Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
ABWR Subcommittee: Open Session

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Tuesday, October 4, 2011

Work Order No.: NRC-1181 Pages 1-223

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

\+ + + + +

ABWR SUBCOMMITTEE

\+ + + + +

OPEN SESSION

\+ + + + +

TUESDAY,

OCTOBER 4, 2011

\+ + + + +

ROCKVILLE, MARYLAND

\+ + + + +

The Subcommittee convened at the Nuclear Regulatory Commission, Two White Flint North, Room T2B1, 11545 Rockville Pike, at 8:30 a.m., Said Abdel-Khalik, Chairman, presiding.

SUBCOMMITTEE MEMBERS PRESENT:

SAID ABDEL-KHALIK, Chairman

J. SAM ARMIJO

DENNIS C. BLEY *

CHARLES H. BROWN, JR.

JOHN W. STETKAR

WILLIAM J. SHACK

CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

GRAHAM B. WALLIS

NRC STAFF PRESENT:

MAITRI BANERJEE, Designated Federal Official

GEORGE WUNDER

DINESH TANEJA

DONALD DUBE

ED FULLER

MARK TONACCI

ALSO PRESENT:

SCOTT HEAD

CAROLINE SCHLASEMAN

JIM TOMKINS

TIM ANDREYCHEK

MARTIN VAN HALTERN

STEVE THOMAS

TOM DALEY

* Present via telephone.

T-A-B-L-E O-F C-O-N-T-E-N-T-S

T-A-B-L-E O-F C-O-N-T-E-N-T-S

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

8:28 a.m.

CHAIR ABDEL-KHALIK: The meeting will now come to order. This is a meeting of the ABWR Subcommittee of the Advisory Committee on Reactor Safeguards. I'm Said Abdel-Khalik, Chairman of the Subcommittee.

ACRS Members in attendance are Charlie Brown, Bill Shack, Sam Armijo and John Stetkar.

Dennis Bley will also be joining us by phone.

MEMBER BLEY: I'm already here.

CHAIR ABDEL-KHALIK: Thank you, Dennis. Our consultant, Graham Wallis, is also in attendance. MS. Maitri Banerjee is the Designated Federal Official for this meeting.

As announced in the Federal Register on October 3rd, we are scheduled to discuss resolution of several issues raised during previous ABWR Subcommittee meetings.

Some of these issues relate to the long-term core cooling aspect of the staff Safety Evaluation Report on the COL Application submitted by the Nuclear Innovation North America for two ABWR units at their STP site in Texas.

The rules for participation in today's meeting were announced in the Federal Register for an open/closed meeting. Parts of this meeting will be closed to the public to protect proprietary and security-related information. I'm asking the NRC staff and the applicant to verify that only people with the required clearance and a need-to-know are present before we enter in such discussions.

We have a telephone bridge line for the public and stakeholders to hear the deliberations. This line will not carry any signal from this end during the closed portions of the meeting.

Also, to minimize disturbance, the line will be kept in a listen-in-only mode until the end of the meeting when time will be allocated for public comments. At that time, any member of the public attending this meeting in person or through the bridge line can make a statement or provide comments, if they desire.

As the meeting is being transcribed, I request that participants in this meeting use the microphones located throughout the room when addressing the Subcommittee. Participants should first identify themselves and speak with sufficient clarity and volume, so that they can be readily heard.

We will now proceed with the meeting and I call upon Mr. George Wunder of NRO to begin the presentation. George?

MR. WUNDER: Thank you, Mr. Chairman. We have no introductory remarks for the staff and we don't really have a planned staff presentation. It's -- we would like to turn it over to you to, you know--

CHAIR ABDEL-KHALIK: Okay. At this time, I would like to call on the applicant. Scott?

MR. HEAD: Thank you, Mr. Chairman. Appreciate this opportunity to brief you on this topic. And as George alluded to, we do have some open items, follow-up items that we would like to discuss with you today.

The presenters have all presented these topics before to you and they will be involved again today.

The agenda we would like to talk about, we want to talk the action items that came out of the June 21, 2011 meeting and then we want to review Action Item #47(a) with respect to certain aspects of that and the potential closure. And obviously, we will be discussing our response to each item.

This morning we are going to talk about Action Item #98, which is the Strainer Screen Loading topic; Action Item #99 the Zinc Oxide Concentration, some clarification there; Action Item #80 was pressure drop vs. the relationship to the exponent; and then, like I mentioned, #47 is an older one and it's a Briefing on the Downstream Fuel Test and the Analysis. We want to revisit that one if we can.

With that, I'm going to turn it over to Caroline.

MS. SCHLASEMAN: Good morning. This is Caroline Schlaseman with MRP Associates and representing Toshiba. I'm addressing Action Item #98 and there are -- the action item is listed here on the slide to address the modeling of perforated strainer screen loading and also to provide evidence that there will be no local damage due to the strainer pockets due to the loads imposed during the hydrodynamic loads of vent clearing, condensation bubble collapse and condensation oscillation.

