

8 MEMBER ABDEL-KHALIK: Thank you.

9 DR. WALLIS: This 95/95 presumably comes
10 from the NRC. It's nothing that you claim. It's not
11 something that you put forward. It's something that
12 you were told to assume, right?

13 MR. WOJCHOUSKI: It was a standard
14 approach that has been used previously. It was
15 reasonable.

16 DR. WALLIS: Something else, right?

17 MR. WOJCHOUSKI: And we --

18 DR. WALLIS: There is nothing magical
19 about 95/95. There are some things which you might
20 want to be more sure of than 95 percent. I mean, five
21 percent of something, probability of something, going
22 wrong is tolerable in some aspects of LOCAs and not in
23 other aspects of LOCAs.

24 So maybe when the staff gets up there, we
25 should say 95/95 isn't a magic formula that you can

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1 apply to everything because sometimes you want to be
2 more certain, sometimes you want to be less certain
3 depending on how severe the consequences are.

4 It's not really a question for you, but
5 you're just taking this as given, right?

6 MR. WOJCHOUSKI: I'm taking this as an
7 acceptable method of doing the statistical. The
8 statistical approach input parameters can be
9 statistically defined and identified and will not
10 necessarily be at their extremes, your maximum, your
11 minimum values at the same time. The remaining inputs
12 are identical to those used in a deterministic
13 approach.

14 The statistical approach, these are the
15 different input parameters that can be statistically
16 defined. You can go ahead and do initial reactor
17 power, decay heat, initial suppression pool
18 temperature, surface water temperature, basically the
19 river water temperature, heat sink, the initial
20 suppression pool volume, the initial drywell
21 temperature, the RHR heat exchanger, heat removal
22 capability, initial drywell pressure, wetwell
23 pressure, and the containment leakage rate. All those
24 can be statistically defined and put within the
25 statistical model.

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1 DR. WALLIS: Do you want to tell us which
2 are most important? As I remember from one of our
3 presentations earlier, the heat sink temperature is
4 important.

5 I mean, the river may be in very extreme
6 conditions because it's at 95 degrees Fahrenheit but
7 almost never. And that makes a big difference to the
8 answer.

9 Isn't that the one that's the most
10 important?

11 MR. WOJCHOUSKI: Montecello, our ultimate
12 heat sink design temperature is 90 degrees. We never
13 got up to that temperature. We got to 87 and a half
14 degrees. I think we reached that twice over the life
15 of the plant for the last 40 years.

16 Montecello also -- seeing as how we are up
17 in the north, about half the year, we have very cold
18 river water. Part of it is that we've got ice on some
19 of it coming up.

20 DR. WALLIS: In the north?

21 MR. WOJCHOUSKI: So average temperature is
22 in the mid 50s. And what we go ahead and do for these
23 particular different inputs is we take five years'
24 worth of data, put them in different temperature bins
25 if you're talking river water, and then find out how

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1 much time each one of those different bins is
2 accumulated, comes up with an exceedance probability.

3 Once those exceedance probabilities are
4 developed, you go ahead and use the random number
5 generator. You go ahead and pick the values for the
6 59 different cases. So that's how the statistical --

7 DR. WALLIS: I understand that. I was
8 just saying you didn't give us an order of magnitude
9 which one is most important. As I remember, the
10 surface --

11 MR. WOJCHOUSKI: Surface water was one of
12 the top ones on it. Your decay value is another
13 important one. I don't remember within the Topical
14 report. We went ahead and did a sensitivity study on
15 varying all of these different parameters and shows
16 what the net effect was on --

17 MR. CROWTHERS: Can you talk to that,
18 Guanjan?

19 MR. LI: Yes. Yes, you're right. The
20 surface water temperature, it's the most important one
21 parameter. Actually, in our RHR table 3-1, we did a
22 sensitivity study. So if you change the surface water
23 temperature by 20 degrees, surface temperature changes
24 10 degrees.

25 DR. WALLIS: So a very thing to do without

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1 changing the plant at all is to decrease your power on
2 the day when the roof is very hot. Isn't that
3 something you should consider as an alternative?

4 MR. WOJCHOUSKI: That was thought of. The
5 problem with that is it's decay heat. And what has
6 been your power history? So that becomes an issue
7 with it also.

8 MEMBER ARMIJO: You picked the range.
9 Does the guidance provide the range of initial reactor
10 power or is that at the discretion of the individual
11 utility? What is that range for? Is it 100 percent
12 plus/minus a couple --

13 MR. WOJCHOUSKI: Deterministically, if you
14 do a deterministic evaluation, you use 102 percent of
15 your reactor thermal power. If you're doing a
16 statistical approach, it uses a normal distribution at
17 the 100 percent mark.

18 MEMBER ARMIJO: So what is the range?
19 From what to what? Ninety to 102, something like
20 that?

21 MR. LI: Yes, yes.

22 MR. WOJCHOUSKI: We've mentioned this a
23 little but. Statistical approach combines the
24 variables and input parameters through a Monte Carlo
25 process. Random draws are made from corresponding

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1 probability distributions in order to determine the
2 input values.

3 Calculations of containment responses with
4 one set of those random draws input values represents
5 one trial of statistical process. So you do that 59
6 times. So you have 59 independent calculations of
7 containment response in order to come up with a 95
8 percent probability, 95 percent confidence level.

9 MEMBER BANERJEE: The first line I was
10 just reading there, "Consistent with TRACG AOO." What
11 is that? You show that the method is acceptable for
12 this?

13 MR. WOJCHOUSKI: It shows that it's been
14 applied other places.

15 MEMBER BANERJEE: Okay.

16 CHAIR SHACK: It just means he's following
17 the order statistics. That's all.

18 MR. WOJCHOUSKI: That is all it really
19 means and just gave a reference to it.

20 Other statistical approach, the outputs
21 that are needed for NPSHa is the pool temperature, the
22 wetwell airspace pressure, and the pool volume. Those
23 are calculated with SHEX. And those are used on a
24 time history basis to drive what your NPSHa
25 requirements are.

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1 Based on these outputs, calculation of the
2 term Hww as a function of time for each one of the 59
3 different calculations are obtained. And you obtain
4 the minimal values of Hww as a function of time. The
5 resulting minimum values are used as a magnified
6 percent value.

7 CHAIR SHACK: It just comes back to that
8 question that Sanjoy raised about the code. I mean,
9 we're not dealing with the uncertainty in the model
10 here. We're dealing only with the parameter
11 uncertainty.

12 From my mind, that's okay if I'm convinced
13 that the modeling errors in the code are on the
14 conservative side. And you made the comment that it's
15 conservative as far as temperature goes, but it's not
16 the temperature that I'm worried about here.

17 It's pressure minus vapor pressure. It's
18 the head. So do you have any demonstration that SHEX
19 is calculating that quantity conservatively?

20 MR. LI: Yes. Actually, we have talked
21 here this Hww. So that term --

22 CHAIR SHACK: Right. That's the --

23 MR. LI: -- actually term that --

24 CHAIR SHACK: You made the comment about
25 temperature before. And temperature isn't the

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1 parameter I am interested in. It's Hww.

2 MR. LI: Yes. It's Hww. For example, in
3 our statistical calculation, where you assume a
4 drywell/wetwell relative humidity of 100 percent, that
5 one minimizes drywell and wetwell pressure.

6 So probably not in this version of our
7 presentation, in our LTRs, we issue the wetwell
8 comparisons. You will see.

9 So basically one for the parameters we
10 worry the other parameters will remain the same as
11 deterministic.

12 MEMBER BANERJEE: I think we need to at
13 some point review this whole business of S HEX
14 seriously. But it's different when we're dealing with
15 something like TRACG, which has been scrutinized and
16 looked at and we understand what the uncertainties
17 are, they have been compared to experiments very
18 widely. But here it is quite a different matter.

19 Let's pursue this when we discuss the
20 codes, come back to this. We table this as an item.

21 MR. WOJCHOUSKI: Special events. NPSH
22 methodology for special events is also presented in
23 the Topical report. It briefly describes what each of
24 the special events are, the similarities and contrasts
25 between the DBA LOCA, NPSH analysis, and identifies

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1 conservatisms in the special events NPSH valuations.

2 Topical report did not do any analysis of
3 the special events. You're using similar methodology
4 to what was presented for the LOCA, which just
5 discusses --

6 DR. WALLIS: I am a bit puzzled by that.
7 I read that. And it says for special events, which
8 would be ATWS and SBO and so on, it says, "If COP is
9 required, special consideration is given to
10 potentially non-conservative modeling assumptions."
11 Well, what does that mean?

12 MR. WOJCHOUSKI: Repeat your question
13 again.

14 DR. WALLIS: In this report of yours, it
15 says, "For special events, each one of the special
16 events," it says, "if COP is required," --

17 MR. WOJCHOUSKI: Right.

18 DR. WALLIS: I'm just quoting now.

19 -- "special consideration is given to
20 potentially non-conservative modeling assumptions." I
21 don't know what that means. I don't know what it
22 implies that you now do. If you need COP, what does
23 special consideration mean?

24 MEMBER ABDEL-KHALIK: You already are in
25 the hole. That is the question.

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1 MR. WOJCHOUSKI: Yes.

2 MEMBER ABDEL-KHALIK: So you're going back
3 to look at non-conservative assumptions to put you
4 deeper in the hole?

5 DR. WALLIS: Are you trying to make them
6 conservative or what are you doing?

7 MR. CROWTHERS: We'll have to get back to
8 you. We'll have to go look at the context of where
9 that statement is unless you guys can answer that.
10 No? Okay. We'll get back to you on this.

11 MR. WOJCHOUSKI: The deterministic
12 approach utilizes nominal input values will be used in
13 the calculation for NPSHa for a special event. Should
14 the approach not satisfactorily show that NPSHa minus
15 NPSHr is greater than zero, then the statistical
16 approach utilizing the mean output values will be used
17 to show that the expected realistic response to the
18 event.

19 DR. WALLIS: Do you have experience with
20 doing that? I'm not sure if the mean value from the
21 statistics is greater or less than the nominal value.

22 MR. WOJCHOUSKI: The mean value of the
23 statistical report -- statistics, you have the
24 minimum, the maximum, and the mean.

25 DR. WALLIS: Yes. But you're using it

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1 when nominal values don't work. And I'm not sure if
2 that makes it better or worse.

3 MR. LOBEL: This is Richard Lobel from the
4 staff. In my presentation, I have some comparisons of
5 statistical analysis, realistic analysis, and
6 conservative analysis.

7 DR. WALLIS: Under nominal?

8 MR. LOBEL: Well, what I am calling
9 realistic is what they're calling nominal pretty much.
10 Again, it's calculated with GOTHIC, but we did three
11 types of calculations. We did the conservative,
12 typical conservative.

13 We did a realistic where we tried to make
14 everything as realistic as we could except for the
15 things like surface water temperature that it's hard
16 to get a realistic value of and realistic,
17 conservative, and statistical. And I'll show the
18 comparisons.

19 CHAIR SHACK: By "realistic value" for a
20 parameter, you mean an estimated mean value?

21 MR. LOBEL: It turns out, yes, it's almost
22 exactly that.

23 CHAIR SHACK: Well, no. I know. There's
24 a statistical mean for the discombined distribution.
25 There's also the individual parameter means. And what

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1 you're saying is that when you calculate using the
2 mean values of the distribution, you get something
3 that sort of looks like the mean of the statistical?

4 MR. LOBEL: No. What I'm talking about is
5 what we did was we ran the 59 cases and took the mean
6 of the 59 cases.

7 CHAIR SHACK: Just when anybody says a
8 "nominal value," I always want to know what the
9 nominal value is.

10 DR. WALLIS: What is it? Is the nominal
11 --

12 CHAIR SHACK: Is the nominal value the
13 mean? You know, that's -- or what is it if it isn't
14 the mean?

15 DR. WALLIS: What is it?

16 MR. WOJCHOUSKI: What we will have done
17 for our special events is used either bounding numbers
18 the same as deterministically and occasionally a few
19 of the numbers. Instead of using an absolute bounding
20 number, we'll do it about the 95 percent confidence
21 level on that particular parameter.

22 So typically we do not go ahead and change
23 all of the numbers on the statistical or all the
24 inputs to a nominal average value. It's normally
25 using the same deterministic. Only one or two of the

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1 different variables will go ahead and be put at a 95
2 percent value.

3 Does that answer your question a little
4 bit better, how we actually do the --

5 CHAIR SHACK: No. Maybe you ought to tell
6 me how you get the distributions of these parameters.

7 MR. WOJCHOUSKI: Input parameters, what we
8 did for the Montecello and the statistical, we took
9 five years worth of our plan data. You can come up
10 with a mean on it. You can come up with a standard
11 deviation on it. And you can come up with a 95
12 percent confidence level of that particular input
13 variable.

14 DR. WALLIS: And what is the nominal
15 value?

16 MR. WOJCHOUSKI: The nominal value is a
17 value that isn't bounding that you select to put as an
18 input.

19 MR. CROWTHERS: It is realistic, right?

20 MR. WOJCHOUSKI: It is typically more
21 realistic than the bounding deterministic.

22 MEMBER RYAN: So how does the nominal
23 value relate to the mean of the distribution of your
24 data that you just described? Is it the same?

25 MR. WOJCHOUSKI: Typically you do not just

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1 pit the mean of that distribution. You'll pick a 95
2 percent confidence level on it. So it's an upper
3 bound.

4 MEMBER RYAN: Not always.

5 MR. WOJCHOUSKI: I do not know exactly all
6 the inputs on those special events that we have used.
7 I have done certain calculations of those. You have
8 to go ahead and have a nominal value, whatever you
9 call a nominal values. You have to be conservative
10 enough to have a defendable why that is a good number
11 to use within your calculations.

12 DR. WALLIS: I think what you are saying
13 is the nominal value is always more conservative than
14 using the mean.

15 MR. WOJCHOUSKI: Yes.

16 DR. WALLIS: That's true?

17 MR. WOJCHOUSKI: That's true.

18 DR. WALLIS: I thought that's what you
19 wanted to say.

20 MEMBER RYAN: But by how much?

21 MR. WOJCHOUSKI: Going on, example of
22 plant analysis. This is where we took five years of
23 data was used for developing the exceedance
24 probability distribution for each one of the different
25 parameters that were defined statistically.

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1 Containment analysis --

2 DR. WALLIS: No. Wait a minute. Excuse
3 me. Five years of data on river water temperature,
4 there must be some action you take if it's an unusual
5 year when the river water gets warmer than it's been
6 for five years. You don't do anything special then?

7 MR. WOJCHOUSKI: We take the plant data as
8 it is recorded.

9 DR. WALLIS: Yes, but five years' data is
10 not very reliable for that sort of environmental
11 parameter, is it?

12 MR. WOJCHOUSKI: We went ahead and plotted
13 10 years and 15 years.

14 DR. WALLIS: El Ninos and things are
15 cycles which are longer than five years that affect --

16 MR. WOJCHOUSKI: What we are trying to
17 define is a methodology of how you go ahead and come
18 up with an exceedance probability --

19 DR. WALLIS: I understand that.

20 MR. WOJCHOUSKI: Five years seemed like a
21 very reasonable time to go back.

22 DR. WALLIS: I understand that. But I
23 know the river water temperatures is a very important
24 lever in determining CAP. So if you're running
25 Montecello, which I agree is in the north, there may

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1 be some time when the river water temperature gets
2 above your specs. What do you do then?

3 MR. WOJCHOUSKI: If it's above your open
4 heat sink requirement --

5 DR. WALLIS: Right.

6 MR. WOJCHOUSKI: -- tech specs will have
7 you shut down.

8 DR. WALLIS: You actually shut down?
9 Okay. That's --

10 MR. WOJCHOUSKI: Tech specs on --

11 DR. WALLIS: That's a good answer. Thank
12 you. Okay.

13 MR. WOJCHOUSKI: The next one that we went
14 ahead and did is did three different scenarios. One
15 is short-term, which is less than 600 seconds and
16 using a single limiting failure; the long-term
17 analysis, containment analysis, which is greater than
18 600 seconds, using a different limiting single
19 failure. And the last scenario that we did is
20 containment integrity was not credited. What happens
21 if you lost containment integrity?

22 Each one of these different scenarios was
23 done two ways: the deterministic approach, which is a
24 typical licensing basis; and the statistical approach,
25 which is the Monte Carlo which we have been talking

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1 about.

2 This represents the suppression pool
3 temperature for the DBA LOCA with a diesel generator
4 failure. This is our long-term results, greater than
5 600 seconds, in which a single failure is the loss of
6 a diesel generator.

7 The reason why that is considered the
8 worst failure is that you lose one division of your
9 low-pressure ECCS. And you only have one division
10 remaining for you.

11 Part of the other assumptions for the DBA
12 LOCA is that you lost off-site power. So you have one
13 diesel operating, two RHR pumps and one core spray
14 pump to address this scenario.

15 You can see here from the different curves
16 the deterministic calculation showed the peak
17 suppression pool temperatures as a function of time.
18 That's your line number 4.

19 Out of statistical analysis, you have
20 lines 1, 2, and 3, the maximum, the mean, and the
21 minimum. And it just shows a comparison of what your
22 expected suppression pool temperatures are doing those
23 different methodologies.

24 This slide shows long-term again, greater
25 than 600 seconds. And it shows what happens if you

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1 consider that you lost your containment. This
2 scenario is different than a design basis LOCA in that
3 you're not assuming that you have a loss of your other
4 diesel.

5 So you have both trains of low pressure
6 uses GS. You have two RHR heat exchangers up in
7 operation. And you have a full complement. We wanted
8 to demonstrate and show you what that looked like
9 also. We'll have the plots, other plots other than
10 this, shortly.

11 As you can see here, it goes ahead and
12 shows you that what the deterministic model shows is
13 line number 4. If you compare to the earlier slide,
14 you can see that, instead of being above 200 degrees,
15 this is around 170 degrees, much lower. That's
16 because of the extra heat exchangers.

17 DR. WALLIS: What effect does this have on
18 NPSH?

19 MR. WOJCHOUSKI: Well, the slide or two
20 will show you right there.

21 DR. WALLIS: Are you going to show us your
22 --

23 MR. WOJCHOUSKI: The main driver on NPSH
24 is a suppression pool temperature.

25 DR. WALLIS: Are you going to show us that

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1 with 95/95, you don't need CAP at all?

2 MR. WOJCHOUSKI: With 95/95, you don't
3 need CAP at all. That's correct.

4 DR. WALLIS: And with existing plants with
5 existing power levels?

6 MR. WOJCHOUSKI: Existing plants, existing
7 power levels. This particular analysis was done at
8 Montecello's EPU power level.

9 Going long term deterministically --

10 DR. WALLIS: Did VY do an analysis like
11 that?

12 MR. WOJCHOUSKI: I'm unsure. Maybe,
13 Guanjan, do you know what VY did, analysis similar? I
14 don't think they did the statistical analysis.

15 MR. LI: I am sorry. I don't know this.

16 MR. LOBEL: This is Richard Lobel from the
17 staff. VY didn't do exactly this kind of analysis,
18 but they did sensitivity studies that were under
19 appendix B that showed that with just relieving some
20 of the conservative assumptions but not all, they
21 didn't need containment accident pressure.

22 DR. WALLIS: I remember that. In fact, we
23 wrote a report where we said we would like to see a
24 statistical analysis or some of us did. Have they
25 done any statistical analysis since that? Do you

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1 know?

2 MR. LOBEL: I don't believe so.

3 DR. WALLIS: Okay.

4 MR. WOJCHOUSKI: This curve shows the
5 results deterministically of what you expect for the
6 wetwell pressure. And what the other line is, the RHR
7 wetwell pressure required deterministically.

8 What that line represents, the black line
9 represents, what wetwell pressure is needed to have
10 NPSHa equal NPSHr. So you actually can go ahead and
11 look where the peak is. There is the margin between
12 that and what your calculated wetwell pressure is.

13 MEMBER ABDEL-KHALIK: For this particular
14 case?

15 MR. WOJCHOUSKI: For this particular case.

16 DR. WALLIS: So the margin is how many psi
17 here, something like six psi or something?

18 MR. WOJCHOUSKI: Six to seven psi. And
19 you need approximately six psi, too.

20 DR. WALLIS: Does that mean, what's his
21 name, the pump man's criteria, Budris? Budris
22 recommended certain margins. Does that make his
23 margins?

24 MR. WOJCHOUSKI: That I'm unsure of.

25 DR. WALLIS: Unsure of.

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1 CHAIR SHACK: You are under 15 percent.

2 DR. WALLIS: I think it does.

3 CHAIR SHACK: Yes.

4 DR. WALLIS: I think it does.

5 MR. WOJCHOUSKI: This is a comparison of
6 containment accident pressure required for the RHR
7 pumps to do DBA LOCA, a comparison of what it is
8 deterministically and what you would need
9 statistically. You can see that if you do the
10 statistical approach on here, that it's a lot less.

11 DR. WALLIS: Of course, the pressures
12 varies statistically, too.

13 MR. WOJCHOUSKI: Pressure is different.
14 And it's lower also.

15 This shows a core spray DBA LOCA, a
16 comparison of its deterministic and its statistical
17 approach.

18 This shows you the RHR pumps without the
19 containment integrity. If you do it
20 deterministically, in which you are using bounding
21 inputs or river temperature, initial suppression pool
22 temperature, and those sorts of things, it shows you
23 that with all of your complement of RHR pumps, that
24 deterministically you would need some containment
25 accident pressure to have NPSHa equal --

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1 DR. WALLIS: This is all for Montecello?
2
3 MR. WOJCHOUSKI: This is Montecello's
data.

4 DR. WALLIS: What's the elevation of
5 Montecello?

6 MR. WOJCHOUSKI: Ninety thirty-five.

7 DR. WALLIS: So the atmospheric pressure
8 is --

9 MR. WOJCHOUSKI: What we're doing here is
10 conservative. What you have on here is 14.26 is used
11 for --

12 DR. WALLIS: Okay. Thank you.

13 MR. WOJCHOUSKI: -- is conservatively
14 defined as the lowest monthly average that we have
15 seen in umpteen years.

16 DR. WALLIS: Okay.

17 MR. WOJCHOUSKI: So what you also have on
18 here is statistical. And statistical as you look at
19 that shows you that you're underneath what your
20 atmospheric pressure is. So you're --

21 DR. WALLIS: Yes.

22 MR. WOJCHOUSKI: You do not need
23 containment at pressure if you lose your containment.
24 And that was your major single failure.

25 DR. WALLIS: So is this what is done now?

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1 Is it usual for plants to use a minimum atmospheric
2 pressure for this calculation?

3 MR. WOJCHOUSKI: I am not sure what
4 everybody else has used, whether they used 14.7. It's
5 just how this is our licensing basis. We do
6 conservative assumptions.

7 One of the assumptions is, what is your
8 atmospheric pressure? Montecello uses 14.26 as a
9 conservative number. That just demonstrates one of
10 the other conservatisms that we are using. If you use
11 14.7, just move the line up.

12 Core spray, similar results.

13 DR. WALLIS: It's interesting because the
14 difference between 14.3 and 15.3 on some of these
15 curves would make a difference.

16 MR. WOJCHOUSKI: That's how close they
17 are.

18 So, in closing, the Topical report goes
19 ahead and tries to provide a methodology to the
20 utilities on how to do the calculations for requesting
21 containment accident pressure. It provides guidance
22 on how to do deterministic calculations and how to go
23 ahead and do statistical calculations to try to show
24 you the margin inherent in the deterministic
25 calculations.

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1 MEMBER BLEY: Let me ask you, can you back
2 up to either one of your two graphs, the last two you
3 had? There you go.

4 You did the statistical calculations where
5 you told us before. But on the earlier graphics, you
6 presented a high, a bottom, and a mean. This is the
7 mean, I assume.

8 MR. WOJCHOUSKI: This is the bottom.
9 Minimum Hww was used for determining statistical.

10 MR. LI: This is a minimum.

11 MR. WOJCHOUSKI: Minimal.

12 MEMBER BLEY: This is the mean.

13 MR. WOJCHOUSKI: No.

14 MR. LI: Minimum.

15 MEMBER BLEY: No, no, no. Minimum. Okay.

16 MR. LI: That's right.

17 MEMBER BLEY: From the statistical
18 calculation. Okay.

19 MEMBER ABDEL-KHALIK: Now, these
20 statistical methods do not account for uncertainties
21 in the required NPSH?

22 MR. WOJCHOUSKI: We have not addressed
23 uncertainties in NPSHr at this time. What we had used
24 for calculations is right out of what the vendor
25 provided us for NPSHr.

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1 MEMBER ABDEL-KHALIK: But you acknowledge
2 that there are uncertainties in NPSHr; for example,
3 you know, air content in the water. How would you
4 handle that in this methodology?

5 MR. WOJCHOUSKI: What you would do on this
6 methodology is you would go ahead and take your -- the
7 staff will describe this in better detail, but you
8 will go and take your NPSHr three percent. And, using
9 that value, you will use NPSHr-effective, which
10 addresses the uncertainties in it, and put that into
11 your spreadsheet, instead of NPSH, three percent. And
12 it will slightly raise everything up by those
13 uncertainties.

14 MR. CROWTHERS: The staff will be talking
15 about that.

16 DR. WALLIS: When you said this was the
17 "minimum," I tie it to the maximum. It's the one that
18 comes closest to the deterministic. It's the highest.

19 CHAIR SHACK: Yes. I hope it's the
20 maximum.

21 MEMBER BANERJEE: But pursuing the
22 question that --

23 DR. WALLIS: Can you just clarify that so
24 we get it straight for the record that what you're
25 showing us is the highest curve, isn't it, the ones

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1 that's closest to the --

2 MR. LI: Let me clarify. Yes, this is the
3 maximum --

4 DR. WALLIS: Right.

5 MR. LI: -- containment overpressure you
6 need.

7 DR. WALLIS: Right.

8 MR. LI: Actually, if you look at the
9 curve H_{ww} , we use H_{ww} minimum. So the requirement
10 then is maximum.

11 DR. WALLIS: But in this figure here, it
12 is the maximum pressure.

13 MR. LI: Yes. It's the requirement.
14 Maximum.

15 CHAIR SHACK: Can you also explain to me
16 the difference between 19 and 20 for both containment
17 accident pressure required the DBA LOCA for RHR pumps?
18 And they're different.

19 MR. WOJCHOUSKI: Nineteen and 20.

20 CHAIR SHACK: And what's the difference
21 between the two?

22 MR. WOJCHOUSKI: I am just trying to look
23 to see. The curve itself, right here, the black
24 curve, and this curve should be identical.

25 MEMBER BLEY: The bottom?

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1 MR. WOJCHOUSKI: No. The top curve.

2 MEMBER BLEY: The top curve.

3 MR. WOJCHOUSKI: The top curve on here and

4 --

5 CHAIR SHACK: That is what is required for
6 the pump.

7 MR. WOJCHOUSKI: And this curve, the black
8 one, are identical curves. The only difference
9 between this particular one is all we're showing is
10 the wetwell pressure on top of it to show the margin
11 between what your calculated wetwell pressure is and
12 what is required.

13 And then the next slide I am comparing
14 that same curve to statistical.

15 MEMBER BROWN: So this was the wetwell
16 pressure that results from the accident as you go
17 through the accident transient and then you need the
18 RHR pumps, right?

19 MR. WOJCHOUSKI: The red line is the
20 wetwell pressure from the accident.

21 MEMBER BROWN: Okay.

22 MR. WOJCHOUSKI: And that is what is
23 calculated underneath the containment analysis. And
24 then the black line is how much of the wetwell
25 pressure do you need to make NPSHa equal --

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1 MEMBER BROWN: What is the difference
2 between those two if what you -- I guess I didn't
3 understand it. To me, this one says, "I've got enough
4 wetwell pressure to ensure that I have enough NPSH to
5 start" --

6 MR. WOJCHOUSKI: Right. That's the
7 containment accident pressure.

8 CHAIR SHACK: And then I need a red curve
9 on the next graph?

10 MR. WOJCHOUSKI: The red curve on the next
11 graph would have been exactly the same as this graph.
12 We could have put them both together. And then we
13 could have also gone ahead and put the set of
14 pressures out of statistical on top of that.

15 MEMBER BROWN: Okay. So all of these
16 other curves you have just shown me are the additional
17 margin that I presumably get out of having the
18 statistical method?

19 MR. WOJCHOUSKI: Yes. The red line would
20 be on all of them, what I got out of --

21 MEMBER BROWN: For the deterministic?

22 DR. WALLIS: Can we clarify the red line
23 now in response to Charlie's question? The red line
24 here is a conservative minimum containment pressure.
25 What you calculate to determine whether the

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1 containment pressure needs its maximum limit is a
2 different calculation, which is much higher. Isn't
3 that true?

4 MR. WOJCHOUSKI: When we are doing the
5 deterministic calculations, it is to minimize what the
6 containment wetwell pressure will be.

7 DR. WALLIS: Minimize it.

8 MR. WOJCHOUSKI: It's going to minimize
9 it. That's the deterministic.

10 DR. WALLIS: When you're doing the
11 containment --

12 MR. WOJCHOUSKI: When we're doing a
13 containment analysis for maximizing pressure, all the
14 inputs are all flipped around to maximize it.

15 DR. WALLIS: Way up high.

16 MEMBER BROWN: This is going to make sure
17 you don't break the containment.

18 MR. WOJCHOUSKI: That's correct.

19 DR. WALLIS: You don't do a statistical
20 analysis of the containment pressure, though. You
21 don't do a similar 50.59 run on --

22 MEMBER BROWN: So the way I would read
23 these other curves, then, is if you have a containment
24 breach, there is no integrity. Where you've got
25 atmospheric and this defines how long you would have

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1 to and the magnitude of the delta that you have for
2 the NPSH, it just -- I don't have any credit.

3 If I've lost credit, this is how long I
4 would go with potentially no pumps, well, if they
5 don't operate on the deterministic method.

6 MR. WOJCHOUSKI: On the deterministic
7 method --

8 MEMBER BROWN: Well, it's the same for
9 both, just a different method to do the calculation.

10 MR. WOJCHOUSKI: Right.

11 MEMBER BROWN: Let me go back.

12 MR. WOJCHOUSKI: Sure.

13 MEMBER BROWN: On slide 20, slide 20, that
14 would tell me if I had no containment pressure, I had
15 a breach. Then I've effectively got whatever the
16 number of delta seconds is in there if I get a look at
17 that 47 hours or so if you go through that, you would
18 have had no cooling, if you have lost integrity to
19 containment, you're above atmospheric now.

20 MR. WOJCHOUSKI: You're above atmospheric
21 on here. What you have right now is you have a DBA
22 LOCA going on. You have a loss of a diesel.

23 MEMBER BROWN: Yes.

24 MR. WOJCHOUSKI: And you're going to put
25 on top of that the loss of containment integrity. So

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1 you've got beyond design basis. Underneath those
2 conditions, deterministically if your pumps will not
3 run with eating six extra pounds, --

4 MEMBER BROWN: Yes.

5 MR. WOJCHOUSKI: -- they would shut down.

6 MEMBER BROWN: You'd have no cooling.

7 MR. WOJCHOUSKI: And you'd have no
8 cooling.

9 MEMBER BROWN: Okay. I like the litany
10 that you went through, but --

11 MR. WOJCHOUSKI: That's just making sure
12 that you have the right scenarios, what's going on
13 with that.

14 MR. LOBEL: Let me say that is the
15 conservative assumption that the pumps are going to
16 shut down.

17 MR. WOJCHOUSKI: Right.

18 MR. LOBEL: The operator has instructions
19 in his procedures -- tell me if I'm wrong -- that if
20 the pumps are cavitating but he needs that flow to
21 keep the core cool, he's going to keep trying to use
22 those pumps. He's not going to turn off the pumps.

23 And it doesn't necessarily mean that the
24 pumps aren't going to keep pumping. They may be
25 vibrating. And they may not be delivering the flow

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1 that was considered in the safety analysis because
2 we're beyond the safety analysis now. But it doesn't
3 necessarily mean that there's no cooling anymore.

4 MEMBER BROWN: It just means you've got a
5 loss of cooling. That's all. I recognize you might
6 get some -- at some point the pumps don't --

7 MEMBER SIEBER: Sooner or later the pumps
8 will fail.

9 MEMBER BROWN: You're going to lose it.
10 So I'm just trying to make sure I understood the
11 curves on the --

12 MR. WOJCHOUSKI: You also can go ahead --
13 these calculations are done at a specific flow rate.
14 RHR is 4,000. If you go ahead and take operator
15 action to throttle them back, your NPSHr goes down.
16 You will need a little bit less.

17 MEMBER BROWN: Yes.

18 MR. WOJCHOUSKI: So you can do mitigating
19 actions with that. EOPs may also direct you into
20 adding water into the torus or something else, which
21 will also mitigate this.

22 MEMBER BROWN: The valves, do you have
23 throttle values on the --

24 MR. WOJCHOUSKI: Yes.

25 MEMBER BROWN: Are they manually or are

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1 they remotely operable or what?

2 MR. WOJCHOUSKI: For RHR, this is from a
3 control room.

4 MEMBER BROWN: Okay.

5 MEMBER BLEY: They are throttle. You can
6 adjust.

7 MR. WOJCHOUSKI: They're throttle.

8 MEMBER BLEY: Is that in the procedures?
9 I don't recall seeing that sort of operation in the
10 procedures.

11 MR. WOJCHOUSKI: If you look in the EOPs,
12 there are curves in there that go ahead and show you
13 the operators are looking at their NPSH --

14 MEMBER BLEY: Yes.

15 MR. WOJCHOUSKI: -- and has one pump, two
16 pumps, and what flow rates they are to be within the
17 curves. And it directs them to watch for that, look
18 for cavitation, and to direct the flow accordingly.

19 MEMBER BLEY: Okay. I didn't remember
20 that.

21 MEMBER BROWN: Is it an individual
22 throttle valve for each of the RHR pumps or is there
23 just one where they --

24 MR. WOJCHOUSKI: For Montecello, we are
25 the mixed-loop plant.

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1 MEMBER BROWN: I don't know what that
2 means. You'll have to tell me.

3 MR. WOJCHOUSKI: You can go into one loop.
4 Let's say it's two loops: alpha and bravo loop.
5 Logic will try to pick the unbroken loop. You have
6 put all of your flow into the unbroken loop. And
7 those have the ejection values are throttle-able
8 because we have one on each path that is throttleable
9 so that you can arrange it.

10 MEMBER BROWN: You can pick and choose?

11 MR. WOJCHOUSKI: You can pick and choose.

12 MEMBER BROWN: Yes.

13 MR. WOJCHOUSKI: Also, on our core spray,
14 they also on their ejection valves have a throttleable
15 valve. So --

16 MEMBER BROWN: Is that consistent on all
17 of the Mark I plants?

18 MR. WOJCHOUSKI: Yes.

19 MEMBER BROWN: Thank you.

20 DR. WALLIS: Do you have performance
21 curves for these pumps when they're throttled that you
22 can appeal to then so the operator knows where he is
23 and when he is throttling, he knows where he is in
24 terms of NPSH?

25 MR. WOJCHOUSKI: Those are part of our

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1 EOPs in which they have SPDS displays, which will show
2 what the flow rate is on it and will show the bands
3 that you have to be in. And as the flow rates change,
4 it will show graphically where they are in or outside
5 the band.

6 MEMBER BANERJEE: What is the pressure
7 loss due to the debris? You had a previous slide
8 which showed that you fully loaded it up with debris.

9 MR. WOJCHOUSKI: I would have to look
10 through my calculation to break out the term for the
11 debris.

12 MEMBER BANERJEE: Is it a very small
13 amount or --

14 MR. WOJCHOUSKI: For Montecello, it's a
15 pretty insignificant amount.

16 MEMBER BANERJEE: Less than psi?

17 MR. WOJCHOUSKI: I would have to look at
18 my calculations and pull that value out. I just
19 haven't looked at it to answer that question.

20 MEMBER BANERJEE: Can you just repeat what
21 assumptions you made about the debris?

22 MR. WOJCHOUSKI: Okay. For debris which
23 is used on this, Montecello, our particular one --
24 others may be different -- we assumed that we had 100
25 percent of our new kind installation become debris and

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1 be held up in the transportation going down into our
2 torus. We also assumed that we had 300 pounds per
3 year of accumulation of sludge, which is very
4 conservative.

5 We also in our calculations have accounted
6 for paint chips, in which when we went ahead and did
7 our prototype testing, we created paint chips, had
8 different sizes, different densities, or different
9 weight thicknesses, and threw that all into the slurry
10 to come up with the correlation for our calculations.

11 We also took on our strainer with -- I
12 don't know if other people did this or not, but
13 Montecello took a plastic sheet, 15 square feet, and
14 taped it right onto the suction strainer to make that
15 unavailable during the testing. And it's also within
16 our calculations that that's accounted for that we
17 lost that amount of surface area.

18 We put that in there for extraneous debris
19 that could be inside of our containment that wasn't
20 specifically accounted for.

21 MEMBER BANERJEE: Are these disc strainers
22 or what sort of strainers?

23 MR. WOJCHOUSKI: Stacked disc strainers,
24 stacked vertically in between a whole bay. And we
25 have four of them. Montecello has a ring header on

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1 the outside of the torus with four penetrations going
2 into the torus itself. At those penetrations on the
3 inside of the torus is where we have --

4 MEMBER BANERJEE: The stacks?

5 MR. WOJCHOUSKI: -- the stacks, but they
6 don't go vertically. They come up with a ram's head.
7 And then they go horizontally right near the bottom of
8 the bay.

9 MEMBER BANERJEE: How far below is the
10 intake from the surface?

11 MR. WOJCHOUSKI: Just from memory, it's
12 four, four and a half feet.

13 MEMBER BANERJEE: Give me the Froud number
14 in rough terms.

15 MR. WOJCHOUSKI: Say it again.

16 MEMBER BANERJEE: You don't know the Froud
17 number?

18 MR. WOJCHOUSKI: Sorry. I do not.

19 MEMBER BANERJEE: But the issue is
20 vortexing. And you have looked at that, right?

21 MR. WOJCHOUSKI: We have looked at that.
22 We have looked at approach velocities. There are lots
23 of different factors that you have to go ahead and
24 look at for determining this.

25 MEMBER BANERJEE: But the approach

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1 velocity you are using, is it the approach velocity
2 normal to the surface of the strainer or because
3 they're stacked, is it -- because you know -- I would
4 have to draw it for you, but this is a problem that a
5 lot of them have that if you do single strainer tests,
6 what ends up happening is that the debris really
7 accumulates in the space between the disks.

8 The ultimate approach velocity is really
9 the surface area on the outside of the disk is the
10 normal to the surface strainer. Do you see what I am
11 saying?

12 MEMBER SIEBER: Right.

13 MEMBER BANERJEE: Yes because the debris
14 stacks into the little spaces in between. So the
15 issue really then becomes what should be the approach
16 velocity that you use. And I assume that you didn't
17 the approach velocity based simply on the available
18 surface area of the strainer?

19 MR. WOJCHOUSKI: That one I cannot answer
20 for you right now.

21 MEMBER BANERJEE: It gives you a very
22 different answer.

23 MR. WOJCHOUSKI: The sort of thing that I
24 can relate to that is when we were doing the testing,
25 instead of taking our paint chips and just putting

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1 into the pool, the only way to go ahead and have them
2 have any effect is we had to dump them right on top of
3 the strainer, which is physically above it, and dump
4 them on there so that as they came down, they settled
5 and landed on top of the strainer itself.

6 MEMBER BANERJEE: I would have to look at
7 the design, but there is sort of an uncertainty
8 associated with these pressure losses. Now, if the
9 pressure loss is extremely small, it may not matter.
10 But if it is significant, then you would have to put
11 that sort of into the uncertainty analysis at some
12 point.

13 Let's keep that in abeyance right now.

14 MR. WOJCHOUSKI: That's why --

15 MEMBER BANERJEE: Let's get an answer to
16 the question, though, how large the pressure loss was
17 that you had and maybe what the approach velocity was
18 and the surface area. Give us all of those. Then
19 I'll get a rough idea of what is going on then.

20 MR. WOJCHOUSKI: The loss of surface area
21 and the approach velocity?

22 MEMBER BANERJEE: Yes, that you used. And
23 did you use any number for air entrainment at all?

24 MR. WOJCHOUSKI: Not in these
25 calculations.

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1 MEMBER BANERJEE: Okay. Because air
2 entrainment, of course, will have a significant effect
3 on NPSH.

4 MEMBER SIEBER: Yes, it does.

5 MEMBER BANERJEE: It generally is very
6 sensitive. Even if you get --

7 MEMBER SIEBER: One or two percent.

8 MEMBER BANERJEE: -- less than one
9 percent, it will give you a huge difference in NPSH.
10 So you used pure water?

11 MR. WOJCHOUSKI: Pure water?

12 MEMBER BANERJEE: Okay.

13 DR. WALLIS: So you have talked a lot
14 about what is available for NPSH. Now, what is
15 required? Are you using this three percent
16 degradation in head value?

17 MR. WOJCHOUSKI: The Hydraulic Institute
18 has the standard, saying that NPSH_r is determined at
19 the three percent. And that's what we used in these
20 calculations.

21 DR. WALLIS: And this is from tests of the
22 pumps themselves?

23 MR. WOJCHOUSKI: These are from tests of
24 the pumps themselves. These pumps were built back in
25 the '68-'69 time frame. They have tests that they did

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1 on our pumps. They were not NPSH three percent tests.
2 They were demonstration tests that they meet an NPSH
3 curve that the vendor provided us.

4 So when we started doing this work, we
5 went back to Sulzer. They had pulled all of our data
6 that we had. They have similar pumps that were made
7 at the same time with the same type of models. They
8 pulled that data together and came up with a three
9 percent curve for Montecello and provided us that
10 information.

11 DR. WALLIS: These pumps don't change at
12 all with time? They don't corrode or something?

13 MR. WOJCHOUSKI: These pumps are used --
14 they're RHR pumps. They're used for shutdown cooling,
15 which is about 30 days every 2 years. They're used
16 for suppression pool cooling whenever we're doing
17 testing on our hips in RCIC. And they're run through
18 their surveillance tests themselves.

19 So the core sprays, they're only used for
20 surveillance testing. And basically what we do on
21 this is according to the IST program, we plop the
22 differential pressure across the pumps. And we
23 monitor and trend that. If we see a negative trend,
24 we'll go ahead and do corrective action, such as
25 rebuild the pump, replace the wear rings. So that's

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1 monitored.

2 MEMBER ABDEL-KHALIK: Let's just look at
3 the graph that you have on this screen.

4 MR. WOJCHOUSKI: Sure.

5 MEMBER ABDEL-KHALIK: You have the
6 deterministic calculation. And you have the
7 statistical calculation. And this graph obviously is
8 demonstrating that if you were to use the statistical
9 calculation, you can demonstrate that the amount of
10 containment accident pressure that you would need
11 would be smaller and would be for shorter duration.

12 But if you put that in words, what the
13 statistical calculation is telling you is that we are
14 95 percent confident that we will not require more
15 than about 2 psi of containment overpressure for more
16 than about 10 hours.

17 MR. WOJCHOUSKI: Okay.

18 MEMBER ABDEL-KHALIK: Now, given the
19 potentially severe consequences of this, do you think
20 a 95 percent confidence level associated with this
21 calculation is appropriate?

22 MR. WOJCHOUSKI: I believe it is
23 appropriate.

24 MEMBER ABDEL-KHALIK: Okay. That is a
25 judgment. Okay. And so we'll move on.

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1 In your analysis, have you done only the
2 59 calculations required to determine the 95/95 value
3 or have you done more calculations?

4 MR. LI: That is right. We only did 59
5 calculations for this.

6 MEMBER ABDEL-KHALIK: So you have no idea
7 where this graph would be if you were to assign a 99
8 percent confidence level, for example? How close
9 would it get to the deterministic calculation?

10 MR. WOJCHOUSKI: We have not done those
11 calculations.

12 MEMBER BANERJEE: So to explain to me when
13 you go to those curves with the minimum and maximum,
14 maybe you can go to one which shows the mean, the
15 deterministic, all those nice colors. Okay. Take
16 that.

17 So the 2 is your best estimate. Let me
18 call it a best estimate because I understand what that
19 means. I don't really understand these curves, but
20 two is your best estimate.

21 MR. WOJCHOUSKI: That is what we expect.

22 MEMBER BANERJEE: Yes. And one is your
23 best estimate plus uncertainty. That's what I would
24 call it, with a 95/95, right? If I said 99, it would
25 be higher?

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1 MR. WOJCHOUSKI: A little bit higher.

2 MEMBER BANERJEE: Yes, all right. So 1 is
3 best estimate plus uncertainty. And I see that that's
4 not all that different from 4, I mean, within -- it's
5 not gaining you all that much, at least in this curve.
6 I mean, there could be other scenarios where it does.

7 What you would normally use as best
8 estimate plus your uncertainty, that is going to be
9 your determining -- that is what we do with other
10 things, right, unless the staff has a deal with this
11 other than best estimate, this uncertainty.

12 MR. LOBEL: When I give my presentation, I
13 have some curves like this that I'll show again for
14 conservative, realistic, and statistical. And the
15 point that we have tried to concentrate on isn't so
16 much the pressure and the temperature, but the thing
17 we're really interested in is whether the pump is
18 going to have what it needs.

19 And so what we are looking at in terms of
20 statistics and conservative and all of that is the
21 available NPSH and the margin from available to
22 required NPSH. And I'll show you those curves. And
23 that's what we're asking for in the guidance.

24 We're trying to get away from looking at
25 containment conditions, although they feed into the

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1 available, and look at what the pump really needs. So
2 we're going to look at the available NPSH and the
3 required and the margin between those.

4 MEMBER BANERJEE: Right, but there will be
5 a best estimate plus uncertainty there in your
6 calculations, right? It depends on --

7 MR. LOBEL: Not quite that way, but yes,
8 there will be an estimate of a realistic. And then
9 there will be an estimate of a conservative and a
10 statistical where we can quantify different levels of
11 available NPSH.

12 MEMBER BANERJEE: So if I understand this
13 curve -- maybe I don't know who wants to answer this,
14 but one is really what would -- imagine this is what
15 we were using as a measure at the moment, that we are
16 trying to predict. Pool temperature here looks like
17 maximum clad temperature, too.

18 MR. LOBEL: Okay.

19 MEMBER BANERJEE: So it's 1 that could be
20 used, not the 2 ever, unless you have something to say
21 about that.

22 MR. LI: Yes. Actually, the calculation,
23 we did use 1.

24 MEMBER BANERJEE: Okay.

25 MR. LI: So that is a one-sided upper

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1 limit for 95/95.

2 MEMBER BANERJEE: Okay.

3 MR. LI: Yes. We used 1 to calculate the
4 curve in the slide 20.

5 MEMBER BANERJEE: Right.

6 MR. LI: Yes.

7 MEMBER BANERJEE: It's not 2 ever?

8 MR. LI: No.

9 MEMBER BANERJEE: No. And certainly not
10 3? All right. So that at least satisfies me that
11 it's one that you have to use.

12 MR. LOBEL: Yes.

13 CHAIR SHACK: Although in some -- you
14 know, this is not just uncertainty in a calculation.
15 What we are really looking at here is a range of
16 scenarios. I mean, you know, the 1 is sort of if the
17 accident occurs at the worst conditions in the
18 summertime with the hottest pool. Three is actually a
19 realistic calculation if the break happens to occur in
20 January sort of thing.

21 So best estimate in this sense, I look at
22 it as it's kind of a proportion of scenarios that
23 you're dealing with more than in a classic best
24 estimate plus uncertainties kind of thing. I'm trying
25 to look at a range of scenarios here.

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1 MEMBER BANERJEE: And it's true because, I
2 mean --

3 CHAIR SHACK: It's a fraction of the time.

4 MEMBER BANERJEE: It is not a true random
5 --

6 CHAIR SHACK: Well, that comes back to
7 this 95/95 and what does it mean.

8 MEMBER BANERJEE: Because, really, if you
9 take that bad-day scenario and then you put your
10 uncertainty on that, well, then that's a different
11 ball game.

12 CHAIR SHACK: Part of this is that, too.
13 I mean, you know, the uncertainty in the --

14 MEMBER BANERJEE: Fifty-nine.

15 CHAIR SHACK: Well, that comes back to
16 what are statistics?

17 MEMBER BANERJEE: Yes.

18 CHAIR SHACK: I mean, we are mixing things
19 here between a range of scenarios and uncertainties.

20 MR. LOBEL: That's right.

21 CHAIR SHACK: I mean, it's all lumped into
22 one calculation here.

23 MEMBER BANERJEE: So you could argue take
24 the worst day possible. Then put your ordered
25 statistics on that and see what the uncertainty is.

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1 DR. WALLIS: It is a very important point,
2 really. Should Minnesota and Vermont would be allowed
3 to trade off their very cold winters against a very
4 occasional warm water in the summer?

5 It's a very important point because what
6 is happening here is the statistical method throws it
7 all in together, like the winters and the summers all
8 mixed up; whereas, the worst status of the plant in
9 the summer is different than what it is in the winter.

10 MEMBER BANERJEE: So, Bill, if you were
11 doing it the way you are saying, you would do a best
12 estimate for let's say --

13 CHAIR SHACK: No. That says I want 95/95
14 for every day of the year. The question is, do I want
15 95/95 for all of my scenarios? But, you know, coming
16 back --

17 MEMBER BANERJEE: It's not so clear.

18 CHAIR SHACK: I am sampling here from the
19 conditions. Then, of course, I am also sampling from
20 uncertainties like the power in the reactor, which is
21 a true uncertainty because in any given day of the
22 year, that is a truly --

23 MEMBER BLEY: There is a correlation
24 there, the hottest and coldest days. So there is a
25 correlation there.

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1 CHAIR SHACK: If you run this thing at
2 full power, this is a nuke. I mean, if we want to run
3 it at full power, the power for Minnesota Power
4 probably goes up and down during the year. But I
5 think the --

6 MEMBER BANERJEE: If you want to introduce
7 the phases of the move into your DBA --

8 CHAIR SHACK: All I want to say is that
9 this is slightly different from a best estimate plus
10 uncertainty, that there is kind of a mix of things
11 going on here.

12 MEMBER BANERJEE: Which is why I am having
13 difficulty grappling with this methodology. I mean,
14 it's not clean in the same way as you do it for a CSAU
15 problem, where --

16 MEMBER BLEY: Or you are doing it for one
17 scenario.

18 MEMBER BANERJEE: Or we can do it for
19 different scenarios, but each scenario would have to
20 have --

21 MEMBER BLEY: This is really a mix of
22 scenarios. Bill has got that right.

23 MEMBER SIEBER: The problem is you have to
24 do it for all scenarios, even the ones you --

25 MEMBER ABDEL-KHALIK: But wouldn't this

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1 problem be alleviated if you have more realistic
2 distributions from which you are sampling that are
3 consistent with the time distribution of the various
4 parameters, whether it's winter or summer?

5 MEMBER BLEY: I don't quite --

6 MEMBER ABDEL-KHALIK: I mean, we are
7 mixing things, right?

8 CHAIR SHACK: It seems to me the
9 uncertainty in the power -- you know, I am willing to
10 believe that is kind of independent of whether it is
11 summer or winter. So doing it --

12 MEMBER BLEY: Okay. Yes.

13 CHAIR SHACK: There may be some
14 correlations in here between pressures and
15 temperature. We didn't come up with the famous Dana
16 Powers, you know, are all of these independent kind of
17 parameters in the calculation. We could go through
18 that, but just sort of looking at it in a rough
19 engineering sense that I don't see that is the big
20 problem here.

21 MEMBER BANERJEE: He's really saying the
22 surface water temperature is the heat sink parameter
23 which is correlated for the time of the year.

24 DR. WALLIS: If you did this calculation
25 for every day of the year and then plotted it, those

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1 would wiggle up and down. Now we know it's July.
2 Then you would have a different curve. You would know
3 it's December.

4 MEMBER BANERJEE: The issue is whether
5 they should do the ordered statistics on the hottest
6 day of the year.

7 PARTICIPANT: Then you break down to the
8 deterministic again.

9 PARTICIPANT: Sure, sure. That's where
10 you are.

11 MEMBER ABDEL-KHALIK: So what distribution
12 do you use in sampling these various different
13 parameters; for example, the heat sink temperature?

14 MR. WOJCHOUSKI: What we did for sampling
15 it, every four hours of every day for five years, we
16 pulled all that data together, put it in an Excel
17 spreadsheet, then went ahead and set up bins,
18 basically temperature ranges, 32 to 35, 35 to 40,
19 straight on up.

20 Then it had the Excel program go through
21 and say, "Here is my data that I took off the process
22 computer. Put an X wherever it meets that range,"
23 added those all up, calculated how many days that was.

24 Now I know how many days in each bin they
25 are and then came up with an exceedance probability on

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1 them. So what you find out is between the 95 and --
2 excuse me -- between 85 and 90 degrees, there are 2 or
3 data points, period, very few data points between
4 that range because we don't get that high.

5 Where you are sitting between the 32 and
6 35 degrees we'll have 6-7 hundred days over those 5
7 years worth of data. That hits those points. So
8 that's how you come up with it.

9 MEMBER ARMIJO: What did you do with decay
10 heat? Did you --

11 MR. WOJCHOUSKI: Decay heat --

12 MEMBER ARMIJO: -- pick a range or did you
13 say, "I'm going to pick it at the end of cycle what
14 I've got. You know, this event will happen at end of
15 cycle" and make that part deterministic, even in your
16 statistical?

17 MEMBER SIEBER: Which curve did you use?

18 MEMBER ARMIJO: Yes.

19 MR. LI: Okay. Actually, this one we
20 answered this question to the NRC RAI. So, actually,
21 this here is bounding. So we use end of cycle,
22 consider the exposure, the enrichment, everything, and
23 also he has the methodology that the 0636 considers
24 other --

25 MEMBER ARMIJO: So in this analysis, even

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1 though it's statistical, you were deterministic about
2 the decay heat. And you picked the most --

3 MEMBER SIEBER: An official curve.

4 MEMBER ARMIJO: -- severe situation.

5 MR. LI: It came in also a statistically
6 --

7 MEMBER BANERJEE: It is sampled. The --

8 MEMBER ARMIJO: It is sampled again. So
9 the event could happen at the beginning of cycle or
10 could happen mid cycle or end of cycle, but wouldn't
11 the worst case be end of cycle?

12 MR. LI: We didn't -- I am sorry. I
13 interrupted you. Actually, we didn't do that. So the
14 decay heat curve we used is the most conservative
15 curve. So basically from that curve, you would get
16 nominal value and one sigma, one sigma.

17 MEMBER ARMIJO: Right.

18 MR. LI: So we --

19 CHAIR SHACK: You got a bounding value for
20 the decay heat, but he does an uncertainty on that so
21 that --

22 MR. LI: That is right.

23 CHAIR SHACK: Because he really doesn't
24 know what that cycle condition -- so he's got the
25 worst point in the cycle. He's not bearing the

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1 scenario for the -- he is including an uncertainty in
2 that variant.

3 MR. LI: That is exactly right.

4 MEMBER BANERJEE: That is consistent, I
5 think, with the CSAU.

6 MEMBER ARMIJO: That's right.

7 CHAIR SHACK: As I say, that comes down to
8 what you are really doing here, which is a mix of
9 these things.

10 MEMBER BANERJEE: The concern that I have,
11 though, on the day of the year when this LOCA occurs
12 is really you're saying you're putting some
13 probability on the chance of a LOCA occurring.

14 MEMBER ARMIJO: That's right.

15 MEMBER BANERJEE: And that to me is a
16 curious way to do it, you know. That's why I'm saying
17 the older statistics should be done on the hottest day
18 of the year if you really want it.

19 MEMBER ARMIJO: At the end of cycle,
20 end-of-cycle power, back to deterministic.

21 MEMBER BANERJEE: Well, it's not clear.
22 You're really talking about the probability of a LOCA.

23 MEMBER ARMIJO: I agree.

24 CHAIR SHACK: Gentlemen, this is a Friday.
25 So we can't run over schedule too much. If you have a

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1 burning question, please ask it. But otherwise I
2 would like to bring this part of the session to a
3 halt.

4 MEMBER BLEY: I just want to make sure I
5 understand what I thought I heard earlier. Despite
6 all the things that are mixed into this uncertainty
7 calculation, when you get to the end and you show us
8 curves, you're taking what would be equivalent to the
9 number one curve in this particular calculation as
10 what you're showing us?

11 MR. WOJCHOUSKI: That would be used to --

12 MEMBER BLEY: Have a comparison.

13 MR. WOJCHOUSKI: -- have a comparison into
14 --

15 MEMBER BLEY: What's deterministic.

16 MR. WOJCHOUSKI: -- your NPSHa.

17 MEMBER BLEY: You're taking --

18 MEMBER BROWN: That is the statistical
19 curve that's fallen into the lines there. That's the
20 way I read that.

21 MEMBER BLEY: That is what I just wanted
22 to make sure.

23 MEMBER SIEBER: I guess mine is not a
24 question. It's a statement. I'll keep it to less
25 than 60 seconds. Paragraph 5.4, "Defense in Depth,"

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1 relies on NUREG-0800 or its basis for satisfaction,
2 which is really a little bit different than the way
3 defense in depth was originally defined. The idea was
4 no dependence of one barrier upon another.

5 And the ACRS through the years initially
6 had said "We aren't going to allow any dependence of
7 one barrier on another." And they allowed a small and
8 short, small amount for a short period of time. And
9 as we move on and look at some of these applications,
10 the small and short becomes a little bigger and a
11 little longer.

12 And I would say that in these instances,
13 beyond which a pump would be where you actually need
14 containment pressure and ignoring those situations
15 where a pump was cavitating but not destroying itself,
16 that we have to be really careful about what it is we
17 do.

18 And a probabilistic argument that says all
19 of the barriers remain intact goes beyond the
20 philosophy of the way the regulations in the Atomic
21 Energy Act were originally written.

22 And so I intend to use caution in what it
23 is that is proposed in the case of some BWRs. The
24 allowances that are requested are modest and perhaps
25 justified on these bases, but in other cases, they may

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1 not be.

2 So I urge a word of caution because of
3 foundation, the founding principles of our agency, and
4 the rules that are out there in the steps that the
5 industry has taken and so that we just don't go over
6 the edge.

7 Thank you.

8 DR. WALLIS: There was a question I asked
9 at the beginning. You said you would get to it, this
10 independence of barriers question.

11 MR. CROWTHERS: We'll get back to you. I
12 don't know if we have had a chance to look at it.
13 We'll look at it. We'll get back to you.

14 DR. WALLIS: You have got it now?

15 MR. CROWTHERS: I'm going to look at the
16 Topical and see what we've got.

17 DR. WALLIS: Oh, I see.

18 MEMBER SIEBER: You are on page 39. It
19 doesn't help very much to give a deterministic
20 argument concerning the independence of the barriers
21 in the answer to objective 2.

22 CHAIR SHACK: Crediting containment
23 overpressure does introduce dependency between the
24 first barrier, fuel clad, and the third barrier,
25 containment.

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1 MEMBER SIEBER: Yes.

2 CHAIR SHACK: However, previous examples
3 indicate a very small delta CDF. So there is an
4 insignificant increase in the likelihood of failure as
5 compared to existing conditions.

6 MEMBER SIEBER: That is the probabilistic
7 argument.

8 CHAIR SHACK: Okay. I would like to take
9 a break for ten minutes. And if we can come back in
10 ten minutes?

11 (Whereupon, the foregoing matter went off
12 the record at 10:12 a.m. and went back on the record
13 at 10:25 a.m.)

14 CHAIR SHACK: I would like to come back
15 into session now.

16 Our next topic will be the NRC review of
17 the licensing comparable report that we just heard
18 about from the BWR Owner's Group. And Mr. Sallman
19 from NRR will be presenting to us.

20 MR. SALLMAN: Good morning. My name is
21 Ahsan Sallman. I'm a reactor systems engineer in the
22 Containment and Ventilation Branch of NRR. And I'll
23 go over the safety evaluation part of this topical
24 report. Thank you.

25 The overview has been presented by the

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1 Owner's Group. So we'll go through the highlights
2 that staff looked at in order to provide the safety
3 evaluation. The staff looked at these GDC-35, -38,
4 the Standard Review Plan 6.2.2, Reg Guide 1.82, and
5 1.157 to perform the review.

6 In the technical review, we looked at the
7 deterministic NPSH available analysis and the staff
8 found that the topical report had conservative
9 assumptions and bounding values of inputs. And the
10 typical analysis that was done by the Owner's Group
11 had been accepted by the staff in the previous
12 containment overpressure reviews.

13 The topical report had a conservative
14 computer code, SHEX, which has been accepted by NRC
15 for previous licensing calculations.

16 CHAIR SHACK: Now do you really believe
17 that SHEX itself are conservative? Or does all the
18 conservatism come from the assumptions that you are
19 making for the inputs?

20 MR. SALLMAN: Both, inputs are
21 conservatives and the SHEX itself is a conservative
22 code.

23 MEMBER ABDEL-KHALIK: And how was that
24 determination made?

25 MR. SALLMAN: This is in the past, I

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1 guess.

2 MR. LOBEL: How did the staff determine
3 that?

4 MEMBER ABDEL-KHALIK: No. The question is
5 that the code is conservative both because the models
6 are conservative and the inputs are conservative. And
7 the question then is absent a formal evaluation of
8 SHEX, how did you arrive at the conclusion that the
9 models within SHEX are conservative?

10 MR. LOBEL: Well, there was a presentation
11 made to the staff many years ago. There were some
12 view graphs that listed some of the conservative
13 assumptions in SHEX. And we have done independent
14 calculations ourselves for some of the power uprate
15 submittals.

16 We did a comparison using MELCOR a while
17 ago for the Duane Arnold power uprate. We did
18 comparisons for the topical -- well, we did
19 comparisons for the guidance document that we are
20 going to put out that I'll show later.

21 So it is a combination of looking at the
22 assumptions that were made and seeing that they
23 appeared to be conservative. They were on the
24 conservative side. And staff calculations comparing
25 SHEX and GOTHIC and to MELCOR and CONTAIN.

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1 So there have been two staff codes, MELCOR
2 and CONTAIN, and the industry code that our branch is
3 using now for containment calculations, GOTHIC, and
4 all those show that SHEX itself is biased to the code.

5 So when we put in input from -- we put in
6 the same input basically into our code that SHEX used,
7 which the input has conservative assumptions in it,
8 SHEX is still more conservative than those codes.

9 DR. WALLIS: I'm rather puzzled, Richard,
10 I mean you've got two things you worry about. You
11 worry about being conservative in the maximum
12 containment pressure for a containment and you're
13 really conservative in the minimum containment
14 pressure.

15 MR. LOBEL: Right.

16 DR. WALLIS: And I don't see how the same
17 code can be conservative in both directions.

18 MR. LOBEL: Well --

19 CHAIR SHACK: Smart code.

20 MR. SALLMAN: Well, the inputs are --

21 MR. LOBEL: Yes, go ahead.

22 MR. SALLMAN: -- the inputs to the --
23 first of all the inputs are conservative and inputs
24 are biased --

25 DR. WALLIS: I understand the inputs can

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1 be conservative because you can bias them one way or
2 the other. But the code itself, how can it -- the way
3 it models with nodes and so on, it is going to be
4 biased up or down. But it can't be both biased up and
5 down.

6 MR. LOBEL: GE can correct me if I'm wrong
7 but it is biased in the sense that it increases the --
8 it overestimates the temperature. And that's the same
9 for both.

10 And the assumptions do have a big effect.
11 But the SHEX is biased to give a higher temperature.
12 The higher temperature is the most important parameter
13 for this --

14 DR. WALLIS: High temperature of what?

15 MR. LOBEL: I'm sorry, highest temperature
16 of the suppressible water.

17 DR. WALLIS: But not of the containment
18 atmosphere because that would change the pressure,
19 right?

20 MR. LOBEL: Well, the containment
21 atmosphere could be made higher. The containment
22 atmosphere for the purposes of design basis
23 calculations, the highest temperature for that you
24 obtain with a small steam line break analysis.

25 When you do the peak pressure analysis,

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1 you bias the assumptions to give you the peak
2 pressure. When you do the suppression full
3 temperature analysis, you bias the assumptions for
4 that. But the code is also biased for that. I don't
5 know, maybe GE wants to add.

6 MR. LI: Yes. I totally agree. So
7 actually we have two kinds of calculations, one called
8 containment integrity. Actually you want to maximize
9 the pressure so basically based on the inputs.

10 So for this NPSH calculation, we want to
11 minimize the pressure and maximize temperature. For
12 both cases actually we maximize the pool temperature.
13 Since that is a design limit, we have to --

14 DR. WALLIS: For things like heat
15 transfers to structures, you assume in one case the
16 maximum and in another cost the minimum it could be?

17 MR. LI: For the NPSH calculation, as I
18 know, we credit that since we will heat transfer to
19 the heat sink as we reduce the pressure for the
20 integrity calculation. For some plants, we did credit
21 for some and not. So in order to maximize pressure.
22 So that's based on their licensing basis. So that
23 will change.

24 DR. WALLIS: Then there are things like
25 how you nodalize the containment.

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1 MR. LI: We don't have nodalization. For
2 the SHEX, it is a very simple code. RPV is one node.
3 Drywall is one node. And the separation pool is one.
4 And wetwall is one. So actually basically it is not
5 an estimating code. It's a simplified code.

6 DR. WALLIS: So which way does that bias
7 the results? Up or down?

8 MEMBER BANERJEE: Randomly more or less.

9 MR. LI: Not randomly. It actually
10 depends on what is your purpose.

11 MR. LOBEL: You have to realize for the
12 peak pressure calculation, the peak pressure occurs in
13 a very, very short time. So the heat transfer usually
14 doesn't have much of an effect on that. It's more the
15 flow resistance through the vent system to the
16 suppression pool that you make conservative. That
17 keeps the pressure up higher for the peak pressure
18 calculation.

19 MEMBER ABDEL-KHALIK: But what we're
20 trying to find out is whether the bias up or down is
21 determined by varying the input parameters only or
22 there are specific model approximations or assumptions
23 that you change depending on whether you want the code
24 to bias the results high or low.

25 MR. LI: I think this --

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1 MEMBER BANERJEE: Such as the condensation
2 coefficient for the loss. I mean there are obviously
3 --

4 MEMBER ABDEL-KHALIK: Yes. That's what
5 we're trying to find out. What parameters do you bias
6 within the model rather than the inputs that would
7 cause the results to be either biased high or biased
8 low?

9 MR. LI: Mainly through the inputs. So we
10 do have another parameter. So we discussed it before.
11 We call it mixtures coefficient. Actually you the
12 break flow, depending on the condition in the
13 containment, you will have some liquid flashing. It
14 depends on the condition. You may -- if it's cold,
15 there is no flashing.

16 We have another parameter actually
17 controls. Since you have this flashing and heat
18 through, you have some kind of a heat transfer between
19 the break flow with every measurement. So that one
20 for calculation, we really set it in the way with the
21 sensitivity study actually response to the staff's
22 RAI. So we set it in the conservative direction.

23 DR. WALLIS: Well, I understand all these
24 inputs but I don't know how you can make the statement
25 the code is conservative because --

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1 CHAIR SHACK: Well, I think we've probably
2 beat this enough. If we can just move on?

3 MR. LOBEL: I think maybe that is a
4 question if we're going to have a proprietary session,
5 maybe GE can speak to some of the assumptions in SHEX
6 then.

7 MEMBER BANERJEE: It would be helpful if
8 you just outlined SHEX during this closed session with
9 the model parameters which contribute to model
10 uncertainties. Can you do that briefly so that we
11 understand where the model uncertainties arise here?

12 MR. LOBEL: Yes.

13 MEMBER BANERJEE: Thanks.

14 MR. SALLMAN: Okay. We will proceed.
15 Statistical NPSH analysis uses order statistics method
16 that is NRC approved. Reference 17 is the reference
17 in the Owner's Group topical report. And it uses
18 conservative values of some while some remaining input
19 parameters are sampled.

20 It quantifies uncertainty in the output,
21 which was H_ww parameter, wetwall pressure minus the
22 vapor pressure. The calculated NPSH is more
23 conservative than a 95/95 because a lot of the inputs
24 were used as conservative.

25 DR. WALLIS: Now this input parameter

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1 sampling, you heard the discussion about

2 MR. SALLMAN: Yes.

3 DR. WALLIS: -- whether you can trade off
4 Winter versus Summer because you don't when the LOCA
5 is going to be. Is that okay with you to do that?

6 MR. SALLMAN: That's the statistical
7 approach.

8 DR. WALLIS: Well, the statistical
9 approach on the river temperature, river temperature
10 in the winter is probably, you know, it's 30 or 40
11 degrees or something all winter.

12 MR. SALLMAN: That's right.

13 DR. WALLIS: And then for a few times in
14 the summer, it goes way up. And so if you use
15 statistics and say we're going to smooth that over the
16 whole year and make a probability distribution, you
17 are simply saying we don't know when the LOCA is going
18 to be.

19 So it is fair to do that. Is that okay
20 with you? Or should you look at the worst days in the
21 summer and say we've got to be okay then? And then do
22 statistics about that.

23 MR. SALLMAN: The worst days in the
24 summer, so that would not be a representation for the
25 entire year.

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1 CHAIR SHACK: It comes back to this
2 question whenever you guys call this calculation
3 realistic and I don't think -- you know, it's
4 realistic some days of the year. It's conservative
5 some days of the year. And it's unconservative -- I think
6 it's much fairer to say that you've got a typical
7 result.

8 Fifty percent of the time it could be a
9 little more. Or fifty percent of the time it could be
10 a little less. You know when we mix this uncertainty
11 with the different scenarios, we get a kind of
12 confusing state of things.

13 MR. LOBEL: Yes, you are right. They are
14 broad descriptions. They're not -- it isn't exactly --
15 the statistical calculation isn't all statistical,
16 the realistic calculation isn't all realistic. It's
17 must more so than conservative.

18 DR. WALLIS: But the question is is it
19 okay to tradeoff the cold days in the winter with the
20 hot days in the summer? Or should you make a separate
21 evaluation of the summer without letting the winter
22 balance it?

23 MR. LOBEL: In our calculations, we assume
24 the hot temperature for the statistical calculation.
25 Is that right?

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1 MR. SALLMAN: We assume the maximum -- we
2 sampled -- we did a calculation similar to the Owner's
3 Group calculation in 59 runs. And we sampled between
4 the two extremes, random sampling.

5 DR. WALLIS: Between some summer and
6 winter? Between 90 degrees in the summer and 38
7 degrees in the winter?

8 MR. SALLMAN: Yes, yes.

9 DR. WALLIS: Random sampling?

10 MEMBER BROWN: So you didn't use the
11 hottest temperature then?

12 MR. LOBEL: No, I was wrong.

13 DR. WALLIS: You didn't use the hottest
14 temperature. And you used an actual distribution
15 based on measurements throughout the year?

16 MR. LOBEL: We --

17 MR. SALLMAN: Sorry, we just randomly --
18 we did not use that sample.

19 DR. WALLIS: You can't be random unless
20 you know the distribution.

21 MR. DENNIG: Bob Dennig --

22 MR. LOBEL: That we got from --

23 MR. DENNIG: Rich?

24 MR. LOBEL: Yes?

25 MR. DENNIG: We could certainly break up

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1 and we did talk about doing a separate calculation for
2 winter and a separate calculation for summer. The
3 temperature distribution, you know, it weights the
4 probability of the thing being that bad when the LOCA
5 happens.

6 And the question is is that satisfactory
7 in the big scheme of things? And I think we can think
8 about that. I mean we understand your point.

9 But we take that into account with the
10 conservatisms that we put in and some other
11 conservatisms for scenario, for example, for the
12 single failure assumption, and some of these other
13 things that we'll talk about, perhaps about SHEX. But
14 we understand the point of your question.

15 MEMBER BANERJEE: Also, the main
16 sensitivity, I take it, is to the river temperature.
17 Or is it not? The sensitivity is primarily due to
18 that. Or are there other factors which are as
19 important?

20 MR. LOBEL: There is a sensitivity table
21 in my presentation later that assigned -- ranked all
22 these variables in decreasing order of sensitivity.
23 And so you can look at that and see where it ranked.
24 And it ranked high. I think power was first.

25 MEMBER BANERJEE: Okay. Power we have no

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1 disputes over.

2 MR. LOBEL: Yes.

3 MEMBER BANERJEE: That is fine.

4 MR. LOBEL: But it was definitely one of
5 the most sensitive.

6 MEMBER BANERJEE: Other than power, is
7 this the most sensitive to surface water?

8 MEMBER ARMIJO: Stored energy, I would
9 think that would be in the cycle.

10 MR. LOBEL: But we didn't have anything
11 called stored energy per se.

12 MEMBER ARMIJO: Yes, but it's in the --

13 CHAIR SHACK: Yes, in the BWR Owner's
14 Group, it is the biggest parameter mostly because it
15 has the widest range, I think, as much as anything
16 else. I mean it gives them a ten-degree variability.

17 DR. WALLIS: I think it would help me if
18 rather than just talking about it, we had an actual
19 statement showing what you did. What you used for a
20 probability distribution for river temperature and
21 where it came from and why it was okay to average
22 throughout -- to use the sort of the statistic for the
23 year rather than focusing on summer, which is the
24 worst time.

25 MR. LOBEL: Well, we can tell you what we

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1 did.

2 DR. WALLIS: But that doesn't --

3 CHAIR SHACK: That's all we can do today.

4 MR. LOBEL: I guess we haven't been very
5 clear about that. We can tell you what we did. Why
6 we did it, let me say one other thing. Maybe this is
7 just philosophy, but the topical report, the
8 deterministic analysis is still going to be the
9 licensing basis.

10 The topical report was done originally for
11 that but the BWR Risk Group changed their minds. They
12 didn't want to use it for a licensing basis. So it's
13 only going to be used to demonstrate margin.

14 So looking at it that way, if we realize
15 how they did things, then that gives us a perspective
16 for judging the margin. And that's all we were trying
17 to do. We weren't trying to say a particular thing
18 was acceptable or not acceptable as much as just
19 trying to understand so we could understand what the
20 margin.

21 CHAIR SHACK: But you have the same
22 problem whenever you give a realistic calculation
23 because that's -- you have to tell me what the
24 realistic calculation really is.

25 MR. LOBEL: Well, tell me if I'm wrong

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1 again. I think I got things mixed -- it's the
2 realistic calculation where we still use --

3 CHAIR SHACK: Okay, it uses the summer
4 day.

5 MR. LOBEL: -- the summer day.

6 MR. SALLMAN: The realistic calculation
7 uses the maximum summer temperatures --

8 CHAIR SHACK: Okay.

9 MR. SALLMAN: -- which is 90 degrees. The
10 tech spec uses 100 percent power, zero sigma decay
11 heat, and the travel pressures are nominal values
12 which is higher than the minimum. The relative
13 humidity is about -- not about -- I think we used 40
14 percent instead of 100 percent. So those are the kind
15 of realistic numbers that were used in NRC's
16 calculations.

17 CHAIR SHACK: So you take a bounding
18 scenario but you use realistic input for that bounding
19 scenario --

20 MR. LOBEL: Yes.

21 CHAIR SHACK: -- as just sort of a way to
22 look at it.

23 MR. LOBEL: Yes. Because we're still --
24 we're calling it realistic but it is still taking a
25 single failure assumption also. So it is realistic in

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1 the input but the scenario is still pretty much the
2 same scenario.

3 MEMBER BANERJEE: But do you then do some
4 statistics on that?

5 MR. LOBEL: No, not on that -- on the
6 realistic?

7 MEMBER BANERJEE: Yes.

8 MR. LOBEL: No, no.

9 MEMBER BANERJEE: So that's just the
10 bounding scenario?

11 MR. LOBEL: The scenario is the same
12 scenario. It's a large break LOCA.

13 MEMBER BANERJEE: Right.

14 CHAIR SHACK: On the worst day.

15 MR. LOBEL: And we do the same calculation
16 but we use input that is more what you would expect
17 rather than bounding --

18 MEMBER BANERJEE: Okay.

19 MR. LOBEL: -- input. And it's not
20 statistical. We don't do any statistics with the
21 realistic calculation.

22 MEMBER BANERJEE: Realistic inputs for the
23 worst day? That's what you're saying?

24 MR. LOBEL: We used -- because of this
25 business of trying to figure out what to use for a

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1 single calculation when the temperature can go from 30
2 to 80 degrees, we decided to just use the 80 degrees.

3 MEMBER BANERJEE: Okay.

4 MR. LOBEL: In our calculations.

5 MEMBER BANERJEE: Yes.

6 MEMBER RAY: I don't want to -- this is
7 such a fascinating discussion, I don't want to divert
8 it. But if we have time, I'd like to come back to
9 Rich said about what the purpose of the topical report
10 is because we got mired down in river temperatures and
11 stuff as if we were just applying this to one plane.

12 And I think the fact is that the topical
13 report plays a different role. And I'd like to
14 understand that better. But I don't want to -- like I
15 said, this is too fascinating now.

16 CHAIR SHACK: Well, I'd like to move on.

17 MEMBER BROWN: Can I interject since I'm
18 not a -- I just want to provide another perspective of
19 the way I come from it. Bill knows how I think about
20 this from my past background in the naval nuclear
21 program.

22 But I'm trying to relate this -- the
23 statistical approach in this case, and I'm not trying
24 to say we never used that because we did. You have to
25 in some cases.

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1 But so the way we do sizing of cables, for
2 instance, in ship, you look at a ship. Typically
3 today you will have connected load of somewhere --
4 look at an aircraft carrier, probably 100 megawatts of
5 connected load. And you have about 30 or 32 megawatts
6 of your generating capacity.

7 So as you size and layout your circuits,
8 you determine, based on load demand factors, how many
9 of those are going to be on this but it is random. It
10 is a truly random thing. This compressor will be on,
11 this one will go off, this one will come on. And it
12 is balanced all throughout the ship.

13 So in a random manner like that, we have,
14 for instance, and the same thing goes on in your
15 house, you'll look at -- you've got a 20-amp circuit
16 for all your circuits. But if you put -- and that's
17 based on a statistical evaluation in some way in the
18 electrical world that you are not going to hook up 20
19 amps from one outlet when you have a bunch of other
20 things on it.

21 And if you don't, your wife puts the iron
22 on at the same time you've got the toaster, the
23 breaker trips. But those are random type of events.

24 Here, to me, the way that I've been
25 looking at this is that you are not truly random in

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1 establishing how the parameters are set up. I mean
2 you've got periods of time during the year when
3 certain parameters are fixed. They're there.

4 And if I relate that to the circumstances
5 I faced in the electric plant world, we had
6 circumstances where you have this big line with a bunch
7 of stuff on it, there would be a pump. It was there
8 all the time. You couldn't put a load -- it had to be
9 one. It had to be figured at the highest temperature
10 advice, I'm using that as an analogy.

11 So what I've been trying to figure out is
12 there a way for me to change my mind into how I think
13 about this from the deterministic standpoint to say
14 are there random parameters where this, you know,
15 combining them over the entire year and everything
16 could kind of make some sense because they are never
17 the same thing in the same place.

18 Where there are periods when you have
19 fixed number, and they're going to be there for one
20 month, two months, three months, in which your risk is
21 far higher. And so I'm just listening to the
22 conversation and integrate then -- and I don't see a
23 concise -- I mean Graham has addressed in terms of,
24 you know, when do you pick this. And that's the way
25 I've been looking at it.

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1 And if I could see something that kind of
2 put that in that category, what are the random ones?
3 Which are the ones -- we really ought to pick the
4 highest and then do the analysis. That would seem to
5 me to be a more acceptable approach. I don't know
6 whether I was totally confusing but that's kind of the
7 way that I --

8 MR. LOBEL: The licensing basis analysis
9 is that. We pick the highest temperature. The
10 deterministic analysis that is used as the licensing
11 basis we pick the highest temperature.

12 MEMBER BROWN: How about the heat sink
13 temperature in this case?

14 MR. LOBEL: The service water, yes, the
15 ultimate heat sink temperature, there are calculations
16 that show that the high temperature is more
17 conservative than the low temperature. The low
18 temperature lowers the containment pressure because
19 the sprays are spraying cooler water.

20 But the high temperature is more
21 conservative because temperature has a bigger effect
22 than pressure does. But for the deterministic
23 analysis, all of these are biased to give you the
24 worst result. The highest temperature is used, the
25 end-of-cycle decay heat --

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1 MEMBER BROWN: But in our program we had
2 to do this in similar circumstances. And on this type
3 of stuff, we went and looked at the range of the eight
4 or nine parameters and said okay, here are -- six of
5 those nine are going to be bouncing all over the place
6 and three aren't.

7 So we always pick those three to be the
8 worst. And then we did the statistics based on the
9 other ones because they weren't -- they couldn't occur
10 in some circumstances under the same time.

11 And I haven't heard that in terms of
12 laying out against each of the parameters that is
13 being considered in the analysis. And maybe I'm not
14 smart enough to figure that out from reading it.

15 MR. LOBEL: We don't do that for the
16 conservative analysis. Everything --

17 MEMBER BROWN: Oh, I understand.

18 MR. LOBEL: -- gets a bias.

19 MEMBER BROWN: I understand that.

20 MR. LOBEL: Okay.

21 MEMBER BROWN: But if you want to -- you
22 are trying to back away from that using a statistical
23 method.

24 MR. LOBEL: Yes.

25 MEMBER BROWN: And I'm just trying to

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1 integrate it -- you know, understand from my
2 standpoint of, you know, can you truly take ten
3 parameters and move them all down so that, you know,
4 they are in this variable range where you can assume
5 they are all random when they're not.

6 CHAIR SHACK: I think we ought to let them
7 move ahead because we're going to come back to the
8 pump program where, again, what's conservative and
9 what's not conservative becomes unclear as to --

10 MEMBER BROWN: That's fine. I'm finished.
11 I just wanted to give a perspective, that's all.

12 MR. SALLMAN: Okay. The next slide just
13 discusses a few limitations and conditions for this.
14 Some portion of the NPSHa analysis to be reviewed on a
15 plant-specific basis like the head loss. And that's
16 an example.

17 There is a new staff guidance, which Rich
18 Lobel will present next. It requires margin for
19 uncertainty in the required NPSH.

20 Model, and this is another condition, is
21 model other than SHEX should be capable of analyzing
22 LOCA and the special events.

23 Use of best-estimate code shall include
24 uncertainty to calculation in the statistical method.

25 The topics that were not reviewed by the

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1 staff, one of them is a risk assessment --

2 DR. WALLIS: I don't understand the
3 purpose of that bullet.

4 MEMBER ARMIJO: I don't either.

5 DR. WALLIS: I mean the whole purpose of
6 statistical method is to use uncertainties. So what
7 do you mean by calculation uncertainties. Is that
8 something different from the uncertainty that is
9 already in the statistical method?

10 MR. SALLMAN: It is the difference between
11 the conservative code and the best estimate code if
12 they use -- some licensee uses a best estimate code,
13 we are saying that an uncertainty in the calculation
14 will be used -- will be added.

15 DR. WALLIS: So this is uncertainty that
16 is due to the code itself --

17 MR. SALLMAN: Yes.

18 DR. WALLIS: -- such as the way you
19 nodalized --

20 MR. LOBEL: That's what we are saying.
21 For the topical report, SHEX was used. SHEX is a
22 biased code. So there wasn't any -- there was a
23 preliminary discussion of model uncertainty and we
24 dropped it.

25 If somebody comes in with another code

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1 that is a best estimate code, then we would ask for a
2 model uncertainty analysis.

3 MR. SALLMAN: Okay. Topics in the report
4 were not reviewed by the staff, one of them is the
5 risk assessment, which will follow the SPR 19.2
6 Appendix D.

7 Accident management to preserve COP and
8 modifications that would reduce or eliminate need for
9 COP. That is our Appendix C and D of the topical
10 report, which are to be reviewed on a plant-specific
11 basis.

12 We'll just go over a few RAIs. There were
13 like about 30, 36 RAIs. But we'll just go over about
14 four or five of them.

15 First RAI was how is the statistical
16 approach consistent with and different from the
17 NUREG/CF-5249, which is Quantifying Reactor Safety
18 Margins. And I think that response was discussed in
19 the earlier presentation.

20 The next one is will the same computer
21 code, SHEX, be used as in the topical report? If not,
22 what should be the conditions for using a different
23 code? And the response was not limited to SHEX.
24 Aspects of topical report specific to SHEX should be
25 evaluated and dispositioned by the licensee if a

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1 different containment response model is used.

2 RAI-7, for some BWRs in which MSIV leakage
3 is considered separately from containment leakage, how
4 is this considered in the analysis?

5 Response was maximum allowed MSIV leakage
6 should be combined with the maximum containment
7 leakage rate for input as a conservative leakage
8 assumption.

9 The next RAI-10, what type of statistical
10 distribution will be used for variables included in
11 the statistical analysis? Will this be determined on
12 a plant-specific basis? What guidance or criteria, if
13 any, are used to determine the statistical
14 distribution?

15 Response was normal distribution or with a
16 distribution that represents plant/parameter-specific
17 data, for example, normal distribution for power and
18 decay heat, and parameter-specific for those that can
19 be measured periodically.

20 RAI-16, why is it conservative to assume
21 that spray droplets are in thermal equilibrium with
22 airspace before falling to the bottom of the drywell
23 or suppression pool?

24 The response was spray water being less
25 than the drywell or wetwell temperature, the

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1 containment pressure would be minimized due to the
2 energy transfer from the airspace to the spray liquid
3 drops.

4 RAI-19, how is a credit for operator
5 action of throttling of flow included in the analysis
6 for special events?

7 The response, timing for the special
8 events would be dictated by the analysis results and
9 consistent with operator actions as directed by
10 procedures.

11 RAI-34, Section 2.3 of the report states
12 that if COP is required, the most realistic NPSHr
13 should be used. Explain what is meant by realistic
14 NPSHr.

15 Most realistic, the standard three percent
16 required NPSH curve, but the most realistic term was
17 used to allow licensees the option to contact pump
18 vendors to establish NPSHr values commensurate with
19 the minimum acceptable hydraulic performance.

20 DR. WALLIS: What I haven't heard yet
21 really is what is the criterion for acceptability? Is
22 it that they never go beyond the standard three
23 percent curve? Or are they allowed to do it for a
24 certain period of time? And for how long are they
25 allowed to use COP credit? Is there a time limit on

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1 for how long? I don't know what the evaluation
2 criteria are. And are we going to get to that?

3 CHAIR SHACK: Well, I think that will come
4 in the guidance, something that Rich is going to talk
5 about.

6 MR. LOBEL: Yes, we can talk about that.

7 DR. WALLIS: That's good because I haven't
8 heard about it yet. And I just want to make sure.
9 Can we sort of step over this for a little while or
10 something?

11 MR. SALLMAN: Our discussion of the
12 acceptability of required NPSH values used should be
13 included in the individual license amendment request
14 if based on other than three percent or one percent
15 head drop values. And the BWR Owner's Group concurs
16 with that.

17 And the next slide, NRC performed a
18 similar NPSH analysis to support the guidance document
19 that will be presented next. And the staff analysis
20 will discuss the guidance document presentation.

21 Conclusions, a deterministic analysis
22 shall be the licensing basis. Statistical analysis is
23 to be used to quantify uncertainty and demonstrate
24 margins.

25 DR. WALLIS: Well, I don't quite

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1 understand that. I mean it's so simple. If they've
2 already got a license and the deterministic analysis
3 is satisfactory, why do they need to do anything else?

4 MR. SALLMAN: To demonstrate margins.

5 DR. WALLIS: Well, why do you need to do
6 that if they've already got a license and it is
7 satisfactory?

8 MR. LOBEL: Well, I think it's partly to
9 help the Committee --

10 CHAIR SHACK: It's ACRS.

11 (Laughter.)

12 MR. LOBEL: The original suggestion was
13 that from the experience with Vermont Yankee, we
14 talked with General Electric Hitachi and the BWR
15 Owner's Group about isn't there some way we can reduce
16 the conservatism that -- you know, it sounded like
17 terrible things were happening when really it was that
18 the analysis was so conservative.

19 Wasn't there some way that we could get
20 together and agree on an analysis that was less
21 conservative that was still satisfactory to both
22 sides. And so the statistical approach was suggested
23 and started. And as that was going along, we had a
24 call with the Owner's Group and they said for their
25 reasons, that they didn't want it to be a licensing

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1 basis. So it became just a --

2 DR. WALLIS: Well, to go back to VY, VY
3 didn't meet the requirements on the basis of a
4 deterministic analysis.

5 MR. LOBEL: Well, they met it with
6 containment pressure and such.

7 DR. WALLIS: Well not for a long time.

8 MR. LOBEL: Oh, the short time and all
9 that, they did -- VY did use containment pressure.
10 And they showed that -- and this isn't true for all
11 BWRs -- but they showed that if they just made some
12 other more realistic assumptions, just a few of them,
13 they didn't need overpressure.

14 DR. WALLIS: Well, I think the ACRS was
15 concerned about how much pressure they needed and for
16 how long they needed it.

17 CHAIR SHACK: Well, our last letter said
18 they should do the deterministic analysis and that
19 should be the licensing basis. And they should do
20 this analysis to give us some idea of the margins.

21 So we asked for this. We got it. Now we
22 can't really complain about it.

23 MR. LOBEL: And I think the guidance is
24 also going to -- that we're going to talk about, what
25 we're proposing for the future is going to demonstrate

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1 margin, too, in a different way.

2 MEMBER BROWN: For perspective on margin,
3 no matter what accident or transient you're dealing
4 with when you do it on a design basis and you meet
5 your criteria, whether it's 1.1, DNB, whatever the
6 ratios are, you really want to know what a realistic -
7 - and you don't want people thinking they're walking
8 on eggshells when they're operating a plant.

9 There was a real problem years ago with
10 people operating plants. And this going back 20, 25
11 years before most of you were born but -- that's a
12 joke --

13 (Laughter.)

14 MEMBER BROWN: -- where we did have
15 operators that thought that they were operating at the
16 edge. They were very nervous about things -- you're
17 not getting this right or that right. And having an
18 analysis, it showed there was, you know, it was a very
19 conservative approach to doing things.

20 So I just throw that out. I think
21 whatever the Committee previously agreed, that's a
22 great idea to have an idea that hey, look, we're not
23 operating on the -- you know, right at the edge of all
24 of this stuff, the very conservative line.

25 MR. LOBEL: And that was the problem with

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1 the Vermont Yankee power uprate that we almost went to
2 a hearing because of the conservative results in the
3 calculation. I think it was a lot to do with that.
4 Some of it was just people just didn't want the power
5 uprate.

6 But some of it was -- one of the concerns
7 for that was the conservative analysis and it is hard
8 for people, especially in the public, to understand
9 this issue and the power rates.

10 MEMBER BROWN: They're not going to.

11 MR. LOBEL: And so that's one of the
12 reasons we -- that's the main reason we approached
13 General Electric Hitachi in the Owner's Group was to
14 see if there was something we could do to make things
15 a little --

16 DR. WALLIS: Did I misunderstand this
17 morning though? I thought that you do the
18 deterministic analysis and if it doesn't work then
19 they do a statistic analysis. And then they submit
20 that to show that the plant is okay. I thought there
21 were --

22 MR. LOBEL: No, the deterministic analysis
23 has to work.

24 DR. WALLIS: It has to work.

25 MR. LOBEL: That's their license --

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1 DR. WALLIS: So there's no incentive to do
2 this --

3 MR. LOBEL: The only thing is that they
4 first do it without -- the topical report says you can
5 first do it without -- with atmospheric pressure. And
6 if that doesn't work, then you use overpressure. And
7 if you use overpressure, then you do the statistical
8 analysis to show you have some margin -- to show what
9 the margin is.

10 DR. WALLIS: I know but if your
11 deterministic analysis doesn't work --

12 MEMBER ABDEL-KHALIK: You have to define
13 what work.

14 DR. WALLIS: Well, if the statistical
15 analysis -- deterministic analysis shows that when you
16 make these conservative assumptions, you don't have
17 enough overpressure.

18 MR. LOBEL: Yes.

19 DR. WALLIS: The pumps with --

20 MR. LOBEL: That's what it means not to
21 work.

22 DR. WALLIS: Well, I understood you did
23 then was you then did the statistical analysis. You
24 submit that to the NRC and say we don't need to base
25 everything on deterministic analysis because our 95/95

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1 shows we're okay. Isn't that what they do?

2 MR. LOBEL: No, it's just for margin.
3 It's just to demonstrate margin. If they don't meet
4 the deterministic calculation, that's their licensing
5 basis.

6 DR. WALLIS: There's no incentive to do
7 it.

8 MR. LOBEL: They haven't satisfied their
9 licensing basis.

10 DR. WALLIS: So maybe --

11 CHAIR SHACK: The incentive is to satisfy
12 the ACRS and the staff.

13 DR. WALLIS: I misunderstood what they
14 said then.

15 MEMBER ABDEL-KHALIK: But the word work
16 means that you can meet this condition that is
17 required NPSH or the available NPSH is equal to the
18 required even if you were to take full credit for all
19 containment pressure. That's what the word work
20 means.

21 MR. LOBEL: Yes. And what we're proposing
22 is that there will be an uncertainty in available and
23 then uncertainty in required that addresses the things
24 that you are not sure of.

25 MR. SALLMAN: Statistically determined

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1 NPSHa is, we say it's not strictly statistical because
2 some of the import parameters are conservative that we
3 already discussed. Then in staff calculation, we
4 found that there was a similar trend in Hww and the
5 temperature of the suppression pool with the Owner's
6 Group deterministic and statistical analysis.

7 And the staff analysis will be discussed
8 in the next presentation.

9 CHAIR SHACK: Any more questions for Mr.
10 Sallman?

11 MEMBER RAY: Well, again, I have this --
12 we touched on it here just at the end. What is the
13 purpose of the topical report? What role does it
14 play? How is it used in the regulatory process? It
15 is not Monticello-specific by definition.

16 For the sake of time, we should go on.
17 But I'd like to again note that I would like to
18 discuss that further if we have time because this is a
19 -- I'm interested in what the implications are of that
20 because as they said, the licensing basis remains
21 deterministic and you satisfy it with overpressure.
22 If it's too long or too much, you do the statistical
23 analysis to show that you --

24 MEMBER ABDEL-KHALIK: No, we don't care
25 about how long or how much as long as --

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1 MEMBER RAY: You have to do the
2 statistical analysis in accordance with the topical
3 report if you are taking credit for containment
4 accident pressure to show that it has got --

5 CHAIR SHACK: Understand the margin
6 associated with that calculation.

7 MEMBER RAY: Right. Now presumably that
8 calculation could say no, you don't have enough margin
9 in theory. Or is that not even a theoretical
10 possibility?

11 MR. LOBEL: The deterministic calculation?

12 MEMBER RAY: No, the second step --

13 MR. LOBEL: The statistical?

14 MEMBER RAY: -- that you take to show --

15 MR. LOBEL: Sure, I guess it could show
16 that.

17 MEMBER RAY: And maybe in some theoretical
18 way you could fail the statistical analysis also.
19 That's what I'm trying to say.

20 But where else are we going to wind up
21 doing this, you know? It seem like a new regulatory
22 device to me that I'd like to understand how it works
23 because I don't see why you can't apply it to lots of
24 things that you don't satisfy.

25 Why not just come back in and do a

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1 statistical report to say well, yes, I didn't satisfy
2 the deterministic rule. But I got a lot of margin.
3 So that's okay.

4 CHAIR SHACK: You have to satisfy the
5 deterministic rule.

6 MEMBER RAY: All right, Bill. Make me say
7 it the whole way. You satisfy the deterministic rule
8 by taking credit for containment overpressure. But
9 you can only do that to the extent that the
10 statistical analysis says you have enough margin. Is
11 that a fair rendition?

12 MR. LOBEL: No, it's only to demonstrate
13 margin. It's only to show you that --

14 MEMBER RAY: Yes, to demonstrate something
15 implies that you might not be able to demonstrate it
16 to me anyway, okay, that's why I say it the way I do.

17 MR. LOBEL: I guess it is hard to see that
18 if you met the deterministic you wouldn't meet the
19 statistical --

20 MEMBER RAY: You meet the deterministic by
21 taking credit for containment overpressure. So far so
22 good?

23 MR. LOBEL: Yes.

24 MEMBER RAY: But if that happens, you have
25 to do the statistical analysis to demonstrate margin.

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1 And I thought that you just agreed with me that at
2 least theoretically you might not pass that. That's
3 all I was trying to say.

4 Now my conclusion is is that that's a new
5 regulatory process. Maybe it has been used somewhere
6 else. I don't know. But to me it's new.

7 CHAIR SHACK: It's probably new.

8 DR. WALLIS: Well, then, the LOCA they can
9 used realistic analysis with uncertainty and the
10 statistical method is the way of satisfying the
11 regulation.

12 MR. LOBEL: Yes, so that's different.

13 MEMBER RAY: Again, I don't want to take
14 up time here with this discussion that I'm trying to
15 have here. And it seems I have a hard time stating it
16 in a satisfactory way.

17 But in any event, I still want to leave
18 that on the table because I'm concerned that this is a
19 new --

20 CHAIR SHACK: Well, this is what we asked
21 for.

22 MEMBER RAY: It may well be, Bill, but it
23 is still new as far as I'm concerned. And I would
24 like to have a chance to revisit that.

25 DR. WALLIS: I thought what we asked for

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1 was the statistical analysis as the basis for how to
2 satisfy the regulation.

3 CHAIR SHACK: No.

4 DR. WALLIS: We didn't ask for that?

5 CHAIR SHACK: No, we didn't ask for that.

6 MEMBER BLEY: Read the letter. Not in the
7 letter.

8 CHAIR SHACK: Not in the letter. There
9 were many discussions. But we didn't put that in the
10 letter.

11 MEMBER RAY: I agree with all of that. I
12 still think, though, that we're at a point where there
13 is a new process on the table. And we ought to
14 understand it and see if there are any implications
15 that we're concerned with.

16 MEMBER BROWN: One of the other points
17 that falls from that is if somebody has problems in
18 some other area other than this, they'll say well,
19 gee, you agreed to this approach because we've got a
20 compensating factor in this other area, so let's -- so
21 that's, I think, a little bit of that is the slippery
22 slope routine.

23 MEMBER RAY: Yes, we are using margin here
24 that we are deriving by this topical report for a
25 purpose and I just think it can be used in many ways.

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1 And I think we ought to understand it.

2 CHAIR SHACK: Okay. I think we're ready
3 to move on now to the next topic.

4 Bill, are you going to make some
5 introductory remarks?

6 MR. RULAND: Thank you, Mr. Chairman.

7 Good morning. As some of you -- well,
8 most of you are fully aware, by letter dated March 18,
9 2009, the ACRS made five recommendations to the staff
10 on the use of containment accident pressure for
11 demonstrating the ECCS pumps can perform their safety
12 function.

13 One of the things said was essentially,
14 you know, it should only granted a little bit of
15 pressure for a short time. Both the staff and the
16 ACRS struggled with that. What does that mean? You
17 know we know it when we see it. This is something
18 that the staff has a tough time implementing as a
19 practical matter.

20 So what the staff asked, well, how can
21 these pumps fail? What is, in fact, the pressure is
22 available? And ultimately what are the margins in
23 both of those parameters?

24 So during the past year, the staff has
25 developed a different approach than previously

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1 discussed with the ACRS. This new approach is
2 described in the current draft guidance document that
3 you have been provided.

4 Examples of the application of this
5 guidance will be discussed today and have been
6 discussed with the BWR Owner's Group and we got some
7 information from them although for us to go forward
8 explicitly for a particular review, the staff is going
9 to need a significant amount of information from the
10 particular licensee.

11 This guidance document, as I said, has
12 been issued draft not only to the BWR Owner's Group
13 but also to the PWR Owner's Group.

14 The staff guidance, as I said, focuses on
15 pump performance. With the help of two experts in
16 pump cavitation and pump NPSH, we have studied the
17 phenomena that effect pump performance in these areas.
18 We have also quantified the uncertainty in pump NPSH.
19 The guidelines, we believe, are quantitative and the
20 uncertainty in the margins have, in fact, been
21 quantified.

22 The staff has also analyzed the risk of
23 using containment accident pressure and will discuss
24 those results with you today.

25 We are here today, of course, to brief you

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1 on this proposed guidance and to carefully consider
2 your comments. Of course this is a Subcommittee
3 meeting and you folks don't provide us letters as the
4 result of Subcommittee meeting but the staff goal
5 ultimately is to get a letter from the full Committee
6 when we do that briefing.

7 Our discussions with the industry have
8 just begun. And after considering the ACRS and
9 industry comments, we intend to publish the interim
10 guidance document. The final document will be a
11 revision to the Regulatory Guide 1.82 and its current
12 revision is Revision 3.

13 Those are my introductory remarks, Mr.
14 Chairman.

15 CHAIR SHACK: Thank you.

16 Marty is next.

17 MR. RULAND: Marty Stutzke was kind of
18 kidding about this presentation. He said this is one
19 of the first time that the risk guy doesn't go last.
20 And the reason we have asked Marty to go first is
21 because we're trying to put the overall risk of this
22 issue that faces both of us in its overall
23 perspective. And then we will discuss the individuals
24 parameters that I have mentioned.

25 MR. STUTZKE: You know, if things didn't

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1 fail, I'd be out of a job. Okay, I'm Marty Stutzke.
2 I'm the senior technical advisor for PRA Technologies.
3 I would in the Division of Risk Analysis in the Office
4 of Nuclear Regulatory Research.

5 My involvement with containment pressure
6 for determining adequate NPSH started back with the
7 Vermont Yankee EPU. At that time, I worked in NRR.

8 It continued on with the submitted Browns
9 Ferry EPU. By that time I was smart enough or lucky
10 enough to get transferred to the Office of New
11 Reactors.

12 Then I got promoted and I moved to
13 Research and I didn't hear anything about the subject
14 for a year. And it was great. Unfortunately, Mr.
15 Lobel happened to be in my office up on Church Street
16 and he ran into Dr. Brian Sheron, who said of course
17 Marty would like to help you out. So here I am.

18 Before we start the actual risk
19 evaluation, what we've done is to conduct our own in-
20 house PRA. What we've had before are licensee's
21 evaluation of the risk like that. And it has been a
22 little bit unsatisfying because I have to poke and
23 prod the model through an RAI process.

24 So we built our own PRA-type of model.
25 And that's the bulk of my presentation. There is a

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1 novel use of an old technique in there.

2 But before we get into that, I thought we
3 would talk a few words about defense in depth since
4 Dr. Wallis raised it almost immediately. And it's
5 true. The impact on defense in depth of the use of
6 containment pressure to determine available NPSH is
7 one of the central issues here like this.

8 We tend to think about it thus far in what
9 I'll call an elementary view of defense in depth, the
10 old physical barrier concept. It's here's the clad,
11 here's the reactor coolant system, here's the
12 containment, like this.

13 The Commission's white paper actually
14 provided us a definition of defense in depth and I've
15 showed you some excerpts out of it. And you don't see
16 the barrier concept leaping out at you. Rather it is
17 a more holistic concept. Anything that we can do to
18 improve the situation could be counted as defense in
19 depth.

20 The last thing I would call your attention
21 to is this notion of adequacy of or necessity of
22 defense in depth should reflect risk insights. Okay.
23 I won't call it a new concept. This is the first time
24 the Commission actually annunciated it like this.

25 Shortly after the Commission wrote this

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1 white paper, you guys issued a letter on the role of
2 defense in depth in risk-informed regulatory systems.
3 This is the rather famous letter that hypothesized the
4 structuralist school of thought and the rationalist
5 school of thought on defense in depth like this.

6 And, you know, the Committee's concern at
7 the time the letter was written was maybe appeals to
8 defense in depth had been used to making changes that
9 seemed appropriate based on PRA-type of results. The
10 phrase sticks in my mind, arbitrary, because that's in
11 the eye of the beholder, right? But it is a rather
12 catchy phrase that I continue to remember.

13 CHAIR SHACK: Seemingly arbitrary.

14 MR. STUTZKE: Yes. And then later on it's
15 this idea unless you can justify defense in depth in
16 terms of necessity and sufficiency, you know, you
17 can't go forward with risk-informed regulation.

18 So the way that we tend to view this is
19 there is some approach or some circumstances where it
20 is reasonable to accept some reduction in defense in
21 depth if the corresponding risk increase is acceptably
22 small. It's not an either/or sort of thing. There is
23 some sort of balance, a tradeoff involved like that.
24 The problem is making that tradeoff to any specific
25 situation like this.

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1 And what we have to guide us here
2 currently is Reg Guide 1.174. These are the
3 acceptance guidelines consistent with defense in depth
4 for seven bullets down like this. And the one that
5 inevitably causes us the problem with respect to
6 containment pressure credits is the independence of
7 barriers. It's number five on the list because it's
8 true. If we rely on containment accident pressure to
9 provide NPSH and the containment loses its integrity,
10 we could find ourselves in a core damage accident and
11 damage to clad.

12 Okay, so we have just the very fact that
13 we want to credit overpressure or containment accident
14 pressure or whatever we're calling it today, induces
15 that dependency in there. And that dependency doesn't
16 matter on whether we're talking about 95/95 bounds or
17 anything. It just simply exists. It is a matter of
18 fact, okay?

19 So it is troublesome. Now there are
20 situations where we achieve balances between defense
21 in depth and risk before. I was asked earlier this
22 week to gin up a list and we know when reactors were
23 originally built and designed --

24 MEMBER BROWN: Hold on a minute, Marty.
25 The last five pages -- it's the last five pages in

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1 your handout. We're on page four of the last seven
2 pages.

3 MEMBER BANERJEE: Yes, somehow they are
4 out of order.

5 MR. STUTZKE: Oh.

6 MEMBER ARMIJO: We're all catching up.

7 MEMBER SIEBER: Thank you.

8 MR. STUTZKE: Yes, I think these things
9 got sent over to you late yesterday afternoon. It's
10 been confusing.

11 MEMBER BROWN: Kind of like COP.

12 MR. STUTZKE: Yes, COP, CAP.

13 MEMBER BANERJEE: Are we at conclusions?

14 CHAIR SHACK: We're at similar situations.

15 MR. STUTZKE: Yes. But similar situations
16 where we've achieved a balance between defense in
17 depth concerns and acceptable risk are in the original
18 design of plants. In other words, we accept plants
19 that have possibilities of suffering interfacing
20 system LOCAs, steam generator tube ruptures. These,
21 in fact, directly bypass the containment.

22 We allow situations where redundancy or
23 diversity could be lost. Whenever equipment is taken
24 out of service for maintenance, there is some
25 reduction in the defense in depth posture of the

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1 plant. And that is managed or limited by the allowed
2 outage times that are provided in technical
3 specifications.

4 We have a process, Reg Guide 1.177, that
5 says how much increase in risk we can tolerate, the
6 increase in allowed outage time we can tolerate.
7 These are kind of interesting with respect to the
8 containment accident pressure credit.

9 When we talk about a tech spec change to
10 an allowed outage time, what you really see in risk
11 space is a series of pulses. The risk is very small.
12 The equipment is taken out. And the risk goes
13 screaming up, okay, for the duration of that
14 maintenance. Things are put back in proper order and
15 the risk goes way down. And so you see spikes.

16 Now industry has a speed limit on how big
17 a spike can be. But the staff has not formally
18 endorsed that. We haven't accepted it or rejected it.
19 Rather we base our judgment on the area under that
20 risk pulse.

21 Containment accident pressure is a
22 different type of animal than this. There is no
23 spike. We're just talking about a bump up in the
24 baseline risk and it is uniform throughout the year.

25 DR. WALLIS: No, it's not. It's worse in

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1 the summer on the hottest days.

2 MR. STUTZKE: It can be worse in the
3 summer and whatever but I'll show you how I tried to
4 get rid of that, like that. And then finally there
5 are risk informed changes that actually relax
6 programmatic elements of defense in depth, risk-
7 informed and in-service inspection, 50.69 special
8 treatment requirements.

9 So what I'm trying to leave you with is
10 the message that yes, we have, in fact, and we
11 routinely strike balances between defense in depth and
12 risk, like that. And so containment accident pressure
13 should be treated the same way.

14 MEMBER BROWN: Go back one.

15 MEMBER RAY: Hold on a minute. That last
16 statement is too -- go ahead, Charlie.

17 MEMBER BROWN: You said that we -- I
18 looked at these three at the top, the interfacing
19 system LOCAs, steam generator tube ruptures where we
20 violate, I guess, the containment issue. In a PWR, if
21 you have a steam generator tube rupture, do you
22 violate the containment?

23 MR. STUTZKE: Yes. It will bypass the
24 containment. You bet.

25 MEMBER BROWN: That's if it breaks -- you

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1 are talking about the stop valve that's outside versus
2 a stop valve that is inside?

3 MR. STUTZKE: It will go through the
4 safety valves. Tube ruptures.

5 MEMBER BROWN: No, I understand that. But
6 you can isolate it.

7 MEMBER BLEY: Not safety valves.

8 MR. STUTZKE: Not safety valves, no.

9 MEMBER BROWN: The steam generator stop
10 valves?

11 MR. STUTZKE: You mean the overpressure
12 relief valves?

13 MEMBER BROWN: Yes.

14 MR. STUTZKE: No, the code safety valves.

15 MEMBER BONACA: The direct way you effect
16 defense in depth in this particular case is by
17 changing the criteria for running the pumps.
18 Essentially what you are doing, you're increasing the
19 likelihood of cavitation of the pumps.

20 MR. STUTZKE: I understand.

21 MEMBER BONACA: Okay. So I'm trying to
22 understand how that fits into Reg Guide 1.174. You
23 know you listed a number of attributes. And maybe
24 they could be defense against potential common cause
25 failures.

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1 MR. STUTZKE: Yes, in order to really get
2 after it, one would have to --

3 MR. RULAND: Marty, could you repeat the
4 question please? What the question was?

5 MR. STUTZKE: Okay. The issue is what can
6 we do, if I understand by looking at these objectives
7 --

8 MEMBER BONACA: I can repeat it. You gave
9 us an example of defense in depth or examples. And
10 then going back to what we heard before, which is the
11 fact that we have increased the likelihood of having
12 to rely on cavitation of the pumps in any one of these
13 events. And that's the heart of the issue.

14 And I'm trying to understand the process
15 where we should -- I mean there has to be some
16 tradeoff for us to get there, okay.

17 MR. STUTZKE: Yes.

18 MEMBER BONACA: The tradeoff here is the
19 convenience of the licensee to use his approach.

20 MR. STUTZKE: We believe with our new
21 guidance that there are other tradeoffs being made.

22 MEMBER BONACA: Okay.

23 MEMBER RAY: Well, on that point, Marty,
24 you were using tech specs as an example. And you are
25 quite right. Nowadays, plants keep track in the daily

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1 report what the risk is during the day based on what
2 is out of service. So it goes all over the place.

3 I guess the one observation I would make
4 is having negotiated a few tech specs in my life, that
5 the duration of that outage is strictly limited not to
6 what is acceptable from a risk standpoint but what is
7 necessary given whatever the component or device or
8 system is to maximize the long-term assurance of
9 performance.

10 So there is a dimension there which I
11 think was implied by what Mario was saying, which is
12 that I mean even things that have a tiny, tiny
13 contribution to risk, you've got to keep the outage
14 really short just because you don't want to allow any
15 increase in risk more than is necessary for the
16 maintenance of the item involved.

17 And I can give you battery chargers or
18 lots of things where you've got these ridiculously
19 short allowed outage times, all of which are just part
20 of an effort that we all accept to keep the risk as
21 low as we possibly can. So that's what I wanted to
22 say in response to your comment.

23 MEMBER BONACA: Yes. And it is a design
24 change -- it actually is a design change in which you
25 are running those pumps in a configuration that wasn't

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1 designed to operate in that mode. So I'm trying to
2 understand how it fits in defense in depth.

3 MR. STUTZKE: Okay.

4 MEMBER BONACA: I mean it's more like a
5 design change. And what does it produce?

6 MR. STUTZKE: Yes, with respect to that,
7 when I did the risk evaluation, I assumed if the
8 required NPSH -- or the available NPSH was lower than
9 the required, the pump has functionally failed. It's
10 like it is turned off. Period. So it is not allowed
11 to operate in a period of cavitation. I take no
12 credit for that in the PRA even though I know the pump
13 is running and it is probably working.

14 MEMBER RAY: Or that the operators don't
15 throttle it back so it doesn't --

16 MR. STUTZKE: That's right.

17 MEMBER RAY: -- cavitate, which is another
18 mitigating step here.

19 MR. STUTZKE: That's right.

20 MEMBER RAY: But -- okay.

21 MEMBER ABDEL-KHALIK: But that's sort of
22 the assumption that you do deterministically.

23 MR. STUTZKE: Yes, it is. But I would
24 argue -- let me go through the logic of this slide.
25 And I have to apologize. There is a horrendous typo.

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1 The last less-than sign is a greater-than sign.

2 MEMBER BANERJEE: Was that a Freudian
3 slip?

4 MR. STUTZKE: No, that's what comes from
5 working at midnight. I've actually seen that in
6 License Amendment Requests where the LERF was bigger
7 than the CDF. You go how can that be?

8 Okay, so to recap, the notion is, just the
9 very use of a CAP credit effects the independence of
10 barriers but it doesn't, by itself, make changes to
11 programmatic elements. In fact, we want to think
12 about changing certain programmatic elements or other
13 ways of improving or ensuring we have adequate defense
14 in depth.

15 And some of those are the fact that we've
16 treated the thermal hydraulic uncertainties in both
17 the available new required NPSHr. That's what Rich
18 Lobel will talk to you in great detail this afternoon
19 about how they quantified that margin.

20 DR. WALLIS: What is a programmatic
21 element?

22 MR. STUTZKE: Things like inspections of
23 the reactor coolant system, quality assurance
24 requirements. All of these are elements of defense in
25 depth.

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1 DR. WALLIS: Okay.

2 MR. STUTZKE: And we're not -- the second
3 part of our guidance and the heart of this risk
4 evaluation that I've done will show you the influence
5 of containment integrity testing on the increase in
6 core damage frequency.

7 MEMBER ABDEL-KHALIK: What is L_a in words?

8 MR. STUTZKE: I'm going to let Rich define
9 it.

10 MR. LOBEL: I'm sorry. I didn't hear
11 that.

12 MR. STUTZKE: L_a .

13 MEMBER ABDEL-KHALIK: L_a .

14 MR. STUTZKE: The design basis leak rate.

15 MR. LOBEL: This is Richard Lobel from the
16 staff. L_a is containment leakage rate when the
17 containment is pressurized to the maximum LOCA
18 pressure. That's the leakage rate over 24 -- mass
19 leakage rate over 24-hour period.

20 DR. WALLIS: What unit?

21 MR. LOBEL: Assigned basis LOCA.

22 DR. WALLIS: What units are these?

23 CHAIR SHACK: Whatever units you want.

24 DR. WALLIS: Well, a leak rate must have
25 units.

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1 CHAIR SHACK: He's scaling it.

2 MR. LOBEL: It's a percent.

3 DR. WALLIS: Oh, it's a percent.

4 MR. LOBEL: So it's dimension-less.

5 MEMBER BROWN: You said over what time?

6 MR. LOBEL: Twenty-four hours.

7 MEMBER BROWN: You said it is the maximum
8 amount? Or the average?

9 MR. LOBEL: It's the leakage rate in a 24-
10 hour period, a percent leak -- percent of the mass
11 that leaks at 24 hours.

12 DR. WALLIS: So how could it greater than
13 100 percent? How can it be greater than 100.

14 MR. STUTZKE: One hundred percent of the
15 design basis.

16 DR. WALLIS: Oh, of the design basis.

17 MR. STUTZKE: Right it is a ratio of the
18 design basis or the actual to the design basis.

19 DR. WALLIS: Okay. So a LERF would be
20 tens of thousands or something? Or what is --

21 MR. STUTZKE: No, a LERF is roughly 100 L_a
22 or bigger. There's different values one finds in the
23 literature. I've heard as low as 35 and as high as
24 600. Like this.

25 DR. WALLIS: But a catastrophic failure

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1 presumably is much bigger than that.

2 MEMBER ABDEL-KHALIK: This quantity here
3 is an integral quantity.

4 MR. STUTZKE: Right.

5 MEMBER ABDEL-KHALIK: Over 24 hours?

6 MR. STUTZKE: Yes.

7 MEMBER ABDEL-KHALIK: Okay. Does the
8 distribution of the leak rate make any difference on
9 this result?

10 MR. LOBEL: I'm not sure what you mean by
11 the distribution.

12 MEMBER ABDEL-KHALIK: In other words, if I
13 have a very high leak rate early on that causes the
14 pumps to fail, does it make any difference whether you
15 have a uniform leak over 24 hours or you have a big
16 leak early on that reduces the pressure in the
17 containment and the pumps fail?

18 MR. LOBEL: L_a is really not a major
19 contributor to the accident analysis. It is a really
20 -- it's a pretty small contributor.

21 MEMBER ABDEL-KHALIK: But that's not my
22 question.

23 MR. LOBEL: Well, if the leak was high
24 enough at the beginning, I suppose you could lose the
25 pressure and if somehow you stopped up the leak after

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1 that, you could maybe get this average -- you could
2 maybe get this total over the 24 hours to come out to
3 be the same number.

4 MEMBER BLEY: Rich, let me ask it a
5 different way because I've got a confusion in this.

6 I think what we've asking is aren't we
7 talking about the leak rate that could cause loss of
8 NPSH is equivalent to that average leak rate over 24
9 hours.

10 MR. LOBEL: Yes.

11 MEMBER BLEY: On an instantaneous basis.
12 But that's where you get the number, that's all.

13 MR. STUTZKE: Yes, the point of the
14 argument is you need a smaller hole to lose
15 containment accident pressure than you need to create
16 a LERF necessarily. It's more likely you will get a
17 small hole than a big hole. And so even if the
18 sequence progresses to core damage, you are not
19 necessarily going to suffer a LERF.

20 And that's different thinking. People
21 have not credited that total.

22 CHAIR SHACK: Right.

23 MR. STUTZKE: Not necessarily, it is
24 possible.

25 MEMBER BLEY: Not much to hang your hat on

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1 is it?

2 MR. STUTZKE: Okay. So we have performed
3 our own risk evaluation of this with an eye on the
4 clock here. The idea was to estimate the increase in
5 CDF from relying upon containment accident pressure.

6 And we did this by using our SPAR models.
7 We've looked at Browns Ferry and Montecello so far.
8 Our SPAR models are what we use to drive the, for
9 example, the significance determination process. They
10 have been benchmarked against licensee's PRAs that
11 have undergone peer reviews in accordance with the
12 consensus standard. We've done two peer reviews of
13 our own SPAR models and they compare reasonably well.

14 So the idea is for these plants, both main
15 Mark I plants, is that I assume CAP credit is
16 necessary whenever either the core spray pumps or the
17 HRH pumps are drawing suction on the suppression pool.
18 Okay, no assumption about winter versus summer in
19 here. Just -- you need it. No assumption about
20 numbers of pumps running or what the reactor power is,
21 okay?

22 MEMBER ARMIJO: There is no assumption
23 about the magnitude of the CAP credit.

24 MR. STUTZKE: I'll get to that.

25 MEMBER ARMIJO: Okay.

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1 MR. STUTZKE: I'll get to that.

2 MEMBER SIEBER: Not yet.

3 MR. STUTZKE: Not yet. Of course our SPAR
4 models are currently limited to internal events so a
5 full spectrum of transients and LOCAs, we haven't yet
6 looked at the impact on fires and seismic. We don't
7 have adequate models to do that yet. Mainly the
8 detailed table routing information to do a proper PRA
9 that is lacking.

10 We don't have fragility information on
11 seismic events that could create small leakages of the
12 size we need. And even if I had the fragility
13 information, I don't have a seismic PRA to use it in.
14 So, you know, it is a catch-22. So it is a known
15 limitation like this.

16 So to be specific, you guys, as usual, are
17 a step ahead of me. The definition of the event loss
18 of containment integrity in the PRA model means that
19 you've got a hole big enough to prevent adequate NPSH.
20 The first realization is I need to understand how big
21 is the hole, okay. And the real way to go about it
22 would be to use some thermal hydraulic tool like
23 MELCOR or GOTHIC or SHEX to get a feel on that.

24 It's most likely plant-specific. The leak
25 sizes that have been used in previous valuations we

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1 got from licensees at Vermont Yankee. They got a 27
2 L_a hole and that is the full-blown Appendix K
3 treatment. They later said it could be up to 60 L_a if
4 it was more realistic.

5 Notice there is a tradeoff here. If L_a is
6 small, that means you don't have as much potential for
7 a large early release. The larger L_a gets, the closer
8 you get to the LERF criteria. So there is a little
9 tradeoff.

10 At Browns Ferry, in their EPU submittal,
11 they used 35 L_a.

12 MEMBER RAY: Marty, did I understand -- I
13 don't want to bog you down here but we're talking just
14 -- we're not considering an external event as a cause
15 of --

16 MR. STUTZKE: That's correct.

17 MEMBER RAY: -- a containment leakage?

18 MR. STUTZKE: That's correct.

19 MEMBER RAY: Even though most of us,
20 that's the first thing we think of.

21 MR. STUTZKE: Yes. The problem is the
22 staff doesn't have a good set of external event PRA
23 models. But we do have some SPAR -- they are called
24 SPAR external event models for some of the plants.

25 MEMBER RAY: Well, this is all very

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1 interesting but I mean with that sort of hanging in my
2 head, I can't think about it very easily because it's
3 like I set aside the most important circumstance.

4 CHAIR SHACK: Aside from that, Mrs.
5 Lincoln, what did you think of the play?

6 MEMBER RAY: Right. Okay. All right. Go
7 ahead, I'm sorry.

8 MR. STUTZKE: I'll come back to that
9 thought.

10 So I just picked 20 L_a as kind of a lower
11 edge to this. There's no rhyme or reason. There's no
12 thermal hydraulic behind it. I'll show you how it can
13 be readily adjusted.

14 We considered three different time frames
15 when the containment could leak. It could be before
16 the initiating event, when the initiating event
17 occurs, or after the initiating event occurs, okay,
18 and all of these are in the model.

19 The pre-initiator leak probabilities, in
20 the previous risk evaluations that licensees did was
21 they went to this EPRI document that was developed to
22 support extending integrated leak rate test intervals.
23 Okay.

24 And they went down and they picked out
25 what size of leak they thought they needed, be it 35

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1 L_a or whatever. And they read over in the table and
2 they used these numbers. And they put them into their
3 PRA. So kind of a monolithic failure probability of
4 preexisting leaks.

5 At the same time --

6 MEMBER ABDEL-KHALIK: Excuse me, Marty,
7 what are the units of these numbers in the first
8 bullet?

9 MR. STUTZKE: They are pure probabilities.
10 It's the probability that a preexisting leak develops.

11 MEMBER ABDEL-KHALIK: Okay.

12 DR. WALLIS: For a year?

13 MR. STUTZKE: No, just the probability.

14 DR. WALLIS: You can't have a probability
15 without some time involved.

16 MR. STUTZKE: That's the troublesome
17 thing.

18 DR. WALLIS: Well --

19 MR. STUTZKE: Yes. These are the
20 troublesome things. And you'll see how I got around
21 it -- what I did about it.

22 DR. WALLIS: Because if it is in a
23 microsecond, we're in trouble.

24 MR. STUTZKE: One of the difficulties is
25 that when you base these sorts of numbers, these

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1 preexisting leak probabilities, the probability that a
2 leak exists when the initiating event occurs, on these
3 types of numbers is that you ignore other ways that
4 one could detect containment leakage.

5 And licensees are fond of telling us gee,
6 but we would know because we would be blowing nitrogen
7 like crazy into the containment trying to keep up with
8 that or our oxygen concentration would go squirrely
9 and we would detect it. Some licensees actually have
10 differential pressure alarms that come off when you
11 get a delta P between the wetwell and the drywell like
12 this. And yet none of that was being credited in the
13 previous risk evaluations. And we wanted to get after
14 it and see what we could do.

15 The other issue that comes up is that when
16 you're testing things like containment leakage is we
17 know the test is not perfect. And sometimes it
18 doesn't find the leaks or it won't find the right size
19 of leak with this.

20 So we wanted some approach to expand it.
21 And the approach was to develop what's known as a
22 semi-Markov model that handles all of this alphabet
23 soup.

24 MEMBER BLEY: Marty?

25 MR. STUTZKE: Yes?

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1 MEMBER BLEY: Before you go on, I've been
2 a little confused and I think I've got a handle on it.
3 But let me say what I think.

4 I was a little confused why we are using
5 the licensed leak rate for this. And it is not
6 because that has a direct tie in principle to when you
7 would lose net-positive suction head, I think, because
8 that could have been anything. Physics do the other
9 one.

10 It's because you are hoping and other
11 people have tried to anchor the likelihood of a
12 preexisting leak to monitoring of leakage associated
13 with tech spec requests.

14 MR. STUTZKE: Exactly, exactly. That's
15 the strategy here. Okay.

16 So I hypothesized a technical
17 specification that looks like this. This one is
18 actually patterned after the primary containment O₂
19 concentration that already exists. But it says
20 something like this. If the leakage rate is at or
21 above the magic number, and here 20 L_a, reduce it.
22 And you have time, T_{ST}, in which to do so. In my base
23 case, that's 24 hours. That's what this tech spec
24 says.

25 If you don't get the leakage below that,

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1 shut the plant down. And you've got another eight
2 hours in order to get the plant shut down. Okay.
3 What that says is that once a leak is detected, there
4 is at least a 32-hour window before the plant would --
5 up to a 32-hour window while the plant could be
6 operating with a known leak that would defeat the
7 containment accident pressure credit. Okay.

8 The other part of the tech spec, it says
9 you would verify containment leakage. And that has a
10 surveillance test interval. For this one, the nominal
11 case is seven days. And I will show you a full
12 sensitivity study. We played with all of these
13 numbers because I knew you would ask.

14 MEMBER BLEY: I take this is hot off the
15 press. You don't have a report on this stuff yet.

16 MR. STUTZKE: No, I'm writing furiously.

17 MEMBER BLEY: Okay.

18 MR. STUTZKE: I've got other -- we'll talk
19 about that.

20 So when you get down to determining this,
21 it turns out the important parameters are leakage
22 failure rate itself, lambda, the mean time to repair
23 the leak, the surveillance test interval, how much
24 time you are going to allow the licensee to try to fix
25 the leak while the reactor is still operating, how

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1 much time you want to shut the plant in, and then
2 finally what is known as test sensitivity, probability
3 that the test doesn't find the leak.

4 DR. WALLIS: These are all pre-event
5 leaks?

6 MR. STUTZKE: Yes, this is only the pre-
7 event leakage calculation.

8 Now knowing that you guys are not confused
9 about containment accident pressure, I thought I would
10 throw up my confusion matrix, just a classic from
11 statistical hypothesis testing.

12 Across the top you see the actual
13 containment condition, whether it is leaking or
14 whether it is intact, true or false. On the lefthand
15 side, you see the test result. Did the test indicate
16 it was leaking or is it intact?

17 This type of thinking and hypothesis
18 testing is very common in medical tests. Okay. This
19 is the one that says gee, if one percent of the
20 population has H1N1 virus and my test is 99 percent
21 sensitive and I feel bad and I go to the doctor and I
22 get the test and he says yes, the test was positive,
23 what is the probability I'm really sick? In that
24 case, 50 percent, not very good, okay.

25 So we have the notion of false positives

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1 where, in this case the way I've set up the matrix is
2 the containment is intact but the tests would indicate
3 it is actually leaking. Okay. That's an operational
4 problem because they'd have to go chase that down but,
5 in fact, the containment is intact.

6 But the worst one for us, as far as
7 safety, is the false negative where there is actually
8 a leak and the test says everything is okay. And,
9 therefore, there's no remedy like that. So we're
10 interested in what is called the sensitivity of the
11 test as opposed to its specificity.

12 Now I got asked when we were dry-running
13 this presentation what is a semi-Markov model. And to
14 answer that, we'd probably sit here for two semesters
15 like I did in an advanced probability theory. But let
16 me try to give you an idea.

17 The system is in one of a number of
18 discrete states. So the containment is intact. Or
19 it's leaking but we don't know that it is leaking. Or
20 the leak has been found and we are furiously trying to
21 repair it. Or we don't get that done and now we have
22 to shut the plant down and go fix it. Those are
23 discrete states like this.

24 The probability of transitions from one
25 state to another only depends on its current state.

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1 It doesn't matter how it got there. It just matters
2 where it is. This is the fundamental that is called
3 the Markovian property that makes this process work.

4 MEMBER BLEY: And these first two describe
5 any Markov process.

6 MR. STUTZKE: That's true. What makes it
7 semi-Markov is the idea that it waits in a given state
8 for a random period of time with an arbitrary
9 distribution. Okay.

10 MEMBER BLEY: What do you mean by
11 arbitrary?

12 MR. STUTZKE: Whatever you want. If I
13 fixed all of the waiting times, in special cases like
14 this, if they are all fixed and they are equal, we
15 call that a Markov chain. So daily sorts of things.

16 If we allow the waiting times to be
17 exponential, which is typical in risk assessment work,
18 then it is called a continuous time Markov process.
19 The reason why I had to use semi-Markov is the tech
20 spec is not exponentially distributed. It's not fixed
21 and constant. I have all kinds of things going on.
22 And so okay. The difference doesn't really matter
23 that much when you look at the average.

24 The classic analogy that I learned in
25 school from my math professors, when you think of a

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1 Markov process, think of a lake. And the lake's got
2 lily pads on it and there is a frog sitting on one of
3 the pads. And he sits there for a while. And then he
4 jumps to the next one. And he sits for a little while
5 and he jumps back or he goes to the third one. And so
6 it is this bouncing around from state to state with
7 different probabilities and different amounts of time
8 the frog is sitting on the lily pad. Okay.

9 Let me walk you through the semi-Markov
10 model that I actually built. Whenever people see the
11 whole thing, they tend to choke. Okay. So let me
12 walk you through it.

13 We'll start out with State 1, which is the
14 containment is intact. And by the way, in all of the
15 states, the reactor is actually operating. It's
16 critical; it's making power. Okay.

17 Now we consider some possibilities here.
18 The leak occurs with some probability. If it does, it
19 transitions to a new state, number two, the undetected
20 leak state. Okay.

21 Alternatively, the leak doesn't occur.
22 It's probability one minus P. Once it is in state
23 number two, eventually a surveillance test is run and
24 the leak would be detected. And here is our Type II
25 error coming from the confusion matrix which is

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1 probability of one minus beta.

2 And if that test indicates there is
3 actually a leak, the action statement of the tech spec
4 is entered. And the licensee would attempt out power
5 repair. That's our new State 3.

6 Some chance the test doesn't work. It's
7 not effective. So the leak is not detected and it
8 continues to remain in the undetected leak state.
9 There is a chance while the reactor is still operating
10 that they get the repair fixed within the tech spec
11 allotted time and it returns back to State 1.

12 There is also a chance where they think
13 they fixed the leak but they didn't really. So it
14 returns back to the undetected leak state. There is a
15 chance here where now you run out of time. The tech
16 spec expires and the plant has to enter a transition
17 into shut down mode. Eventually --

18 DR. WALLIS: Well, some of these
19 probabilities are intervals of time and some are just
20 probabilities, aren't they?

21 MR. STUTZKE: That's correct.

22 DR. WALLIS: So they're not congruent.
23 They're different things.

24 MR. STUTZKE: Well, this leak detected,
25 these are all pure probabilities.

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1 DR. WALLIS: But the leak occurs is some
2 interval of time, isn't it? Or is that --

3 MR. STUTZKE: No, it's the probability
4 actually that the leak occurs over the surveillance
5 interval.

6 DR. WALLIS: Over that interval. It's got
7 to have some time in it somewhere.

8 MR. STUTZKE: Right. Right. And I gave
9 you -- there are some backup slides that have got all
10 the algebra if you're interested like that.

11 But anyway, so there is some chance that
12 at power, you know, that they get down to transition,
13 to shutdown, they think they repair the leak. They
14 start back and, in fact, the whole is still there like
15 this.

16 DR. WALLIS: And of course you have a very
17 good idea where all these areas are.

18 MR. STUTZKE: Pretty good. Well, the
19 point is the probability of a preexisting leak is it
20 is a long-run fraction that the system is residing in
21 either State 2, 3, or 4. Okay. That's the reason why
22 you go to all of this.

23 Either it's leaking and we don't know it's
24 leaking, or it's leaking and they are trying to repair
25 it. And during that repair activity, lo and behold

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1 they get a LOCA and they need it to work and they know
2 it's not going to work. Or the tech spec expires and
3 they are trying to transition to shutdown. Maybe
4 they, you know, shutdowns are stressful on systems and
5 maybe the LOCA occurs like this.

6 So, okay --

7 DR. WALLIS: Well, some of these are real
8 leaks and some of them are valves left open, aren't
9 they? I mean it's different kettle of fish.

10 MR. STUTZKE: Valves are another part of
11 the model.

12 DR. WALLIS: You can fix those but I mean
13 if you've got a hole in containment, then fixing it is
14 not a trivial thing.

15 MR. STUTZKE: That's right. Yes, they may
16 not be able to fix it.

17 MEMBER RYAN: In mean in reality probably
18 what you have for the containment intact and a leak
19 occurs, it is not just one probability. It's
20 probability I'm guessing a couple dozen pathways out
21 of leak occurs. So this is one layer of probably a
22 very complicated --

23 MEMBER BLEY: Or this is a condensation
24 effect.

25 MR. STUTZKE: Right. It is a

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1 condensation.

2 MEMBER BLEY: Yes.

3 MR. STUTZKE: For example, we determined
4 that the lambda for a 20 L_a leak is on the order of
5 ten to the minus seven per hour. That comes out of
6 some data that people collected that says here is how
7 often plants fail integrated leak rate testing.

8 MEMBER BLEY: No, I'm just curious. The
9 slide you showed earlier of the two cases you had
10 looked at where licensees had used the old EPRI report
11 had probability that differed by a factor of two to
12 three.

13 MR. STUTZKE: I'll show.

14 MEMBER BLEY: Are you going to talk about
15 that?

16 MR. STUTZKE: Yes, I'll show you where
17 they stack up --

18 MEMBER BLEY: Okay.

19 MR. STUTZKE: -- because it is almost
20 spooky sometimes.

21 And so we got these leak rate
22 distributions, so forth and so on.

23 MEMBER BLEY: So this first one is based
24 on data essentially?

25 MR. STUTZKE: Yes. These are the results

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1 of the preexisting leak. And the reason why you see a
2 family of curves here is that we went after the fact
3 we didn't know some of the parameters very well and we
4 did some sensitivity studies. But basically you get
5 this characteristic shape like this.

6 DR. WALLIS: Units of time are --

7 MR. STUTZKE: These are per hour. Excuse
8 me, the surveillance test interval is per hour.

9 DR. WALLIS: So ten to the six hours
10 between tests? Is that reasonable?

11 MR. STUTZKE: Well, we extended it all the
12 way from a once per hour test, as indicated by the
13 labels on the plot, all the way up to one test in 15
14 years, which is the current ILRT. Remember one of the
15 things when we developed this semi-Markov model is we
16 were not only looking at BWR Mark IIs but we realized
17 PWRs might want to avail themselves. And this model
18 is flexible enough it will handle everything in here.

19 The current ILRT rate, you know, of three
20 in ten years like this, annually, monthly, right in
21 the middle of the plot here is once per week, which
22 corresponds to the oxygen monitoring that currently
23 goes on in containment. And what you basically find
24 is once you get beyond once a week, it is only
25 sensitive to the surveillance test interval. It is

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1 not sensitive to the other parameters, the
2 probabilities of Type II errors, the tech spec.

3 MEMBER BLEY: This one number off of these
4 curves is for one set of all these parameters. And
5 that number is the stationary state of your Markov
6 model?

7 MR. STUTZKE: That's what I call the base
8 case. All of these are steady-state solutions.

9 MEMBER BLEY: Okay.

10 MR. STUTZKE: Okay. What the base case
11 says is once the leak occurs, they have 24 hours to
12 try to fix it. If not, you shut down in eight hours,
13 lambda ten to the minus seven tau. So that is the
14 base case. So I had my associate put it on because I
15 couldn't remember it.

16 DR. WALLIS: And the slope of the line is
17 one there?

18 MR. STUTZKE: That's a good question.

19 MEMBER BLEY: On a log-log.

20 MEMBER BROWN: You said once it got past
21 one week or longer than one week, it wasn't sensitive?
22 Or do you --

23 MR. STUTZKE: Yes, you see where you get
24 beyond here at one week --

25 MEMBER BROWN: Well, it keeps going up.

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1 MR. STUTZKE: Well, it goes up. It's not
2 sensitive to the other parameters other than
3 surveillance testing.

4 MEMBER BROWN: Oh, oh, other than
5 surveillance. I'm sorry

6 MR. STUTZKE: Right.

7 MEMBER BROWN: I misunderstood you. I got
8 it.

9 MR. STUTZKE: It's the sensitivity to the
10 leak failure rate. And basically it goes up by the
11 same factor. We did two cases of minus seven and
12 minus six to try to get a feel for it.

13 The other thing we did with this semi-
14 Markov model is we actually built a little Monte Carlo
15 tool and we ran it to simulate the process going back
16 and forth.

17 MEMBER BLEY: First time since school?

18 MR. STUTZKE: No, fortunately I have a guy
19 that just got out of grad school that knows how to
20 write Visual BASIC very efficiently. So we did ten to
21 the eighth trials.

22 Okay. Here's the leak upon the initiating
23 event, the containment isolation consideration. For
24 this type of plant, the Mark I containment during
25 routine power operations, there are no pathways open

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1 between the containment and the atmosphere. If there
2 were, the nitrogen would go someplace.

3 Pathways exist while the plant is being
4 inerted, right after startup, and while the plant is
5 being de-inerted like this. So basically we weighted
6 the probability of a containment isolation system
7 failure by the time when it really mattered. Okay.

8 The two days in the whole fuel cycle like
9 this. That's probably a little optimistic. Maybe
10 it's three days, maybe it's four days. But it is
11 clear it is not that the containment isolation system
12 doesn't always have to work. That's the point here.
13 And that had been assumed before in previous risk
14 evaluations that licensees had done.

15 There is one other sneaky path going on in
16 here and that was raised to us during the Vermont
17 Yankee EPU. And the notion is this. That if you had
18 a LOCA and you failed to shut the main steam isolation
19 valves, you could depressurize the containment
20 backwards through the steam pipe out the valve and
21 into the plant. Okay. That was the concern.

22 So I actually introduced that into the
23 model for all the LOCAs, not just the double-ended
24 large LOCA like this. It turns out it is a very small
25 contribution mainly because MSIVs are pretty reliable.

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1 This is the probability that they all fail, including
2 all the independent, all the different common cause
3 combinations there. That's ten to the minus four.

4 Okay. To get to --

5 DR. WALLIS: This includes operator action
6 or is it --

7 MR. STUTZKE: This is all automatic.

8 DR. WALLIS: It's all automatic?

9 MR. STUTZKE: Yes.

10 MEMBER ABDEL-KHALIK: So you don't need
11 all of them to fail.

12 MR. STUTZKE: You just need one steam line
13 to -- yes, you just need -- actually you need two
14 valves to be open.

15 MEMBER ABDEL-KHALIK: Right.

16 MEMBER BLEY: Marty, help me out with your
17 -- I guess it's the first one -- the time periods in
18 which this can occur. When you are in power
19 operations, the reactor building is closed up, I
20 guess. But it could be open.

21 MR. STUTZKE: It could be open because
22 sometimes they --

23 MEMBER BLEY: If it is open, you'd know it
24 right away but you'd still have that 32-hour exposure
25 period.

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1 MR. STUTZKE: Only if -- it depends on how
2 you'd write that tech spec, you know, you're
3 deliberating opening it up for certain reasons.

4 MEMBER BLEY: Yes.

5 MR. STUTZKE: You know you would have to
6 be able to get around that.

7 MEMBER BLEY: Go ahead. I've got to think
8 about that a little.

9 MR. STUTZKE: Yes.

10 MEMBER BLEY: It looks like you're missing
11 a piece.

12 MR. STUTZKE: Yes, there could be. And
13 I'm no expert on tech spec language like that.

14 The other one that has come up repeatedly
15 in our discussions of containment accident pressure is
16 a little amount for a short amount of time. Okay.
17 Post-initiator leak probability is where that show up
18 at least in part. It's called the mission time of the
19 PRA. And so what I assumed was we are interested in
20 leaks that happen up to 72 hours of the occurrence of
21 the initiating event.

22 If the licensee did a calculation and said
23 gee, I only need containment accident pressure for the
24 first 12 hours, I'd change that 72 to 12. It's the
25 only parameter in the model that is sensitive to the

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1 mission time, okay, to the duration over which
2 containment accident pressure is needed.

3 These others, the pre-initiator leak and
4 the upon initiator leak probabilities, of course, are
5 insensitive to the duration.

6 CHAIR SHACK: Of course now you've assumed
7 your leak rate during the accident is the same as it
8 has been all the time.

9 MR. STUTZKE: That's right.

10 CHAIR SHACK: Which probably --

11 MEMBER RAY: Well, again, we're excluding
12 external events, Bill, which, you know, I can't get my
13 mind around that.

14 MR. STUTZKE: Yes.

15 MEMBER RAY: And the most likely breach of
16 the containment is going to be a seismic event.

17 MR. STUTZKE: When you put all this in, we
18 generate the following plot. Surveillance test
19 interval in hours on the x axis. This is the change
20 in core damage frequency per reactor year. This is
21 delta CDF. You see the different contributions with
22 different colors. The black line is the sum of all of
23 the contributions.

24 Again, some labels to indicate how often
25 the surveillance test is, you know, whether it's once

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1 a month, once a week, et cetera. These arrows on the
2 right-hand side correspond to the labeled regions in
3 Reg Guide 1.174 for risk acceptance guidelines.

4 That Reg Guide says delta CDF below ten to
5 the minus six is called a very small change. Between
6 minus five and minus six is a small change. And above
7 minus five, we would not normally accept.

8 And so you get this type of result. There
9 are some interesting insights you can ferret out of
10 this. First of all, once you get testing more
11 frequent than once a week, it doesn't really effect
12 the delta CDF because it goes asymptotically
13 horizontally flat like this.

14 On the other hand, when you get up to
15 large surveillance test intervals around ILRT time,
16 three in ten years, once in 15 years, if that is the
17 only way you have of confirming containment integrity
18 for CAP credit, it is probably unacceptably high
19 change in risk.

20 MEMBER ABDEL-KHALIK: Bit is a one-per-
21 week inspection frequency a reasonably realistic --

22 MR. STUTZKE: Well, that's how often they
23 test for oxygen in the containment now. That's how
24 often some plants monitor nitrogen mass balances.
25 Okay. The issue here -- in other words, and again I'm

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1 no expert on how to test containments, my feeling is
2 for the Mark I containments that are inserted for
3 plants that have sub-atmospheric, they are probably
4 already doing enough to be helpful to us like this.

5 Again, the whole point of the confusion
6 matrix and looking at the test efficiency was you
7 don't need that good a test. It doesn't need to be
8 that accurate to find a hole of the size we're talking
9 about. Okay.

10 It's different than an ILRT when you are
11 trying to measure something extremely precise. Okay.
12 So the idea here is if I test more often, my test
13 doesn't need to be of highest quality.

14 MEMBER BANERJEE: Is there a sort of
15 uncertainty on this change in CDF?

16 MR. STUTZKE: Yes.

17 MEMBER BANERJEE: How much is that?

18 MR. STUTZKE: I haven't computed it.

19 MEMBER BANERJEE: You are going to do
20 that?

21 MR. STUTZKE: Yes. No, I haven't done it
22 yet and the reason is I need to decide appropriate
23 uncertainty distributions for everything in the model.
24 The failure rate, that's pretty easy. We do that all
25 the time in PRA. And the same thing for the mean

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1 repair time.

2 The real problem is what sort of
3 uncertainty do I put on the other parameters of the
4 model? I'm not even clear what an appropriate
5 uncertainty distribution would look like for testing
6 efficiency.

7 I mean is it log normal? Is it normal?
8 We haven't done the work yet. Rather the approach was
9 rather than a full-blown parametric Monte Carlo
10 approach, to try to treat it with sensitivity studies
11 and see did it really matter a great deal.

12 MEMBER BANERJEE: But even with that, you
13 would need some sort of a distribution rate.

14 MR. STUTZKE: To be complete, I would
15 agree.

16 MEMBER BANERJEE: Yes.

17 MR. STUTZKE: I would agree.

18 MEMBER ABDEL-KHALIK: So would this be a
19 new tech spec that you would require that if you
20 detect a leak of a given size, as long as you do the
21 testing once a week --

22 MR. STUTZKE: That's one way to do it.

23 MEMBER ABDEL-KHALIK: -- then you have to
24 shut down --

25 MR. STUTZKE: The other way would be to

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1 utilize -- I think licensees could utilize an existing
2 tech spec. I think they could make a case. What
3 bothers me or what I don't know is that if you utilize
4 an existing one, for example oxygen concentration,
5 okay the tech spec is four percent. And the reason
6 why it exists is that you don't want to have hydrogen
7 explosions.

8 MEMBER ABDEL-KHALIK: Right.

9 MR. STUTZKE: Okay. I don't know four
10 percent oxygen concentration in a containment equals a
11 hole of this big a diameter, you know that's a pretty
12 obtuse relationship curve.

13 MEMBER RAY: Well, Said says such a tech
14 spec would be relevant to the stuff Marty's looked at
15 is good insights here. I don't see how you would
16 write a tech spec that would pertain, for this
17 purpose, that would somehow not be applicable to a
18 design basis event like an earthquake.

19 If you're talking about CAP credit and the
20 probability of a containment leak effecting your
21 ability to get CAP credit, how can you set aside the
22 major reasons why you are going to need CAP credit in
23 the first place? That's why it's -- I mean I
24 appreciate this. It's really good and helpful
25 insight.

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1 But it is hard for me to translate that
2 into well what the heck do you do with the plant
3 because we're not looking at what we all tend to think
4 of, maybe wrongly, as the circumstances in which CAP
5 credit is most likely to be required. That's an event
6 that could be called --

7 CHAIR SHACK: We've ignored, too.

8 MEMBER RAY: -- rather than just a crack
9 in the pipe and we'll assume an accident.

10 MR. STUTZKE: The fire personally worries
11 me worse than the earthquake.

12 MEMBER RAY: That's a fair point. I mean
13 I take it -- I'm from California. You're from the
14 East Coast.

15 MR. STUTZKE: Multiple spurious actuations
16 due to fire has been a big deal in NFPA 805. We
17 continue to wrestle with that issue.

18 I'm also one of the lead analysts for
19 Generic Issue 199, which is increased seismic hazards.
20 So I can speak to that.

21 But to answer your question, yes, the
22 analysis is not complete. And I don't know where else
23 I can go without having full fire PRA or a full
24 seismic PRA.

25 MEMBER RAY: This is good. Don't get me

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1 wrong. I'm not criticizing.

2 MR. STUTZKE: Not to let the cat out of
3 the bag but I have an SRM now from the Commission that
4 says go forth and update NUREG-1150. Just tell us how
5 to do it. And we are in the process of planning. And
6 that is a full-site comprehensive Level 3 PRA that
7 would include all of the reactors, including multiple
8 unit interactions, and all of the spent fuel on site.
9 One study.

10 MR. RULAND: That's job security.

11 MR. STUTZKE: That's why I've been a
12 little busy guys.

13 MR. WOJCHOUSKI: Hello. This is Alan
14 Wojchouski. I'd like to make a kind of statement on
15 your tech specs.

16 MR. STUTZKE: Yes.

17 MR. WOJCHOUSKI: Currently Montecello and
18 a lot of the BWRs have tech spec on L_a, one L_a, if you
19 are above that, you've got one hour to restore it or
20 in 12 hours to go ahead and shut down.

21 So basically what we have to do on that is
22 we monitor it. And the one way that we can monitor --
23 this is not a tech spec requirement but Montecello has
24 a low pressure alarm in a control room. So that if
25 the pressure inside the drywell or containment is less

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1 than .1, you'll get an annunciated alarm. It's also
2 the same alarm that will give us a high level pressure
3 alarm at one and a half.

4 So basically it is continuously monitored.
5 And if you are talking about a leak the size of 20 L_a
6 or 30, whichever, you are talking a very large leak
7 and you will not be able to make that up with your
8 normal make-up capabilities. So the control room will
9 be aware of that really fast.

10 MEMBER BLEY: Just to help me think about
11 it, is the nitrogen always supplied? Or do you apply
12 it and cut it off and then if you lose pressure, add
13 it again?

14 MR. WOJCHOUSKI: Most of the BWR Mark Is
15 have a make-up system in which it can be put in
16 service to maintain the pressure. Montecello, we have
17 a nitrogen system which we have a liquid tank outside,
18 goes through a vaporizer, and that's what supplies our
19 normal instrumentation inside the drywell.

20 MSIV, solenoid valves, actuators, and
21 diaphragms, what we found out is that just a small
22 leakage through some of those fittings, because they
23 are at 100 pounds, is enough to maintain the
24 containment atmosphere positive.

25 And how we actually control what the

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1 pressures are is we have a continuous air monitor in
2 which it pulls sample off the containment, runs it
3 over filter paper to find radionuclides on it, to
4 estimate any leakage inside of it. And we can either
5 pump that right back into the containment to maintain
6 the pressure or we can put it off to our reactor
7 building plenum, which will go ahead and reduce the
8 pressure.

9 So typically what happens is if you're
10 losing pressure, we'll put it right back in the
11 reactor vessel containment. And if you're hitting
12 high pressure, you can go ahead and put it off on the
13 plenum.

14 MEMBER BLEY: I guess what I'm thinking is
15 you might never hit one of the alarms but you might
16 gradually over some months ramp up the rate of
17 nitrogen feed or something. I don't know that on a
18 daily basis you'd actually --

19 MR. WOJCHOUSKI: That would be something
20 each licensee would have to look at. At Montecello,
21 the last time we actually did the make up was in 2005.

22 MEMBER BLEY: So it's certainly time,
23 okay.

24 MR. WOJCHOUSKI: Just some insights into
25 what's out there right now.

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1 MR. STUTZKE: Thank you.

2 So, looking at the clock, one of the
3 qualitative insights is there is only one minimal cut
4 set, one accident sequence with a loss of containment
5 integrity. It goes directly to core damage. And
6 that's the large LOCA sequence.

7 All the other cut sets have multiple
8 failures involved in them. Okay. So there's defense.
9 There's defense in depth, there's redundancy like
10 this.

11 MEMBER BANERJEE: Well, Marty, I have a
12 question to ask you.

13 MR. STUTZKE: Yes?

14 MEMBER BANERJEE: This is a sort of a
15 specific scenario. But imagine that I look at it
16 somewhat differently and say that I am concerned
17 about, for example, sump strainer blockage or
18 something, take that just as an example. The reason I
19 need this sort of overpressure is to take care of my
20 uncertainties, margins, and things like that.

21 That could be a scenario where I would get
22 core damage. Perhaps it wouldn't matter because the
23 containment integrity would still be preserved.

24 But if I wanted just to limit core damage,
25 then that sort of margin that I have there is useful

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1 to me for all the unknowns about something where I
2 don't know things, you know, that well. And strainer
3 blockage is one. And I can probably think of a couple
4 of others. So how does that get factored into this
5 risk assessment?

6 MR. STUTZKE: Well, in the PRA like this,
7 the strainer blockage would be a separate basic event
8 in my model to a loss of containment integrity. And
9 they both would have the same functional effect on the
10 system. And though their likelihoods of occurrence
11 could be different --

12 MEMBER ABDEL-KHALIK: But if you don't
13 know it, you can't have it in your model.

14 MEMBER BANERJEE: Well, you can put
15 uncertainty on it, right?

16 MEMBER ABDEL-KHALIK: Well, I mean this is
17 sort of --

18 MR. STUTZKE: There are failure modes that
19 we don't model in PRAs because we're not smart enough
20 to put them in there. The so-called unknown unknown.
21 And the mitigation for the unknown unknown is defense
22 in depth.

23 MEMBER ABDEL-KHALIK: Correct.

24 MR. STUTZKE: Okay. That's what NUREG-
25 1855 tell us like this.

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1 MEMBER BANERJEE: But we know about
2 strainer blockage. We know a lot about it.

3 MR. STUTZKE: Yes. But the Committee has
4 been right over the years. Dr. Powers has always
5 asked what if you're wrong? What if you forgot
6 something. You know the PRA can only model what it
7 knows to model.

8 DR. WALLIS: But it doesn't model events
9 which could cause both a LOCA and the leak.

10 MR. STUTZKE: It could. But it doesn't.

11 DR. WALLIS: It doesn't.

12 MR. STUTZKE: You mean like the big
13 earthquake, things like that.

14 DR. WALLIS: Or other imaginable events.

15 MR. STUTZKE: I mean my argument on the
16 seismic is if I had a big earthquake that would create
17 a LOCA, okay, and failed the containment, most likely
18 the low-head ECC pumps are already failed anyway. And
19 they don't care whether they have overpressure.

20 MEMBER RAY: Well --

21 MR. STUTZKE: You know just looking at the
22 relative HCL PF values.

23 CHAIR SHACK: But fire is a different
24 beast.

25 MR. STUTZKE: Fire is a different beast.

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1 Anyway, so you get these contributions
2 like this. The pre-initiator seems to be the largest
3 one. I think the graph is a little bit more
4 illuminating because you can see how it functions as a
5 function of surveillance test interval.

6 Something I actually learned doing this
7 was we always do importance measures, Fussell-Vesely
8 and Risk Achievement Worth and in our standard, that's
9 how you decide whether something is significant or not
10 -- the Fussell-Vesely is bigger five E minus three or
11 the RAW is bigger than two, then it is significant.

12 Well, what I found here was it didn't
13 matter what parameters I put into the model, the
14 events were always significant. So I did a little
15 arithmetic and I found out why that could be. It's
16 very interesting insight.

17 There are some basic events that
18 structurally are so significant that the numbers the
19 go into the PRA model become irrelevant. So this is
20 always going to be a significant basic event.

21 The major sensitivities seem to be the
22 containment failure leakage failure rate, the
23 surveillance test interval like this. This is a
24 breakdown of the contributors by all the different
25 initiating events and so forth and so on.

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1 There's not a big change in the risk
2 profile as indicated by the relative percentages here
3 like this. Some of the initiators did go up
4 considerably, the loss of service water, the loss of
5 plant control there. But you would sort of expect
6 that. Loss of service water is a pretty severe
7 transient.

8 CHAIR SHACK: Yes. But what does it mean
9 no CAP credit and with CAP credit? I couldn't figure
10 that out.

11 MR. STUTZKE: Okay. This is assuming I
12 don't need a CAP credit. The column is labeled no CAP
13 credit. With the CAP credit was assuming I need one.
14 And so it actually models -- this is like it models
15 the loss of containment integrity in here. So it is
16 all of these failure modes plus loss of containment
17 integrity is in here.

18 MEMBER BLEY: Okay.

19 MR. STUTZKE: Does that makes sense? It's
20 like a before-license amendment and an after-license
21 amendment sort of snapshot.

22 And so this three E minus eight is the
23 actual delta CDF for the base case. And that is what
24 we would compare to Reg Guide 1.174.

25 MEMBER BROWN: So the numbers look low

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1 from a math standpoint. And I know it depends on your
2 intuitive --

3 MR. STUTZKE: Yes.

4 MEMBER BROWN: -- look at the
5 circumstances as to how you --

6 MR. STUTZKE: Yes.

7 MEMBER BROWN: -- you fall back to
8 judgment there.

9 MR. STUTZKE: To me when I see a delta CDF
10 this small, I immediately think the uncertainty and
11 the whole calculation is going to overwhelm any
12 perceptible delta.

13 MEMBER BLEY: And what you've left out.

14 MR. STUTZKE: And what I've left out. You
15 know that is somewhat --

16 MEMBER BROWN: And it also doesn't factor
17 in Harold's thought relative to if you had an external
18 initiator.

19 MR. STUTZKE: Right. Seismic or a big
20 airplane crash or --

21 MEMBER RAY: Yes, to me the fragility of
22 the containment is much different than that of a pump,
23 having tested lots of pumps. And so I'd count on the
24 pumps even if the containment fails.

25 MEMBER BANERJEE: But you have to break a

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1 pipe as well somewhere.

2 MEMBER RAY: You do. You have to.

3 Understood.

4 MEMBER BLEY: And they are generally hard
5 to break.

6 MR. STUTZKE: Okay. So that's where I am
7 now. Clearly it's significant. It's an important
8 type of event like this. It looks like with adequate
9 testing, we can control the delta at least from
10 internal events to some low level.

11 I'm not quite certain how to progress with
12 respect to fire. The staff's guidance talks about a
13 deterministic approach to treating the fires like
14 that. There is reasonably nothing we can do in short
15 order in the PRA field to get more information to
16 treat that.

17 Any further questions?

18 MEMBER SIEBER: Good presentation.

19 MR. STUTZKE: Well, thanks. It was fun.

20 CHAIR SHACK: If there are no additional
21 questions for Marty, I think it is time to break for
22 lunch. Half an hour. So ten of.

23 (Whereupon, the foregoing matter went off the record
24 at 12:23 p.m. to be reconvened in the
25 afternoon.)

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1 A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

2 (1:00 p.m.)

3 CHAIR SHACK: Okay, I would like to come
4 back into session. Our next presentation is from Rich
5 Lobel of the NRC on the guidance.

6 MR. LOBEL: Good afternoon. My name is
7 Richard Lobel. I am a Senior Reactor Systems Engineer
8 in the Office of Nuclear Reactor Regulation and I
9 would like to talk about the staff guidance that we
10 are working on for the use of containment accident
11 pressure and determining available NPSH.

12 Sitting next to me is Ahsan Sallman from
13 the same branch and office. He gave a presentation
14 earlier.

15 Before we start, I would suggest that it
16 might be helpful to explain the nomenclature we have
17 been using in accident pressure and overpressure. We
18 started trying to use the term containment accident
19 pressure because overpressure had some confusion and
20 some connotations to it that weren't helpful.

21 Overpressure kind of implies that
22 something is being overpressurized and in this
23 context, it is not. The containment is not being
24 overpressurized. There is no system component
25 structure that is being overpressurized. And another

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1 reason we didn't want to use overpressure is that it
2 had several definitions, depending on which licensing
3 was using it. It was a pressure greater than
4 atmospheric pressure; the pressure greater than
5 saturation pressure; the pressure greater than the
6 containment pressure prior to the accident; and the
7 BWR Owners' Group topical report used the first
8 definition, greater than atmospheric pressure.

9 So, we have used the phrase use of
10 containment accident pressure in determining available
11 NPSH, which is a little cumbersome.

12 The containment accident pressure is
13 simply the pressure in the containment during a
14 postulated accident.

15 This slide illustrates the approach the
16 staff is taking. We have made estimates of the
17 uncertainty of both the available and the required
18 NPSH for UCCS pumps in a BWR-4 with a Mark I
19 containment. And that method can also be applied to
20 other reactor designs.

21 And estimate of the uncertainty in the
22 required NPSH includes both the uncertainty and the
23 required NPSH determined at the pump vendor's facility
24 and the uncertainties expected for an installed pump,
25 which we are calling the installed or field

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1 uncertainties.

2 We have called the NPSHR, including
3 uncertainty, the effect of required NPSH, which is a
4 little cumbersome, too.

5 The uncertainty in the available NPSH
6 includes the uncertainty and the calculation of the
7 containment conditions, the containment conditions are
8 input to the determination of the NPSH. For both the
9 required and available NPSH, a realistic value is
10 determined for the available NPSH. Conservative and
11 statistical values are also determined.

12 The difference between the conservative
13 available NPSH and the effect of required NPSH is the
14 conservative NPSH margin, which we will use for
15 postulated design basis accidents. There is also a
16 margin between the realist required NPSH and the
17 realistic available NPSH, which was used for non-
18 design basis accidents.

19 MR. WALLIS: Excuse me, Rich. When you
20 say realistic, nominal, and statistical, which is that
21 of the curve here? It is the --

22 MR. LOBEL: It is the bottom curve, the
23 bottom straight horizontal line.

24 MR. WALLIS: No, the top very highest
25 curve is the one I am asking about.

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1 MR. LOBEL: Oh, okay. That would be --

2 MR. WALLIS: Is that the 95/95 or is that
3 the mean?

4 MR. LOBEL: No, there isn't a 95/95 on
5 here per se. The top one would be what we are calling
6 the realistic or the nominal.

7 MR. WALLIS: Well what does that mean?

8 MR. LOBEL: The next one down, when we
9 include the uncertainty in the nominal value, that
10 makes it less for conservatism. We subtract the
11 uncertainty and so that is the conservative. And I
12 will show you later on that the conservative and the
13 95/95 are very close together.

14 MR. WALLIS: So nominal is placed on what?

15 MR. LOBEL: Nominal would be the value we
16 would try to calculate. We would calculate with
17 trying to make the most realistic values we can, for
18 the most part. They would be 100 percent power.

19 MR. WALLIS: But you can't make a
20 realistic value for the water temperature in the river
21 because it varies.

22 MR. LOBEL: Right. And what we did for
23 that, which isn't in the title is that we used the
24 conservative value. So nominal isn't nominal for
25 everything. It is not nominal for the service water

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1 temperature and it is not nominal for the head loss
2 across the strainers. Those are the two things that -
3 -- because we don't know what a nominal value is for
4 head loss and didn't try to calculate one. And the
5 service water temperature like we were talking about
6 this morning, we just assumed it was the conservative
7 value.

8 CHAIR SHACK: The bounding scenario with
9 realistic inputs for the analysis of the scenarios.

10 MR. WALLIS: Right.

11 MR. LOBEL: Okay, so this is just an
12 illustration of the approach we are trying to take.

13 MR. WALLIS: What is the regulatory
14 requirement here? That the margin be some value for
15 some time?

16 MR. LOBEL: Thank you. I did mention
17 that. No, we are not putting any restriction on the
18 margin because we have included the uncertainties in
19 the required and in the available NPSH. And we are
20 talking in terms of NPSH. Because like I was saying
21 this morning, we are trying to concentrate on the
22 pump. Is the pump going to be able to do its job?

23 And so we are not so much interested in
24 the bottom line looking at the containment pressure or
25 the suppression pool temperature, that kind of thing.

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1 They go into the calculation of available NPSH but we
2 are trying to look at the NPSH margins at the final
3 answer.

4 MR. WALLIS: But in order to run the
5 plant, they have to show that the conservative curve
6 is above the dashed line. Is that what they have to
7 do?

8 MR. LOBEL: Yes.

9 MR. WALLIS: And the size of the margin is
10 irrelevant.

11 MR. LOBEL: Yes.

12 MEMBER BLEY: Your paper, as I recall,
13 says even though it is a 95/95 you think the
14 conservatism and the calculation are sufficient that
15 the margin is adequate if you are right below. Did I
16 read that correctly?

17 MR. LOBEL: Not below the effective
18 required.

19 MEMBER BLEY: I'm sorry, above. If you
20 are okay but just by a hair, you are still okay, --

21 MR. LOBEL: Yes.

22 MEMBER BLEY: -- even though it is a 95/95
23 because of the conservatisms elsewhere.

24 MR. LOBEL: Well, because we have included
25 the margins in those two calculations but yes.

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1 MR. WALLIS: No, 95/95, as I understand
2 it, doesn't come into this at all. It is just
3 conservative.

4 MR. LOBEL: I'm sorry. You are right. We
5 are talking about conservative. Like I said, I will
6 show later that the 95/95 and the conservative are
7 almost the same line.

8 MR. WALLIS: The regulatory basis is the
9 conservative.

10 MR. LOBEL: Is the conservative.

11 CHAIR SHACK: Well, your Guideline 1 on
12 slide four says you can use either.

13 MR. LOBEL: Yes, because they are so close
14 together.

15 CHAIR SHACK: So close.

16 MR. WALLIS: Now wait a minute.

17 CHAIR SHACK: To be precise, you can't use
18 both, according to the guidelines.

19 MEMBER ABDEL-KHALIK: But is that
20 consistent with the results that we saw this morning.

21 MR. WALLIS: But what you said this
22 morning --

23 MEMBER ABDEL-KHALIK: What we saw from the
24 applicant this morning.

25 MR. LOBEL: No, it is not consistent

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1 because the topical report, in a way, is old news now.
2 It was started a couple of years ago and our SER was
3 written before we even started working on this. So, I
4 believe somebody from the Owners' Group said this
5 morning that when we get to the point where we have
6 guidance that is ready to be finalized; there will
7 probably be a supplement to the Topical Report that
8 will include the guidance.

9 We talked about that a little with the
10 Owners' Group but we haven't reached any final
11 conclusions about how to do this. But what we are
12 proposing to do is from now on forward fitting the
13 staff guidance would be used.

14 MEMBER ABDEL-KHALIK: I am still trying to
15 nail this down. The words "NPSHA conservative" that
16 line, is this a Design Basis LOCA --

17 MR. LOBEL: Yes.

18 MEMBER ABDEL-KHALIK: -- analysis?

19 MR. LOBEL: Yes.

20 MEMBER ABDEL-KHALIK: And you are saying
21 that this is going to be close to the 95/95
22 calculation that --

23 MR. LOBEL: We have calculated that and I
24 will show it to you a little later.

25 MR. WALLIS: Yes, but the regulatory basis

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1 is the conservative analysis.

2 MR. LOBEL: Yes.

3 MR. WALLIS: So the 95/95 is not an
4 alternative.

5 MR. LOBEL: Well, we made it an
6 alternative. We said --

7 MR. WALLIS: This is a risk --

8 MR. LOBEL: -- you could either. We said
9 you could use either.

10 CHAIR SHACK: In the current version of
11 the guidance, it is an alternative. We can comment on
12 that later.

13 MR. WALLIS: This morning, I was assured
14 that it was the conservative one, which was the
15 regulatory basis.

16 MR. LOBEL: The topical report says it is
17 the conservative one because the only other choice in
18 the topical report is the statistical. What I am
19 talking about is the staff guidance and that is a
20 little different.

21 MR. WALLIS: But when the licensee does go
22 through all this stuff, they can submit the
23 statistical analysis as their basis for having an
24 acceptable NPSH.

25 MR. LOBEL: They could have done that.

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1 MR. WALLIS: Would the staff accept that?

2
3 MR. LOBEL: Well we probably would have,
4 we definitely would have thought about it a little bit
5 more in terms of wanting a little more detail about
6 things but yes, eventually we probably would have
accepted it.

7 MR. WALLIS: It must be yes or no. It
8 must be yes or no. The regulations are yes or no.
9 They are not --

10 MR. DENNIG: Well these are draft
11 guidelines.

12 MR. WALLIS: Oh, they are draft
13 guidelines. Guidelines are not regulations, are they?

14 MR. LOBEL: No, they are not anything yet.
15 They are being presented to you as a first draft and
16 we discussed them with the BWR Owners' Group as a
17 first draft and we have gotten some input from the
18 Owners' Group that we haven't even put into these
19 slides yet. It doesn't change anything much.

20 But the reason -- the conservative -- Let
21 me try again.

22 The design, the licensing basis if the
23 conservative available NPSH or the 95/95 statistical,
24 saying they can use either and comparing that with the
25 required effective NPSH. And the margin between that

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1 can be down to zero.

2 MR. WALLIS: That is what I thought it was
3 but then this morning we seem to be --

4 CHAIR SHACK: That is okay. That is this
5 afternoon so move on.

6 MR. LOBEL: The top part was a little
7 different. We haven't married the two together yet.

8 MR. DENNIG: As Rick said, starting in
9 2005 with the concept of working with the Owners'
10 Group and quantifying uncertainties in NPS. And then
11 subsequent to that, we have had the ACRS interest. So
12 what you are seeing is what we have developed in large
13 part in response to ACRS input. And this meeting is
14 another part of getting that input.

15 MR. LOBEL: We committed to the ACRS that
16 we would come back and talk about the topical report.
17 And the reason for putting it first this morning was
18 to get some discussion of the Monte Carlo approach
19 before we gave this presentation.

20 So, I wanted to go through the guidelines
21 just in a summary from, just to give you an idea of
22 what is coming. We are proposing this effective
23 required NP -- I'm sorry.

24 MR. WALLIS: So you are doing what Harold
25 Ray suggested this morning. You are introducing a new

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1 way of enforcing regulations.

2 MR. LOBEL: Yes.

3 MR. DENNIG: Now, this is guidance. It is
4 not a regulation.

5 MR. LOBEL: Right. This is draft
6 guidance.

7 MR. DENNIG: It is like a reg guide but
8 not as formal.

9 MR. LOBEL: We are presenting it to the
10 ACRS. Then if we get a favorable reaction from ACRS,
11 then we will go to CRGR and present it to them. And
12 if CRGR agrees, then we would start the reviews of the
13 two power uprates that have been suspended for this
14 issue and it would be the guidance we would use going
15 forward for these types of reviews.

16 MEMBER RAY: To be clear, my concern
17 wasn't with the precedent of the form, it was with the
18 precedent of the content. In other words, what you
19 call this thing isn't important. It is what it does.
20 To me it is precedential.

21 MR. LOBEL: Well, I think it is. Some of
22 what are in the guidelines hasn't changed from what we
23 were doing before and some of it is brand new. And so
24 some of it is things that you haven't seen before.

25 MR. WALLIS: When you have either/or,

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1 though, the question is if they disagree, which one is
2 acceptable. And suppose 95/95 is bigger than
3 conservative, if it could possibly be.

4 MR. DENNIG: To get back out, how this is
5 going to be used, this is what we are proposing is
6 generally acceptable to the staff, as all of our
7 guidance is. And as always, the licensee has the
8 flexibility to propose some other way. A licensee
9 could have come in independently and proposed this to
10 staff as the way to do things and we might have found
11 it acceptable. We are basically standardizing and
12 giving people a heads' up as to what we think we need.

13 MR. LOBEL: Another point, too, is we
14 presented this as a draft because we were hoping to
15 get input from the Owners' Groups. We were hoping
16 that the Owners' Groups would help us define the
17 uncertainties. Some of the limits that we have,
18 particularly a hundred hours' limit that I will get
19 to. We were hoping that the Owners' Groups and maybe
20 their pump vendors would help show us whether that is
21 really necessary or not, or whether that is the right
22 number or not. So this really is draft at this point.
23 We are still hoping to have more interactions with the
24 industry on this before we go any further.

25 MR. RULAND: Rich, let me add one thing to

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1 that matter. If we don't get numbers from the
2 industry, it is likely we are not going to approve
3 power uprates. We are going -- you will see for
4 containment accident pressure credit. There are
5 certain numbers we are going to need from pump vendors
6 and the like. And without that data, licensees, we
7 could, one of the things we are thinking about is just
8 saying that submittal is incomplete and we are not
9 going to review it. So that is under consideration.

10 MR. LOBEL: Okay, let me go on.

11 The second guideline is that maximum flow
12 rate chosen for the NPSH analyses should be greater
13 than the flow rate used for the core and containment
14 cooling analyses. In other words, we are trying to be
15 consistent or at least to make sure that the NPSH
16 analysis is conservative and are the requirements of
17 the pump to the containment and core cooling analyses.

18 Like we were just talking about, either a
19 conservative or a 95/95 lower tolerance limit from a
20 Monte Carlo calculation should be used in determining
21 the available NPSH for the design basis events.

22 Another guideline which is a current
23 requirement of the review is that the containment
24 isolation shouldn't be lost due to an Appendix R Fire,
25 the association circuits problem, or due to

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1 containment venting required by procedures. There
2 shouldn't be a situation where an operating following
3 procedures is told to vent the containment at a time
4 when they are taking credit for containment accident
5 pressure. That is kind of obvious.

6 Operator action to control containment
7 pressure is acceptable if justified by human factors
8 considerations and included in the appropriate
9 procedures.

10 Operation for a limited time with the
11 available NPSHA less than the required NPSH is
12 acceptable if justified by testing. This was already
13 a position in Reg Guide 1.82 but we, I think we have
14 added considerably to tightening up that requirement
15 to making it more of a -- to define the conditions
16 better, make it better defined as to what would be
17 acceptable in that case.

18 Licensees should have the capability to
19 detect and take action for a containment leakage rate
20 large enough to adversely affect containment
21 capability to retain pressure. That is what Marty
22 talked about this morning.

23 A licensee should justify that the use of
24 containment accident pressure is necessary to because
25 the design cannot be practicably altered.

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1 MEMBER ARMIJO: Could you expand on that?
2 That has bothered me a lot. Does practicably altered
3 mean a certain amount of money or is it a real
4 engineering challenge that can't be accomplished?

5 MR. LOBEL: To be honest, we haven't sat
6 down and talked about the details. We haven't really
7 been, we have made the, I guess you could call it
8 generic judgment that the types of things that looked
9 like they were necessary, new pumps, bigger heat
10 exchangers, some kind of additional cooling capability
11 to the water before it got into the suction, those
12 kind of things, would have qualified as not being
13 practical.

14 MEMBER ARMIJO: Why is that? I don't
15 understand that.

16 MR. LOBEL: Well, in terms of --

17 MEMBER ARMIJO: It is expensive. I
18 understand that.

19 MR. LOBEL: But what we are saying by
20 putting this in here is now that in the past we
21 haven't asked licensees that question. We made the
22 judgment ourselves. What this bullet is saying is
23 that we are going to ask the licensees that question
24 and we are going to have to come up with guidance and
25 criteria for that.

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1 MEMBER RAY: So you will have some
2 specific criteria.

3 MR. LOBEL: Yes, I think we have to. If
4 it is going to be a review item, we are going to have
5 to have --

6 MEMBER RAY: Because I think that any of
7 us anyway would feel like we needed to see what you
8 come up with, in order to know if this makes sense.

9 MR. LOBEL: Well, if you don't see it
10 again in terms of the guidance, if we don't pump it
11 back again with the guidance, you would certainly see
12 it with the extended power uprate reviews that you do.

13 But there may be take-aways here that --

14 MEMBER RAY: It would surprise people if
15 we then said that guidance is no good on an individual
16 power uprate. But anyway, leave that --

17 MR. DENNIG: Alternatively -- excuse me,
18 Rich -- rather than carry along that concept of design
19 cannot be practicably altered, alternatively, using
20 this new approach and new criteria, you either make
21 the guidance or you don't make the guidance. And if
22 you don't make the guidance, then it is up to you to
23 decide what you want to do next, as far as improving
24 the situation.

25 Alternatively to having this concept

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1 needing further definition is just that position. You
2 are not, you don't meet the guidance for margin is
3 less than zero and you are going to have to do
4 something about that.

5 MEMBER RAY: Well, excuse me. I will be
6 brief. On that point, though, going back to the
7 operator action credit, for example, if it is
8 justified by human factors considerations. Well
9 again, that is a murky kind of things, necessarily.
10 There always will be a subjective judgment as to
11 whether human factors considerations justify taking
12 credit for operator action, whether it is practical
13 under the circumstances to do that. We referred to
14 the head-flow curves earlier. We have all seen those.
15 We understand in principle at least what the operator
16 is expected to do.

17 So again, it becomes a matter if you just
18 took away item eight to respond to your comment and
19 said well, full stop, you didn't meet the guidance,
20 that is the end, go away, it would suggest, I think
21 that everything else was sufficiently objective that
22 we would be satisfied that the requirements were met,
23 the guidelines had been met.

24 I don't know that eliminating eight, which
25 I took to be your point, is what we are asking for.

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1 CHAIR SHACK: It is consistent with our
2 previous letter. What we asked for was that eight be
3 the first priority, rather than the last.

4 MEMBER RAY: It just seems like it is out
5 of order is the problem.

6 MR. LOBEL: No, I think putting it in here
7 means that we are going to ask licensees isn't there
8 anything else you can do. And we will have to develop
9 criteria to evaluate an answer to that.

10 MEMBER BROWN: But you have already got it
11 in your mind what those criteria are. I mean, you
12 have already said if they had to replace a pump, that
13 is too hard. If they had to replace a heat exchanger,
14 that is too hard. And on, and on, and on.

15 MR. LOBEL: Well, I mean, that is what we
16 have been doing.

17 MEMBER BROWN: It becomes a money issue.

18 MR. LOBEL: That is what we have been
19 doing up until now.

20 MEMBER BROWN: Oh, it is.

21 MR. LOBEL: I really think -- I don't have
22 the prejudice about what this would mean, what the new
23 criteria would be. That is how we were thinking of it
24 in terms of not asking the question. Now that we are
25 going to ask the question, I think we have to come up

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1 with criteria for evaluating it.

2 MR. WALLIS: Rich, how about a new
3 reactor? Does eight apply to a new reactor? They
4 have to keep changing the design until they don't need
5 CAP?

6 MR. LOBEL: Let me just say I have talked
7 to the new reactors people. I can't speak for them
8 but I have talked to the new reactors people and I
9 have advised them that they would be much better off
10 not approving use of containment accident pressure.

11 I can't speak for what they are going to
12 approve but we are in contact with them. We have
13 talked with them quite a bit actually. So they know
14 what has been going on here.

15 MEMBER ARMIJO: Would turning off a
16 containment spray be an acceptable operator reaction
17 in these guidelines? In the event you are in a LOCA,
18 to maintain sufficient head, you just --

19 MR. LOBEL: I think you would have to
20 think about that. I mean, when you said that the
21 first thing that came to my mind was it might be okay
22 to turn it off but how long can you turn it off before
23 you need to turn it on again, if you do?

24 It is that kind of question that would go
25 into the review of an action like that.

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1 MEMBER ARMIJO: Well that is the
2 philosophy that really bothers me the most. It kind
3 of just says that is, we never should do that. We
4 never should disable or --

5 MR. LOBEL: Well BWR procedures now have a
6 caution. If a plant is taking credit for containment
7 accident pressure that cautions the operator, the
8 normal action is the containment pressure can go down
9 to zero psig. That is okay. But if you are taking
10 credit for containment accident pressure, then there
11 is a caution that says make sure that you have the
12 pressure that you need. So that kind of thing is
13 already in their procedures.

14 MEMBER BROWN: What if you can't turn it
15 back or now it becomes something breaks but you have
16 got now air in the line or something like that.

17 MR. LOBEL: Or the motor needs some time
18 before you can turn the --

19 MEMBER BROWN: Whatever. Okay but once
20 you are in these accident conditions, you can all of a
21 sudden get air in the line, where you may not be able
22 to -- it will block the flow. Whereas, it already had
23 vented, it was ready to go and was operating. Now you
24 turn it off, you can't turn it back on.

25 MR. LOBEL: And that is the kind of

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1 question that would be asked in the review. I am not
2 saying we would automatically say any operator action.
3 That is the kind of question that would be asked
4 during the review.

5 And we have asked that kind of question
6 before. Licensees have, in terms of what was the
7 issue -- there was an issue where licensees came in
8 and they said we don't need this many pumps. Our
9 first operator action is going to be to turn off the
10 pump. And there are a lot of questions about, you
11 know, are you sure you are never going to need that
12 pump? What about if one of the pumps you are taking
13 credit for doesn't start when it is supposed to?

14 All that kind of thing goes into the
15 review. It is hard to put all that into a statement
16 beforehand. So that is the kind of thing the staff
17 should be asking.

18 MEMBER ABDEL-KHALIK: Are we doing away
19 with GDC-38?

20 MR. LOBEL: No.

21 MEMBER ABDEL-KHALIK: So GEDC-38 says
22 essentially that operators should rapidly reduce the
23 containment pressure and temperature. So how does
24 that square with what you are proposing?

25 MR. LOBEL: Well in a way it squares with

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1 GDC-35 that requires abundant cooling.

2 The first priority is flow to the core.

3 MEMBER ARMIJO: If that is the only
4 alternative you had, either ignore 35 or ignore 38 but
5 there is another alternative and that is fix the pump
6 and meet both criteria.

7 MEMBER SIEBER: Or don't bring the power
8 uprate.

9 MEMBER ARMIJO: Or only run power uprate
10 to --

11 MEMBER BANERJEE: There are thousands of
12 things that you can do.

13 MEMBER ARMIJO: I guess I am hardware-
14 oriented and deterministic and I said, look, you know,
15 there is a way to fix this stuff but it is not getting
16 enough attention.

17 MR. LOBEL: Well that gets into another
18 issue, which is backfit and we have regulations for
19 that. And we have to follow that 51.09 also.

20 MEMBER ARMIJO: But for a power uprate,
21 would that be a backfit?

22 MR. LOBEL: No, that wouldn't be a
23 backfit.

24 MEMBER BANERJEE: We are talking about
25 upgrades, right?

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1 MR. LOBEL: Well, there are other
2 situations, too, but for uprate, no, that wouldn't be
3 a 51.09 issue.

4 MEMBER ARMIJO: That is where my concern
5 is.

6 MR. LOBEL: I think we haven't discussed
7 that --

8 MR. RULAND: Rich, let me add something
9 about this.

10 Essentially the implied cost benefit
11 analyses, current Commission policy does not require
12 licensees to do cost benefit analyses for
13 modifications that they are proposing. The staff is
14 required to determine if their proposal is acceptable
15 and assures reasonable assurance of adequate
16 protection. There is no requirement for the staff to
17 do a cost benefit analysis.

18 What we are saying by number eight is we
19 are going to require licensees to answer this question
20 and the staff is going to make a case-by-case judgment
21 about whether or not this is practicably altered. You
22 have the staff in the past two reviews, I am thinking
23 at least Browns Ferry, excuse me, Vermont Yankee, the
24 licensee claimed it was not practicable to dig a hole
25 under their ECCS pumps and lower them. The staff

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1 accepted that.

2 MEMBER RAY: Yes, but that is not the only
3 alternative that might exist.

4 MR. RULAND: That is correct. Rich, go to
5 the next. Does the next slide talk about the cooling
6 system? Number 12. Number 12 says, and this is a
7 modification that licensees in fact might be
8 reasonably required to do is to protect the mechanical
9 seals from excess entrained air.

10 One of the things we discovered when we did
11 the -- when we talked to our pump consultants was they
12 brought out the importance of mechanical seal faces.
13 So one of the things we have added to our guidelines
14 is in fact that we believe that they should provide
15 external cold-water flushing to the mechanical seal
16 faces. In our concept of the way this works right
17 now, we believe that as a practicable modification
18 that licensees could make.

19 The history --

20 MEMBER RAY: Now wait a second because you
21 just used the word practicable again but a little bit
22 earlier you talked about reasonable. You used both of
23 those terms. I think you mean to stick with
24 practicable. Correct?

25 MR. RULAND: Yes.

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1 MEMBER RAY: All right. Certainly what you
2 said is practicable. Other things are practicable,
3 too. Practicable doesn't imply cost benefit. It
4 doesn't. Reasonable might.

5 CHAIR SHACK: Well, I also look at 12 as
6 closer to adequate protection. That is, the
7 conclusion is that you can't do this kind of operation
8 without this system. So there really is no cost
9 benefit here. This is what you need to do if you are
10 going to run these pumps in that region.

11 MEMBER RAY: From my standpoint, I realize
12 I interrupted and I apologize but I just wanted
13 because you just used the word again.

14 Practicable is a very regulatory space
15 that you deal with in rate regulation and so on.
16 Practicable is a very precise term that means it can
17 be done. And I am satisfied with your use of that
18 term, if you use it consistently and you mean it.

19 MR. RULAND: I would argue at this point
20 that the staff probably didn't use it to the precision
21 that you are asking us to use it.

22 MEMBER RAY: Okay, I would ask you to use
23 it to that precision or come up with something else
24 that is equally understandable because practicable
25 means exactly what the dictionary says it means, which

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1 is -- well, I will defer --

2 MR. RULAND: It is doable.

3 MEMBER RAY: That's right. It can be
4 done.

5 MR. RULAND: I understand your question.

6 MEMBER RAY: All right.

7 MS. ABDULLAHI: Can I make a correction?
8 Vermont Yankee came up a couple of times today in
9 which you were the reviewer at the time, I suppose. I
10 thought they made a modification so that their heat
11 exchanger was able to cool for the LOCA. They made
12 some plant modification. Maybe they put a service
13 water or another heat exchanger.

14 MR. LOBEL: Yes, I think it was for
15 Appendix R. They added two service water pumps. Two
16 RHR service water pumps.

17 MS. ABDULLAHI: And that was their most
18 limiting case.

19 MR. RULAND: Yes, I think --

20 MR. LOBEL: I am not sure if it was.

21 MR. RULAND: I think they protected a
22 second pump is what they did. It was they wrapped the
23 cables to protect the setting.

24 MR. LOBEL: If I remember right, what they
25 did, what they used, they made that change so they

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1 didn't need containment accident pressure for the
2 Appendix R event.

3 MS. ABDULLAHI: I just want to make that
4 clarification.

5 MEMBER BANERJEE: I think Rick is
6 precisely correct. The reason they did it was against
7 Appendix R. They protected one train.

8 MR. WALLIS: Can I ask about number nine?
9 I don't know what you mean by maximum erosion zone.

10 MR. LOBEL: I am going to explain that in
11 as much detail as --

12 MR. WALLIS: I don't know where the
13 hundred hours came from. It was just thrown up by
14 your consultant without any justification.

15 CHAIR SHACK: Let's go on. We will come
16 back to these. We are just trying to get through the
17 guidelines.

18 MR. WALLIS: -- what you mean later on?

19 MR. LOBEL: Yes.

20 MEMBER ABDEL-KHALIK: This is an important
21 point, though because the maximum erosion zone
22 corresponds to a ratio of greater than one. Right?
23 Both the lower bound and the upper bound.

24 MR. LOBEL: Yes.

25 MEMBER ABDEL-KHALIK: So you are allowing

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1 them, I mean, I can be outside this maximum erosion
2 zone.

3 MR. LOBEL: Inside.

4 MEMBER ABDEL-KHALIK: I can be outside
5 this maximum erosion zone if I operate at a ratio less
6 than one.

7 MR. LOBEL: Yes.

8 MEMBER ABDEL-KHALIK: And would you allow
9 them to do that?

10 MR. LOBEL: And there is another criterion
11 they have to meet. They still have to show that the
12 available is greater than the required so they can't
13 go less than one.

14 MEMBER ABDEL-KHALIK: So they always have
15 to be on the high end of this maximum erosion zone.

16 MR. LOBEL: Yes. They are always going to
17 be above.

18 MEMBER ABDEL-KHALIK: Okay.

19 MR. LOBEL: This criterion is just
20 speaking to this maximum erosion zone.

21 MR. WALLIS: Oh, okay. Well that makes -
22 that creates margin.

23 MR. LOBEL: A realistic calculation of
24 available NPSH would also be done to compare with the
25 available NPSH determined from the conservative or the

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1 95/95 Monte Carlo.

2 MR. WALLIS: I don't know what you mean by
3 that again. I mean, realistic, the Monte Carlo
4 presumably embraces the realistic somewhere. Well the
5 59 runs, I mean, the mean or something is realistic,
6 isn't it?

7 MR. LOBEL: It turns out that for the
8 calculations we did, the realistic and the mean are
9 practically on the same line also.

10 MR. WALLIS: Have the same conservatives
11 in them?

12 MR. LOBEL: No but it turns out they are
13 about the same line. And --

14 MEMBER ABDEL-KHALIK: Now what would be
15 the purpose of number ten. If you are only comparing
16 available NPSH using different calculational methods.

17 MR. LOBEL: Just to give another
18 indication of margin. Really for the ACRS more than
19 anything just as another indication of margin. We are
20 going to have margin between the available and the
21 required, conservative or realistic.

22 We also wanted to have a comparison
23 between conservative and realistic just to show the
24 margin that there is in the realistic.

25 The question that was asked several times

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1 here was I had a slide once with like a page and a
2 half single spaced of all these conservatisms and the
3 calculation and the question was asked how much is any
4 of that worth. And so one of the things we tried to
5 do here was to answer that question. So this goes to
6 answering that question in a way, too. We are going
7 to show a comparison between conservative and
8 realistic.

9 MR. WALLIS: I have difficulty with asking
10 them to calculate something without them knowing what
11 you are going to do with it. And if they say you must
12 calculate this and it must be less than something, I
13 understand that.

14 You must calculate something to show a
15 mountain. That doesn't tell me what you are going to
16 do with it. Are you going to say the margin looks to
17 me okay, or looks to me not okay? What do you do with
18 these numbers after they have submitted them?

19 MR. WALLIS: It is just a demonstration.
20 But that is not a regulation. That is not a useful
21 regulation.

22 MR. LOBEL: Well it is not meant to be a
23 regulation. It is not meant to be a restriction on
24 anything. It is only to demonstrate something. The
25 other ones, the available being greater than the

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1 required, the maximum erosion zone, the mechanical
2 seals --

3 MR. WALLIS: It is like a homework
4 problem. If you calculate this, this, and this, then
5 I will give you a grade.

6 CHAIR SHACK: Graham, one answer is we ask
7 for it in our report. Okay? Just let that one go.
8 You can complain to us later.

9 Let me ask another question. I thought
10 nine and ten were coupled because nine says that that
11 maximum operation is a ration of 1.1 to 1.6. So I
12 thought that you wanted the realistic calculation to
13 find out whether you really were in that zone of
14 maximum erosion.

15 MR. LOBEL: Yes, that is another use of
16 the realistic.

17 CHAIR SHACK: And again, that whole
18 treatment I think is something we could discuss
19 further but to my mind, it is not just margin. It
20 really is a question of seeing where you really are
21 with relation to that maximum erosion zone.

22 MR. LOBEL: Yes, I was just speaking to
23 ten. For nine, you need the realistic calculation for
24 that.

25 CHAIR SHACK: Okay and there you need a

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1 realistic calculation that is more like the 95/95.
2 That is, most of the time where you are really likely
3 to be operating, the conservative answer may not be
4 conservative from that point of view.

5 MR. LOBEL: Right. It gets back to the
6 Vermont Yankee -- I hate to keep saying Vermont Yankee
7 when they are not around. But it is the situation
8 where you were so conservative that you really didn't
9 know where you were anymore. And so that is why we
10 are suggesting to use the realistic value.

11 MEMBER ABDEL-KHALIK: The hundred hours
12 limit would apply to both the conservative analysis
13 and the realistic analysis?

14 MR. LOBEL: No, it is just the realistic.

15 MEMBER ABDEL-KHALIK: Just the realistic.

16 MR. DENNIG: The logic, I think, we are in
17 violent agreement is that for something where you have
18 to get it just right between two bounds, the only
19 appropriate way to do it is what your best information
20 tell you about where you are going to be.

21 So your best information should tell you
22 that you are not going to be in that zone for more
23 than a hundred hours. And the hundred hours is an
24 extrapolation of some limited experience data from the
25 field and it is a number that we put out there. And

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1 if anybody has a better number or something that we
2 can use to inform that better, then we certainly would
3 consider it.

4 MR. LOBEL: Okay, we are going to come
5 back to almost all this again.

6 MR. WALLIS: This is going to get all much
7 more specific and understandable when you get a final
8 draft is it? Because at the moment it seems that you
9 answer questions which help to explain things, which
10 aren't evident at all from what you put on the screen.

11 MR. LOBEL: Well, I am going to go through
12 it all. This was just supposed to be a rough overview
13 to show you where we were going. But certainly if we
14 are going to get to it today.

15 The status, the issue now, there are 27
16 operating reactors that use containment accident
17 pressure for NPSH, 19 BWRs and eight PWRs. There are
18 two EPUs on hold pending revised guidance on the use
19 of containment accident pressure.

20 MEMBER ABDEL-KHALIK: Of the 19 BWRs --

21 MR. LOBEL: All BWRs with Mark I
22 containments.

23 MR. LOBEL: Of the 19 BWRs, how many of
24 those have already received power uprate approval?

25 MR. LOBEL: I don't know that number off

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1 the top of my head. I can name quite a few of them if
2 you want but I don't know the number off the top of my
3 head.

4 MEMBER ABDEL-KHALIK: I think it would be
5 a good idea to know that.

6 CHAIR SHACK: Not now. Please continue.

7 MEMBER BANERJEE: Are there two EPU
8 applications on the books right now?

9 MR. LOBEL: There are several that are
10 under review.

11 MEMBER BANERJEE: Under review, yes.

12 MR. LOBEL: Yes.

13 MEMBER BANERJEE: Were they both Mark I's?

14 MR. LOBEL: Yes. All the BWRs, so far
15 that need containment accident pressure are Mark I's.

16 MEMBER BANERJEE: Yes, that I realize but
17 the ones under review are both Mark I's.

18 MR. LOBEL: Yes. There is at least one
19 other BWR that is in for an EPU review that doesn't
20 need containment accident pressure.

21 MR. RULAND: For the record, those aren't
22 under review currently. Those two applications have
23 been suspended.

24 MEMBER BANERJEE: Oh, okay. That is good.
25 Thank you.

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1 MR. LOBEL: Oh, okay, I didn't understand
2 what you were asking.

3 Okay, to start the technical discussion a
4 little, I don't know that, I guess I am running short
5 of time. Let me skip some of the basics that we
6 talked about. Let me mention this, slide nine,
7 suction energy, since we do talk about it later.

8 Suction energy is a concept that provides
9 a classification of the degree to which centrifugal
10 pumps are prone to the adverse effects of cavitation
11 and also another pump effect, suction recirculation.
12 Suction recirculation is a low flow phenomenon that
13 isn't directly connected to containment accident
14 pressure. It is a condition where the flow is low
15 enough that the flow doesn't completely fill the
16 impeller blades and you get cavitation as well as
17 surging. It is similar in some ways to different
18 mechanism but in some ways it is similar in effect to
19 a water hammer. You get large pressure surges in the
20 system that can damage the system but it is not
21 directly connected to containment accident pressure.

22 I give the definition of suction energy.
23 It is a concept that is proposed that has some
24 benefits over some of the previously used criteria for
25 limitations on pump operation. It is classified as

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1 low suction energy, high suction energy, and very high
2 suction energy.

3 The BWR, RHR, in-core spray pumps are
4 either high energy or very high suction energy pumps.
5 As the suction energy increases, the pumps become more
6 susceptible to adverse effects. So it is a fairly
7 accurate description of the susceptibility of the pump
8 to problems.

9 I will skip net positive suction head.
10 That was just to define some of the terms that we have
11 been talking about today so far.

12 On this slide, the purpose of this slide
13 was to try to give the first introduction to required
14 NPSH. As the flow comes through the suction pipe,
15 Item 1 and gets to the pump suction flange, Item 2,
16 the pressure at the suction flange decreases as the
17 liquid flows from the suction flange through the
18 suction nozzle from two to three and into the impeller
19 eye, item four.

20 MR. WALLIS: It looks like an orifice but
21 it isn't, is it?

22 MR. LOBEL: I'm sorry. What?

23 MR. WALLIS: The way you have drawn it, it
24 looks like an orifice but it not.

25 MR. LOBEL: It is not, no. I didn't draw

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1 it. I don't take credit for it. It was the only
2 reasonably simple drawing I could find and it already
3 had the numbers on it so I used it. But no, there is
4 no orifice there.

5 It has a few other problems to it. But
6 anyway, the point is that from the suction flange to
7 the impeller, there is a decrease in pressure and an
8 increase in flow. And so the low-pressure point, the
9 point at which you would expect cavitation to occur is
10 all or near the entrance to the blade. It is usually,
11 and it depends on the flow rate you have and the angle
12 of incidence to the blade and all that exactly where
13 you will get the cavitation but it is usually close to
14 the blade leading edge and may continue for some
15 distance up the blade.

16 The required NPSH is just the NPSH that is
17 needed. The stagnation energy or the total energy
18 that the liquid has to have in order that the pressure
19 at the beginning of the blade would be low enough to
20 give you a certain amount of cavitation. And that is
21 specified in the number for the required NPSH how much
22 cavitation you are going to allow.

23 The next slide just goes into a little
24 more detail of this. The required NPSH is determined
25 by a test. Usually this type of test where you have -

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1 -

2 MR. WALLIS: At which point in this
3 figure, one, two, three, four, five, do you measure
4 the pressure in which you evaluate NPSH?

5 You would calculate the available NPSH at
6 two.

7 MR. WALLIS: At two.

8 MR. LOBEL: And the required NPSH is to
9 give you a certain cavitation for a drop in pressure
10 from two to four.

11 So you would start at the suction source
12 and figure all the lines losses, valves, fittings,
13 piping, and all that until you get to two. And that
14 would be the loss term and the elevation term and the
15 pressure term above the water would all be the values
16 that you would calculate at two, at location two.

17 The test that is done to determine the
18 required NPSH simply is usually at a tank of water, a
19 suction source. The pump takes suction from that tank
20 at a given flow rate at a given pump speed and returns
21 the water back to the tank. The tank may have a
22 constant level or you may change the level to change
23 the available NPSH. And what you do is you start out
24 the test at a given flow rate and pump speed and the
25 pump will put out a certain head, a certain discharge

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1 head, a total dynamic head it is called. And that
2 will be horizontal. It will be constant until you get
3 to a point where the cavitation in the pump is such
4 that the pump just can't put out that head anymore and
5 the head starts to drop. And the three percent head-
6 drop, which is what the hydraulic institute recommends
7 for the definition is simply where this curve has
8 dropped three percent from --

9 MEMBER BLEY: I thought it was a three
10 percent drop in flow, not in --

11 MR. LOBEL: No, it is in head.

12 MR. WALLIS: So you have some of the valve
13 --

14 MR. LOBEL: Well what it says, I think is
15 that for that three percent drop in head, you have to
16 determine the corresponding flow.

17 MR. WALLIS: Well you have to have to have
18 something that keeps the Q constant while this is
19 happening.

20 MR. LOBEL: Yes. You adjust valves and
21 you also, in a good test, might have a vacuum pump to
22 control the pressure above the water and also to de-
23 aerate the water. I am describing it very simply.

24 Okay, getting on to some of the new stuff.

25 The uncertainty in the pump vendor's test

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1 for some of the reasons I said is really on the low
2 side because the test is carefully controlled. You
3 are controlling the height of the water. You are
4 controlling the temperature of the water. You are
5 controlling maybe the air in the water, the pump
6 speed. All those things, the suction piping is
7 usually a straight run of pipe. So you are minimizing
8 the uncertainty in that determination.

9 If you take that pump, when you take that
10 pump and you install it in the field or at the power
11 plant, you may not have the same kind of control over
12 all those conditions. And so the uncertainty is going
13 to be greater on the installed pump and thanks to our
14 pump consultants, we have considered these effects to
15 increase the uncertainty over the vendor uncertainty.

16 So we have looked at the possibility that
17 the pump speed could change, that the water
18 temperature could be different than the temperature
19 that is used. Usually in a required NPSH test, the
20 temperature is at ambient 60, around 60 degrees or so.
21 The suction piping layout could be much different.
22 The air content of the water could be different. The
23 pump that is tested at the pump vendor facility will
24 be basically a new pump and it won't have any wear.
25 So the wear rings will have whatever the starting

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1 clearances they have won't be increasing in time.

2 MEMBER ARMIJO: Rich, where is that on
3 that little sketch? Is it right at the bottom of the
4 impeller?

5 MR. LOBEL: It is not really shown. It is
6 between, it separates the discharge flow in the region
7 of the impeller from the suction flow going into the
8 impeller.

9 MEMBER ARMIJO: Okay, I just was curious
10 where that would be.

11 MR. LOBEL: I have a better pump drawing
12 that shows it. Let me see if I can work this thing.

13 MEMBER ARMIJO: Well when you get to it
14 just point it out. I may be the only one --

15 MR. LOBEL: Well, I had it as a backup
16 slide. Okay, let's just go on.

17 MEMBER ARMIJO: Yes, just keep -- when you
18 get to it.

19 MR. LOBEL: Okay. So what we are
20 proposing to do is to essentially define a new
21 required NPSH, an effective required NPSH that would
22 include these uncertainties. And we will use that
23 required NPSH, the effective NPSH for NPSH margin
24 determinations for the LOCA.

25 For the non-design basis events,

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1 consistent with current staff practice, we just use
2 the three percent head-drop NPSH, the hydraulic
3 institute definition of NPSH. That is the proposal.

4 We talked about this a little already. It
5 turns out that the maximum erosion occurs between the
6 point of incipient cavitation and the three percent
7 head-drop.

8 MR. WALLIS: When you get more cavitation
9 you start to get less erosion?

10 MR. LOBEL: Yes, and I am going to explain
11 that.

12 MR. WALLIS: Because they don't collapse
13 so rapidly or something?

14 MR. LOBEL: You have so much more vapor.
15 The quality is very high. There is --

16 MR. WALLIS: It makes a difference how
17 much air you have because the air cushions the
18 cavitation.

19 MR. LOBEL: Air also cushions the
20 cavitation, too. That is right. It turns out that
21 the point of maximum cavitation is between the
22 incipient cavitation where you have the first numbers
23 way out to the right on that curve, the test curve I
24 was showing and the three percent head-drop.

25 Let me go to --

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1 MR. WALLIS: These guys have to calculate
2 both incipient cavitation and NPSHR three percent.

3 MR. LOBEL: Well, no. What I was going to
4 say --

5 MR. WALLIS: To know if they are in that
6 zone.

7 MR. LOBEL: Let me do the next slide. I
8 think it will be easier.

9 This is a picture trying to explain what
10 is going on in the pump with different levels of
11 cavitation. The effects of cavitation depend on the
12 amount of voiding you get, the amount of vapor you are
13 forming and the distribution of the vapor in the
14 front. This picture shows that test curve again and
15 it also shows an edge view of two impeller veins, just
16 to illustrate where the voids are.

17 Moving from left to right on the curve, at
18 very low available NPSH values at Point D, it is
19 called, you are in the break off region. The pump is
20 hardly pumping anymore.

21 MR. WALLIS: -- is the same NPSH as C. So
22 you don't know where you are if you just measure NPSH.

23 MR. LOBEL: Well, C is supposed to be,
24 there is a little artistic license. Three is supposed
25 to be the three percent --

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1 MR. WALLIS: There has to be some
2 curvature because you are at a complete cliff.

3 MR. LOBEL: Yes.

4 MR. WALLIS: You don't know where you are
5 on a cliff.

6 MR. LOBEL: Yes. And that is the reason -
7 - there are two natural limits to cavitation. The
8 first one is A, incipient cavitation where it first
9 starts and you get just a few bubbles. There is no
10 effect on the pump but that is a physical thing that
11 is happening.

12 The break-off is also a physical thing
13 that is happening. The pump is just not pumping
14 anymore. But neither of those are very useful as
15 limits because you don't know where the incipient is
16 and you don't want to know where the break-off is
17 because you are in trouble if you are there.

18 So the limit that was chosen by the
19 hydraulic institute is the three percent value because
20 it is something that is relatively easy to measure and
21 gives you a change that you can measure. But you
22 could use a one percent head-drop. You could use a
23 zero percent head-drop right before you started to get
24 the head-drop there. The three percent is more of an
25 arbitrary number.

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1 MR. WALLIS: I see because you measure it
2 but I don't understand how you know where B is.

3 MR. LOBEL: Where B is? You don't know
4 where B is.

5 MR. WALLIS: But you have a guidance which
6 says you can only operate a B if you are going to --

7 MR. LOBEL: Well, I am going to show you
8 how we came up with the guidance. Let's see, we are
9 kind of going through these things fast.

10 So anyway, --

11 MR. WALLIS: Well it is important if you
12 are going to have something which says you use B for
13 some purpose, you have got to know how to determine
14 where B is.

15 MR. LOBEL: Well, I am going to show you
16 how we know where B is.

17 MR. WALLIS: Okay.

18 MR. LOBEL: Point D, the impeller is
19 running in a vapor cloud. The cavitation erosion is
20 very limited, since the impeller is surrounded
21 predominantly by vapor and not much in the way of
22 vapor bubbles. So even though the pump isn't pumping
23 anymore, the good news is the impeller is in great
24 shape.

25 So then moving to point C, which is the

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1 three percent head-drop value, you still have a lot of
2 vapor, huge volumes of vapor exist, but you have more
3 vapor bubbles and the collapsing of these vapor
4 bubbles is causing some pitting and erosion of the
5 impeller and the flow is also slightly unstable or
6 maybe more than slightly unstable.

7 If we go to point B, this is a state
8 reached where there is a lot of vapor bubbles, a lot
9 of vapor cavities and entrained bubbles in the liquid.
10 When the bubbles collapse after moving to a higher
11 pressure zone at the pump, you don't have the
12 cushioning effect of the vapor clouds as much and you
13 get a lot more erosion and this is the maximum
14 erosion.

15 So even though there is no indication on
16 the pump curve, the pump from outward appearances
17 seems to be working just fine but it is having the
18 highest level of cavitation.

19 And then finally the incipient cavitation
20 of point A, like I was saying, there are only a few
21 bubbles and it is not doing any damage and the pump is
22 working fine.

23 MEMBER ABDEL-KHALIK: Now at point C, do
24 you assume that the pump characteristics remain
25 unchanged?

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1 MR. LOBEL: At C, yes because there is
2 another difference between what we are talking about
3 and the usual type of thing a pump person would talk
4 about it. We are talking about a limited amount of
5 time. We are only talking about the time the pump is
6 going to be operating at this three percent head
7 value. At a process plant, if the pump was operating
8 at that condition, it could be operating there a year
9 or more before somebody did maintenance on the pump.
10 So we are not talking about a very long time that the
11 pump is going to be in that condition. And these are
12 very robust pumps, they are very well designed, very
13 well made, good materials, materials that can
14 withstand cavitation. And so the time that we are
15 talking about the pump would be in point C. We don't
16 expect to see any damage to the point that would
17 affect the pump performing its safety function.

18 MEMBER ABDEL-KHALIK: No, I am concerned
19 about how would you go about determining the
20 corresponding volumetric flow rate, given the fact
21 that you now have a two-phase mixture.

22 MR. LOBEL: You don't. You don't. I
23 haven't seen anything in the pump literature where
24 people have even tried to define things similar to
25 quality avoid fraction or that kind of thing. But

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1 they speak in more qualitative terms.

2 MR. WALLIS: You have a three percent loss
3 of head and you draw your load line and you can match
4 it with this three percent loss of head.

5 MEMBER ABDEL-KHALIK: But that is why I am
6 asking whether the characteristic curve remains
7 unchanged because it wouldn't change.

8 MR. WALLIS: But it is all in this pump
9 consultant report. He has these curves.

10 MR. LOBEL: Oh, the pump curve?

11 MR. WALLIS: Yes.

12 MR. LOBEL: They had flow curve?

13 MR. WALLIS: Yes.

14 MR. LOBEL: It was changed. Yes, it will
15 change at that point, depending on what the available
16 NPSH is, instead of being on the curve, you will start
17 to drop vertically down.

18 MR. WALLIS: Three percent below. It is
19 not completely different.

20 MR. LOBEL: I'm sorry. I didn't
21 understand your question.

22 This is how we treated the maximum
23 erosions. One way to measure the amount of cavitation
24 is with acoustic measurements. People put pressure
25 transducers or other acoustic transducers on the pump

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1 suction and they measure the noise, the cavitation
2 noise that comes from the imploding bubbles.

3 And this is the relative noise that is
4 stated in terms of cavitation, erosion rate, but it is
5 really a measurement of cavitation noise as a function
6 of the NPSH margin ratio, the available to the
7 required and you can see when you are up at a high
8 value, the noise is relatively low. As you lower the
9 margin, as the available NPSH goes down, the noise
10 increases until you reach a peak, then from the peak
11 you start to decrease again. And that is due to the
12 bubbles, the vapor bubbles and due to the air that is
13 coming out of solution in the water.

14 And what we did was to just, we took this
15 curve to a typical curve and picked a high and a low
16 boundary to this curve that captured the peak and said
17 that was the result of maximum erosion.

18 MR. WALLIS: But this occurs long before
19 the three percent.

20 MR. LOBEL: Yes.

21 MR. WALLIS: But the three percent seems
22 to be what you are putting into the guidance that they
23 use.

24 MR. LOBEL: That is what is getting put
25 into the guidance --

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1 MR. WALLIS: Then the hundred hours --

2 MR. LOBEL: -- in comparing the available
3 to the required. And the other criterion is that you
4 can't stay in this zone for more than a hundred hours.

5 MR. WALLIS: A hundred hours applies to B.

6 MR. LOBEL: Yes.

7 MR. WALLIS: So you have another line you
8 should show the B line on your, way back when when you
9 show what is allowable, the -- there should be a B
10 zone shown on there somewhere. On slide three there
11 should be a B line, shouldn't there? The B line is
12 somewhere in there.

13 MR. LOBEL: Oh, this is --

14 MR. WALLIS: Is the B line -- where is the
15 B line? It is above NPSHA conservative or where is
16 it?

17 MR. LOBEL: Where would it be? It would
18 probably be --

19 CHAIR SHACK: It could be anywhere.

20 MR. LOBEL: Yes, this was for a different
21 purpose. It would probably be above the effective
22 somewhere below that. Somewhere in the margin, what
23 we are calling margin, I guess.

24 MR. WALLIS: It is a fraction of 1.5 on
25 the NPSH, isn't it? Looking at this figure which is

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1 up on the screen now, 1.4 and 1.5. That is quite a
2 big change, isn't it, in NPSH?

3 MR. LOBEL: Yes.

4 MR. WALLIS: Well you should show a B line
5 on this figure then.

6 MR. LOBEL: Off-hand, I am not sure where
7 I would put it on here. I don't even know where to
8 put it on --

9 MR. WALLIS: It can't be the requirement
10 for a hundred hours. You have to be able to put it on
11 the figure and see how long the time is.

12 MR. LOBEL: Well, let me go on. You will
13 see how we use this. Look at the next slide, 19.
14 This is a calculation of a large-break loss of coolant
15 accident. It is a plot of the available over the
16 required NPSH, the NPSH margin ratio as a function of
17 time. And what we did was plot the zone of maximum
18 erosion and it is in green, it is filled in in green.
19 And we did calculations for the statistical and the
20 conservative and the realistic cases for the ratio as
21 a function of time for this large break LOCA.

22 And we are saying that the time that you
23 are in this green zone shouldn't be more than a
24 hundred hours. And that is how we would use this
25 maximum erosion zone limit.

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1 MEMBER ARMIJO: In some of the material
2 that the staff or someone that has gotten to us, the
3 impeller materials make a big difference, whether it
4 is cast iron or chrome, steel, or bronze. I have even
5 seen some stuff on bronze that is supposed to be
6 really good.

7 Now in the case of the BWR pumps, are they
8 all using the very best material for those impellers?
9 Or would you make any difference on your guideline?

10 MR. LOBEL: It wouldn't make any
11 difference on the guideline. Well, certainly if they
12 were using something really bad, it would make a
13 difference. It would make a lot of difference.

14 MEMBER ARMIJO: So this guideline is for
15 the very best material for the impeller?

16 MR. LOBEL: I don't know if you say the
17 very best but the very good.

18 MEMBER ARMIJO: Best available in the
19 industry.

20 MR. LOBEL: Very good, considering the
21 pumps were built in the '60s, too. There may be
22 better materials that might be used now. But it is
23 very good material. We have talked with pump vendors
24 about this and our pump consultants about this.

25 The material isn't a concern for the times

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1 that we are talking about.

2 MEMBER ABDEL-KHALIK: Now the hundred hour
3 limit, does that only apply to the realistic input
4 results?

5 MR. LOBEL: Yes.

6 MEMBER ABDEL-KHALIK: Okay. So in this
7 case, it is of no consequence.

8 MR. LOBEL: Right.

9 MR. WALLIS: Why should you only apply it
10 to realistic?

11 MR. LOBEL: Well the reason we are saying
12 is because we want to know what is really happening.
13 If we used --

14 MR. WALLIS: You never know what is really
15 happening. There is uncertainty in the statistics.
16 You never know what is really happening.

17 MR. LOBEL: It is --

18 MR. DENNIG: With a two-sided zone, there
19 is no way to bias it conservatively one way or the
20 other so the strategy is to get it as best you can or
21 as best you know is the criteria. What is my best
22 knowledge about where I am actually going to be for
23 what you might consider a secondary criterion that
24 goes with a more primary.

25 MR. WALLIS: But safety isn't based on the

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1 mean. It is based on being reasonably sure that
2 probably nothing will go wrong. So you go for
3 something like 95/95 don't you?

4 MR. LOBEL: Well, if you go for 95/95, you
5 could even end up below here. It is a judgment.

6 MR. WALLIS: Isn't the statistical minimum
7 the 95/95?

8 MR. DENNIG: For the NPSHA, NPSHR margin,
9 we can bias that so that we have got worst-worst and
10 we know what we have got. But to have this secondary
11 criterion, we don't have a worst-worst. So again, the
12 intention is that we need to have our, what is our
13 best guess, if you will, or estimation of where we are
14 going to operate or where we will be during this
15 accident. And let's just demonstrate that you don't
16 go in there with our best information for more than a
17 hundred hours.

18 MEMBER ABDEL-KHALIK: Now let me just ask
19 one question. The denominator in the ordinate here,
20 NPSHR, is that the same for all graphs?

21 MR. LOBEL: No.

22 MEMBER ABDEL-KHALIK: Is NPSHR effective?

23 MR. LOBEL: For the conservative, it is
24 the effective required. For the other cases, it is
25 the three percent head drop.

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1 MR. WALLIS: So in this case, it is the
2 effective.

3 MEMBER ABDEL-KHALIK: So it is for a
4 different mechanism that you add that.

5 CHAIR SHACK: No, I think in this case, it
6 is the three percent. The effective would require you
7 to be at some higher value instead of one.

8 MR. LOBEL: The effective, for the
9 conservative we are dividing by a higher number. So
10 if we went to the three percent, the conservative
11 curve might move up out of the zone.

12 MR. WALLIS: So the NPSHR, which is shown
13 on the vertical axis there is the conservative.

14 MEMBER ABDEL-KHALIK: Only for one graph.

15 MR. LOBEL: Only for the conservative.

16 MR. WALLIS: That is the same thing as
17 NPSHR effective on slide three.

18 MR. LOBEL: It is the same value but for
19 the statistical cases and the realistic cases, we use
20 the realistic. We use the three percent required
21 NPSH.

22 MR. WALLIS: Well here again, you have got
23 to be damn sure that when you write this up formally,
24 it is not equivocal.

25 MR. LOBEL: Yes.

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1 MR. WALLIS: When you just have an NPSHR
2 without saying which one it is, --

3 MR. LOBEL: Well that is why we didn't say
4 -- yes, I know. It could have been clearer. That is
5 why we didn't say which one it is because it is
6 different for each --

7 MR. WALLIS: So they would be better off
8 to operate as one. You are better off to have more
9 cavitation all the time.

10 MR. LOBEL: But again, this is one
11 criterion and then there is the other criterion.

12 MR. WALLIS: But they meet the other
13 criterion, too.

14 MR. LOBEL: They would meet it as one,
15 yes, if you could be at one.

16 MR. WALLIS: So you are allowed to get
17 through the green zone and down below to one, then
18 come back into the green zone again?

19 MR. LOBEL: I guess you could do that,
20 yes.

21 MR. WALLIS: And then you have a hundred
22 hours in the green zone only. You are better off to
23 slide down lower and then come back up again.

24 MR. LOBEL: Yes.

25 MR. WALLIS: Is that real? It is that a

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1 good --

2 MR. LOBEL: Wait, just a second.

3 Well, in terms of doing damage to the
4 impeller, yes, because at the three percent, you are
5 not doing that much damage to the impeller. It is at
6 the higher value.

7 CHAIR SHACK: If you look at this
8 logically, the one to pick would be the statistical
9 minimum because again, we are not worried just about
10 uncertainties in the calculation. We have a whole
11 batch of scenarios that we have to look at. The
12 statistical minimum is the one that in fact looks at
13 all the scenarios. And if you keep the statistical
14 minimum above 1.6, then that is your only guarantee.

15 Once you sort of pick any other thing, you
16 know, you don't know what scenario you are going to be
17 in. You could be in there, the other one is whether
18 the hundred hours is so conservative that maybe you
19 don't need to worry about it. And you know, but it if
20 you are providing assurance, I don't see how you can
21 pick much of anything except the statistical minimum
22 and put the criteria on that.

23 MR. LOBEL: Well, what we were trying to
24 do is leave the choices to the realistic or the
25 conservative because we are not asking licensees to do

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1 a Monte Carlo calculation. That is a very --

2 CHAIR SHACK: But as you described your
3 realistic input, that really only covers one scenario,
4 the summer day. And if I get my break in January, I
5 could be down in the zone of maximum erosion, unless I
6 know where my statistical minimum is. At least 95
7 percent of the time, I know I am out of there.

8 MR. WALLIS: I have a concern about the
9 numbers.

10 CHAIR SHACK: You know, if you don't like
11 95/95, pick another one but I would think you would
12 want to keep most of your scenarios -- unless you can
13 convince yourself that the hundred hours is extremely
14 conservative, in which case you don't have to worry
15 perhaps where you are in the zone of maximum. You can
16 avoid the erosion by either making the time very short
17 or staying above it but somehow allowing yourself to
18 float around, I don't understand it.

19 MR. LOBEL: Well, we think the hundred
20 hours is conservative. We don't think there is any
21 possibility that the impeller will have enough erosion
22 that it is going to affect the safety pump function in
23 a hundred hours.

24 MEMBER ARMIJO: What does your pump
25 consultants, your expert consultants say about

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1 expected life in that green band?

2 MR. BUDRIS: My name is Allen Budris. I
3 am a pump consultant for NRC, over 40 years'
4 experience working in the pump industry for the likes
5 of Goulds and Worthington and that sort of thing. I
6 was director of product development for quite a long
7 time for them. The last eight years, I have been a
8 consultant.

9 And one of my areas of specialty
10 throughout my career has been cavitation and that sort
11 of thing. And I spent, I don't know, like 25 years
12 working with the Hydraulic Institute on some of these
13 standards. I was the chairman of the work group on
14 the NPSH margin standard that was developed and also
15 on the pump piping standard before I left the
16 Hydraulic Institute.

17 And so anyway, so you are asking about
18 this hundred hours. I mean, there are so many
19 variables, I mean, not to mention air, you know, a
20 little bit of air can reduce the damage and that sort
21 of thing too substantially and all these various
22 variables.

23 But the few things I have looked at when I
24 first got involved in this, there were some Sulzer
25 reports where they had actually done some tests of

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1 these types of pumps in their field and, you know,
2 they ran them maybe for a day and saw absolutely no
3 damage running around a three percent or less than a
4 three percent value.

5 I have personally seen cases where there
6 was substantial damage even with even stainless steel,
7 which is a fairly cavitation corrosion-resistant
8 material and that happened after like two thousand
9 hours or something like that.

10 CHAIR SHACK: Well your report sort of
11 focused on the very high suction pumps, which happen
12 to be the ones that are of interest to us.

13 MR. BUDRIS: Yes, very high suction
14 energy?

15 CHAIR SHACK: Yes.

16 MR. BUDRIS: Yes, suction energy, right.

17 CHAIR SHACK: Those seem more susceptible.

18 MR. BUDRIS: Right and the one I was
19 referring to actually wasn't nuclear power. It
20 happened to be a cooling pump but some of the worst
21 cavitation damage happens water around 100 degrees or
22 something.

23 CHAIR SHACK: Well the other things I
24 wondered was your hundred hours an estimate at the
25 three percent NPSH or at the maximum erosion rate?

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1 MR. BUDRIS: That was at the maximum
2 erosion rate.

3 CHAIR SHACK: Okay. So that is a maximum
4 erosion rate.

5 MR. BUDRIS: And I will agree that the
6 Sulzer tests were probably mostly done in around 1.0,
7 around the three percent intra point.

8 MEMBER ARMIJO: And this experience is for
9 stainless steel impellers.

10 MR. BUDRIS: Yes, at least the one I had
11 for like two thousand hours. That was substantial
12 damage where they had to replace the impeller.
13 Because I mean, you can get a little bit of damage
14 because cavitation is time-related. And you get a few
15 pock marks in an impeller and it is still mostly going
16 to do this performance you probably can't even pick up
17 any real reduction in performance. So you have to
18 almost have the erosion go all the way through and
19 break off pieces of vein, before you really
20 substantially impact the performance of a pump.

21 MEMBER ABDEL-KHALIK: On this graph, these
22 various methods or the various results that you
23 present take into account uncertainties in the
24 calculation of NPSH available.

25 MR. LOBEL: Yes.

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1 MEMBER ABDEL-KHALIK: Okay. Your proposal
2 to --

3 MR. LOBEL: To the degree by their
4 definitions, the realistic not so much, the
5 conservative. Their conservative but you don't know
6 what the margin is.

7 MEMBER ABDEL-KHALIK: My question is, why
8 don't you have the same denominator in this plot,
9 which is the NPSH-effective, required effective for
10 all the calculations, since the uncertainties in the
11 required NPSH would be the same, regardless of how you
12 calculate the available NPSH.

13 MR. LOBEL: We could have done it that
14 way. We chose to, since it was realistic, to use the
15 three percent value. But we could have done it that
16 way. We spent a lot of time talking about --

17 MEMBER ABDEL-KHALIK: But I mean, you are
18 doing a realistic calculation to account for
19 uncertainties.

20 MR. LOBEL: Yes.

21 MEMBER ABDEL-KHALIK: And here, you have
22 decided to essentially forego any concern about
23 uncertainties in the required NPSH value.

24 MR. LOBEL: It would be easy to do it that
25 way. It would be the same containment calculation and

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1 just a different number in a spread sheet.

2 MEMBER ABDEL-KHALIK: But if you were to
3 do that, then these realistic graphs would fall lower
4 than where they are on this plot, depending on how
5 much difference is there between -- right?

6 MR. LOBEL: Yes.

7 MEMBER ARMIJO: Would the statistical
8 minimum go into the green zone then?

9 MR. BUDRIS: I think this would stay the
10 same except that you would say on your NPSH over
11 NPSHR, the NPSHR would be really the effective. But
12 as long as it is effective, as long as it is really
13 what the pump is seeing, then this is still valid, the
14 1.2 to the --

15 MEMBER ABDEL-KHALIK: I understand but if
16 you take the numbers that he has calculated and re-
17 plot them, except for the green curve, all the other
18 curves will go down because you are dividing by a
19 larger number.

20 MR. BUDRIS: Okay, yes.

21 MR. WALLIS: I am pretty concerned
22 applying these figures, these numbers, I mean you have
23 got a 1.21 margin and then you have got a 1.6 factor.
24 So your 22 feet is going to become 39 feet by the time
25 you got those two factors. I wasn't aware that we

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1 were changing these NPSH requirement by such a huge
2 amount.

3 MR. LOBEL: We're not. You mean, as a
4 limit?

5 MR. WALLIS: If you take this 1.6 factor
6 on top of the 1.21 factor --

7 MR. DENNIG: Rich? The uncertainties in
8 required or plus or minus things. Right? They are
9 plus or minus. So about the NPSH are three percent.
10 The adjustments are for measurement or for field, they
11 are plus or minus things.

12 MR. LOBEL: Yes but you apply them as a
13 plus.

14 MR. DENNIG: Right. But then for purposes
15 of what is your best information about what the actual
16 NPSHR is, you know, what should you use, a number that
17 has got uncertainty added to it, a number that has got
18 uncertainty subtracted from it, or something that it
19 is in the middle for this purpose.

20 MR. LOBEL: I'm not sure they are all --
21 Are they all plus or minus?

22 MR. BUDRIS: Well they are not all plus or
23 minus. Like wear would be the only negative. But I
24 mean, there is some. Speed, conceivably could be a
25 plus or minus. So some plus or minus. Temperature,

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1 as a matter of fact, is a minus. That actually helps
2 you. So you throw in water temperature.

3 MR. WALLIS: All of these are pluses here.
4 Aren't they? I mean the 1.6 factor is a plus.

5 MR. LOBEL: The factors put on already are
6 1.21.

7 MR. WALLIS: So what are you going to
8 accept here? The statistical minimum can go into the
9 green zone for a while and come out again. It can go
10 all the way down to one and come back out again, as I
11 said before. Is that acceptable?

12 MR. LOBEL: Yes. It is the total time of
13 maximum erosion.

14 CHAIR SHACK: But again, the question
15 whether you should be using the realistic value, you
16 know, in my mind, it would seem to be that the
17 statistical minimum should not be in the green zone
18 for more than a hundred hours.

19 MR. WALLIS: No but they can tweak their
20 pencil. They can make things more conservative or
21 something and move it down out of the green zone so
22 they can get below.

23 CHAIR SHACK: That is not a good sign.

24 CHAIR SHACK: No, no. Because you are
25 going to have to keep the conservative one above one.

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1 MR. WALLIS: But still, you have got to do
2 that. But you can make a more conservative assumption
3 and make your plot look better because it comes down
4 below the green and then it comes back again. It
5 doesn't seem to be right.

6 MR. DENNIG: My impression is that we
7 agree with the chairman of the subcommittee, that we
8 should seriously consider the statistical minimum as
9 what we should be using here.

10 CHAIR SHACK: For your wear rate, kind of
11 --

12 MR. DENNIG: Yes, for this in the zone
13 thing.

14 MEMBER ABDEL-KHALIK: Provided you divide
15 by NPSHR effective to account for uncertainty in the
16 required NPSH value, R-value.

17 MR. DENNIG: I think we will have to think
18 about that. I understand your point. I just am not
19 convinced that there is an uncertainty that is just in
20 the one direction.

21 MR. BUDRIS: Probably the NPSH required
22 could be like the other where you would have a
23 minimum, a mean, and a maximum uncertainty. You know,
24 there might be a realistic uncertainty which isn't
25 quite as much as you might put in for the maximum.

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1 MR. WALLIS: Well the problem is if it is
2 better to be lower, then I am not sure 95/95 makes
3 sense anymore. It is better to be lower if you got
4 out of the green zone. You are no longer bounding
5 things.

6 CHAIR SHACK: The thing with the
7 statistics issue, you are supposed to try to be
8 realistic. You are not supposed to come in and --

9 MR. WALLIS: That's right. I understand
10 that but then you said the worst case is my 95
11 percent, 95/95 extreme. But in here, it is bound to
12 be more extreme we get down to one.

13 MEMBER ABDEL-KHALIK: A more realistic
14 plot of this would show the green curve below the zone
15 and the red curve within the green zone lasting less
16 than a hundred hours.

17 MEMBER ABDEL-KHALIK: Well, no. This
18 might be a realistic --

19 CHAIR SHACK: But the question, it seems
20 to me that if the conservative calculation is good, to
21 see if you can pump, if you have enough. And again,
22 to protect yourself against erosion, it really seems
23 to me that you need to look at all the possible
24 scenarios which is the statistical minimum.

25 MR. RULAND: Just one point about this

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1 limit, we believe because this was a phenomenon we
2 felt we needed to address, we devised this hundred
3 hour limit that is really an order of magnitude less
4 than typically is found for pump failures. So we are
5 talking typically for erosion failures on the orders
6 of a thousand or thousands of hours.

7 CHAIR SHACK: Yes, but we are talking
8 about very high suction energy pumps here operating at
9 the peak erosion rate.

10 MR. RULAND: I understand. And even for
11 those suction energy pumps, we are talking a thousand
12 or thousands of hours for erosion.

13 CHAIR SHACK: I thought there was a lower
14 number in Mr. Budris' report.

15 MR. RULAND: And because of that, we still
16 felt we needed to have a limit. And that is why we
17 devised this limit as we did. However, in spite of
18 that caveat, the staff is going to go back and re-look
19 at this limit to decide precisely whether we should
20 use the statistical mean or not. And so the staff
21 will get back to you on that.

22 MR. LOBEL: The idea, too, was that doing
23 a Monte Carlo calculation is a very intense thing to
24 do. It takes a lot of effort to do that and we were
25 trying to come up with something that would do the job

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1 without having to do the Monte Carlo calculation.

2 The other thing is maybe the owner wants
3 to speak to this is one of the reasons the topical
4 report is not part of the licensing basis because it
5 put a burden on them in terms of Appendix B keeping up
6 the data, making sure that the data stayed valid, if a
7 calculation was a licensing basis calculation.

8 So we were trying to avoid. We showed it
9 here. We did this ourselves but we were trying to
10 avoid making the Monte Carlo calculation a
11 requirement.

12 CHAIR SHACK: Well it would seem to me
13 then that you really need a much better database to
14 justify the hundred hours. You know, to make sure
15 that in fact there is a large factor of safety on
16 that.

17 MR. LOBEL: Well in fact, I was really
18 hoping for that. I was really hoping that one we put
19 out our draft guidance, one of the reasons it is draft
20 guidance is that we would get some information that
21 would tell us whether a hundred hours was okay,
22 whether we needed a limit at all. I mean, somebody
23 came in and said, look I run these pumps in this zone
24 forever and have never had a problem, then we can drop
25 this criteria. We haven't gotten there.

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1 MR. WALLIS: We have got two criteria now.
2 One is that the minimum has got to be above one. The
3 other one that you have got to be within this zone for
4 not more than a hundred hours.

5 If you do your 59 runs, you look at them
6 and you say well, we are okay because you know, the
7 worst one is above one in that criterion. But there
8 may be three of those runs which are in the green
9 zone. So what is statistically okay for one criterion
10 isn't statistically okay for the other criterion. And
11 I think you have got to think this through whether you
12 want to be in that kind of a bind.

13 There may be ones which are fine. Do you
14 see what I am getting at? There are some intermediate
15 runs. We have spent more time in the green zone
16 because it is at the higher level of NPSH.

17 MR. DENNIG: Yes, we are going to go think
18 about this.

19 MR. WALLIS: You have to go think about
20 it.

21 CHAIR SHACK: That is why you put the
22 95/95 above the green zone.

23 MR. WALLIS: It if is always above the
24 green zone, that is okay. That is a new criterion.

25 CHAIR SHACK: That is a new criterion.

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1 MR. WALLIS: Then the hundred hours is
2 irrelevant if it is always above there.

3 CHAIR SHACK: No, it can dip into the
4 green zone for a hundred hours.

5 MR. WALLIS: But it can't go below and
6 come back up again?

7 CHAIR SHACK: Total hours in the green
8 zone, as I would understand it would be --

9 MR. WALLIS: Then you get into my problem.
10 You have got two criteria.

11 MR. LOBEL: It could but if you look at
12 the shape of the curves, they don't seem to do that.
13 They may seem just to go down and level off.

14 MR. WALLIS: Think about it anyway.

15 CHAIR SHACK: Onward.

16 MR. LOBEL: And again, these calculations
17 are all for one type of plant.

18 Okay, another criterion that was an
19 existing criterion was that the staff was allowing in
20 some previous reviews that the available NPSH could be
21 below the required NPSH, if the licensee performed a
22 test and showed that pump could go for that length of
23 time and when the pump was inspected after the test,
24 there wasn't any sign of damage or wear to the pump.
25 We thought about that some. We got advice from Mr.

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1 Budris and added some extra requirements to that,
2 guidelines to that. An important one, I think, was to
3 make sure that when the pump was tested, it was tested
4 at the available NPSH value that was expected. That
5 hadn't been part of our review before and if you think
6 about what we have been saying if the pump experiences
7 the most cavitation in this area of 1.2 to 1.6, if you
8 are testing the pump farther and farther to the left,
9 you are getting farther and farther away from the area
10 of maximum erosion. So maybe the tests that have been
11 done up until now haven't been the right tests. Maybe
12 they should have been whatever the times is in the
13 area of maximum erosion or at least in an area where
14 it is predicted the pump is going to operate, not at
15 some value where you have so much vapor that you don't
16 have any bubbles anymore and you are not going to get
17 cavitation damage. So that is something that we
18 thought about some more and probably still need some
19 more thought.

20 Protection of the mechanical seals, we
21 talked about the --

22 MR. WALLIS: That the best regulation is
23 the simpler one?

24 MR. LOBEL: Definitely. And actually,
25 that is a lead-in to this next one. Whoops, I am not

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1 keeping up with myself.

2 That is an important point for this one,
3 too, that if you are going to take credit for accident
4 pressure, the way that is done, I don't know that it
5 is clear to everybody, is what you do is you do a
6 calculation assuming no accident pressure. And you
7 see what the available NPSH is and if you are okay, if
8 you have enough margin. If you don't have enough
9 margin, if the available is below the required, then
10 you add pressure to get up to the point where the
11 available is equal to the required. And that is the
12 containment accident pressure that you are crediting.

13 So if you are doing that, you are making
14 the available equal to the required so the pump is
15 going to, according to the calculations, is going to
16 be operating at that point. And at that point, you
17 could be releasing air. The air that is dissolved in
18 the water, which at 190 degrees isn't much, but you
19 would still be releasing that. And that air would
20 tend to go towards the mechanical seals, towards the
21 shaft and the mechanical seals just be centrifugal
22 force throwing the liquid out.

23 And so the concern is that the seal faces
24 may run dry and if they do that, they are not going to
25 do that for very long before they experience damage.

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1 So this criterion says protect the seals by having an
2 external source of cooling so that they won't run dry.

3 Implementing something like this makes
4 things more complicated also. You are adding a system
5 to the pump that the pump is going to need to operate
6 properly. So, it has its drawbacks also.

7 And so this is another one where we have
8 to evaluate whether this is really necessary with
9 experience. Do pumps really see this kind of effect?
10 And is the solution we are proposing really the right
11 solution? And for this one too we would like to get
12 more feedback from the pump vendors and the Owners'
13 Groups and have more discussion with our own pump
14 consultant.

15 CHAIR SHACK: How close do you have to be
16 to the three percent NPSHR before this becomes a
17 concern?

18 MR. LOBEL: Allen, do you want to answer
19 that?

20 MR. BUDRIS: Well it depends on how much
21 entrained air you really have. The one thing I have
22 seen from tests I have performed is that and that is
23 the reason for this peak and then why it drops down.
24 I have measured actually the entrained air in the
25 water as it went through the NPSH test, which meant we

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1 were dropping because NPSH available.

2 And you know, as you get into this point
3 of I guess it is about 1.3, 1.4 or whatever, you know,
4 you are picking up getting air out of solution. You
5 know, I think what happens in part is when cavitation
6 bubbles form, they liberate any dissolved air which
7 now becomes entrained air, so you are adding to the
8 entrained air. And then so the more bubbles you get,
9 the further down you go, the more it is entrained air
10 and that, you know, it also cushions it. But that
11 does generate more and more air that then could then
12 end up at the seal faces and then cause failure.

13 I had seen a case like that but it was
14 really different with the vertical turbine pumps,
15 where the pump was in severe cavitation. And that air
16 that was liberated ended up causing some internal
17 bearings to run dry and the pump to fail. So and the
18 bearings were about the same place where a mechanical
19 seal would be and pumps and such.

20 CHAIR SHACK: It sounds like you need a
21 pink zone.

22 (Laughter.)

23 CHAIR SHACK: If the statistical minimum
24 is in the pink zone, then you have to put in, install
25 your seals, if it is above the pink zone, you don't

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1 have to put in your seals.

2 MR. BUDRIS: I had mentioned, too, you may
3 not absolutely need a double seal with external
4 cooling but as long as you have like a flush line off
5 the discharge and maybe a throttle bushing or
6 something like that, then as long as you preclude the
7 air from getting to the seal. So if you have a flush
8 line off the discharge, then you are causing the flow
9 to go in towards the pump, which should keep the air
10 out.

11 So there are ways to do it, potentially,
12 other than just a dual-seal arrangement. They may
13 even have now, I don't know.

14 MR. WOJCHOUSKI: We have that arrangement.

15 MEMBER ABDEL-KHALIK: Well, back to the
16 issue raised by Graham regarding the need for sort of
17 simpler way to define an acceptable boundary, wouldn't
18 this issue be a lot simpler if we just simply require
19 that this ratio always be above the zone of maximum
20 erosion?

21 MEMBER ARMIJO: Yes, 1.6.

22 MR. LOBEL: That would be simpler, yes.

23 MEMBER ABDEL-KHALIK: Would it essentially
24 address most of the issues that have been raised?

25 MR. WALLIS: I think this might bring some

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1 of the plants which don't need CAP into a situation
2 where they do need CAP. Because you would have to
3 apply this analysis, presumably, back to the cases
4 where they have not requested CAP and now apply it
5 even if it atmospheric pressure in there.

6 MR. LOBEL: It appears from these curves
7 that we have calculated that it may be almost the same
8 thing because the curves seem to go down a certain
9 ways and then flatten out. So at a hundred hours, the
10 curve is still in that zone. So it wouldn't make any
11 difference if you had a limit on the amount of time
12 or you didn't because you are going to exceed the
13 limit anyway.

14 MEMBER ABDEL-KHALIK: But it would make
15 enforcement of that requirement a lot easier.

16 MR. LOBEL: It would make it easier. We
17 were just trying to make it more realistic but still
18 to give the opportunity to -- The hundred hours came
19 before we did these calculations. We didn't know what
20 was going to happen until we had already picked the
21 hundred hour value. We didn't know that the curves
22 were going to go down and then flatten out.

23 Maybe what you are suggesting, like I am
24 saying, it is almost the same thing. So that would be
25 easier.

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1 MR. WALLIS: Could you remind me? What do
2 the plants do now who don't have CAP? Do they apply
3 factors like 1.21 and 1.6? They don't. So they might
4 get themselves in to the green zone if they didn't.

5 MR. LOBEL: Yes and when we got a little
6 farther along with this guidance, that is a question
7 that we have been talking about informally, just
8 discussing among ourselves but we haven't reached any
9 conclusion. Now those plants, that would be a backfit
10 to impose that requirement and we would have to see
11 whether we could justify that requirement and that
12 would depend on what kind of backfit it was determined
13 to be, whether it was going to be a compliance backfit
14 or an increase in safety backfit and we haven't
15 discussed this at all really with our management or
16 with our lawyers. So what I am saying is in the outer
17 edge of where we are in discussing this.

18 MR. DENNIG: The zone of maximum erosion
19 was something that came up in the course of doing this
20 analysis and it wasn't something that we expected.

21 Clearly, I think from your feedback, we
22 have to go back and revisit how we would implement
23 guidance about that particular aspect of operation.
24 And we will do that.

25 MR. LOBEL: Like I said, too, another

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1 option would be to find data that shows that these
2 pumps can operate in that range for some long length
3 of time, longer than we are talking about needing
4 accident pressure and that it is not necessary.

5 MEMBER ABDEL-KHALIK: But that is plant-
6 specific.

7 MR. LOBEL: Well probably it would be --
8 well, it depends how you did it. If you are going to
9 do it with these curves, it would be plant specific.
10 If you were just going to say that maximum cavitation,
11 operationally maximum erosion zone even for a thousand
12 hours isn't going to effect a pump with a certain
13 impeller material or something that maybe that would
14 solve the problem.

15 MR. BUDRIS: Can I just mention something
16 else, too? I mentioned about this air. You know, the
17 air which can hurt the mechanical seal and can
18 actually increase slightly NPSH requirement, also
19 cushions the damage, any damage you are going to get
20 from the cavitation bubbles to the pump.

21 So somewhere when you get like one percent
22 or higher air, you can substantially reduce the damage
23 and stuff. So these pumps may actually, you know, be
24 in better shape, plus the fact that you run quite a
25 bit higher temperatures. The bubbles aren't as big at

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1 higher temperatures as they are when you start out at
2 lower temperatures. So the implosion is not as much
3 energy so you don't do as much damage. So you have
4 two things going for you. You are running at a high
5 temperature and if you have one percent or more air in
6 there, you have some cushioning effect. So if that is
7 the case, you may find out actually in the field, even
8 though there may be in this zone of maximum erosion
9 some of these other factors are mitigating that much
10 damage.

11 So if we had any real world in the nuclear
12 power plants, that would go a long way, I think.

13 MR. LOBEL: Let me point one other thing
14 out.

15 CHAIR SHACK: Rich, hold up here for a
16 second. Many of us are tending to head off for a
17 ceremony here. So I would like to essentially recess
18 until 4:00.

19 MR. LOBEL: Can I just make one fast point
20 about this?

21 CHAIR SHACK: Sure.

22 MR. LOBEL: It is just that we are just
23 talking about LOCA. We haven't talked about the other
24 events yet and the curves may look different for those
25 other events.

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1 MR. WALLIS: This event won't take an hour
2 and a quarter though, will it? We will probably be
3 back here whenever the event is over?

4 CHAIR SHACK: That is fine with me. But I
5 just don't know.

6 MR. WALLIS: Whereas we may run very late
7 tonight.

8 CHAIR SHACK: No we won't run very late
9 tonight.

10 MEMBER BANERJEE: Jack has a plane to
11 catch. Are we off the record?

12 CHAIR SHACK: Let's come back at 3:40.

13 (Whereas, the foregoing matter went off the record at
14 2:46 p.m. and went back on the record at
15 3:39 p.m.)

16 CHAIR SHACK: Okay, if we can come back
17 into session. As you were saying?

18 MR. LOBEL: As I was saying, I skipped
19 quite a few slides because I was going to go through
20 some of the things we have already talked about, the
21 different kinds of calculations, conservative,
22 realistic, and Monte Carlo, and all that, and just go
23 to sensitivity studies.

24 One of the things the committee has asked
25 for several times, I'm sorry, slide 35, was

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1 sensitivity studies, how important were the different
2 parameters. And before this, I could only answer in
3 terms of different markers that I have gotten from
4 licensee submittals from different reactors. So what
5 we did was we put one typical BWR/4 with the Mark I
6 containment, listed all the variables that we thought
7 contributed to the calculation significantly and then
8 did a sensitivity study by taking the base value and
9 varying it by five percent.

10 MR. WALLIS: You varied temperature by
11 five percent. You varied the Kelvin temperature by
12 five percent or what?

13 MR. LOBEL: No, just Fahrenheit. I
14 collect thermodynamics.

15 MR. WALLIS: So you vary the Fahrenheit
16 temperature by five percent?

17 MR. LOBEL: Yes.

18 MR. WALLIS: So if the temperature is 80
19 degrees, you vary it only by a small amount of four
20 degrees?

21 MR. LOBEL: Yes.

22 MEMBER SIEBER: It is better than using
23 the absolute value.

24 MR. LOBEL: We used conservative inputs
25 except that we started with 100 percent power instead

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1 of 102 percent power.

2 And I didn't expect to go through all of
3 these now. Maybe just make some observations. One of
4 the observations is that quite a few of the parameters
5 seem sensitive. Oh by the way, these are ranked in
6 decreasing order so that the top one is the most
7 significant. The ones that are shaded were changes of
8 more than the five percent when we changed numbers.

9 MR. WALLIS: This percent is a bit
10 misleading because you know the power pretty
11 accurately. The surface water, the temperature
12 actually varies a lot more than four degrees. So it
13 is sensitivity but it is not --

14 MR. LOBEL: We just wanted to use the same
15 number for each.

16 CHAIR SHACK: I think he is looking if he
17 changes one thing by five percent and something
18 changes by four percent, that is one thing. If it
19 changes by 0.16 percent, it is another.

20 MR. WALLIS: I understand that, yes. But
21 then you get into which of the variables is most
22 important. And over its range of variation you get a
23 different picture.

24 MR. LOBEL: Well some of them we did that.
25 Containment leakage we varied by a large amount. The

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1 heat sinks we did an absence and present for the heat
2 sinks down in the shaded numbers and heat transfer
3 coefficients we also did that. In GOTHIC, there is
4 quite an array of heat transfer coefficients you can
5 pick. And Ahsan did one case with empirical
6 correlations. In another case, there was more
7 physical with heat mass transfer analogy. Heat
8 transfer coefficients just to see what the difference
9 would be.

10 And decay heat, we did no sigma and a two
11 sigma to see what that difference was.

12 MR. WALLIS: So what did you conclude?

13 MR. LOBEL: Well I guess one observation
14 was that there are quite a few variables that are in
15 the same significance range that seem to be
16 significant for this calculation. The containment
17 leakage didn't appear to be too significant. The
18 decay heat two sigma to zero sigma was certainly
19 significant.

20 MR. WALLIS: But varying the containment
21 leakage again by five percent, it is a very small
22 change.

23 MR. LOBEL: Well we varied it by five
24 percent in the white area and then we varied it by a
25 factor of five hundred or a ratio of five.

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1 MR. WALLIS: That is a more realistic one,
2 yes.

3 MR. LOBEL: About 5.0. Strainer and
4 piping losses weren't very significant. And the
5 presence or absence of heat sinks was significant, as
6 you would expect. The area wasn't too significant but
7 the sensitivity to the condensation heat transfer
8 coefficient was significant.

9 CHAIR SHACK: Strainer and piping seems
10 strange. I would have thought that went right to the
11 bottom line.

12 MR. LOBEL: It is just that it wasn't a
13 very high number. The strainer losses weren't very
14 large for this case, for this plant.

15 CHAIR SHACK: But I would have expected a
16 five percent change to make a five percent change in
17 the available head.

18 MR. LOBEL: Well part of it is, I believe
19 if it is combined with the piping friction number two.
20 So you are not looking just at the strainer loss.

21 MEMBER ABDEL-KHALIK: But this all sort of
22 the order is an artifact of that five percent
23 variability that you have imposed because you know,
24 five percent change in power is a huge change; whereas
25 a five percent in the heat sink temperature in degrees

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1 F, because that is units dependent, is relatively
2 small compared to the range that you expect to operate
3 within.

4 MR. LOBEL: Yes. We can -- if you have
5 any suggestions, other things you would like to see,
6 it is not hard to re-do these.

7 MR. WALLIS: Well how does change in NPSH
8 compare with the margin you have in NPSH?

9 MR. LOBEL: Well we weren't trying to do
10 that for these calculations. I guess we would have to
11 pick a required NPSH and do the calculation. We could
12 do that, too. We weren't trying to do that kind of
13 comparison with this.

14 MR. WALLIS: That is why percent change in
15 NPSH is a strange variable. If you have a bigger
16 NPSH, then you have a bigger change. Because how much
17 does it change in terms of what you need?

18 MR. LOBEL: Well these things aren't going
19 to change the required NPSH because we are not giving
20 any credit for the effect of temperature on the
21 required NPSH so any change in suppression pool
22 temperature isn't going to change the required NPSH.
23 I guess the pump flows would change the required NPSH
24 a little.

25 MR. SALLMAN: These are the maximum values

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1 of the NPSH change. It is a transient -- during the
2 transient -- We pick the maximum value during the
3 transient. So very small numbers, you know, based on
4 the calculation but these are the maximum.

5 MR. LOBEL: Go on?

6 MEMBER ABDEL-KHALIK: Yes, the change is
7 time dependent.

8 MR. LOBEL: The next slide gets to a lot
9 of the heart of a lot of what we have been talking
10 about. This is a plot of NPSH versus time for a
11 large-break LOCA for the RHR pumps. And this one
12 curve has a lot of information in it for the different
13 calculations that we have done. It has the three
14 percent required NPSH horizontal line and the
15 effective required NPSH horizontal line.

16 We used an uncertainty of 21 percent. And
17 what we did to get that was take estimates that were
18 in the Task 2 Report from Mr. Budris here and we added
19 the maximum number that he gave us and didn't include
20 the temperature correction, which was a negative
21 number. So this is a fairly high estimate of the
22 effective required NPSH or the uncertainty in the
23 three percent NPSH.

24 It doesn't include the wear ring number.
25 That came later and wasn't included in the

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1 calculation. So, just as an example, it is not
2 supposed to be any one plan or any problem but just an
3 example of the relative importance of these things.

4 And you can see that the Monte Carlo
5 minimum, which is the 95/95 is very close or overlaps
6 with the conservative available NPSH.

7 MR. WALLIS: This morning we were shown a
8 very different conclusion that the --

9 MR. LOBEL: That wasn't for NPSH
10 available, I don't think. I think that was for
11 temperature, the curve we were shown.

12 MR. WALLIS: But it showed a very big
13 difference between 95/95 and the conservative.

14 MR. LOBEL: Was that your presentation?
15 GE's presentation. I think that was temperature, if I
16 remember right.

17 MR. WALLIS: I think he showed the --

18 MR. LOBEL: It isn't going to overlap for
19 temperature. Let me see if I can find our
20 calculation.

21 MEMBER ABDEL-KHALIK: It was temperature
22 and pressure.

23 MR. WALLIS: And pressure. Pressure was a
24 bigger factor. Pressure were those two black curves
25 with black squares and black triangles. And they

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1 showed a big effect.

2 MR. LOBEL: Okay, here is our temperature,
3 our full temperature calculation and it doesn't have
4 the different curves. Remember which is which?

5 MR. SALLMAN: Well the first one is, the
6 top one is the conservative. The second one from the
7 top is the maximum temperature. Then the third one,
8 the pink color is the realistic. The fourth one is
9 kind of black color it is mean of the statistical.
10 And the blue one is the minimum statistical.

11 MR. WALLIS: Well on this curve, it is
12 good that the statistical is above everything else.
13 On slide 37, it is a bit strange to me that the Monte
14 Carlo minimum actually crosses the conservative. You
15 wouldn't expect that to happen.

16 MR. LOBEL: Yes, I thought that was
17 interesting, too. I would have thought the
18 conservative would have been below.

19 MR. WALLIS: It is really not as
20 conservative as it might be, somehow.

21 MR. LOBEL: We will include this and give
22 a curve with labels on it.

23 MEMBER ARMIJO: Is this for a real plant?

24 MR. LOBEL: More or less.

25 MEMBER ARMIJO: More or less, okay.

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1 CHAIR SHACK: Now if I put the 1.2 and 1.6
2 band on here, the conservative sort of sits in it for
3 most of the time.

4 MR. LOBEL: On here?

5 MR. WALLIS: Yes, you have got 39 for 1.6.

6 CHAIR SHACK: Well, I put the 1.6 on the
7 adjusted, the effective. So I got 42.

8 MEMBER ARMIJO: So you can put a band on
9 there.

10 CHAIR SHACK: I can put a green band on it
11 and it sits on the green band.

12 MR. LOBEL: The other interesting things
13 is that the realistic and the Monte Carlo mean
14 coincide pretty much. And I don't know how much of a
15 conclusion you can draw from that because this is only
16 one calculation.

17 MEMBER ARMIJO: Is that a general finding?

18 MR. LOBEL: For other BWR Mark I's it
19 might be pretty close but you can't say that unless
20 you do more calculations.

21 MR. WALLIS: I think it shows that the 1.6
22 though makes a big difference to what you conclude. I
23 mean, you are up at 42 with a 1.6 factor.

24 MEMBER ABDEL-KHALIK: But the benefit of
25 that is that assures that we will always have a

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1 minimum margin.

2 MR. WALLIS: Does it?

3 MEMBER ABDEL-KHALIK: Yes. Well this plot
4 doesn't meet that. This plot, the realistic is on
5 this.

6 MEMBER ABDEL-KHALIK: But if that is the
7 requirement, then it would assure that we will always
8 have a minimum margin.

9 MR. WALLIS: -- the requirement, they
10 would have to do something about this plant.

11 MEMBER ABDEL-KHALIK: Right.

12 MEMBER BONACA: It is slide number 19.

13 MR. WALLIS: If that were a requirement, I
14 wonder what the impact would be on all these plots.

15 CHAIR SHACK: Well I think it is way
16 premature. We are just making some observations at
17 this point.

18 MEMBER RAY: We are not going to do
19 anything.

20 MR. WALLIS: We aren't going to do
21 anything?

22 MEMBER RAY: Not now.

23 MR. LOBEL: Okay, go on to 38. This is
24 has the observations that we were talking about that
25 he conservative and the conservative and the

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1 statistical minimum are fairly close so he gives an
2 approximate quantification of the conservative
3 calculation, even though you can't quantify margin in
4 the conservative calculation, this comparison gives
5 some idea of the conservatism in the conservative
6 calculation. And likewise the realistic calculation
7 and the mean.

8 MR. WALLIS: But you reached this -- this
9 doesn't agree with what we heard this morning. The
10 statistical is very different. It is 95/95.

11 MR. LOBEL: But I don't think they were
12 doing available NPSH.

13 MR. WALLIS: Yes.

14 MR. DENNIG: This morning it was
15 containment pressure with the plots that we were
16 looking at. It wasn't NPSH.

17 MR. LOBEL: Yes, pressure and temperature.

18 MR. DENNIG: Right.

19 MR. WALLIS: Well it is the same thing,
20 isn't it? I mean, pressure is NPSH.

21 MR. SALLMAN: It was an Hww graph that
22 they were showing in the morning and this is an NPSH
23 graph. They are different.

24 MR. WALLIS: But the difference for
25 several psi which shows up as feet.

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1 SLES Yes, that's right. This is Hww.

2 MR. WALLIS: It is the same thing. Hww
3 says feet instead of psi.

4 MR. LOBEL: Well the only difference is
5 that Hww, to get available from Hww, you just add a
6 constant.

7 MR. SALLMAN: Add the level of suppression
8 coolant to the central line of the pump and subtract
9 the losses.

10 MR. WALLIS: But the difference between
11 the Monte Carlo and the conservative, whether it is
12 NPSH or psi, should be consistent because you are just
13 adding the same thing to both.

14 MR. LOBEL: Right.

15 MR. WALLIS: But it doesn't explain why
16 this four to six psi difference from what --

17 CHAIR SHACK: Well unless there is a
18 significant difference in temperature, which changes
19 the vapor pressure.

20 MEMBER ABDEL-KHALIK: No, no. It is all
21 in there because I mean, what this pressure is the
22 containment pressure required to meet the NPSH
23 requirement. Right? So they are shooting against the
24 same goal and one is significantly different than the
25 other.

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1 This morning, the message to me was that
2 the statistical method bought you several psi.

3 MEMBER ABDEL-KHALIK: Correct.

4 MR. WALLIS: And now you are saying it
5 doesn't buy you anything over the conservative. I
6 don't think that is correct.

7 MEMBER ABDEL-KHALIK: These calculations
8 are not consistent.

9 MR. WALLIS: No. I mean, the conservative
10 usually is so conservative that it is way above or
11 different from the statistical approach.

12 MEMBER RAY: This is like saying, isn't
13 it, that if you took 95 to 99, --

14 MR. WALLIS: They are closer.

15 MEMBER RAY: You would expect a change to
16 occur but in reality, this would imply what you are
17 just now looking at that no change would occur.

18 MR. WALLIS: You see, if you look at river
19 water temperature, this is the conservative value.
20 Let's take 90 degrees for the river water. That
21 occurs so infrequently that it wouldn't really show up
22 in the statistical analysis. You would cut off the
23 tail.

24 MEMBER RAY: Yes. No, I am thinking, you
25 know, five percent exclusion is substantial. And you

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1 would expect if you included what is in the tail, it
2 would make a difference, not that it would make no
3 difference.

4 MR. WALLIS: It makes a difference because
5 the tail is so spread out.

6 MEMBER RAY: Well, yes.

7 MR. LOBEL: I'm not sure I have anything
8 to say to that.

9 MEMBER ABDEL-KHALIK: Other than the fact
10 that your calculation is inconsistent with what we saw
11 this morning.

12 MR. SALLMAN: Which graph?

13 MEMBER ABDEL-KHALIK: Any of these graphs.
14 This graph shows that if you do the conservative
15 calculation, you need a lot more containment over
16 pressure to meet the criterion than you would if you
17 were to use this 95/95 method, which means that there
18 is a big difference between the two analyses.

19 MR. WOJCHOUSKI: Al Wojchouski here. I
20 will try to go ahead and explain is this morning what
21 we were looking at is deterministic in which all of
22 the values were put at bounding peak values and low
23 values. And the statistical was the 95/95 confidence
24 level. I believe what the NRC was doing is their
25 conservative value was realistic and then they added

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1 in some uncertainty to it. So it really isn't the
2 same basis as the deterministic. Is that correct?

3 MEMBER ARMIJO: That is not what I heard.

4 MR. SALLMAN: The deterministic that you
5 are doing is as same as what is conservative labeled
6 here.

7 MR. WALLIS: Extreme values of everything?

8 MR. SALLMAN: Yes, the conservative input
9 values that were used.

10 MR. WALLIS: Well I can't believe that
11 they are on top of each other because the tails are so
12 spread out.

13 MR. SALLMAN: Which curve on the GE report
14 are you comparing with which curve? Can you read the
15 sheet number on that?

16 CHAIR SHACK: Page 20 and 21.

17 MR. LOBEL: We have the same trend for
18 pressure required but for conservative required and
19 realistic required, we have the same type of thing.
20 We are talking about NPSH.

21 MR. SALLMAN: So here is the CAP,
22 containment accident pressure required, which is being
23 calculated by back calculation starting from the NPSHR
24 required and how much wetwell pressure is required.
25 This is not the same calculation, this is not the same

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1 graph that you are talking about in sheet 20 of the GE
2 presentation.

3 If you want to see that comparison, I
4 think it is one of the slides in -- wetwell pressure
5 required which is on sheet numbered 69.

6 MEMBER ABDEL-KHALIK: If they were both on
7 the same scales, you would --

8 MR. SALLMAN: Okay here. This is the
9 required wetwell pressure, which has been calculated
10 by a back calculation starting from the required NPSH
11 and then going further up and --

12 MEMBER ABDEL-KHALIK: But look, the red
13 line and the blue line, they are on top of each other.
14 They are large scales. The red line and the blue
15 line. Okay? They are both available.

16 MR. SALLMAN: Right.

17 MEMBER ABDEL-KHALIK: Okay, this realistic
18 available is not the statistical calculation. This
19 realistic available was calculated based on the
20 nominal inputs which we discussed 100 percent power,
21 zero sigma to K heat, 90 degrees F, which is a
22 conservative service water temperature, and we used
23 the relative humidity, which was 40 percent instead of
24 100 percent. So those are the kind of realistic
25 numbers that were used in the realistic analysis and

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1 conservative analysis, the same input as in the GE
2 deterministic analysis.

3 MS. ABDULLAHI: Different code as well.

4 MR. SALLMAN: This is the same code.

5 MR. LOBEL: This one has the Monte Carlo
6 calculations on it, too, for pressure.

7 MR. WALLIS: I am a bit confused here
8 because your NPSHR is just a straight flat line,
9 whereas their NPSH required seems to be -- there is a
10 CAP required. It must be the same thing.

11 MR. SALLMAN: No, the NPSH required is a
12 straight line but the CAP is the wetwell pressure
13 required, which is -- going backwards you calculate --

14 MEMBER ARMIJO: It ought to be the same
15 curve. They look similar but they be offset
16 somewhere.

17 MR. SALLMAN: And we have in our
18 calculation the required --

19 This is showing the wetwell pressure
20 required. It assumes the effective value for the
21 conservative calculations, the effective value of the
22 required NPSH was used and we came up with this curve,
23 this red curve.

24 And the second realistic curve we came up
25 starting from the three percent required NPSH and we

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1 back calculated and came up with that realistic curve.

2 MEMBER ARMIJO: These were done with your
3 Gothic code. Right?

4 MR. SALLMAN: Yes. Yes.

5 MEMBER ARMIJO: And the Owners' Group was
6 done with SHEX. I am just eyeballing it but if you
7 plot them with the same semi-log scales and pressure
8 scales, taking into account that you had different
9 assumptions in the analyses, they don't look all that
10 different to me. That is what I am -- peaks are about
11 the same time. The magnitudes are about the same.

12 So maybe your independent analysis came up
13 with similar results.

14 MR. SALLMAN: Yes, we have a comparison
15 slide also between the two codes that will come, I
16 think in one or two slides here.

17 CHAIR SHACK: But still you had another
18 curve up here just a little bit ago, with the Monte
19 Carlo, the conservative, the realistic.

20 MR. SALLMAN: Yes, that was the same curve
21 but that included the statistical analysis also.

22 CHAIR SHACK: But again, the problem was
23 there that the Monte Carlo maximum was well above the
24 conservative, which would surprise.

25 MEMBER BROWN: Page 37.

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1 MR. SALLMAN: Is this the one you were
2 talking about?

3 CHAIR SHACK: No, in the backup.

4 MR. LOBEL: Sixty-nine. This one?

5 CHAIR SHACK: No, keep going.

6 MR. LOBEL: Seventy.

7 CHAIR SHACK: Yes, this one. I mean, I
8 can understand the way you guys do a realistic
9 calculation, why it comes out so close to the
10 conservative. I am a little surprised that the Monte
11 Carlo maximum is so different, is above the
12 conservative.

13 MR. SALLMAN: The reason can be because we
14 are trying to minimize the suppression pool
15 temperature but it doesn't have an effect of
16 minimizing the wetwell pressure simultaneously.

17 MEMBER ABDEL-KHALIK: You mean maximize?

18 MR. SALLMAN: No. I'm sorry. Maximizing
19 the suppression pool temperature. And at the same
20 time your parameters will not be able to bring the
21 wetwell pressure to a minimum value.

22 MR. LOBEL: When you do the calculation,
23 you try to minimize the pressure and maximize the
24 temperature. When you maximize the temperature, that
25 increases the vapor pressure above the water and you

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1 are also providing more heat to the non-condensable
2 gas to the nitrogen. So at the point of maximum
3 temperature, you don't have a minimum pressure, if you
4 follow what I am saying.

5 MEMBER ABDEL-KHALIK: I don't think you
6 are going to be able to explain your way through this
7 because it just doesn't make sense.

8 MR. LOBEL: Well I am trying to explain
9 why first of all the conservative pressure is above
10 the realistic pressure because the conservative is
11 maximizing the temperature. That is increasing the
12 pressure, the realistic pressure.

13 MEMBER ABDEL-KHALIK: All along you have
14 been telling us that you have been trying, that
15 conservative means that you are biasing the
16 calculation to give you high temperature and low
17 pressure.

18 MR. LOBEL: You try to do those two things
19 but you can't do them both at once. So the thing you
20 are doing based on sensitivity studies is you go to
21 the maximum temperature for the limiting NPSH. You
22 made assumptions that limit the pressure but it is not
23 going to be the minimum pressure because of what I was
24 saying because the vapor pressure is going to be
25 higher and because you are heating the nitrogen in the

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1 wetwell to a higher temperature.

2 You can't do both things. You can't have
3 minimum and maximum temperature at the same time.

4 CHAIR SHACK: Okay. So you are arguing
5 that this looks funny to us because we are just
6 looking at the wetwell pressure.

7 MR. LOBEL: Right.

8 CHAIR SHACK: And if we looked at the
9 temperature and we turned this into an NPSH plot, it
10 would look like what we think it is supposed to look
11 like.

12 MR. LOBEL: And that is another reason why
13 we are trying to emphasize using an NPSH rather than
14 looking at temperature and pressure, because you have
15 got to go through all this thinking when you look at
16 one or the other.

17 MEMBER BROWN: That is slide 37. That is
18 what I -- the one that has got the NPSH on it. Well,
19 that is consistent with what your through process was.

20 CHAIR SHACK: Right but these graphs begin
21 to look confusing, yes.

22 MR. WALLIS: Well, I still don't
23 understand the difference between what we saw this
24 morning and what you showed here. It seems to me that
25 how far you are from getting what you need has got to

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1 be showing up in both figures. And one of them is it
2 is four to six psi and on the other one it is nothing,
3 when you compare realistic with conservative or Monte
4 Carlo with conservative. I don't see how that can be.

5 CHAIR SHACK: Yes, that is difficult.

6 MR. SALLMAN: Which graph are you talking
7 about?

8 MR. WALLIS: Going back to this morning.
9 I mean, this morning they said that by using
10 essentially the message was, by using statistics
11 rather than conservative, you could buy yourself four
12 to six psi. Whereas, this message from your figures,
13 you don't buy anything. And it doesn't seem to make
14 sense. I can't follow through the reasons for the
15 difference.

16 MR. LOBEL: This is the statistical
17 minimum on your calculation? Okay.

18 CHAIR SHACK: In terms of pressure, we
19 should be looking at the minimum, right.

20 MR. WALLIS: But NPSH and pressure simply
21 translates by the density of water.

22 CHAIR SHACK: My mind is starting to warp.

23 MEMBER BANERJEE: We are moving at warped
24 speed.

25 CHAIR SHACK: No, the plot actually looks

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1 the way it is supposed to look. That is the problem.

2 MR. SALLMAN: Yes, this curve shows the
3 difference between the required, the realistic and the
4 conservative. And this is more or less what GE
5 Owners' Group had in their curve.

6 So if you want to see a sheet number 21 in
7 GE's presentation, that is the one we should compare
8 with this sheet number 39.

9 MR. DENNIG: NPSH in feet is not directly
10 comparable to psi.

11 MR. WALLIS: Their code is not realistic.
12 Their code is the 95/95.

13 MR. DENNIG: These are both BSI's here.

14 MEMBER BROWN: Sheet 21 is pressure, psi.
15 It doesn't say wetwell but it does say -- well, that
16 is what it is. According to the ledger, it is wetwell
17 pressure.

18 CHAIR SHACK: But if you go back to your
19 slide 70 or whatever it was, we should be comparing
20 the conservative with the Monte Carlo minimum, in
21 terms of pressure. We see the same benefit quote-
22 unquote, that GE seeks. If we are only looking at the
23 pressure.

24 MR. SALLMAN: Yes, these are all
25 available. They are not required. These are all

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1 available. You said this is actual wetwell pressure
2 developed --

3 CHAIR SHACK: Yes.

4 MS. ABDULLAHI: Can we take --

5 CHAIR SHACK: I think we just need to move
6 on here.

7 MS. ABDULLAHI: Can I ask for follow-up
8 item that they cut over and resolve these to --

9 MEMBER ARMIJO: Yes, put them on the same
10 scale. But I think you just eyeball them and you can
11 see they are similar. They are very similar. Peaks
12 are about the same point in time. The magnitudes are
13 about the same point in time. The differences between
14 the peaks are similar but you had different
15 assumptions within the analyses.

16 CHAIR SHACK: What we need are some
17 comparisons where we are comparing the same
18 quantities.

19 MEMBER ARMIJO: Yes, apples and apples.

20 CHAIR SHACK: If they are doing required,
21 you need a plot of required. If you are doing NPSH,
22 we need a plot of NPSH from them. But sitting here
23 trying to do these things back and forth in our head
24 just leads to confusion.

25 Lets get back on the track here.

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1 MR. LOBEL: Shall we do that for the full
2 committee?

3 CHAIR SHACK: I think so or else we are
4 going to have a disaster.

5 MR. LOBEL: Okay. This is the comparison
6 we were talking about of SHEX. This is the comparison
7 we were talking about of the GOTHIC code and SHEX for
8 the peak drywell pressure. SHEX gives a higher
9 pressure. Peak drywell gas temperature, atmosphere
10 temperature. SHEX gives a higher temperature. Oh,
11 yes, different accidents.

12 Like I was saying this morning, the peak
13 drywell atmosphere is calculated with a steam line
14 break and the peak drywell pressure is for a LOCA.

15 MR. WALLIS: Now this peak pressure is the
16 one that is calculated in order to see if the
17 containment will pop or not, isn't it?

18 MR. LOBEL: yes.

19 MR. WALLIS: It is the maximum.

20 MR. LOBEL: Yes.

21 MR. WALLIS: It is a completely different
22 thing from what we are talking about for --

23 MR. LOBEL: Completely different thing.
24 But the next two are the long-term suppression pool
25 temperature response. And the peak suppression pool

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1 temperature is higher for SHEX than for GOTHIC.

2 MEMBER RYAN: Just a dump guy question
3 here. Can you ascribe difference to 200 to 203? Is
4 that a big deal?

5 MR. LOBEL: No. It shows the trend of the
6 code. That is all.

7 MEMBER RYAN: But I am struggling with the
8 fact that if it is not statistically different, it is
9 the same number on all four of them coming down.

10 MR. LOBEL: Primarily speaking, it is the
11 same number.

12 MEMBER RYAN: Okay so the codes are
13 producing the same result within the certainty of the
14 code.

15 MR. LOBEL: Absolutely.

16 MEMBER RYAN: Okay.

17 MEMBER ARMIJO: Even though the inputs are
18 somewhat different.

19 MR. SALLMAN: No, these --

20 MEMBER ARMIJO: These are all the Monte
21 Carlo with the same --

22 MR. SALLMAN: No, these are all same
23 inputs, more or less the same inputs. I am not sure.
24 There maybe slight difference. But we try to use the
25 same inputs but the two codes are different. The

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1 codes are different.

2 MEMBER ARMIJO: Yes, I understand that.

3 MR. WALLIS: I am not sure that this is a
4 true statement. I mean a few degrees Fahrenheit in a
5 suppression pool temperature makes a significant
6 difference to the heat required for NPSH, doesn't it?
7 Because the vapor pressure is quite sensitive to
8 temperature when you get up to about 200.

9 So you can't just look at the number to be
10 a few degrees more suppression pool temperature. It
11 shows up on --

12 CHAIR SHACK: But the SHEX is on the high
13 side.

14 MEMBER RYAN: And that may well be but I
15 am trying to understand if this is really one number
16 different from another or it is within the uncertainty
17 of all the inputs. I mean, you have got to propagate
18 error through the calculation and know whether they
19 are different.

20 MR. LOBEL: But these numbers, there is no
21 propagation of errors or uncertainties or anything.
22 These are just putting single numbers in the input for
23 two different computer codes and it is just showing
24 the difference between the computer codes. And there
25 is some bias to SHEX because it is biased that way.

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1 But like you are saying, you can also see
2 that it is not a huge effect. The codes are pretty
3 much calculating the same thing and they have pretty
4 much the same trends.

5 MR. DENNIG: This is just trying to
6 isolate on the code per se with this modeling effect
7 and not deal with all of the uncertainties in the
8 analysis. The only parameter that is changing in the
9 test is the name of the code. Everything else is
10 supposed to be the same.

11 MR. LOBEL: If I were the reviewer and I
12 had the SHEX number and I did a copy calculation and I
13 compared these numbers and I looked at the trends, I
14 would probably say just what you were saying that for
15 all practical purposes, they are the same number and
16 there are some minor differences in the codes.

17 If the numbers were much bigger than this,
18 then I would start to question what the difference and
19 try to figure out what the difference is.

20 MEMBER RYAN: I understand the
21 phenomenological but you know, I am still struggling
22 with the fact that you are trying to predict reality
23 and you have got two numbers that are relatively close
24 together and I appreciate Dr. Wallis' point that if
25 that is a real difference, it could have an important

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1 impact on vapor pressure and so forth.

2 But that is notwithstanding the fact that
3 are these calculationally different or not. I mean,
4 you only have a fancy calculation with a round-off
5 error and a system error in here. Right? I mean, it
6 is just not clear what you are telling us.

7 MR. LOBEL: I am telling you that the SHEX
8 is biased to be conservative for these parameters and
9 GOTHIC we try -- GOTHIC is trying to be a best
10 estimate code in the sense that it has physical models
11 in it, not empirical correlations that are biased to
12 predict a bias overestimate or underestimate of a
13 result.

14 So the codes have different purposes in a
15 way and I am just comparing the two results. One that
16 we got from a licensee calculation SHEX and one that
17 we did ourselves.

18 I don't think we are disagreeing that
19 much. Like I say, if the difference was much more
20 than this, then we would be in the mode of trying to
21 figure out what that difference was and going through
22 all the different models and looking at things model
23 by model to see what difference things made.

24 But this is close enough that we wouldn't
25 bother doing that in this case. The other thing we

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1 would look at, like I was saying also is the trend.
2 As long as the curves have the same shape, that would
3 be another indication that things were okay. If for a
4 reason in one place one curve went up and one curve
5 went down, no matter what the peak was, we would be
6 looking at that too.

7 MR. WALLIS: With this NPSH calculation,
8 you have got the various heads of water and so on
9 which don't change. You have got the pressure drop in
10 the pipe that doesn't change very much. The big actor
11 is the suppression pool temperature. That is the one
12 that is different.

13 MR. LOBEL: Yes.

14 MR. WALLIS: When they get 15 degrees
15 temperature difference this morning, in suppression
16 pool temperature, this showed up as something like six
17 psi difference in the required CAP. So a few degrees
18 difference in the pool temperature could have a
19 significant effect on CAP.

20 MR. LOBEL: Absolutely, yes.

21 MR. WALLIS: So basically they are all the
22 same because they are four degrees different. That
23 may be worth two or three psi or whatever.

24 MR. LOBEL: Yes, you are right. That is
25 the significant effect and that is why you try to

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1 maximize the suppression pool temperature.

2 MR. WALLIS: This is a one-to-one
3 correspondence really. I mean, you have changed the
4 suppression pool temperature. You have changed the
5 required CAP. They are directly proportional really
6 in terms of the vapor pressure.

7 Anyway, it has got to all hang together
8 somehow logically. I would think that is a
9 significant difference.

10 MR. LOBEL: In terms of the effect on
11 NPSH, yes, it would be at that temperature.

12 MR. WALLIS: Because it has a effect on
13 the required CAP, yes.

14 MR. LOBEL: Yes, at that temperature, the
15 vapor pressure would be much different. So by the way
16 --

17 MR. WALLIS: I don't think the message can
18 be that the codes are predicting about the same value
19 and, therefore, it is okay.

20 MR. LOBEL: Well, I am talking about the
21 temperature. Again, that is why we are trying to
22 concentrate on the available for these calculations
23 for the containment accident pressure calculations.
24 We are trying to use available as the figure of merit,
25 so to speak. The thing we want to concentrate on

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1 because that is what the pump sees and the pump is the
2 thing we are worried about in these calculations and
3 the available also combines the pressures and the
4 temperatures and friction factors and all that stuff
5 into one calculation.

6 MR. WALLIS: But the way you calculate
7 available is influenced by the temperature of the
8 suppression coolant, isn't it? The available NPSH is
9 influence by the fact that the temperature --

10 MR. LOBEL: Yes.

11 MR. WALLIS: So the suppression coolant
12 temperature is different by four degrees and that
13 shows up as whatever it is.

14 CHAIR SHACK: You sound like we are in
15 agreement, Graham.

16 MR. WALLIS: Well, I know, but that means
17 that I am disagreeing again with their figure 37,
18 which shows the --

19 MEMBER ABDEL-KHALIK: The vapor pressure
20 at 200 degrees is 11.5 psi. The vapor pressure at 204
21 degrees F is 12.5 psi. So the difference is one psi.

22 MR. WALLIS: That is two feet of water.

23 MEMBER ABDEL-KHALIK: Right.

24 MR. LOBEL: Actually, what you are point
25 out is one of the reasons why we don't normally give

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1 credit for the decrease in required NPSH with
2 temperature because just a little difference in the
3 temperature values makes a large difference in the
4 vapor pressure. And so whatever you are gaining in
5 required NPSH, you could be losing in margin because
6 of the uncertainty in the temperature because the
7 vapor pressure changes so much more with temperature.
8 So that is another reason to just not allow credit for
9 an increase in temperature giving you a decrease in
10 required NPSH.

11 Anyway, that concludes what I had to say.
12 We will have an answer for the difference sin the
13 numbers when we come back from the full committee.
14 And thank you for your time and your interest.

15 CHAIR SHACK: Okay, just a question. When
16 you come to the full committee, I assume you are
17 expecting a letter, even though this is a work in
18 progress.

19 MR. RULAND: Say again? I'm sorry.

20 CHAIR SHACK: Even though this is a work
21 in progress, you --

22 MR. RULAND: That is correct. We are
23 looking for feedback from the committee.

24 CHAIR SHACK: Okay.

25 MR. RULAND: And the advantage of a letter

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1 is that it is written down and the staff can examine
2 it. But it is ultimately the feedback from the
3 committee that we are looking for. A letter, in my
4 mind, is preferable. But if there some other way you
5 want to give us some background, we are open to that,
6 to but it is a letter we are looking for.

7 CHAIR SHACK: Okay. Any more questions
8 for Mr. Lobel at this point?

9 MEMBER ABDEL-KHALIK: Would there be a
10 separate letter on the Owners' Group topical report
11 versus the letter on the staff methodology?

12 MR. LOBEL: I believe we were giving the
13 presentation on the topical report just because we
14 committed to do that. I don't think we were asking
15 for ACRS approval for the topical report. I don't
16 believe that is a usual thing but we invite your
17 comments.

18 MEMBER ABDEL-KHALIK: We can decide that,
19 I guess independently. So the presentation for the
20 full committee will be what? Both the topical report
21 and the staff methodology?

22 MS. ABDULLAHI: It is scheduled.

23 MEMBER ABDEL-KHALIK: Both?

24 MS. ABDULLAHI: It is scheduled right now
25 that both of them are being reviewed and the letter

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1 will cover both of them.

2 MEMBER ABDEL-KHALIK: Okay.

3 MS. ABDULLAHI: Whether they coupled or
4 not.

5 MEMBER RAY: You say it is scheduled and
6 it sounds like a policy decision.

7 MEMBER ABDEL-KHALIK: That is a decision
8 we have to make. Right now we have enough time, I
9 guess. We have three hours scheduled for that
10 presentation.

11 MR. HACKETT: That is exactly what I was
12 going to say. This is Ed Hackett. I don't know if
13 the mike is working.

14 Basically, that is the decision of the
15 ACRS members to decide. And they may be merit to
16 separating the two out and may be merit to considering
17 them both at the same time but that is really mutuals.

18 MEMBER RAY: Well, we are not hearing a
19 request for a letter on the topical report, if I am
20 hearing correctly. That is what I said about good.

21 MEMBER BROWN: Well the critical end
22 result is the guidance that the staff wants to give.
23 The topical report is fundamentally a reference
24 document or a base document from which to draw their
25 recommendations.

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1 MR. DENNIG: Yes, that is exactly what it
2 is. And basically, we are looking for proof of
3 concept. Is this on the right track? Are we close?
4 Does this begin to address or address to any
5 particular degree concerns? And have we gotten closer
6 to achieving this, resolving this with the ACRS?

7 CHAIR SHACK: Well you know, one of the
8 key points is the containment integrity. You know, if
9 we just looked at this summary, you know, we had the
10 containment integrity. I think we had an excellent
11 presentation today on internal events. And the
12 question is whether we can conclude from that and if
13 there is any more insight or discussion that we could
14 have on that as to how applicable that conclusion is
15 we extend it to consider external events like fire and
16 seismic. Because this independence of the barriers is
17 fundamentally a question of just how strongly you
18 believe that you have accounted for all possible
19 losses of containment integrity.

20 And you know, perhaps if we were only
21 concerned about internal events, we might get one
22 answer. If were considering a broader range of
23 initiators, we might get another answer. But I think
24 that would be a critical topic in the overall concept
25 that will need to be discussed.

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1 MEMBER BROWN: Well shouldn't they address
2 that in the full committee?

3 CHAIR SHACK: Yes.

4 MEMBER BROWN: So we should have some idea
5 of what external events normally would be legitimately
6 considered in terms of the overall evaluation of the
7 plants, shouldn't it? Appendix K fires, seismic, and
8 what else?

9 MEMBER RAY: Well, I mean I think he said
10 clearly that they are not prepared to do that.

11 MEMBER BROWN: I know that is what I
12 heard. But I mean, the full committee, I would
13 imagine, would have some answers to your --

14 CHAIR SHACK: I don't think they will give
15 answers at the full committee.

16 MR. LOBEL: I think we can address it
17 deterministically but I am not sure that is what you
18 are asking. You want more than just a deterministic.
19 Here is the inspections we do and here is what it is
20 designed for and that kind of thing. Right?

21 CHAIR SHACK: I mean, that would be one
22 way to make the argument that there is enough margin
23 there that even if we can't quantify it very well, you
24 know, we are talking about something that is operating
25 at design basis conditions, by and large. You know,

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1 we are not out on Level 2, things like that. Whatever
2 argument you want to make but I think that is the
3 fundamental difference up to date has been that we are
4 not ready to assume that containment integrity is a
5 given and, therefore, we have been unhappy with the
6 use of containment accident over pressure. You know,
7 I mean, I think the containment accident pressure.

8 The guidelines that you have developed, I
9 think certainly think quantifying the uncertainties in
10 the NPSH required. That was one of our problems. I
11 think it is helpful to have both the realistic and the
12 conservative NPS, although I think we need a better
13 definition of what realistic is.

14 And I don't think that you can really
15 quantify these margins without doing something like
16 the statistical analysis. But that is, again, my
17 opinion but you might want to think about that as just
18 an off-the-top kind of thing.

19 MR. LOBEL: Yes, I think to quantify the
20 margins, I think you are probably right for the
21 available. I don't know how else you could do it.

22 CHAIR SHACK: And I think it is a very
23 interesting concept with looking at the integrity of
24 the seal and the maximum erosion rate. But again,
25 whether that is ready for primetime is not clear but I

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1 think there are certainly concepts that need to be
2 considered and should be discussed. You know, they
3 have to be addressed either as part of the regulations
4 or finding more data to make them go away.

5 MR. LOBEL: I think we agree with that.

6 MEMBER ARMIJO: It is a lot of material to
7 cover in three hours, including the risk.

8 MEMBER ABDEL-KHALIK: It is in the
9 afternoon. If we have to stay later, we will stay
10 later. It is from 1:00 to 4:00 p.m. Is that correct?

11 CHAIR SHACK: Well, I guess the question
12 is whether we want to do all the three hours on the
13 guidance and not do the topical report.

14 MS. ABDULLAHI: And how do you define the
15 margins?

16 CHAIR SHACK: Well, we are still working
17 on this.

18 Is there any feeling, any contribution?
19 How would the committee think we ought to proceed with
20 the full committee presentation?

21 MEMBER RAY: I thought the guidance as
22 presented by the staff was self-contained. I didn't
23 see that it required the topical. I am only trying to
24 make it so we can grapple with this thing in a
25 practical way. It is not that I think we shouldn't

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1 write a letter about the topical of we are asked to do
2 so or if we feel a need to do so. But it is an awful
3 lot to get shoehorned into here even with a long day.

4 MEMBER ABDEL-KHALIK: Will the staff
5 evaluate this topical report with this guidance in
6 mind?

7 MR. LOBEL: The idea was to put the
8 topical -- the topical report has been around for a
9 long time to just finalize the SER after we have
10 talked with you and put it out with the understanding
11 and I think the Owners' Group agrees that after this
12 guidance is finalized, that there will be a supplement
13 to the topical report.

14 MEMBER ARMIJO: What is the urgency? I
15 don't see anything with a topical report.

16 MR. DENNIG: Excuse me. It was not our
17 intention to focus on the topical report. We are
18 interested in the feedback on the guidance.

19 MEMBER ABDEL-KHALIK: But if you approve
20 the topical report, you are essentially giving people
21 license to follow that methodology. And if you are
22 going to come back with another guidance that
23 contradicts that, then they --

24 MR. DENNIG: The reason why we did not
25 issue a final SE on the topical report was precisely

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1 because we did not want to prejudge what we were going
2 to hear from the industry and from you.

3 MEMBER ARMIJO: I think you should stay on
4 that same track, then.

5 MR. DENNIG: You know, take it off the
6 table and say we are done with the methodology now
7 let's talk about some new guidelines. No, the idea is
8 this is one package. But we started the dialogue with
9 the topical and we have evolved to the guidance and we
10 have incorporated what we learned in the topical into
11 the guidance.

12 MEMBER ABDEL-KHALIK: I would feel very
13 comfortable if we proceed with evaluating the guidance
14 and then you look at the topical, in light of whatever
15 guidance we agree on, rather than --

16 MR. DENNIG: Right. We certainly we would
17 not tell licensees that they could do something that
18 was at odds with the guidance that we give them.

19 MEMBER ABDEL-KHALIK: So if that is the
20 case then we ought to focus the presentation on the
21 guidance, because they will evaluate the topical, you
22 know, based on whatever.

23 MEMBER BANERJEE: And I think we should
24 wait for the SE. SER, whatever.

25 MR. DENNIG: Well our SE will be informed

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1 by the guidelines. It is going to float back. We are
2 basically going to say the topical will have to be
3 adjusted to be in line with these guidelines. And
4 that will be the SE.

5 MEMBER BANERJEE: Well if it conforms, of
6 course, there is nothing to discuss. I mean, if they
7 come up with some new idea, that is different.

8 Suppose they conform to your guidelines
9 but they have some, you know, different way to do
10 something? It is possible.

11 MR. LOBEL: That is why this is just a
12 draft and in the meeting we had, we kept saying that
13 we got the question and we kept answering that we are
14 open to suggestions. We are open to changes. We want
15 more data. We want more documents. And they have
16 given us comments and we are hoping for more data now.
17 And we haven't talked to the PWR Owners' Group yet.
18 So there is still a lot of work to do before we have
19 final guidance.

20 MEMBER ABDEL-KHALIK: But right now on the
21 face of it, there appears to be a very large
22 difference between the topical report and whatever
23 proposed guidance you have.

24 MR. LOBEL: Yes.

25 MEMBER ABDEL-KHALIK: And therefore, if

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1 the ultimate goal is to have a topical report approved
2 that meets whatever final guidance you provide, then
3 it would seem logical that we proceed with the
4 evaluation of the guidance and wait on a decision as
5 to whether or not ACRS decides to review the topical
6 report when that topical report is revised to be
7 consistent with the guidance.

8 CHAIR SHACK: Mario, Charlie, have you got
9 opinions?

10 MEMBER BONACA: Well, you know, in general
11 I agree with what you said as a path forward. I think
12 there was a lot of progress with respect to the
13 previous times that we talked to each other. I think
14 that we are working out some solution here. There is
15 a lot of material information that can be used to
16 achieve some kind of agreement.

17 CHAIR SHACK: Should the full committee
18 discussion be focused on the guidance?

19 MEMBER BONACA: Yes.

20 MEMBER RYAN: I agree with Said in
21 summary.

22 MEMBER BROWN: You passed me by. Can I
23 make my observations?

24 CHAIR SHACK: Well you nodded, Charlie.

25 MEMBER BROWN: Well okay, I was deferring

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1 to Mario, since he was to my right.

2 I agree with the guidance part. We are
3 focused on that. I would not deal with the topical
4 report at all. That is my opinion.

5 Number two, after listening to all the
6 discussions on conservative, realistic, min, max,
7 blah, blah, blah, which parameters are where, that is
8 a total, I lost track of them. And it would be useful
9 to have a table for whatever their evaluation is that
10 says okay, here is the Monte Carlo max, here is the
11 Monte Carlo realistic, here is the Monte Carlo min.
12 Here is the deterministic and list the parameters that
13 are involved and say, what are they, just a table that
14 goes across where you say which ones are held, you
15 know, which are important, which are held. Because
16 they say some of them are conservative and some of
17 them aren't, when they start deviating. I couldn't
18 keep track of what was what from one evaluation to the
19 other.

20 So I don't know how hard that is. Maybe
21 that is an impossible task.

22 MR. RULAND: We'll do it.

23 MEMBER BROWN: With the analysis, you
24 ought to be able to do that.

25 MR. RULAND: We will do it.

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1 MR. DENNIG: It is one of those things
2 where we have been working with it so long we
3 understand what happened without having to write it
4 down. But it is clear that the language that is used
5 has got to be straightened out and you have to see
6 exactly what is going on from case to case in terms of
7 what is changing.

8 MEMBER BROWN: One of my major concerns is
9 there are obviously some parameters, as I expressed
10 earlier in the meeting, that ought to be constant
11 across the board and other ones that are random can be
12 treated randomly. Now whether that is right or wrong
13 from the standpoint of these types of analyses I don't
14 know.

15 MR. SALLMAN: We have the list but we did
16 not put it together in this meeting, I guess.

17 MR. RULAND: The burden is on us to
18 clarify this.

19 CHAIR SHACK: And figure 37 again, which
20 started a lot of this discussion, I mean, it would
21 help if you could explain why the minimum and the
22 conservative are so close to each other, which seems
23 like a somewhat surprising result.

24 And given the way that you have described
25 how you have done the realistic, I am a little

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1 surprised it is so close to the mean, since that is
2 supposed to be a bounding scenario with some parameter
3 evaluation to account for uncertainties. It just
4 seems funny.

5 MEMBER BROWN: The difference between
6 uncertainties and a parameter value is that you have
7 got uncertainties in the parameter values but there
8 are some parameters that ought to be, we ought to know
9 how they are handled as parameters and then the
10 uncertainty comes on top.

11 MEMBER RYAN: I will give you something
12 that catches my eye. You have got 26.62 feet on the
13 calculation of NPSHR effective. NPSHR three percent
14 is 22 feet. You are claiming two extra digits of
15 precision. You know, I want to know is that real or
16 not real. What are we doing here?

17 MR. DENNIG: You are right.

18 MEMBER BANERJEE: I think Bill's point is
19 good that you know, this looks like it is too much of
20 a coincidence or if it is real, then there must be a
21 good physical reason for it. And therefore, that
22 should be explained.

23 MEMBER RYAN: Exactly.

24 MEMBER BANERJEE: And I think there
25 probably is a good reason for it that it is looking

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1 like that.

2 MEMBER RYAN: The last item is a little
3 surprising.

4 MEMBER BANERJEE: So let's understand why
5 it is.

6 MEMBER BROWN: The last item that I had in
7 my mind was the containment. You brought it up, was
8 the containment integrity thing. That is assuming
9 that it is going to be maintained all the time is that
10 is a tough one to come through.

11 MEMBER ARMIJO: And that you have got
12 plenty of margin.

13 MEMBER BROWN: Exactly. I mean, that just
14 has to be the mental level that I come from.

15 MR. LOBEL: Well when you say containment
16 margin, what do you mean?

17 MEMBER ARMIJO: Providing all the pressure
18 we need for the pumps to work that we somehow don't
19 forget that there is a containment there, we don't do
20 something that could damage it.

21 MR. LOBEL: Okay.

22 MEMBER ARMIJO: And that is really --

23 MR. LOBEL: Okay. You don't mean above
24 design?

25 MEMBER ARMIJO: No, no, no.

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1 MEMBER BROWN: But the other issue, I
2 mean, if somebody turns off spray or stops a pump, I
3 am always concerned can you really restart it or is
4 there something else that becomes overriding that you
5 can't restart that if you have to?

6 And I don't, I mean is there some plant
7 condition, some temperature scenario which does not
8 allow them to re-establish a flow or to re-establish a
9 story or whatever? I just don't know.

10 MEMBER RAY: Were you asking a broader
11 question of the reliance placed on operator action?

12 MEMBER BROWN: Part of that, yes.

13 MEMBER RAY: I have an unresolved issue in
14 my own mind, nothing some thing I --

15 MEMBER BROWN: No, I agree. You raised it
16 before. I agree with that. Containment integrity,
17 operator actions, and then the consequence of operator
18 actions. Can the systems be re-engaged, if necessary?
19 Because the pressure or the temperature conditions in
20 the plant don't now prevent them. Sometimes some
21 systems, once you start them and they are running, you
22 have primed the pump. It is going. You turn it off,
23 you can't get it going again. Now whether it is
24 applicable or not, I have no idea.

25 MR. RULAND: So my interpretation of what

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1 you are saying is we need to be able to explain to you
2 the types of human factors reviews for situations like
3 this. What the review criteria is and what we are
4 looking for.

5 MEMBER BROWN: Well the system is would go
6 along with that.

7 MR. RULAND: I understand.

8 CHAIR SHACK: Graham?

9 MR. WALLIS: Well, I am not going to say
10 what the committee should do but it seems to me that
11 focusing on the guidance makes sense. But if I were
12 to focus on the guidance with this kind of a figure, I
13 couldn't take out of my mind the Boiling Water Rector
14 Owners' Group made a presentation. They showed us
15 that we could gain eight feet in available head by
16 using the statistical method, rather than the
17 conservative. This seems to show that there is no
18 gain and I can't accept a figure from the staff
19 knowing that the Owners' Group predicts something
20 quite different. So I can't put out of my mind what
21 the Owners' Group told me and just focus only on the
22 guidance. I think in principal what I see for the
23 guidance looks good but the details really need to be
24 sorted out.

25 CHAIR SHACK: I think that is sort of part

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1 of what we were talking about here is that we need to
2 resolve all these inconsistencies, at least apparent
3 inconsistencies.

4 MR. WALLIS: Are not going to take into
5 account anything from the BWR Owners' Group
6 presentation?

7 MEMBER BANERJEE: But that is the mean,
8 right?

9 MR. WALLIS: No, no. This is the extreme.
10 This is I understand this is the 95/95.

11 MEMBER ARMIJO: Those things are
12 consistent. No, no. I have looked at their curves
13 and those curves. They are consistent.

14 MR. WALLIS: No, they are not.

15 CHAIR SHACK: Curves go up and down.

16 There are too many discussions.

17 MR. DENNIG: I think we will just take on
18 some explanation as to why the curves look different.
19 We will provide that.

20 CHAIR SHACK: Yes I mean, we need to
21 understand whether there really is a significant
22 difference between the staff's statistical
23 calculations. We could all maybe agree on the words.
24 Conservative is the same as deterministic and make
25 sure we are in the same space. Mike?

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1 MR. WALLIS: It is very embarrassing if
2 you approve a guidance which says that the
3 conservative and statistical comes about the same
4 answers so it doesn't matter what they do. And then a
5 plant comes in with a request which shows that they
6 differ considerably. That would be embarrassing.

7 MEMBER ARMIJO: Yes, this is one example.

8 MEMBER ABDEL-KHALIK: First, I would like
9 to sort of acknowledge Marty's presentation. I
10 thought that was very enlightening. Thank you. It
11 was very helpful.

12 And I think despite the sort of concerns
13 about fire and seismic effects and impact on
14 containment integrity I think sort of addresses at
15 least a big chunk of the question.

16 The second thing is, you know, we need to
17 when we sort of evaluate justification for allowing
18 containment accident pressure versus design changes
19 with the practicability of the changes, I think we
20 should keep in mind the potential conflict between
21 GDC-35 and GDC-38. You don't want to sort of say we
22 are going to keep one and sort of forget about the
23 other. Somehow we have to be able to keep both of
24 these in mind.

25 The third point, of course, is what came

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1 up here is that we need to explain or resolve the
2 differences and define the terminology in whatever
3 calculations you will present. And then finally, and
4 this is just a suggestion that you might want to look
5 at the implications of requiring this ratio of NPSH
6 available divided by NPSH required effective is set
7 above this zone of maximum erosion. What would be the
8 implication of setting that requirement?

9 I know that my colleagues may not agree
10 with that, inasmuch as that would provide a minimum
11 margin but at least I would like the thought process
12 to begin as to what the implications of that might be.

13 CHAIR SHACK: Same?

14 MEMBER ARMIJO: Yes, I think we covered
15 this. Stick with the guidance. Don't mess with the
16 Owners' Group stuff. There is no urgency to it and it
17 is out of sequence anyway and there is so much to
18 cover.

19 I think Marty's presentation was very
20 helpful to me. It all hinges on the risk. If you
21 really believe that the risk change is trivial, it is
22 kind of hard to say you shouldn't do it. But there is
23 this fire. There is the seismic. Our concern about
24 people doing things that is counterintuitive about
25 systems that are there to protect the containment.

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1 So you know, that is what I would
2 emphasize. I think when it is all over, I agree with
3 Rich and Ahsan that these are, the Owners' Group stuff
4 and the work that they did looks to me like it is very
5 consistent. It is not identical.

6 But anyway, if you could plot everything
7 on the same scale when you get to that point, I think
8 everything will sort itself out. That is all I have.

9 CHAIR SHACK: Harold.

10 MEMBER RAY: I have said a lot. I will
11 try and keep it very brief. I agree with I think
12 everything I have heard up until now.

13 I am concerned that we become so focused
14 on things that we can measure and calculate and set
15 aside the things we can't that we ignore the real
16 issues that we are here to maintain focus on. And
17 obviously I am talking about external events in this
18 case.

19 But also maybe about whether there is
20 implications here for what we are doing from a process
21 standpoint that are broader. I won't say anymore
22 about that now because I need to think about it some
23 more. That is all I have.

24 MEMBER BANERJEE: Well I think I agree
25 with all the things that people have said so I won't

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1 repeat them but I will say a couple of things.

2 One is, I found Marty's presentation
3 interesting but I would like to see uncertainties
4 because I don't know how large they are. And once you
5 do that, that will make me feel more comfortable.

6 The second thing is we have been making a
7 general push in the ACRS to modernize computational
8 methods. And you have seen that previously with
9 reactor physics methods and a lot of other things.

10 I think something of that nature, perhaps,
11 needs to be taken into consideration here because we
12 are talking about something like SHEX. Whereas the
13 vendor in this case, GEH, has TRACG available to it,
14 which with a little bit of work could be made to work
15 for containment. If it is not already. I mean, I am
16 sure GE is already working on it.

17 I would like to see the staff of
18 modernization somehow being considered by us and I
19 don't know how it can be reflected in the guidelines
20 but I think, you know, people say it is good enough.

21 Well donkeys were good enough for
22 transportation, too. They still are but we have cars.
23 Otherwise, New York City or wherever they use horses
24 would be drowning in, you know.

25 (Laughter.)

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1 MEMBER BANERJEE: So, I think there is a
2 case to be made here that we should try to move
3 forward and try to urge people to do that. And when
4 you do that, then you get rid of a lot of these sort
5 of gray areas that you are talking about. You know,
6 we don't have any sort of quantification of model
7 uncertainties here.

8 I don't know most of the time whether they
9 have got a condensation coefficient or a heat transfer
10 coefficient. I have no idea what is going on in these
11 quotes. So just blessing them is nothing I feel
12 comfortable about, even though they are within a few
13 degrees and using some other code. There has been no
14 very detailed justification for best estimate or
15 something like that that we have seen. So that is
16 concerning me overall.

17 I think that is about it.

18 CHAIR SHACK: Jack?

19 MEMBER SIEBER: I think the presentations
20 were very good and I think a lot of work has been
21 done. And I think the staff has gone the extra mile
22 to make things understandable to us where we aren't
23 going to attack them ferociously on everything they
24 say. So I congratulate the staff for the work and the
25 effort that they have done to put it all together.

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1 I basically agree with what the other
2 members have said. On the other hand back in the back
3 of my mind still is the independence of barriers. And
4 I note that there is a number of PWRs involved. I
5 think all of those are sub-atmospheric plants.

6 MR. LOBEL: No. There are some large drys
7 and the rest are sub-atmospheric.

8 MEMBER SIEBER: Okay. But perhaps the
9 independence with barriers has been given away a long
10 time. On the other hand, every time that we approach
11 that I think we ought to think very carefully about it
12 because it sort of makes a way at one of the basic
13 tenants of the design and safety philosophy for these
14 plants. And somehow it bothers me. On the other
15 hand, I am not sure it bothers me enough that I would
16 veto the legitimate need for consideration such as are
17 being proposed right now.

18 So I would like to thank the staff very
19 much.

20 MR. WALLIS: Can I ask a question now? I
21 am supposed to write a report for the committee. Now
22 is all I have to go on for the guidance this
23 presentation? Is there nothing else?

24 CHAIR SHACK: No, there is a guidance
25 document you should have gotten.

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1 MS. ABDULLAHI: It will be in the CD.
2
3 MR. WALLIS: I haven't got a CD. I never
got a CD.

4 MS. ABDULLAHI: Yes, but I just mailed you
5 the stuff.

6 MR. WALLIS: Well, I don't think you sent
7 me your guidance document. What does this have to do
8 with the BWR and the staff evaluation of that?

9 CHAIR SHACK: Well at any rate, we will
10 get it to you.

11 MR. WALLIS: There is a document.

12 CHAIR SHACK: There is a document and we
13 will get it to you.

14 MR. WALLIS: Get it to me today?

15 MS. ABDULLAHI: Five seconds.

16 CHAIR SHACK: If you have got a stick, I
17 will give it to you now or do you want a paper copy?

18 MR. WALLIS: No, I can take a CD but I
19 just don't think I have --

20 CHAIR SHACK: Any other comments?

21 MEMBER ABDEL-KHALIK: I would really like
22 to add my comments to those expressed by my colleagues
23 here. The staff has done a lot of work and they
24 should be complimented for their effort.

25 MEMBER RYAN: Here here.

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1 MR. RULAND: Thank you.

2 CHAIR SHACK: Again then thank the staff.

3 Thank the Owners' Group for their presentation and I
4 think we will probably have some more interesting
5 discussion shortly.

6 (Whereupon, at 4:57 p.m., the foregoing proceeding was
7 adjourned.)

8

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BWROG Containment Accident Pressure LTR

**Alan Wojchouski
Xcel Energy
BWROG CAP Committee Chair**

**ACRS Subcommittee on
Power Uprates
April 23, 2010**



HITACHI

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Purpose of Presentation

Provide overview of the Licensing Topical Report

- Provides the deterministic method to calculate NPSHa and a statistical method to demonstrate margin inherent in the deterministic methodology

Brief History

2005 – NRC request for BWROG participation

2/8/2008 - BWROG presentation to ACRS on draft LTR

2/15/2008 – LTR submittal

11/20/2008 – RAIs

3/20/2009 – RAI responses

9/29/2009 – Draft SE

10/27/2009 – Comments on draft SE

3/22/2010 - Revised draft SE

LTR Overview

The LTR addresses the following key areas:

- Overview of NPSH evaluation (Section 2.0)
- Available NPSH evaluation of DBA-LOCA (Section 3.0)
- NPSH consideration for Special Events (Section 4.0)
- The safety basis for requesting CAP (Section 5.0)
- The proposed licensing basis methodology for NPSH (Section 6.0)
- Elements of a license amendment request for CAP (Section 7.0)

BWR Mark I Containment



Methodology

Deterministically calculate NPSHa without CAP

- Conservative assumptions for DBA LOCA and nominal assumptions for special events
- Determine wetwell pressure comparing NPSHa to NPSHr

Statistically evaluate NPSHa without CAP if NPSHa lower than NPSHr

- Provides realistic evaluation of the event in support of CAP request based on the deterministic calculations

Use alternative methods if NPSHa with CAP is lower than NPSHr when evaluated statistically

NPSH Overview

$$NPSHa = [H_{ww}] + [H_{pl}]$$

$$= [(P_{ww} - P_v) \times 144/\rho_w] + [H_{pool} - H_{pump} - H_{loss}]$$

Where: H_{ww} Based on containment analysis results

H_{pl} Calculated by utility using plant-specific input

P_{ww} Wetwell airspace pressure (psia)

P_v Saturation vapor pressure at suppression pool temperature (psia)

ρ_w Density of suppression pool water (lbm/ft³)

H_{pool} Elevation of suppression pool surface (ft)

H_{pump} Elevation of pump suction (ft)

H_{loss} Suction strainer and suction line losses from suppression pool to pump (ft)

Deterministic Approach

Traditional conservative analysis performed

- Conservative assumptions and input values
 - Bounding values for containment initial conditions
- Resulting pool temperature response is maximized and the available head response is minimized

This approach will give a conservative assessment of NPSHa

Statistical Approach

Takes credit for variabilities in the analysis input values

The order statistics method is employed

- Input variabilities are defined statistically and combined through a Monte Carlo process
- 59 random draws are made from the corresponding probability distributions. Containment pressure and temperature time-histories are calculated for the 59 cases

Allows for calculating more realistic NPSHa values, which can be used to quantify the conservatism in the deterministic analysis

Statistical and Deterministic Approaches Compared

Deterministic approach: Uses either the maximum or the minimum value for each input parameter

- Depends upon which direction is conservative

Statistical approach:

- Input parameters that can be statistically defined are identified and will not necessarily be at their extreme (maximum or minimum) values at the same time
- Remaining inputs are identical to the deterministic approach

Statistical Approach

For the example plant, the following input parameters were statistically defined:

- Initial reactor power
- Decay heat value after reactor SCRAM
- Initial suppression pool temperature
- Service water (ultimate heat sink) temperature
- Initial suppression pool volume
- Initial drywell temperature
- RHR heat exchanger heat removal capability
- Initial drywell pressure
- Initial wetwell pressure
- Initial containment leakage rate

Statistical Approach

Combine variations in the input parameters through a Monte Carlo process consistent with approved TRACG AOO

- Random draws are made from the corresponding probability distributions in order to determine input values
- Calculation of the containment response with one set of randomly drawn input values represents one trial in the statistical process
- At least 59 trials (calculations) are made to obtain statistically meaningful results at 95%-probability and 95%-confidence (95/95) level consistent with the order statistics method

Statistical Approach

Perform plant-specific containment analysis to determine the following outputs:

- Pool temperature
- Wetwell airspace pressure (P_{ww})
- Pool volume (H_{pool})

Based on these outputs, calculate the value of H_{ww} as a function of time for each of the 59 trials (calculations)

- Obtain the minimum values of H_{ww} as a function of time
- The resulting minimum values are used as 95/95 values

Special Events

NPSH methodology for special events (ATWS, SBO, Appendix R) is presented in the LTR

- Brief descriptions of each of the special events
- Similarities and contrasts to the DBA-LOCA NPSH analyses
- Identified conservatisms in Special Event NPSH evaluations

Special Events

The deterministic approach utilizing nominal input values will be used to calculate NPSHa for special events

Should this approach not satisfactorily show that $NPSHa - NPSHr \geq 0$; then the statistical approach utilizing the mean output values will be used to show the expected realistic response to the event

Example Plant Analysis

Example plant specific data was provided to GEH for NPSH analysis

- Five years of data was used to develop an exceedance probability distribution for each parameter
- Containment analysis input data provided

Plant specific Containment DBA-LOCA NPSH analysis completed

- Three scenarios analyzed
 - Short term < 600 Seconds (using limiting single failure)
 - Long Term > 600 seconds (using limiting single failure)
 - Containment integrity not credited
- Each in two ways
 - Deterministic approach
 - Statistical approach

Figure A-2 Comparison of Suppression Pool Temperature for Long-term DBA-LOCA (with Diesel Generator Failure) between Deterministic Analysis and Statistical Analysis

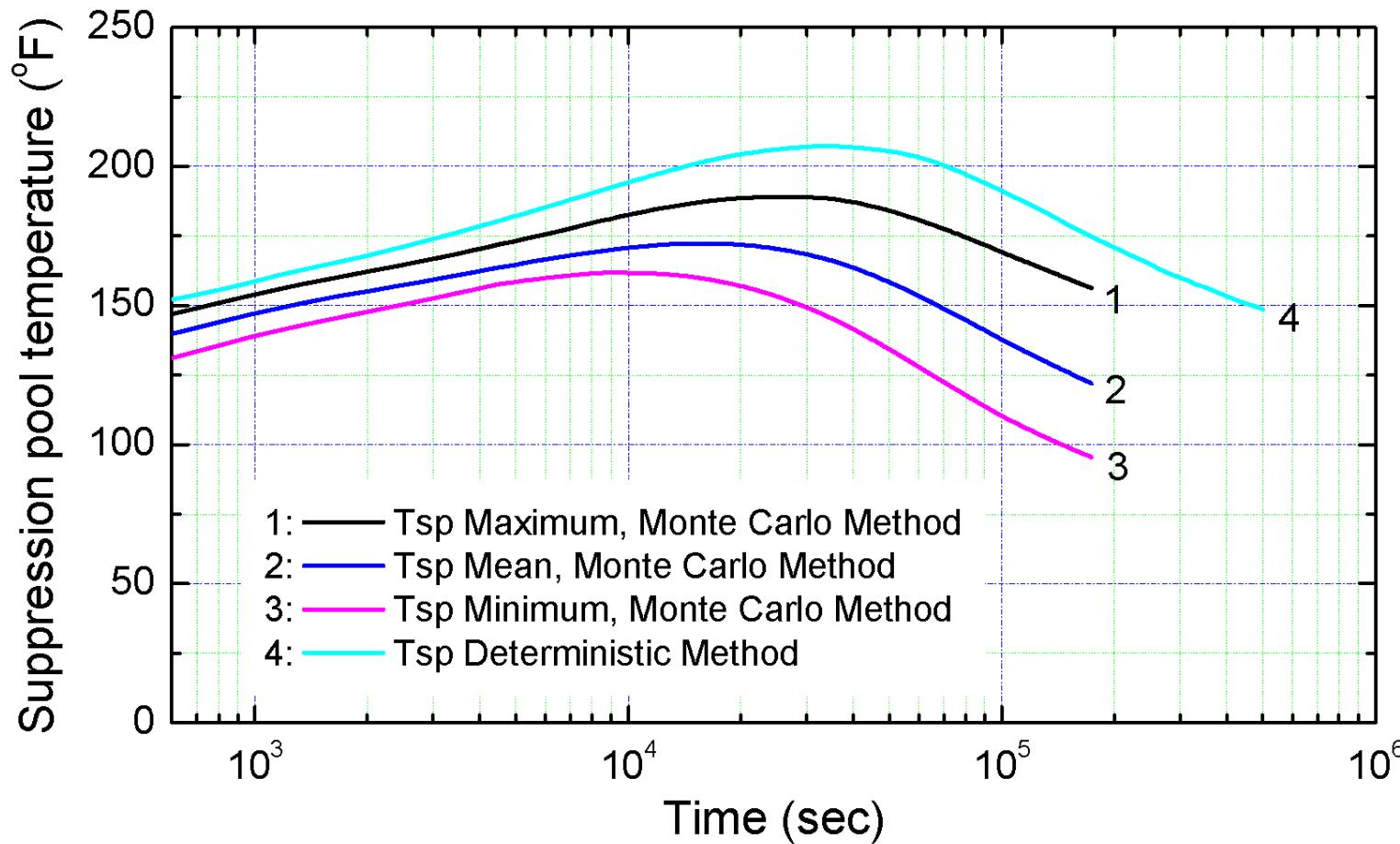
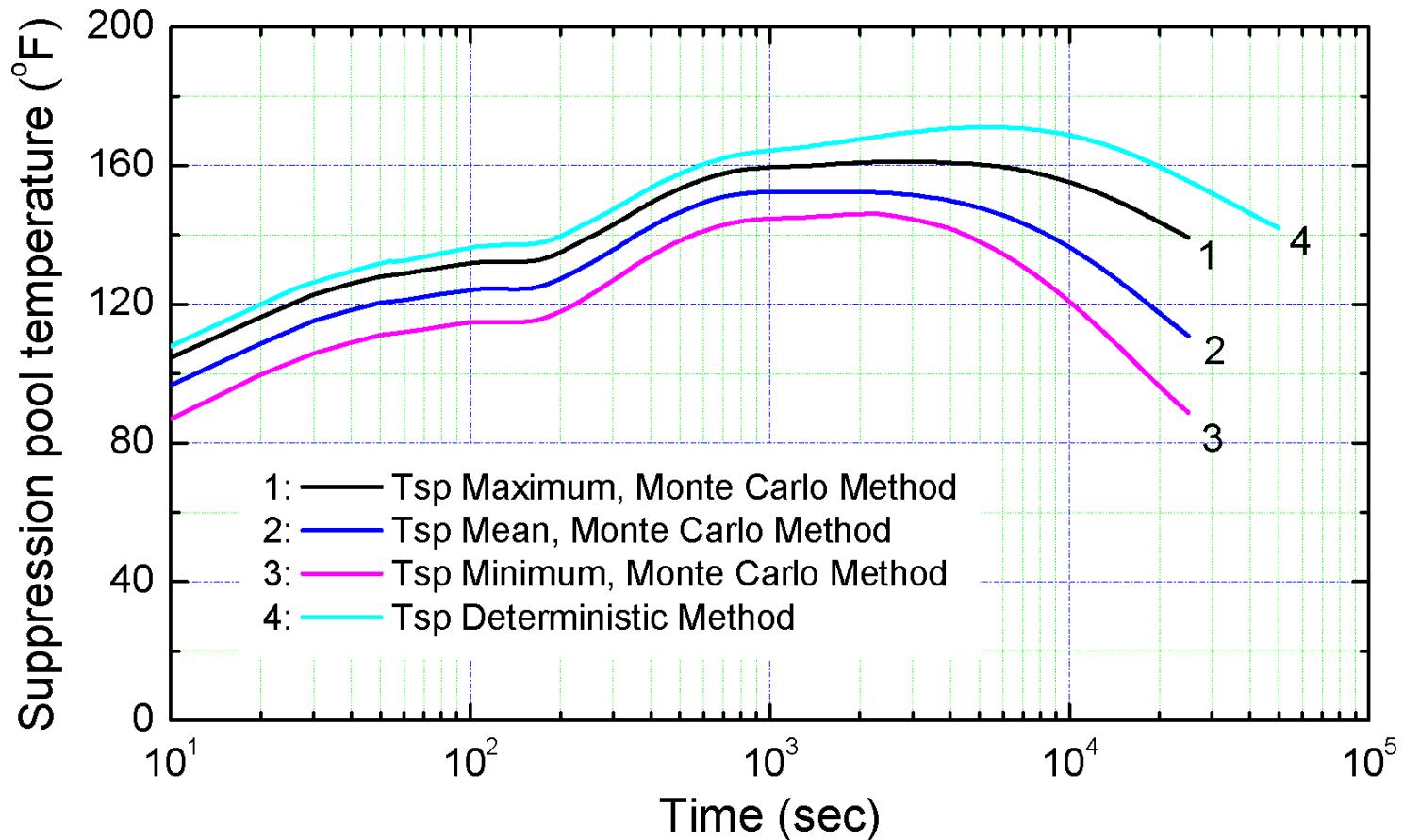
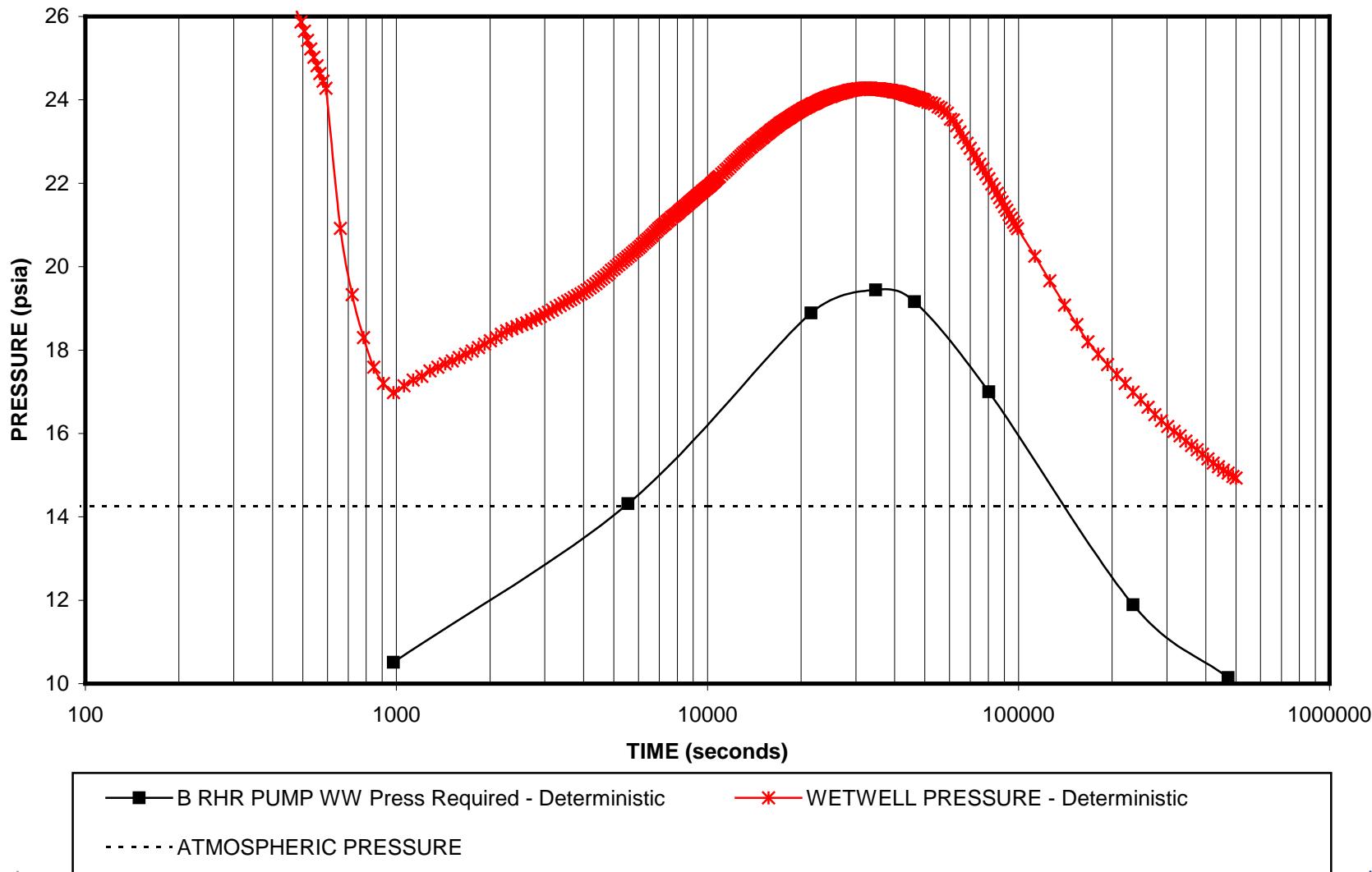


Figure B-2 Suppression Pool Temperature Response to DBA-LOCA with All Safety Systems Available, Containment Integrity not Credited

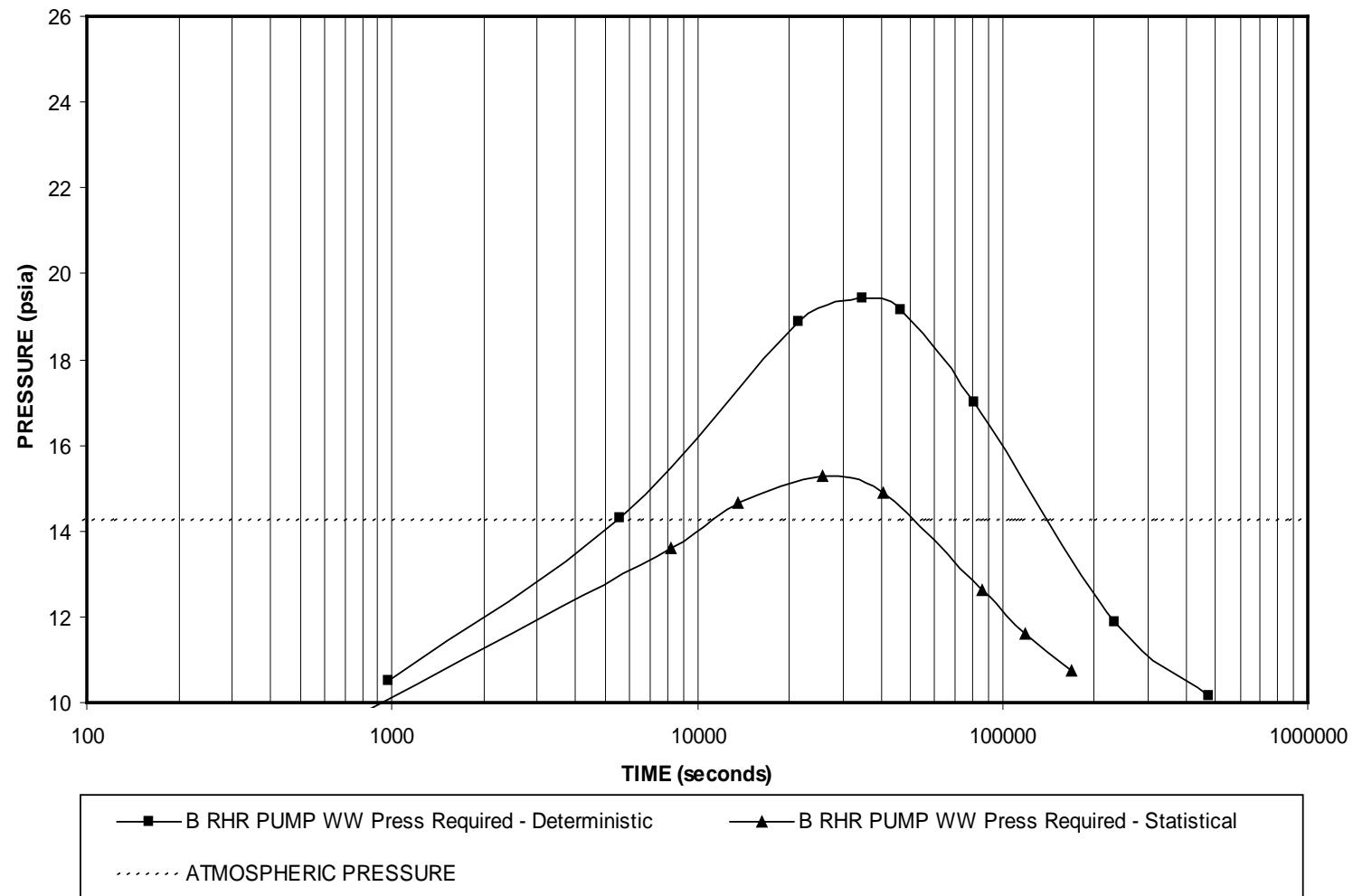


RHR CONTAINMENT PRESSURE REQUIRED FOR ADEQUATE NPSH DURING THE LONG TERM PHASE OF DBA LOCA
(11 DG FAILURE, LOOP AND DEBRIS LOADING ON SUCTION STRAINERS)



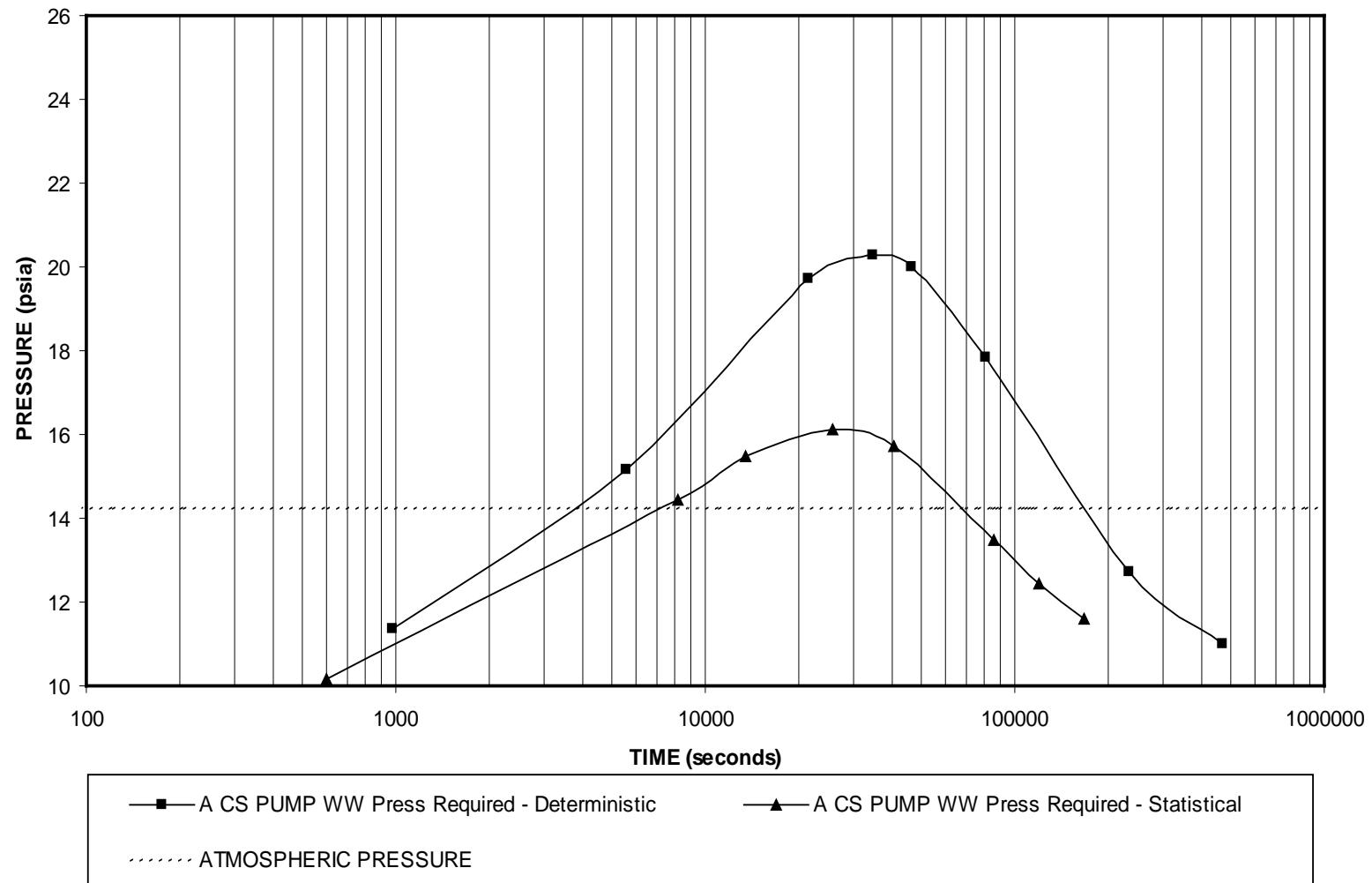
HITACHI

CAP Required for RHR Pumps During DBA LOCA



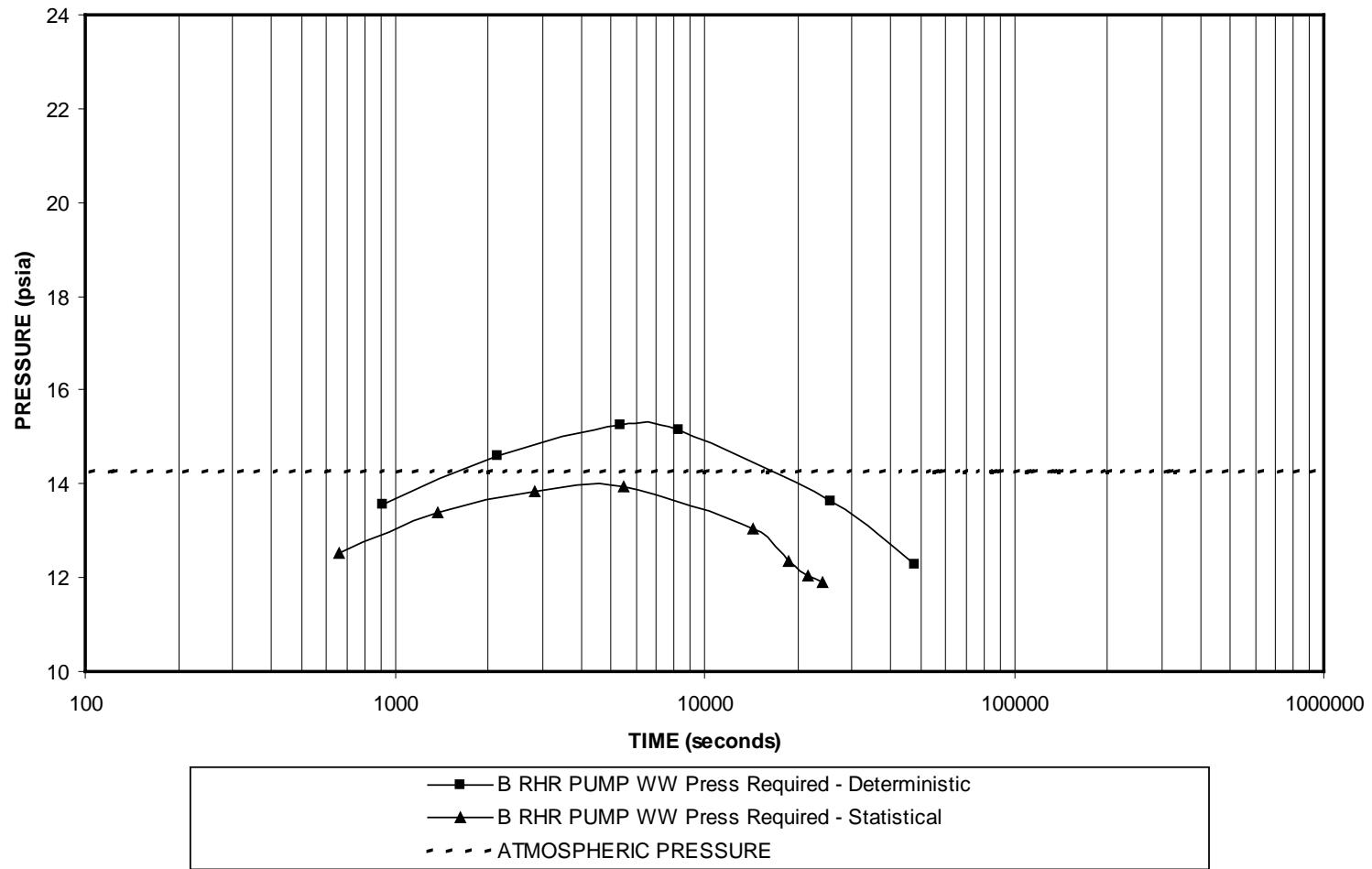
HITACHI

CAP Required for Core Spray Pumps During DBA LOCA

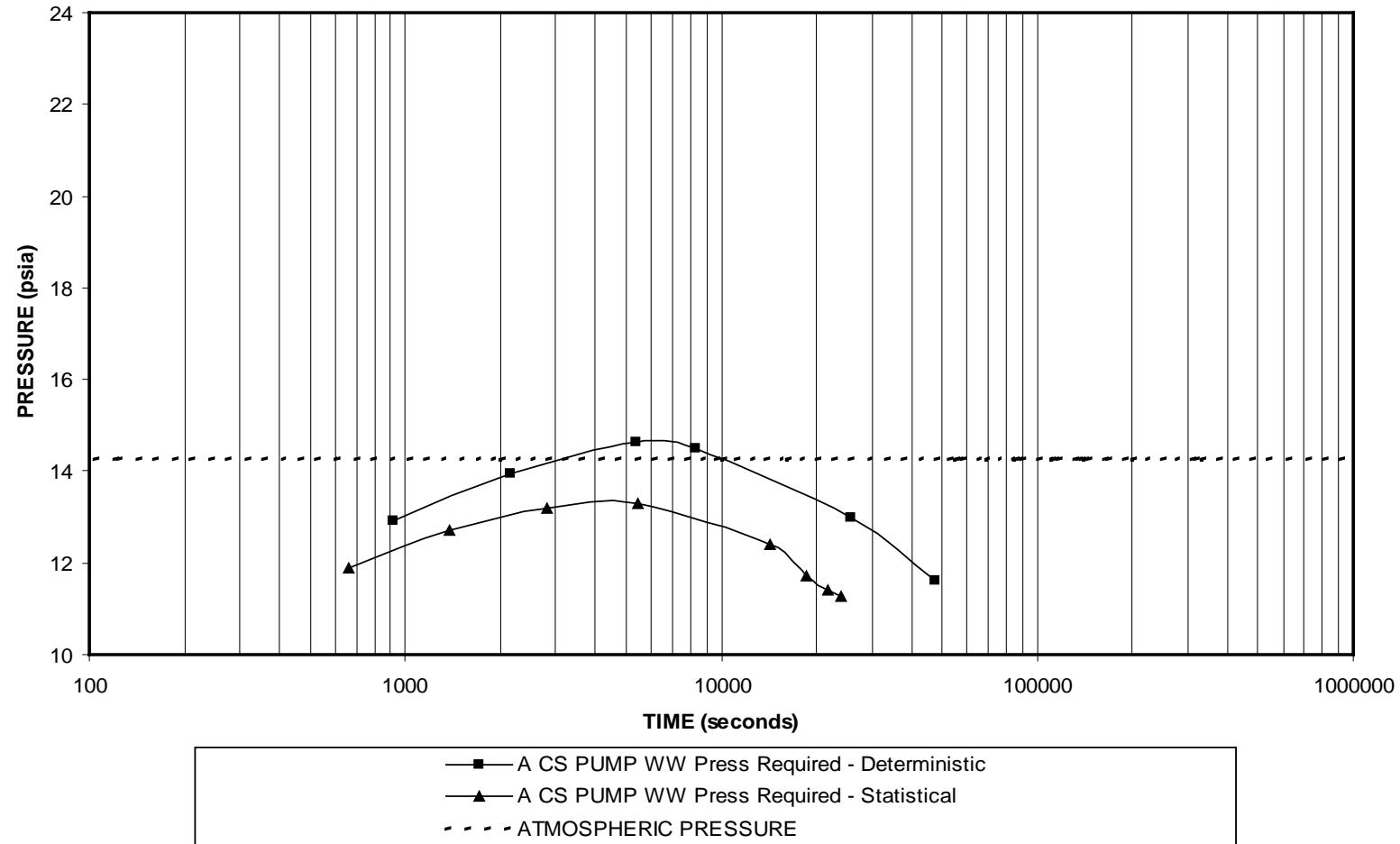


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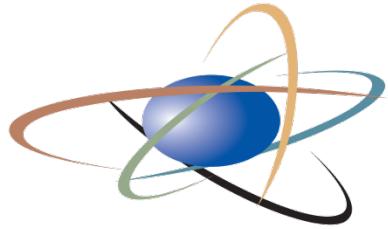
CAP Required for RHR Pumps Without Containment Integrity



CAP Required for Core Spray Pumps Without Containment Integrity



Thank you for your attention



U.S.NRC
UNITED STATES NUCLEAR REGULATORY COMMISSION
Protecting People and the Environment

ACRS Power Uprate Subcommittee Presentation

Safety Evaluation of BWROG Topical Report
on “Containment Overpressure Credit for
NPSH” (NEDC-33347P)

Ahsan Sallman
April 23, 2010

Safety Evaluation of BWROG Topical Report

NEDC-33347P

1. Staff Evaluation

- **Regulatory**

- GDC 35- ECCS to provide abundant core cooling
- GDC 38- Containment heat removal,
- SRP 6.2.2-“Containment Heat Removal Systems,”
- RG 1.82 Rev 3 –provides guidance on use of COP
- RG 1.157 – provides guidance on regulatory position regarding combining best estimate and conservative analyses

Safety Evaluation of BWROG Topical Report

NEDC-33347P

- **Technical**

Deterministic NPSH analysis

- conservative assumptions and bounding values of inputs -
- typical analysis accepted by staff in previous COP reviews
- conservative computer code SHEX- accepted by NRC for licensing calculations

Statistical NPSH analysis

- uses 'order statistics' method- NRC approved (see ref 17)
- uses conservative values of some, while remaining input parameters are sampled
- quantifies the uncertainty in the output H_{ww} ,
- calculated NPSHA is more conservative than a 95/95.

Safety Evaluation of BWROG Topical Report

NEDC-33347P

2. Limitations and Conditions

- Some portions of NPSHa analysis to be reviewed on plant-specific basis
- New staff guidance (draft) requires margin for uncertainty in NPSHR.
- Model other than SHEX should be capable of analyzing LOCA and special events
- Use of best-estimate code shall include of a calculation uncertainty in the statistical method.

3. Topics in TR not Reviewed by Staff

- Risk assessment (section 5.3 of TR) (staff will follow SRP 19.2 Appendix D)
- Accident management to preserve COP, and modifications that would reduce or eliminate need for COP (appendices C & D of TR)- to be reviewed on a plant specific basis

Safety Evaluation of BWROG Topical Report NEDC-33347P

4. RAIs & Responses

- RAI-1 How is the statistical approach consistent with and different from NUREG/CR-5249, “Quantifying Reactor Safety Margins.” ?
Response
 - consistent- employs some of the CSAU steps, for example determination of reactor input parameter and state, sensitivity calculations,
 - different-nominal inputs with statistical distributions of these inputs were used for some parameters, while conservative inputs were used for others,
- RAI-4 will the same computer code (SHEX) be used as is in TR? If not what should be the conditions for using a different code?
Response – not limited to SHEX, aspects of TR specific to SHEX should be evaluated and dispositioned by the licensee if a different containment response model is used.

Safety Evaluation of BWROG Topical Report

NEDC-33347P

- RAI-7 - for some BWRs in which MSIV leakage is considered separately from containment leakage, how is this considered in the analysis?

Response- maximum allowed (TS) MSIV leakage should be combined with the maximum containment leakage rate (La) for input as a conservative leakage assumption.

- RAI-10- what type of statistical distribution will be used for variables included in the statistical analysis, ? Will this be determined on a plant-specific basis? What guidance or criteria, if any, are used to determine the statistical distribution?

Response- normal distribution or with a distribution that represents plant/parameter-specific data, for example- normal distribution for power and decay heat, and parameter-specific for those that can be measured periodically.

Safety Evaluation of BWROG Topical Report

NEDC-33347P

- RAI-16- why is it conservative to assume that spray droplets are in thermal equilibrium with airspace before falling to the bottom of drywell or suppression pool?

Response – spray water being less than DW or WW temperature, the containment pressure would be minimized due to the energy transfer from the airspace to the spray liquid drops.

- RAI-19- How is credit for operator action of throttling of flow included in the analysis for special events?

Response- The timing for the special events would be dictated by the analysis results and consistent with the operator actions as directed by procedures.

Safety Evaluation of BWROG Topical Report

NEDC-33347P

- RAI-34- Section 2.3 states that if COP is required, the most realistic NPSH_r should be used. Explain what is meant by the realistic NPSH_r value.
Response: “most realistic” - the standard 3% NPSH_r curve, but the “most realistic” term was used to allow licensees the option to contact pump vendors to establish NPSH_r values commensurate with the minimum acceptable hydraulic performance.
- RAI-36 - A discussion of the acceptability of NPSH_r values used should be included in individual license amendment requests if based on other than 3 percent or 1 percent head drop values.

Response- BWROG concurs

Safety Evaluation of BWROG Topical Report

NEDC-33347P

5. NRC Staff Analysis

- Performed containment NPSH analysis to support the COP guidance
- Will be discussed in the COP guidance presentation

6. Conclusions

- Deterministic analysis shall be the licensing basis, statistical analysis to be used to quantify uncertainty and demonstrate margins.
- Statistically determined NPSHA is not strictly statistical because some of the input parameters are conservative
- Generally similar trend in Hww and Ts shown in staff and BWROG deterministic and statistical analysis

Commission View

- The Commission's White Paper on Risk-Informed and Performance-Based Regulation (SRM to SECY-98-144, March 1, 1999):
 - Defense-in-depth is an element of the NRC's Safety Philosophy that employs successive compensatory measures to prevent accidents or mitigate damage if a malfunction, accident, or naturally-caused event occurs at a nuclear facility.
 - The defense-in-depth philosophy ensures that safety will not be wholly dependent on any single element of the design, construction, maintenance, or operation of a nuclear facility.
 - Decisions on the adequacy of or the necessity for elements of defense should reflect risk insights gained through identification of the individual performance of each defense system in relation to overall performance.

ACRS View

- ACRS Letter, “The Role of Defense in Depth in and Risk-Informed Regulatory System,” May 19, 1999:
 - Our motivation for this report has arisen because of instances in which seemingly arbitrary appeals to defense in depth have been used to avoid making changes in regulations or regulatory practices that seemed appropriate in the light of results of quantitative risk analyses.
 - Unless defense-in-depth measures are justified in terms of necessity and sufficiency, the full benefits of risk-informed regulation cannot be realized.

RG 1.174, Section 2.2.1.1 Guidance

- Consistency with the defense-in-depth philosophy is maintained if:
 - A reasonable balance is preserved among prevention of core damage, prevention of containment failure, and consequence mitigation.
 - Over-reliance on programmatic activities to compensate for weaknesses in plant design is avoided.
 - System redundancy, independence, and diversity are preserved commensurate with the expected frequency, consequences of challenges to the system, and uncertainties (e.g., no risk outliers).
 - Defenses against potential common cause failures are preserved, and the potential for the introduction of new common cause failure mechanisms is assessed.
 - Independence of barriers is not degraded.
 - Defenses against human errors are preserved.
 - The intent of the General Design Criteria in Appendix A to 10 CFR Part 50 is maintained.

Similar Situations

- Core-damage sequences that involve containment bypass:
 - Interfacing system LOCAs
 - Steam generator tube ruptures
 - Reactor vessel rupture
- Risk-informed changes that involve loss of redundancy or diversity:
 - Allowed outage time extensions
 - Risk-Managed Technical Specifications
- Risk-informed changes that relax programmatic elements which provide defense-in-depth:
 - Risk-informed inservice inspections
 - Risk-informed categorization and treatment of structures, systems and components , 10 CFR50.69

Defense in Depth and the Use of Containment Pressure in Determining Available NPSH

- No changes to any programmatic element that provides defense-in-depth.
- Proposed staff guidance:
 - Considers T/H uncertainties in NPSHA and NPSHR.
 - Specifies adequate containment integrity monitoring.
- The size of a containment leak that causes loss of NPSH is smaller than the size associated with a large early release:
 - 20-40 La compared to > 100 La
 - Therefore: $\Delta\text{CDF} < \Delta\text{LERF}$

Risk Evaluation of Using Containment Pressure to Prevent ECCS Pump Cavitation

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Division of Risk Analysis
Office of Nuclear Regulatory Research

April 2010

Outline

- Overview
- Technical Approach
 - Preliminaries
 - Leak Probabilities
 - Pre-initiator
 - Upon-initiator
 - Post-initiator
- Risk Insights

Technical Approach

- Purpose: To estimate the increase in core-damage frequency (CDF) that results from relying upon containment accident pressure (CAP) to prevent ECCS pump cavitation.
- General approach:
 - Modify Standardized Plant Analysis of Risk (SPAR) models:
 - Browns Ferry - CAP credit is needed whenever the CS or RHR pumps are taking suction on the suppression pool.
 - Monticello - CAP credit is needed whenever the CS or RHR pumps are taking suction on the suppression pool.
 - Analysis was limited to the study of all internal initiating events that are currently contained in the SPAR models (transients and LOCAs). External events were excluded:
 - Lack of detailed cable routing information to assess the impact on fire on containment integrity
 - Lack of containment seismic fragility information for small leaks

The Definition of “Loss of Containment Integrity”

- The event “loss of containment integrity” means that the containment is leaking enough to prevent adequate NPSH.
- The leak size needed to prevent adequate NPSH is plant-specific, and should be determined through containment thermal-hydraulic analyses (e.g., GOTRIC, MELCOR).
- Leak sizes used in previous license-performed risk evaluations:
 - Vermont Yankee EPU:
 - 27 La (calculated using 10 CFR 50 Appendix K requirements)
 - 60 La (using more realistic assumptions)
 - Browns Ferry EPU: 35 La (engineering judgment)
- Assumed 20 La in this analysis.

Three Timeframes Considered

- Pre-initiator: Containment may be leaking before an initiating event occurs.
- Upon-initiator: Containment may fail to isolate when an initiating event occurs.
- Post-initiator: Containment may start to leak after the initiating event occurs.

Pre-Initiator Leak Probability

- Previous risk evaluations used a pre-initiator (pre-existing leak) probability that only depended on the size of containment leakage.
 - Vermont Yankee EPU: 2.47×10^{-4} (from EPRI TR 1009325)
 - Browns Ferry: 9.86×10^{-4} (from EPRI TR 1009325)
- However, the probability of a pre-initiator containment leak should also depend on how the containment integrity is tested:
 - How often the test is performed, for example:
 - Integrated leak rate tests (ILRTs)
 - Oxygen concentration monitoring in BWR Mark I containments
 - Test efficiency (how good is the test at detecting leaks of the size needed to preclude adequate NPSH)
- The staff developed a semi-Markov model to represent the impact of containment integrity testing on the pre-initiator leak probability.

Technical Specification

CONDITION	REQUIRED ACTION	COMPLETION TIME
Containment leakage at or above [20] La	Reduce containment leakage below [20] La	T_{ST} [24h]
Required Action and Associated Completion Time not met	Shutdown plant	T_{SD} [8h]
SURVEILLANCE		FREQUENCY
Verify containment leakage less than [20] La		T_I [7 days]

Patterned after BWR/4 Standard Technical Specification 3.6.3.2,
“Primary Containment Oxygen Concentration”

Parameters that Determine the Pre-Initiator Leak Probability

- Containment leakage failure rate, λ
- Mean time to repair, τ
- Surveillance test interval, T_I
- TS-allowed repair duration while at-power, T_{ST}
- TS-mandated shutdown time, T_{SD}
- Test sensitivity (probability of a Type II error), β , δ , and ε

Test Confusion Matrix

(Statistical Hypothesis Testing)

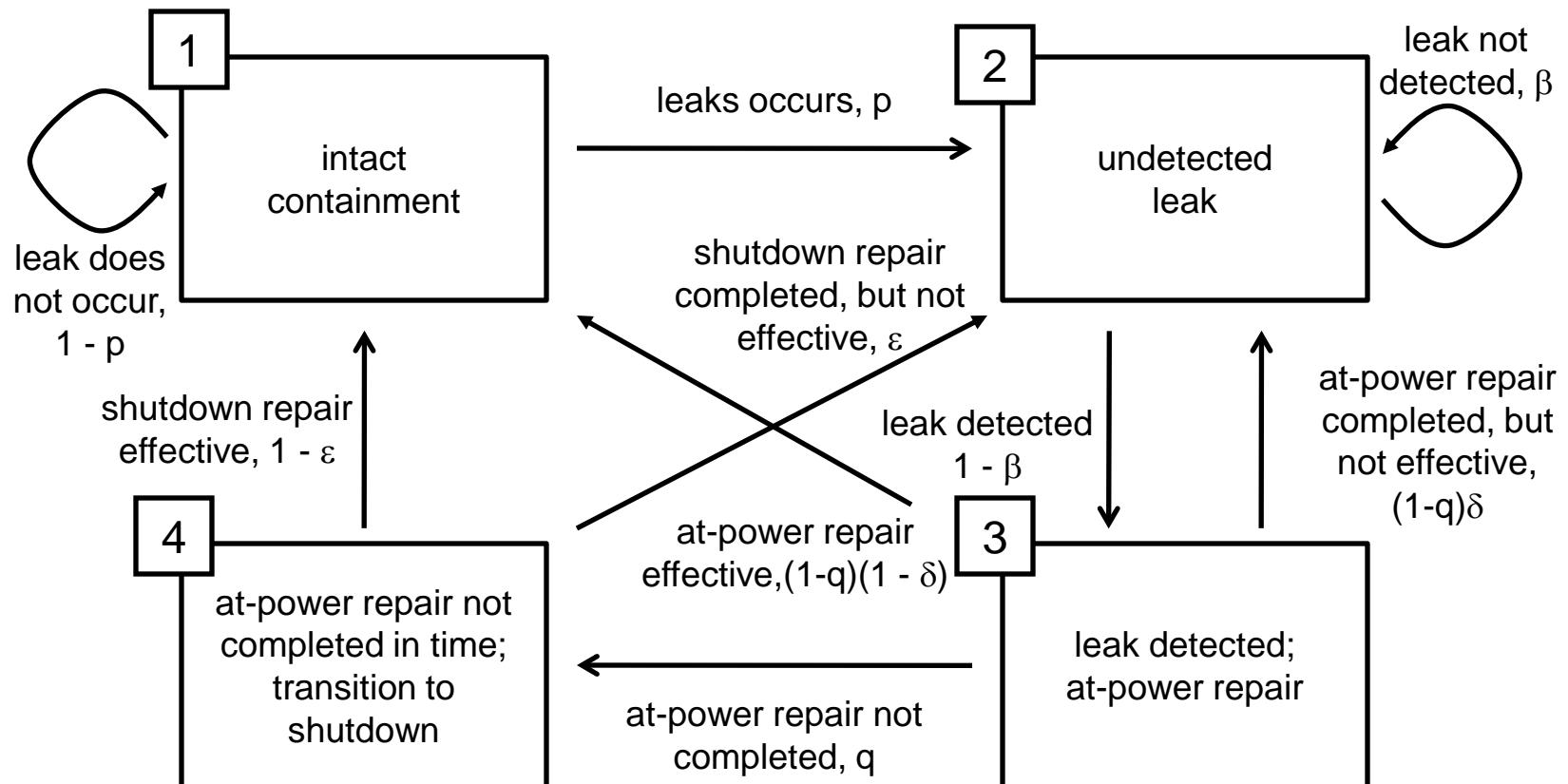
		Actual Containment Condition	
		Leak (true)	Intact (false)
Test Result	Leak (positive)	true positive $\Pr\{T_P C_T\} = 1 - \beta$ = sensitivity	false positive (Type I error) $\Pr\{T_P C_F\} = \alpha$
	Intact (negative)	false negative (Type II error) $\Pr\{T_N C_T\} = \beta$	true negative $\Pr\{T_N C_F\} = 1 - \alpha$ = specificity

- False negatives are important to plant safety.
- False positives are important to plant operations.

Semi-Markov Processes

- System is in one of a number of discrete states.
- The probability that the system transitions to another state depends only on its current state:
 - Transitions are independent of the system's past history.
 - This characteristic is called the “Markovian property.”
- The time that the system waits in a given state is random with an arbitrary probability distribution:
 - In general, each state has its own waiting time distribution.
 - Special cases:
 - Markov chain – all waiting times are fixed and equal.
 - Continuous time Markov process – all waiting times are exponentially distributed.

Semi-Markov Model



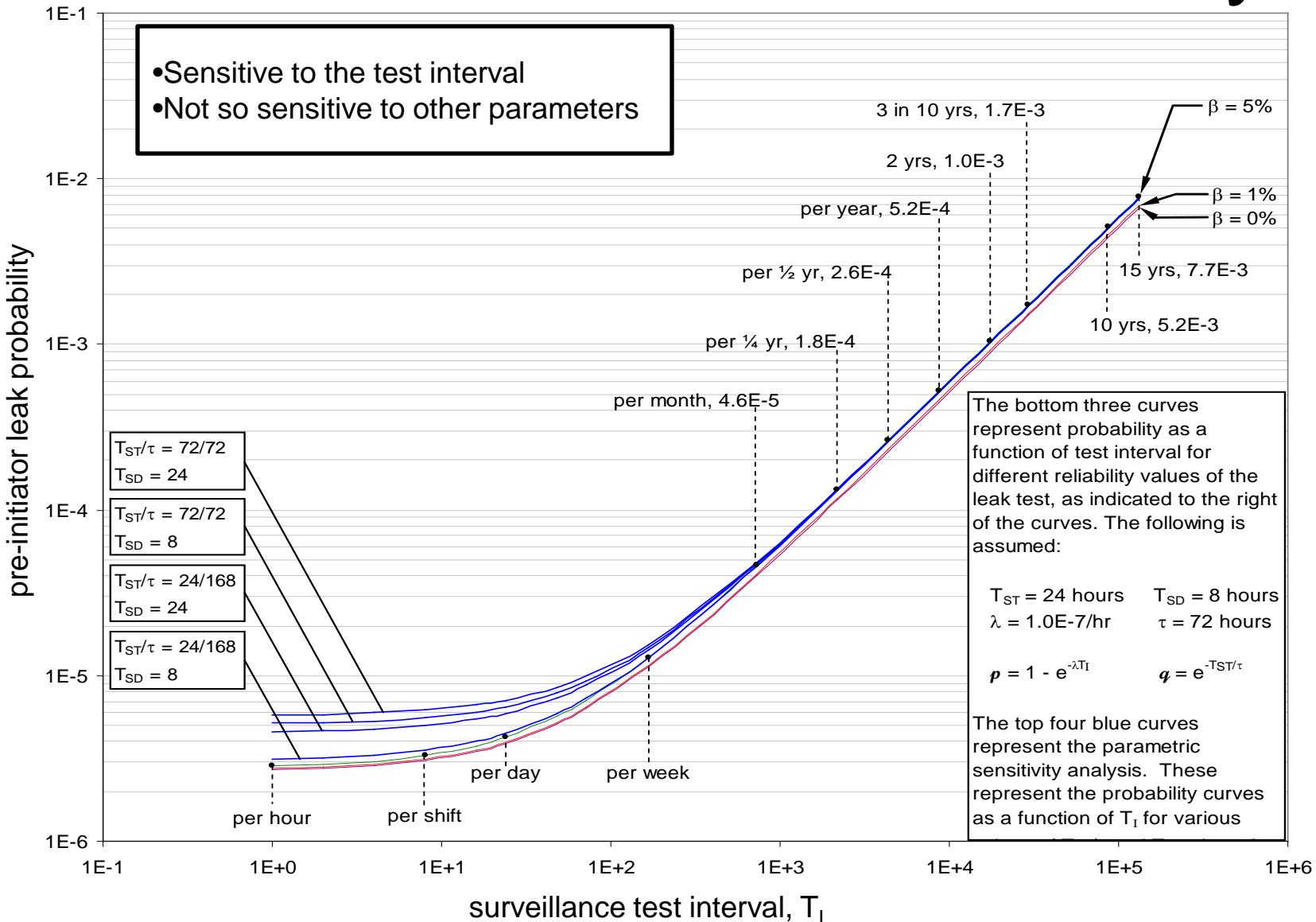
Pr{pre-initiator leak} = long-run fraction of time that the system is in States 2, 3 and 4

Containment Leakage Reliability Parameters

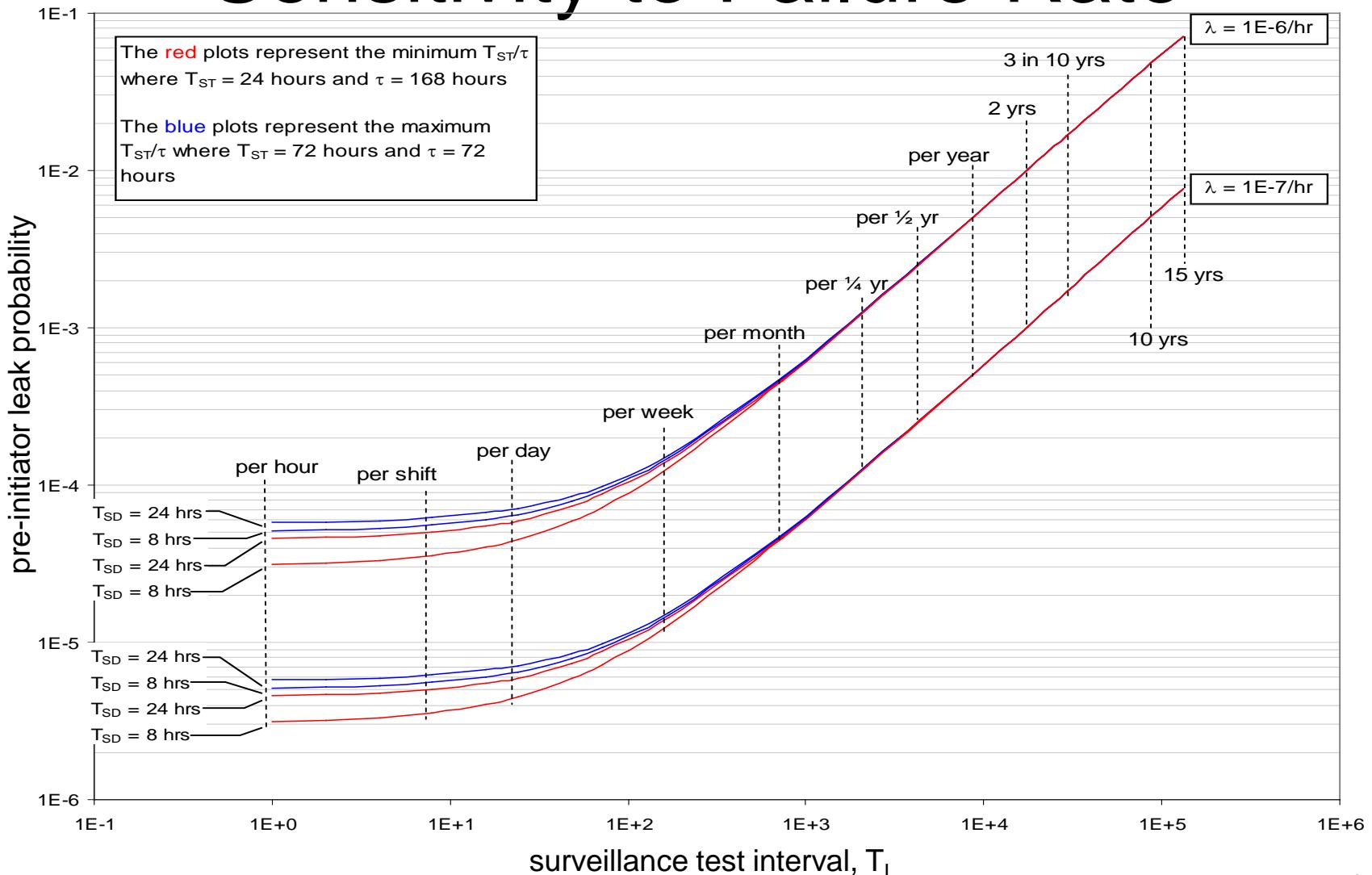
$$\lambda(20 L_a) = \frac{\Pr\{\text{leak} \geq 20 L_a \mid \text{leak}\}}{\Pr\{\text{leak} \geq 1 L_a \mid \text{leak}\}} \times \lambda(1 L_a) = 1 \times 10^{-7} / \text{h}$$

- $\lambda(1 L_a) = 1.1E-2/RY = 1.3E-6/\text{hour}$ from NUREG-0933, “Resolution of Generic Issues,” Section 1 – TMI Action Plan Items, Item II.E.4, “Containment Integrity”
- Leak size distributions:
 - $\Pr\{\text{leak} \geq 20 L_a \mid \text{leak exists}\} = 2E-3$
 - $\Pr\{\text{leak} \geq 1 L_a \mid \text{leak exists}\} = 3E-2$
 - Source: Table D-1 of EPRI, “Risk Impact Assessment of Extended Integrated Leak Rate Testing Intervals,” Report No. 1009325, Rev. 1, October 2005 (ADAMS Accession No. ML053550424).
- Mean time to repair, $\tau = 72$ hours (NUREG-0933)

Pre-Initiator Leak Probability



Pre-Initiator Leak Probability Sensitivity to Failure Rate



Containment Isolation

- During routine power operations, there are no pathways between the containment and the atmosphere.
 - Pathways exist during inerting(24h after plant startup) and deinerting (24 h prior to plant shutdown.)
- As a result, only necessary to model failure of the containment isolation system to close on demand when these pathways exist:

$$\Pr\{\text{upon - initiator leak}\} = \frac{2 \times 24\text{h}}{24\text{m}} \times \frac{1\text{m}}{730\text{h}} \times 10^{-3} = 3 \times 10^{-6}$$

- Different approach than previous licensee-performed risk evaluations, which assumed that containment isolation is always required.

Containment Isolation (Con't.)

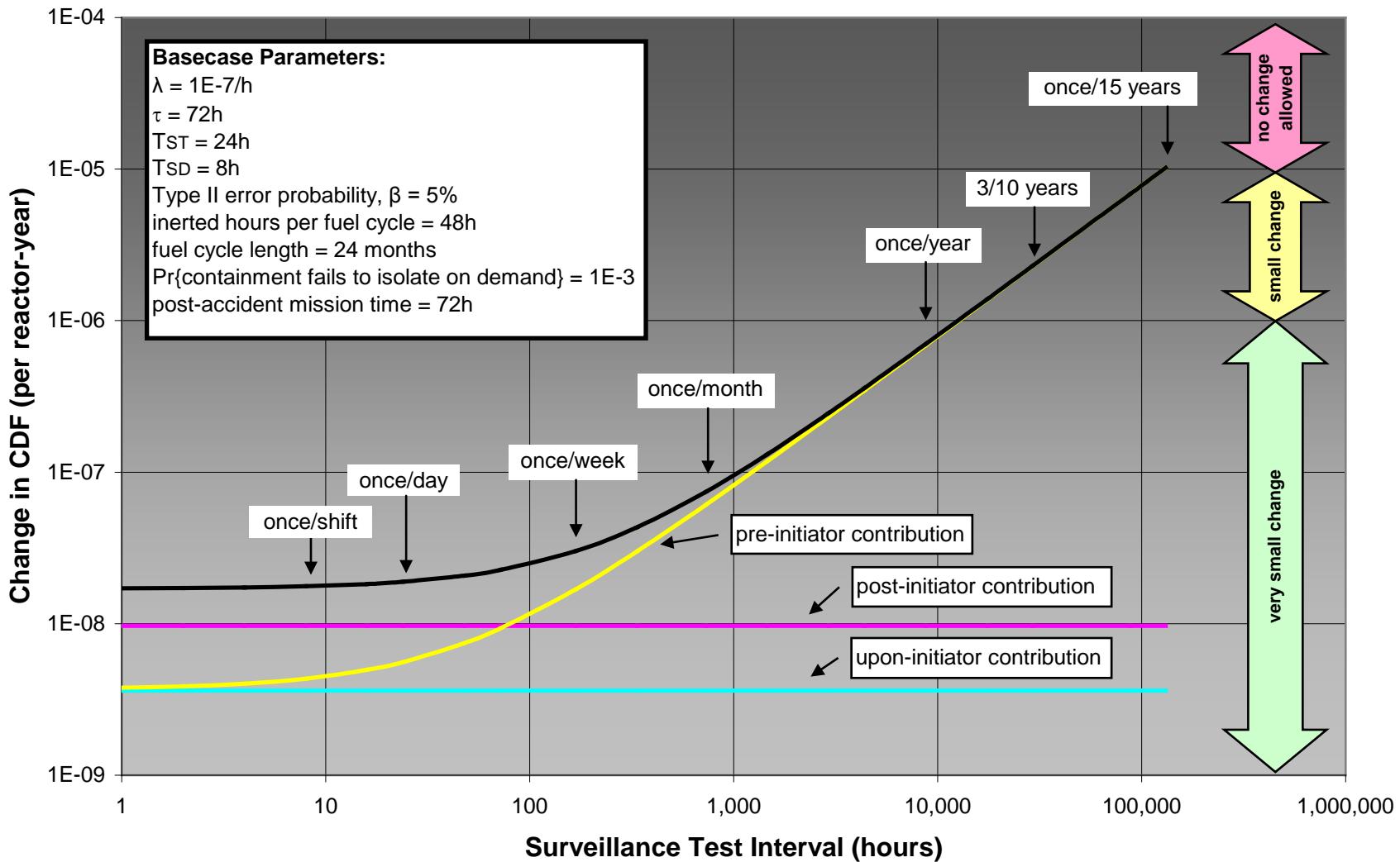
- Following the occurrence of a LOCA (LLOCA, MLOCA, or SLOCA), failure to close the MSIVs introduces a pathway between the containment and the atmosphere.
- The probability that all MSIVS fail to close on demand is about 10^{-4} (including independent and common-cause failures).
- This pathway is a very small contribution to the change in core-damage frequency since LOCAs frequencies are relatively small.

Post-Initiator Leak Probability

- Used 72h mission time to account for the period that containment accident pressure is needed to provide adequate NPSH.

$$\begin{aligned}\Pr\{\text{post - initiator leak}\} &= 1 - e^{-\lambda T} \approx \lambda T \\ &= (1 \times 10^{-7} / h)(72h) = 7 \times 10^{-6}\end{aligned}$$

Browns Ferry CAP Credit



Risk Insights

- There is only one minimal cut set where the loss of containment integrity leads directly to core damage (large LOCA).
- The increase in CDF is very small ($<10^{-6}/y$, as defined in RG 1.174) when testing is conducted at least once/year (assuming a leak failure rate of $10^{-7}/h$).
- Contributions to containment leakage probability:
 - Pre-initiator (basecase): 55.9%
 - Post-initiator: 32.1%
 - Upon-initiator: 12.0%

Risk Insights (Con't)

- Importance measures for loss of containment integrity:
 - Fussell-Vesely (FV): 0.017
 - Risk achievement worth (RAW): 750
 - The loss of containment integrity is a “significant basic event,” as defined in the ASME/ANS PRA Standard ($FV > 0.005$ and/or $RAW > 2$), over a wide range of model parameters.
- Sensitivity studies indicate that the pre-initiator contribution to the containment leakage probability mainly depends on:
 - The containment leakage failure rate
 - The surveillance test interval

Breakdown of Contributions

Initiating Event	No CAP Credit		With CAP Credit		Change in CDF	
	CDF	Percent	CDF	Percent	CDF	Percent
General Transient	3.4E-08	1.9%	3.4E-08	1.9%	2.9E-10	0.9%
Small LOCA	1.1E-09	0.1%	1.1E-09	0.1%	2.5E-12	0.2%
Steam Line Break Outside Containment	6.4E-08	3.7%	6.4E-08	3.6%	1.7E-11	0.0%
Medium LOCA	6.5E-08	3.8%	6.8E-08	3.8%	2.3E-09	3.6%
Loss of Service Water	9.1E-09	0.5%	1.8E-08	1.0%	9.2E-09	101.2%
Loss of Plant Control Air	7.1E-09	0.4%	1.1E-08	0.6%	3.5E-09	49.6%
Loss of Offsite Power	1.4E-06	81.4%	1.4E-06	80.2%	3.5E-09	0.2%
Loss of Main Feedwater	2.9E-08	1.7%	2.9E-08	1.7%	5.0E-11	0.2%
Large LOCA	7.8E-09	0.4%	8.0E-09	0.5%	2.3E-10	2.9%
Inadvertent Open Relief Valve	1.4E-08	0.8%	1.6E-08	0.9%	1.6E-09	11.8%
Loss of Condenser Heat Sink	9.3E-08	5.3%	1.0E-07	5.8%	9.4E-09	10.1%
Total	1.7E-06		1.8E-06		3.0E-08	1.7%

No significant change in
the plant risk profile

Conclusions

- The loss of containment integrity is a “significant basic event,” as defined in the ASME/ANS PRA Standard, over a wide range of model parameters.
- The increase in CDF can be made very small ($<10^{-6}/y$, as defined in RG 1.174) with adequate testing of containment integrity.

Backup Viewgraphs

Average State Durations

M ₁	$T_I \left(1 - \frac{p}{2}\right)$
M ₂	$\frac{T_I}{2} (1 + \beta)$
M ₃	$qT_{ST} + (1 - q) \frac{\tau - (\tau + T_{ST}) \exp(-T_{ST}/\tau)}{1 - \exp(-T_{ST}/\tau)}$
M ₄	T_{SD}

Semi-Markov Model Solution

$$p = 1 - \exp(-\lambda T_1) \quad \text{Probability of leak over interval } T_1$$

$$q = \exp(-T_{ST} / \tau) \quad \text{Probability that leak is not repaired in interval } T_{ST}$$

$$\pi_1 = \frac{1 - \beta}{pD} [1 - (1 - q)\delta - \varepsilon q]$$

$$\pi_2 = 1/D$$

$$\pi_3 = \frac{1 - \beta}{D}$$

$$\pi_4 = \frac{(1 - \beta)q}{D}$$

$$D = \frac{1 - \beta}{p} [1 - (1 - p)\delta - \varepsilon q] + 1 + (1 - \beta) + (1 - \beta)q$$

Steady-state
solutions to the
embedded
Markov chain

$$P_{234} = \frac{M_2 + (1 - \beta)M_3 + (1 - \beta)qM_4}{\frac{1 - \beta}{p} [1 - (1 - p)\delta - \varepsilon q]M_1 + M_2 + (1 - \beta)M_3 + (1 - \beta)qM_4}$$

USE OF CONTAINMENT ACCIDENT PRESSURE IN DETERMINING THE AVAILABLE NET POSITIVE SUCTION HEAD (NPSH) OF EMERGENCY CORE COOLING SYSTEM AND CONTAINMENT HEAT REMOVAL PUMPS

April 23, 2010

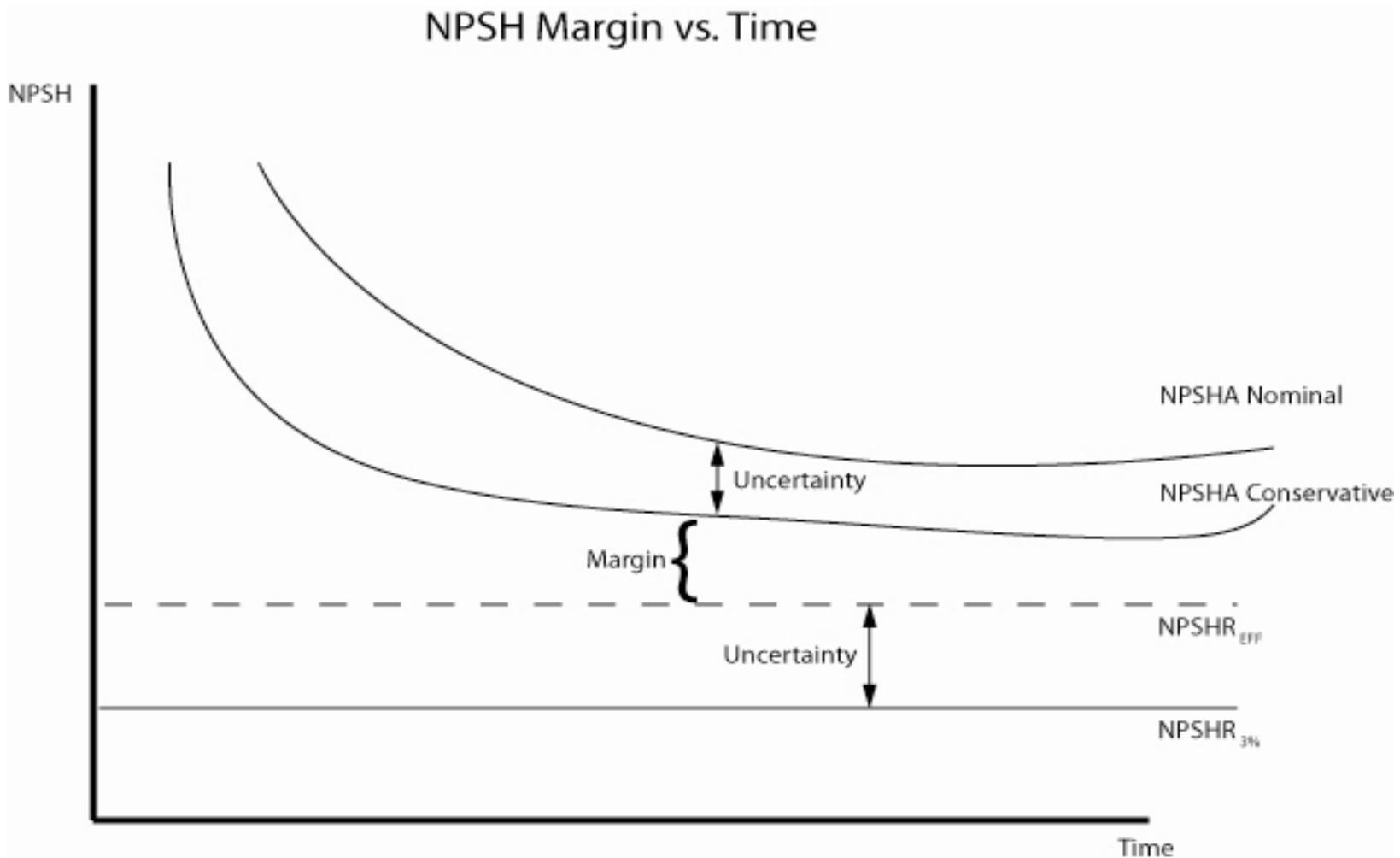
ACRS Power Uprate Subcommittee

Richard Lobel
Ahsan Sallman

Containment Accident Pressure VS. Overpressure

- Staff uses the term *containment accident pressure*.
- No system, structure or component is being overpressurized.
- Overpressure has been used several different ways:
 - Pressure greater than atmospheric pressure
 - Pressure greater than saturation pressure
 - Pressure greater than containment pressure prior to postulated accident (containment accident pressure)
 - BWROG topical report uses the first definition
- Containment accident pressure is greater than the containment pressure prior to the postulated accident

Margin and Uncertainty



Guidelines-1

- 1. Propose use of $NPSHR_{eff}$ defined as
 - $NPSHR_{eff} = (1.0 + \text{uncertainty}) NPSHR_{3\%}$
- 2. Maximum flow rate chosen for NPSH analyses should be greater than flow rate used for core and containment cooling analyses
- 3. Either a conservative or 95/95 lower tolerance limit should be used in determining the available NPSH
- 4. Containment isolation should not be lost due to an Appendix R Fire (associated circuit) or containment venting (required by procedures)

Guidelines-2

- 5. Operator action to control containment pressure is acceptable if justified by human factors considerations and included in appropriate procedures
- 6. Operation for a limited time with $NPSHA < NPSHR$ is acceptable if justified by testing
- 7. Licensees should have capability to detect and take action for a containment leakage rate large enough to adversely affect containment capability to retain accident pressure
- 8. Licensees should justify that use of containment accident pressure is necessary because the design cannot be practicably altered.

Guidelines-3

- 9. Pump operation in the maximum erosion zone should be limited to less than 100 hours
- 10 A realistic calculation of available NPSH should be performed to compare with available NPSH determined from a conservative or Monte Carlo 95/95 calculation
- 11.The mission time of the pump must consider any operation necessary to maintain stable core and containment cooling post-accident.
- 12. To protect the mechanical seal faces from excess entrained air (released during operation at the 3% NPSHR condition), dual mechanical seals with an external cold water flush system (or equivalent) should be provided

Status

- 27 operating reactors use containment accident pressure for determining available NPSH
 - 19 BWRs
 - 8 PWRs
- Extended power uprates:
 - Two EPUs on hold pending revised guidance on use of containment accident pressure for available NPSH

Cavitation

- Cavitation is the formation of vapor in a liquid due to a decrease in the local static pressure followed by an increase in local static pressure which results in the sudden condensation of the vapor.
 - Occurs at constant liquid temperature.
- Excessive pump cavitation can result in:
 - Erosion of the pump impeller and other pump parts
 - Mechanical damage to seals, bearings, shaft, etc.
 - Decrease in pump flow rate
 - Decrease in pump discharge head
 - Vibration
- The degree to which any of these effects adversely affects pump performance depends on the amount of cavitation and its duration, the air/gas content of the liquid, the suction energy of the pump, the NPSH margin, and if the pump is operating in the low flow suction recirculation region.

Suction Energy

- Suction energy concept provides a classification of the degree to which centrifugal pumps are prone to adverse effects of cavitation and suction recirculation.
- Suction recirculation is a low flow phenomenon which can result in pressure surges in the pump and suction piping and cavitation.
 - Suction recirculation is not directly related to the issue of using containment pressure to determine NPSH margin
- Suction Energy = $D_e \ n \ N_{ss} \ sg$
 - n is pump speed (rpm)
 - D_e is impeller eye diameter (in)
 - N_{ss} is the suction specific speed
 - $(n \text{ rpm}) (Q \text{ gpm})^{1/2} / (\text{NPSHR feet})^{3/4}$
- Suction energy classified as
 - Low Suction Energy
 - High Suction Energy
 - Very High Suction Energy

Net Positive Suction Head (NPSH)

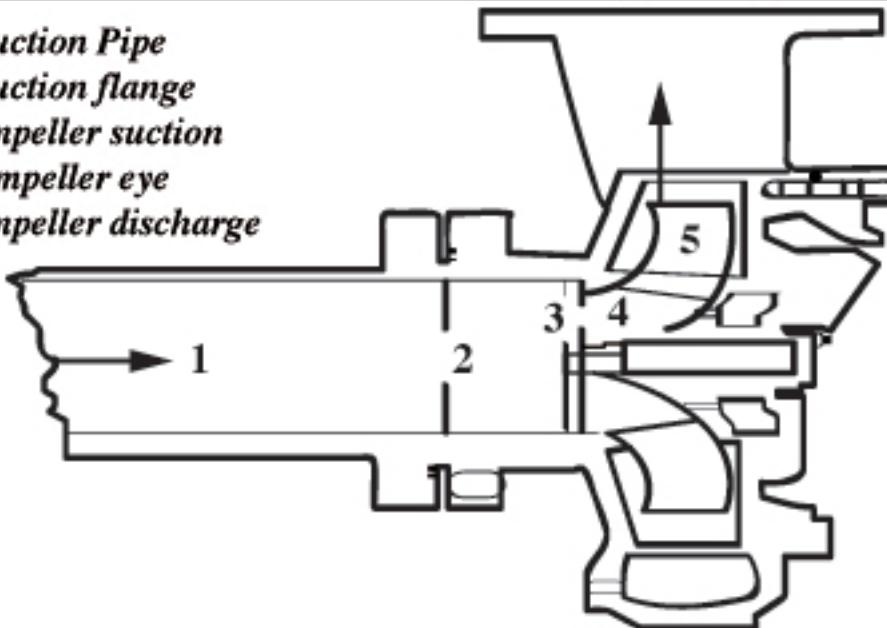
- Net positive suction head is the total (stagnation) head of the fluid at the suction flange and the centerline of the impeller relative to the vapor pressure head.
- NPSH can be regarded as an indication of pump suction performance.

Net Positive Suction Head (NPSH)

- Two important NPSH values:
 - Available NPSH
 - Required NPSH
- Available NPSH is a function of the system design
 - Obtained by calculation
- Required NPSH is the NPSH corresponding to a specified level of cavitation.
 - Obtained by test
 - Hydraulic Institute defines required NPSH as corresponding to a reduction in pump developed head of 3%
- $\text{NPSH margin} = \text{NPSHA} - \text{NPSHR}$
- $\text{NPSH ratio} = \text{NPSHA}/\text{NPSHR}$

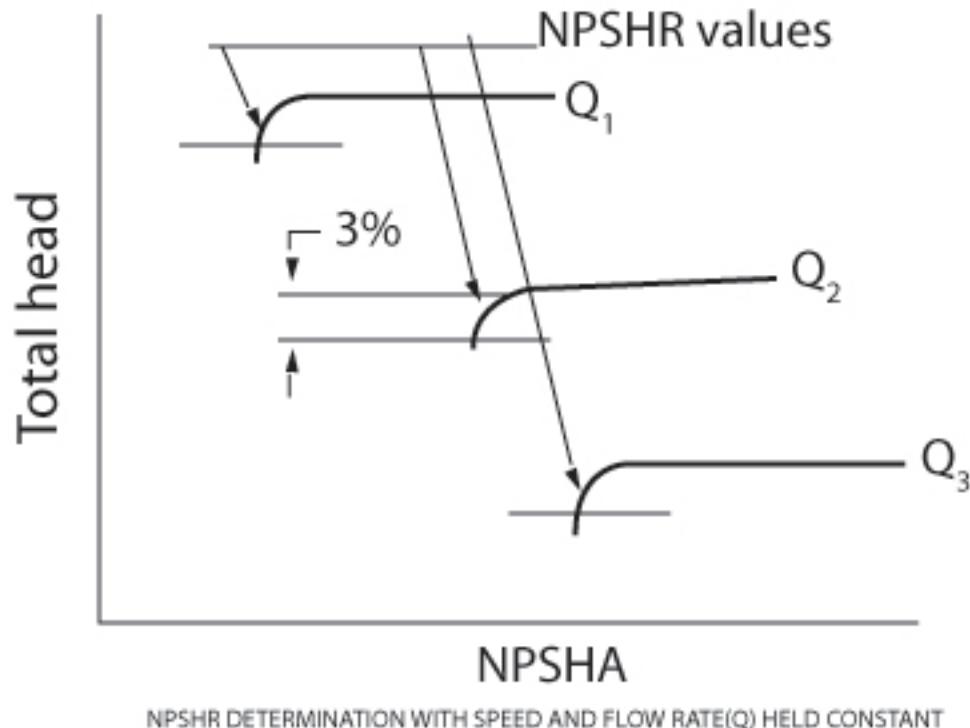
Points within the pump

- 1- Suction Pipe**
- 2- Suction flange**
- 3- Impeller suction**
- 4 - Impeller eye**
- 5- Impeller discharge**



www.cheresources.com, The Chemical Engineer's Resource Page

Required NPSH



- Two natural NPSH values: incipient cavitation and break down.
- Others values of NPSH, such $\text{NPSHR}_{3\%}$, specify an arbitrary level of cavitation.

NPSHR Uncertainty

- Pump vendor test results for $\text{NPSHR}_{3\%}$ are most accurate. For best accuracy, test should be conducted at rated pump speed and impeller diameter with NPSHA controlled by vacuum pump.
- Additional uncertainty in $\text{NPSHR}_{3\%}$ due to field (installed) conditions.
- Installed uncertainty due to:
 - Pump speed
 - Water temperature
 - Suction piping layout
 - Air content of pumped water
 - Wear ring leakage

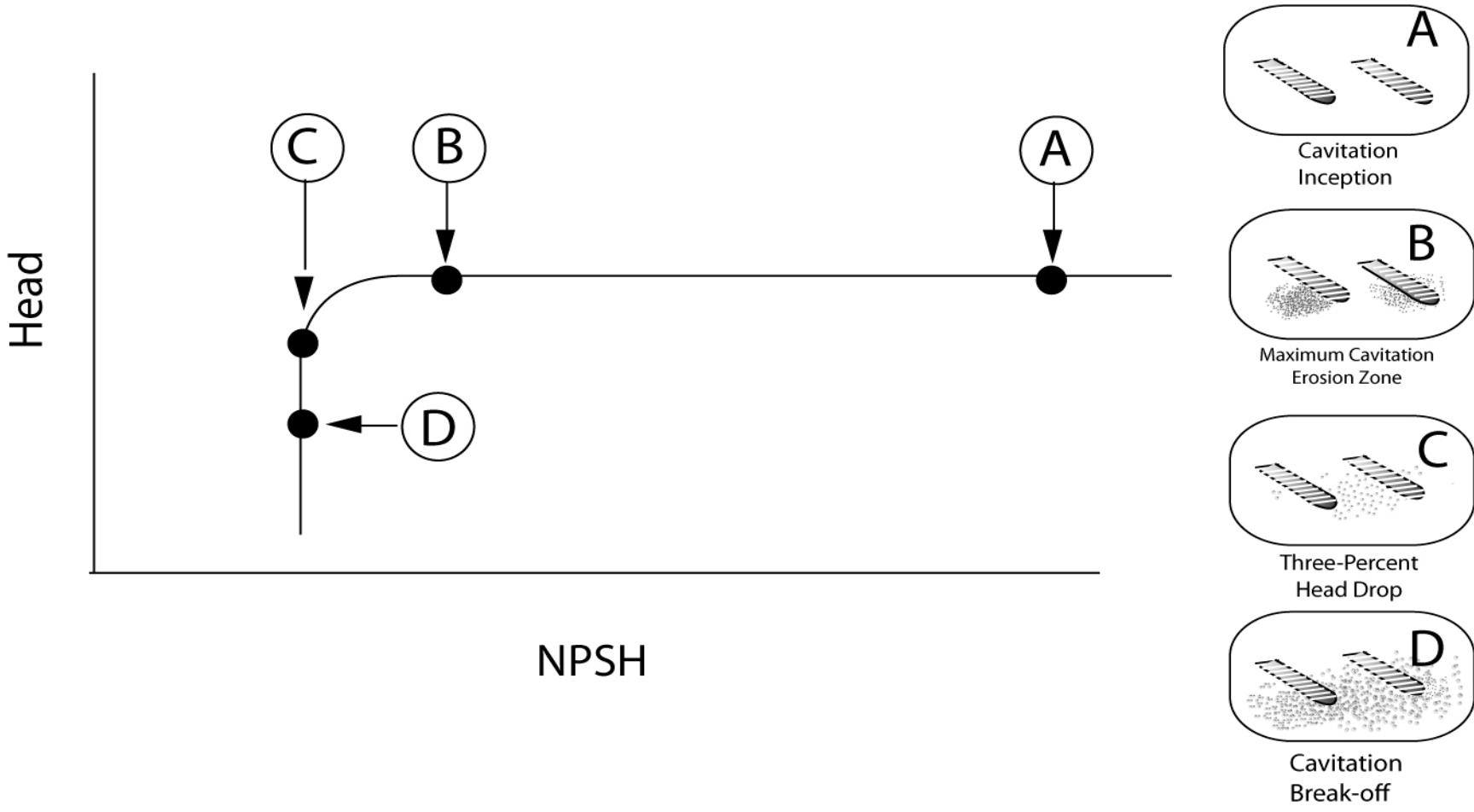
NPSHR Uncertainty Guidance

- Designate new parameter $\text{NPSHR}_{\text{eff}}$
 - $\text{NPSHR}_{\text{eff}} = (1.0 + \text{uncertainty}) \text{ NPSHR}_{3\%}$
- Staff requests licenses to determine value of $\text{NPSHR}_{\text{eff}}$
- $\text{NPSHR}_{\text{eff}}$ should be used in determining NPSHR margin and NPSH ratio for LOCA
- For nondesign basis events, $\text{NPSHR}_{3\%}$ may be used for required NPSH
 - Consistent with current staff guidance for nondesign basis events

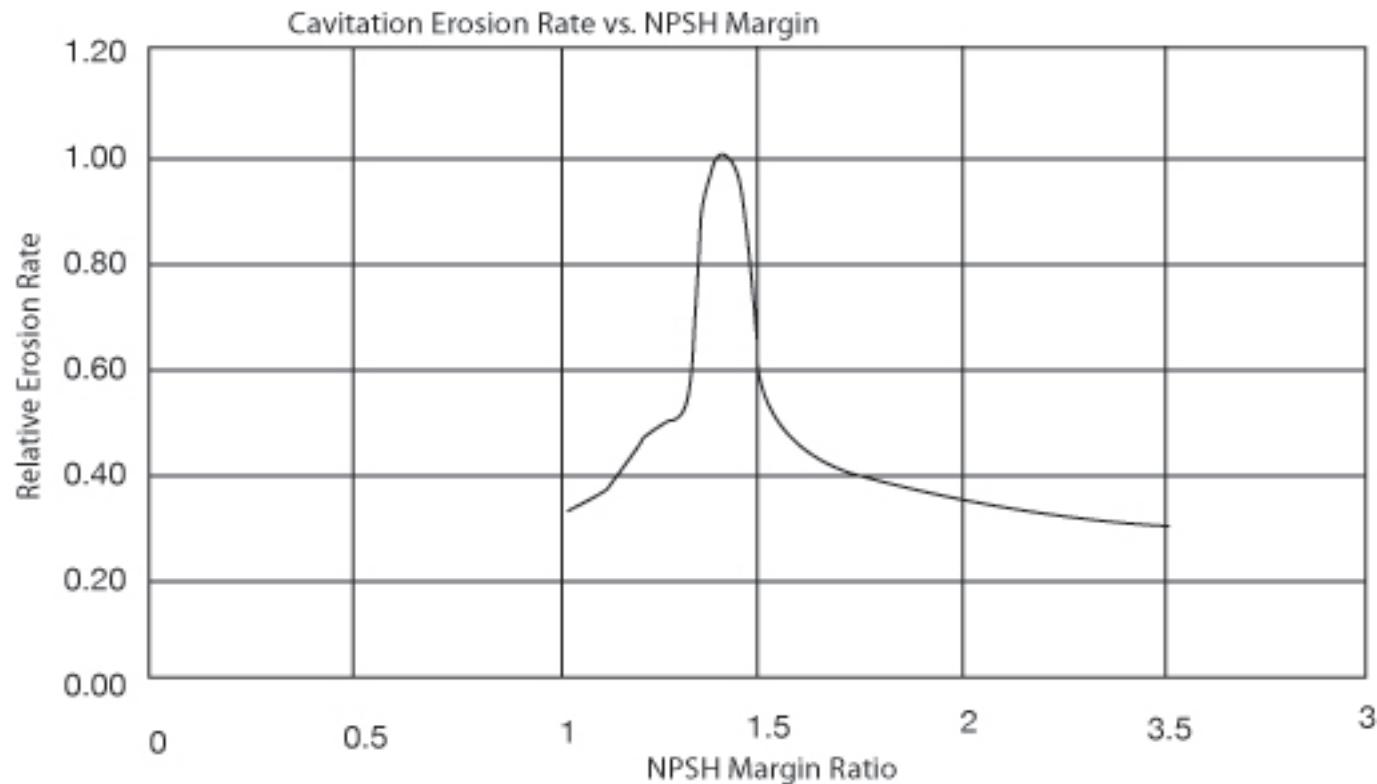
Cavitation Erosion

- Maximum cavitation erosion occurs between incipient cavitation and NPSHR_{3%}.
- Only high and very high suction energy pumps will experience cavitation erosion damage in this zone.
- Using a typical curve of pressure transducer measurements of cavitation, the staff determined that the maximum erosion zone is between NPSH margin ratios of 1.2 and 1.6.
- Based on the failure history of very high suction energy pumps, the staff conservatively selected a limit of 100 hours for very high suction energy pumps as the maximum allowable time for operation in the maximum erosion zone.
 - Pump must continue to function for the remainder of its mission time (up to 30 days)
 - The pump would be at higher available NPSH values (out of maximum erosion zone) during post-accident operation

Cavitation Behavior Based on Impeller Voiding

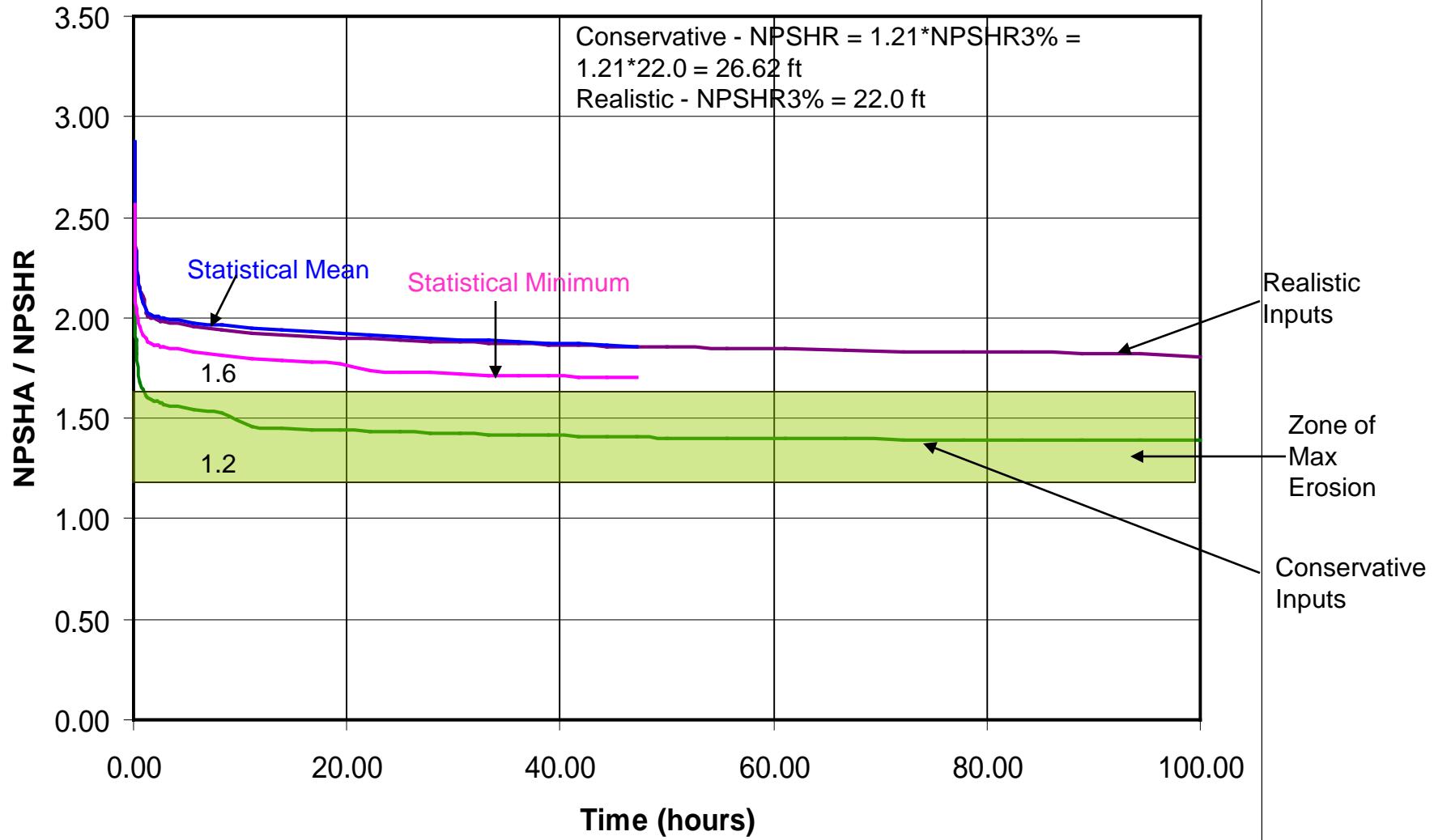


Cavitation Acoustic Signal



Typical Relative Erosion Rate vs. NPSH Margin near BEP Flow Rate

NPSHA / NPSHR Ratio for RHR Pumps and Zone of Maximum Erosion



NPSHA < NPSHR

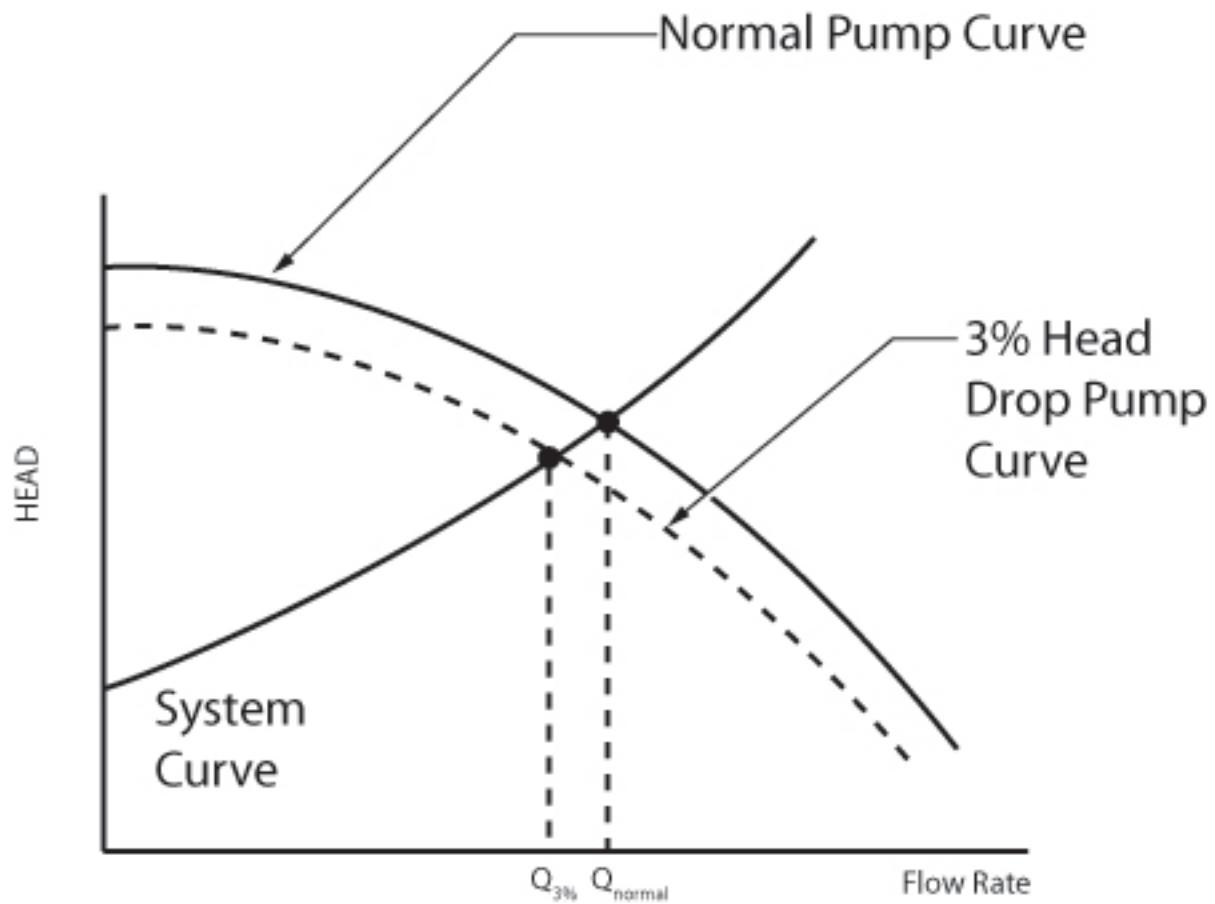
- It is possible that the predicted available NPSH for an event may be less than the required NPSH.
- RG 1.82 Revision 3 states that predicted operation with $\text{NPSHA} < \text{NPSHR}$ is acceptable if testing shows that the pump will continue to perform its safety function.
- Staff has developed the following conditions which should apply to testing:
 - Time of predicted operation in cavitation less than 100 hours
 - Tests conducted on actual pump or important pump hydraulic properties the same
 - e.g., same model, size, impeller diameter
 - Tests conducted at same field speed
 - Test conducted with predicted NPSHA
 - Test should be for predicted time that $\text{NPSHA} < \text{NPSHR}$
 - Flow rate and discharge head remain above values assumed in core and containment cooling analyses
 - No damage or excessive wear to pump components

Protection of Mechanical Seals

- A concern with operating a pump at or below the 3% NPSHR condition is the damage that the water vapor and/or entrained air could do inside the pump to the mechanical shaft seal faces, which could fail in a very short time if the seal faces run dry.
- Excessive entrained air tends to accumulate around the shaft, where the mechanical seal is housed.
- This additional entrained air comes from the dissolved air that comes out of solution as local static pressure drops to the vapor pressure and cavitation vapor bubbles are formed.
- To protect the mechanical seal faces from this excess entrained air (under operation at or below the 3% NPSHR condition), dual mechanical seals with an external cold water flush system (or equal) should be provided.
 - A pump with a single seal should be equipped with a throttle (disaster) bushing and with a flush line from the pump discharge to the mechanical seal chamber.
- Over the long term, vibration due to cavitation also reduces seal life

Pump Flow Rate

- The flow rate chosen for the NPSH analysis should be greater than or equal to the flow rate assumed in the safety analysis that demonstrates adequate core and containment cooling
- If the assumption that $NPSHA = NPSHR_{eff}$ is used to determine the containment accident pressure used, then the pump flow rate used in the core and containment cooling analyses should be the flow rate resulting from a 3% decrease in pump total dynamic head



Duration of Need for Containment Accident Pressure

- Staff concludes that a limit on the duration of use of containment accident pressure is not needed.
 - Not supported by risk analysis
 - Would be arbitrary (no technical basis)
- Staff has proposed a time limit in zone of maximum erosion rate of 100 hours

Reducing Containment Pressure by Cooling the Containment Atmosphere

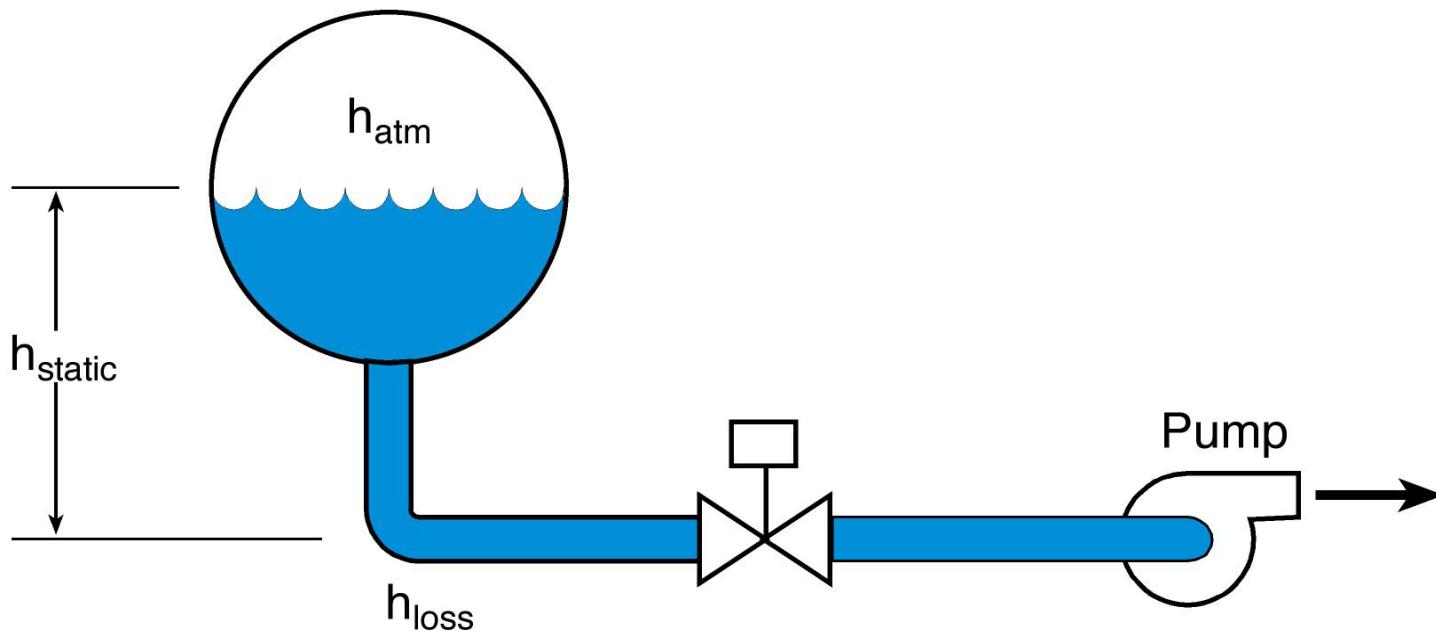
- Licensee analysis should demonstrate that operation of sprays or fan coolers will not cause containment accident pressure to be less than that needed for adequate available NPSH.
 - BWR procedures contain a caution to this effect.
- Operator actions to control containment pressure are acceptable, if justified.
 - Human factors review
 - Actions consistent with procedures
- Containment pressure calculations should be consistent with or conservative to plant procedures.
 - e.g., spray operation rather than suppression pool cooling assumed in BWR NPSH analyses
- Operator error
 - Operator errors (omission/commission) are not considered in design basis and special event analyses

Alternatives to Use of Containment Accident Pressure for NPSH margin

- Staff will request licensees to address the practicality of methods of avoiding use of containment accident pressure in determining NPSH margin

Available NPSH

$$\text{Available NPSH} = h_{\text{atm}} + h_{\text{static}} - h_{\text{loss}} - h_{\text{vp}}$$



Containment Integrity

- Containment integrity is assumed in LOCA and special event analyses
 - Accident analyses verify no containment limits are exceeded for design basis and special events
 - Appendix J leakage rate testing and visual inspection
 - 10 CFR 50.55a(2)viii and ix containment inservice inspection
 - Technical Specifications requirements (e.g., valve position verification)
 - Plant Procedures
 - History of containment integrity
 - Proposed staff guidance to implement a surveillance to ensure containment leakage rate less than that necessary to ensure adequate NPSH margin

Proposed Containment Leakage Rate Surveillance

- To reduce the likelihood of a preexisting leak, licensees proposing to use containment accident pressure in determining NPSH margin should:
 - (i) Determine the minimum containment leakage rate sufficient to lose the containment accident pressure needed for adequate NPSH margin.
 - Staff calculations predict this would be 40La.
 - (ii) Propose a method to determine if the actual containment leakage rate exceeds the leakage rate determined in (i) above.
 - For inerted containments, this method could consist of a periodic quantitative measurement of the nitrogen makeup performed at an appropriate frequency to ensure that no unusually large makeup of nitrogen occurs.
 - Monitoring oxygen content is another method.
 - For subatmospheric containments, a similar procedure might be used.
 - (iii) Propose a limit on the time interval that the plant operates when the actual containment leakage rate exceeds the leakage rate determined in (i) above.

Available NPSH (NPSHA) and Containment Analysis

- To determine available NPSH we must know:
 - containment pressures (drywell and wetwell)
 - containment temperatures (BWR drywell and wetwell atmospheres and suppression pool water)
 - water level above the pump suction
- Calculated with containment thermal hydraulic analysis code
- Staff guideline: Two calculations should be done to demonstrate margin in available NPSH:
 - Conservative or Monte Carlo lower tolerance limit (95/95)
 - Realistic

NPSHA Conservative Calculation

- Conservative calculation uses bounding values or technical specification limiting conditions for operation for important parameters.
- BWROG Topical Report NEDC-33347P describes an acceptable method of performing conservative calculations for BWRs.
- Computer code may or may not have a conservative bias
- Conservative calculation does not explicitly quantify margin

NPSHA Monte Carlo Method

- BWROG topical report NEDC-33347-P, “Containment Overpressure Credit for Net Positive Suction Head (NPSH),” proposes to use a Monte Carlo statistical method which would quantify margin between a specified tolerance limit and the conservative calculation
- Method attaches a statistical measure to a variable $H_{ww} = (P_{ww} - P_{vapor})/\rho g$ which is the portion of the equation for NPSHA calculated by containment code.
 - P_{ww} is the wetwell pressure and P_{vapor} is the vapor pressure of the suppression pool water.
 - Statistical limits attached to H_{ww} .
 - $NPSHA = H_{ww} + H_{static} - H_{loss}$

NPSHA Realistic Calculation

- Realistic calculation uses nominal (expected) values where possible.
- Where nominal values are not available, bounding values are used, e.g.:
 - Head loss across suction strainers
 - Service water temperature

NPSHA Staff Calculations

- NRC Staff performed calculations using the GOTHIC (Generation of Thermal Hydraulic Information) computer code, Version 7.2a.
- GOTHIC is a general purpose thermal hydraulics computer code for analysis of nuclear power plant containments and other confinement buildings.
- Solves conservation of mass, energy and momentum for multi-component, multi-phase flow.
- Interface models allow for thermal non-equilibrium between phases and unequal phase velocities.
- Subject to requirements of 10 CFR Part 50 Appendix B

NPSHA Sensitivity Studies

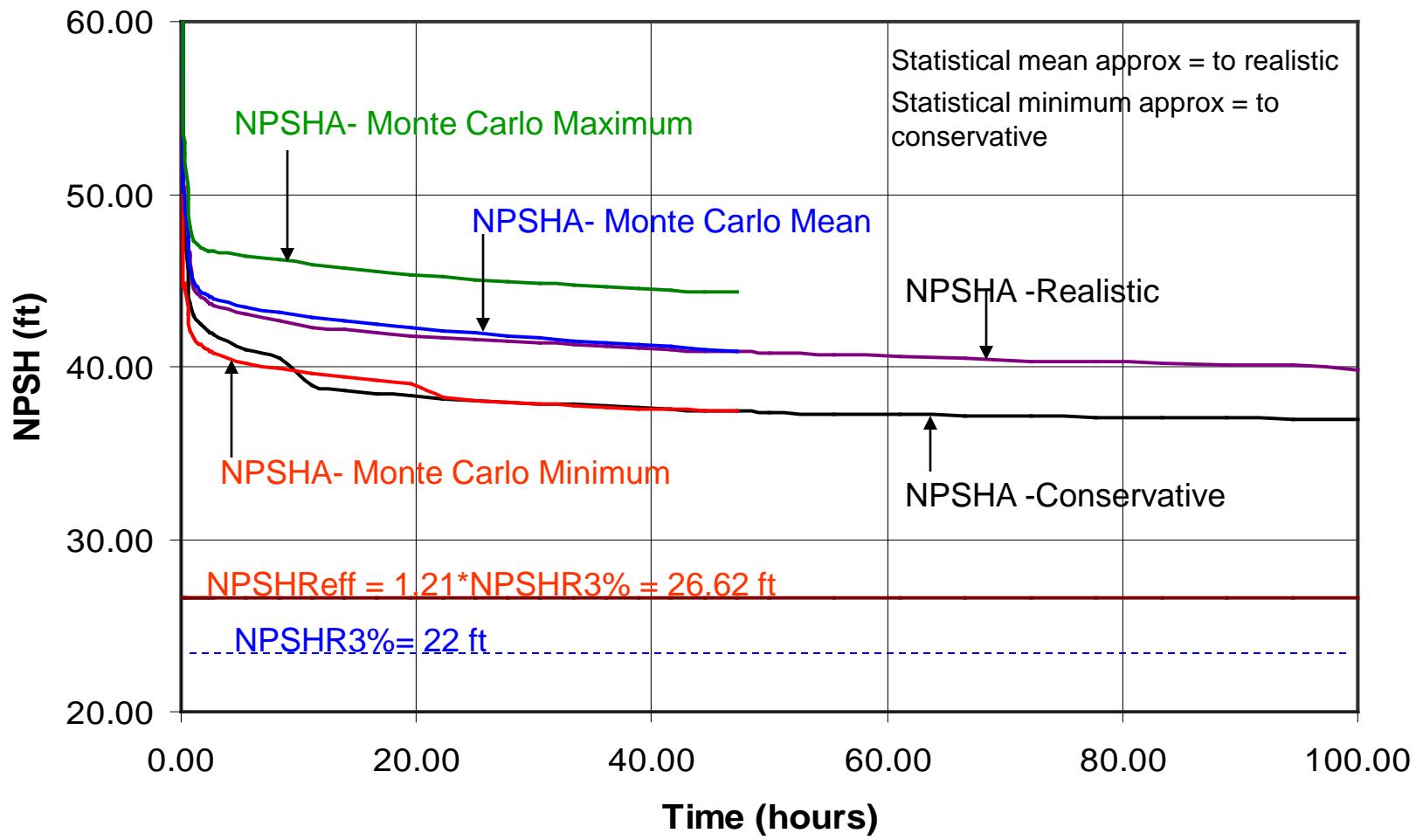
- Staff performed sensitivity studies of input variables to NPSH calculation for a LOCA in a BWR/4 with a Mark I containment
- Each variable varied by 5%.
- Conservative inputs used for base case (except 100% power instead of 102%)

BWR-4 MARK I CONTAINMENT LONG TERM LOCA NPSH ANALYSIS SENSITIVITY STUDY

RESULTS SUMMARY

No	Parameter	Base Value	Compared Value	Change in Parameter Value (%) (Note 1)	Maximum Change in Supp Pool Temp (%)	Maximum Change in Wetwell Pressure (%)	Maximum Change in Available NPSH (%)
1	Power (percent)	100	95	-5	-2.34	-5.47	-4.24
2	Core Spray Flow (gpm)	3027	2876	-5	-0.17	1.12	2.67
3	Initial Drywell Pressure (psia)	14.26	14.97	5	-0.1	2.02	2.53
4	Initial Wetwell Pressure (psia)	14.26	14.97	5	-0.2	2.16	2.32
5	Initial Supp Pool Temp (deg F)	90	85.5	-5	-2.93	-3.89	-2.27
6	Service Water Temperature (deg F)	90	85.5	-5	-2.63	-3.83	-2.26
7	RHR HX K-Value (Btu/sec deg F)	147	139.65	-5	2.76	4.89	2.14
8	Initial Drywell Temperature (deg F)	135	128.25	-5	-0.12	1.58	2.02
9	Initial Torus Liquid/Volume Ratio	0.3858	0.4051	5	-1.82	-3.67	1.29, -0.96
10	Reactor thermal conductors area reduced by 5%	100%	95%	-5	-0.38	-1.11	-0.98
11	Drywell Spray Flow	3800	3610	-5	-0.08	0.77	0.88, -0.22
12	Strainer & Piping Loss (ft)	5.79	5.5	-5	0	0	0.78
13	Initial Drywell Relative Humidity (%)	100	95	-5	-0.09	0.44, -0.72	0.67, -0.76
14	Wetwell Spray Flow	200	190	-5	-0.01	0.34, -0.08	0.54, -0.09
15	Decay Heat (sigma)	2	1.9	-5	-0.12	-0.22	0.21, -0.45
16	Containment Leakage (Weight%/day)	1.2	1.26	5	0.01, -0.03	0.12, -0.14	0.16, -0.17
17	Decay Heat (sigma)	2	0		-4.36	-8.14	-5.04
18	Containment Leakage (Weight%/day)	1.2	6.0	500	-0.02	-2.31	-2.86
19	Passive Heat Sinks	Present	Absent	-	1.31	2.12, -0.15	1.52, -0.03
20	Heat Transfer Coefficient for Containment Heat Sinks	Empirical	Heat & Mass Transfer Analogy	-	0.31, -0.01	0.08, -3.34	0.13, -3.65

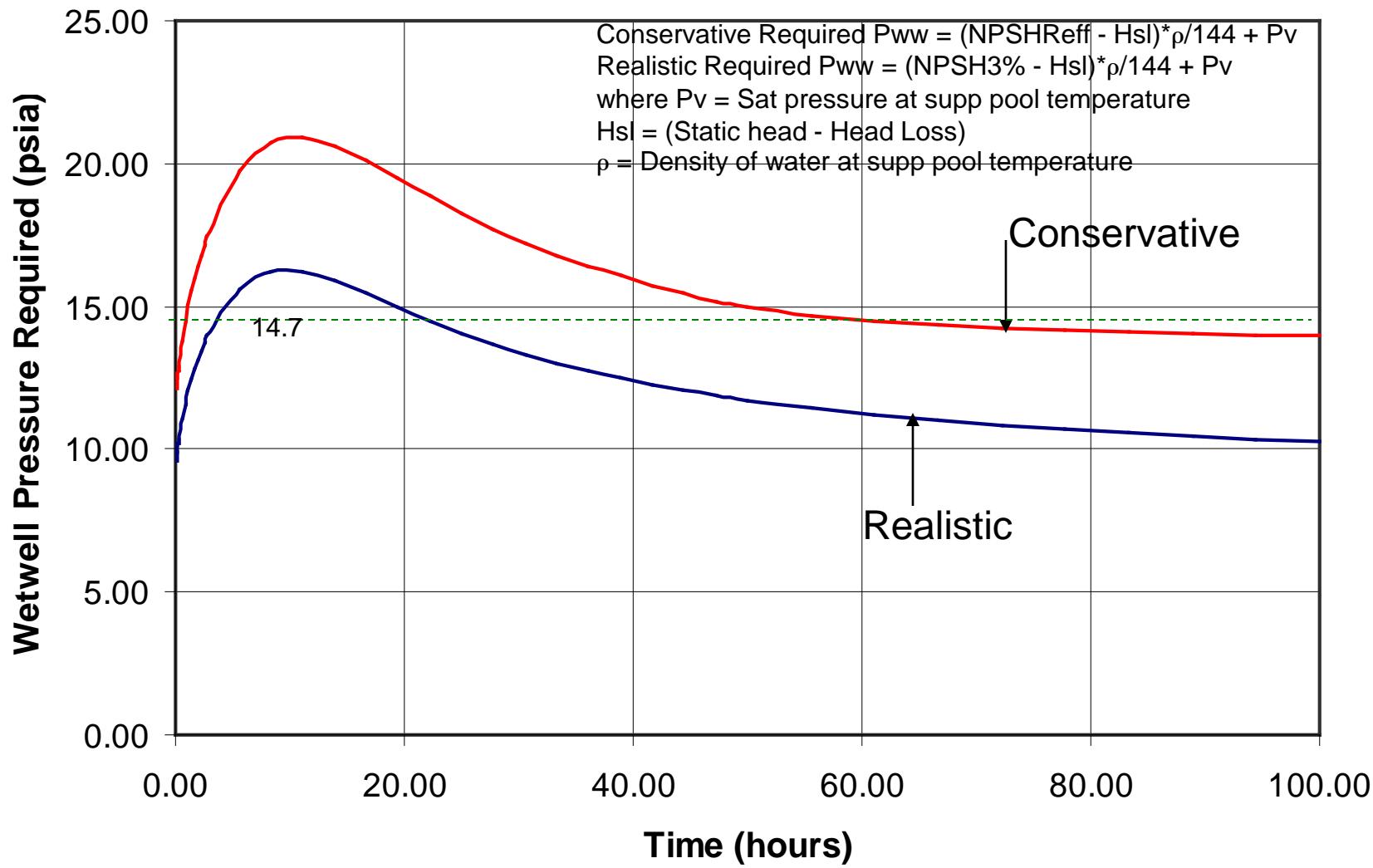
NPSHA and NPSHR for RHR Pumps from LB LOCA Statistical, Conservative and Realistic Analyses



NPSHA Quantification

- Staff calculations for BWR/4 with Mark I containment show that the conservative calculation is approximately equal to statistical minimum (95/95).
 - This provides an approximate quantification of the conservative calculation.
- Staff calculation shows that realistic calculation approximately equal to the statistical mean.
 - This provides an approximate quantification of the realistic calculation.

Wetwell Pressure Required for RHR Pumps Based on Conservative and Realistic NPSH Analysis



Conclusions from NPSHA Calculations

- The realistic NPSHA calculation agrees closely with the statistical mean calculation of NPSHA
- The conservative calculation agrees closely with the Monte Carlo lower tolerance limit (95/95) calculation
- Staff guidance states that a realistic calculation of NPSHA should be performed and compared with either the conservative or Monte Carlo lower tolerance limit calculation to indicate margin in the NPSHA values.
- Staff guidance also states that the appropriate NPSH margin should be determined for each event for which containment accident pressure is used.
- Since margin is included in the conservative NPSHA calculation and $NPSHR_{eff}$ there is no recommendation of a margin between NPSHA and $NPSHR_{eff}$.

Comparison of Staff (GOTHIC) and GE (SHEX) calculations

Typical BWR/4 Mark I

Parameter	GOTHIC	SHEX
<u>Short Term Containment Pressure & Temperature Response Analysis</u>		
Peak DW Pressure (psig) (LB LOCA analysis)	40.7	44.1
Peak DW Gas Temp (°F) (SSLB analysis)	334	338
<u>Long Term Suppression Pool Temperature Response Analysis</u>		
Peak SP Bulk Temp (°F) (LB LOCA Analysis)	199.5	203
<u>Long Term NPSH Analysis</u>		
Peak SP Bulk Temp (90°F) (LB LOCA Analysis)	202.5	207.1

Summary

- Containment integrity is assumed.
 - based on the rigorous requirements for containment integrity (regulations, technical specifications, procedures) and based on risk insights
- Staff guidelines focus on pump performance to ensure that ECCS and containment heat removal pumps are capable of performing their safety function(s)
 - NPSHA and NPSHR uncertainties quantified
 - Staff guidelines quantify margin
 - Between realistic and conservative NPSHA
 - Between NPSHA and NPSHR
- Quantitative guidelines are proposed
 - For LOCA: NPSH margin with uncertainty
 - demonstrates adequate pump performance
 - For non-LOCA events, NPSH margin without uncertainty demonstrates adequate pump performance
 - demonstrates adequate pump performance
 - consistent with current staff guidance for nondesign basis events