Next slide, please. This slide has a brief recap of where we were and what I presented during the June 21st meeting. And, basically, that meeting addressed the entire methodology for how do you determine the hydrodynamic loads on the cassette-type strainer.

The hydrodynamic loads are defined by

Toshiba in accordance with the DCD-prescribed methodology and those are included in the ASME Design Specification.

The loads are then combined in accordance with the DCD Tier 2 Table 9.8-12 and they are applied to the Finite Element model of the strainer to determine the stresses and the different elements of the strainer, including the perforated sheets, the flange plates and the internal ribs.

The resulting membrane, local membrane, membrane + bending stresses are compared to ASME Code allowable stresses in Section III for the Service Levels A, B, C and D allowables for the limiting combinations as applicable.

CONSULTANT WALLIS: Does the ASME Code tell you what to do about perforated surfaces?

MS. SCHLASEMAN: We didn't discuss that during the June 21, that's the main part of this presentation, so I'm going to get to that on the next slide.

CONSULTANT WALLIS: I just wondered, does the ASME Code address that or does it just address continuous --

MS. SCHLASEMAN: It does actually. The methodology that we use is ASME Code. But I'm --

CONSULTANT WALLIS: And the ASME Code does address perforated surfaces?

MS. SCHLASEMAN: Correct.

CONSULTANT WALLIS: Yes.

MS. SCHLASEMAN: There is an appendix, a non-mandatory appendix that addresses --

CONSULTANT WALLIS: Okay.

MS. SCHLASEMAN: -- perforated plate.

CONSULTANT WALLIS: Okay.

MS. SCHLASEMAN: And then there is also an ITAAC that is going to confirm that the ASME Code Design Report exists for all the ASME components. And we have chosen to -- even though these are not pressure-retaining components, we have chosen to designate them and N-stamp them in accordance with the code. So, you know, our ECCS suction strainers are going to have ASME Code Design Stress Report and will be N-stamped in accordance with the code.

Next slide. So the second part, it's a little backwards, but, because there were two sentences in the question, the action item, the second part of it was providing evidence that there is no local damage due to the hydrodynamic loads.

And the proof ultimately, after running through the methodology for developing the hydrodynamic loads for doing the load combinations comparing them with ASME service levels, stress allowables, is going to be satisfied by showing that the local membrane stresses in the perforated sheets meet the ASME Code stress allowables.

The second part or excuse me, well, the first part, the topic that I'm going to discuss this morning is how then do we model the strainer pockets, which are sheet metal and they have -- they are not -- they are metal sheets. In fact, I have brought with me a sample that we are going to pass around.

And the -- when you see this, this is a 1.5 millimeter thick metal sheet and it has the holes machined into it that are the same size as was used for the referenced Japanese plant high-pressure core flooder strainers. And so this is the same material that is going to be used. This is 304 stainless steel and the geometry is the same as will be used for the STP 3 and 4 strainers, because they are identical to the -- they are almost the same as the referenced Japanese ABWR high-pressure core flutter and for RHR also, a similar design.

He's gone, so --

CONSULTANT WALLIS: Well, there's another part to this. It's not just ASME. I mean, you have to determine the stresses by doing some fluid-structure interaction analysis, right?

MS. SCHLASEMAN: The --

CONSULTANT WALLIS: And I'm not sure how that is done.

MS. SCHLASEMAN: That was discussed in the previous meeting.

CONSULTANT WALLIS: But it wasn't really-- there were no details really given.

MS. SCHLASEMAN: That's the --

CONSULTANT WALLIS: The question is -- these are perforated plates, they are not solid. I think it's well-known what to do with solid surfaces, but how --

MS. SCHLASEMAN: Right.

CONSULTANT WALLIS: -- do you treat solid fluid --

MS. SCHLASEMAN: Perforated sheets.

CONSULTANT WALLIS: -- interaction when there is a perforated surface?

MS. SCHLASEMAN: Okay.

CONSULTANT WALLIS: Are you going to test discuss that or not?

MS. SCHLASEMAN: Yes. Yes. Well, here we will see if there is any questions when I get through the end of this presentation.

CONSULTANT WALLIS: Okay. Sure.

MS. SCHLASEMAN: Obviously, it is -- when you do the Finite Element Analysis, the individual holes are not modeled.

CONSULTANT WALLIS: No.

MS. SCHLASEMAN: And so it's modeled as a flat -- well, it's curved, but it's as a solid sheet. ASME Code has a non-mandatory appendix, A-8000, which provides the methodology for determining the -- how to evaluate the stresses in the perforated sheet. And because, like I said, the model will be a solid sheet.

Two parts of the methodology. The first part is where you modify the elastic constants, the Young's modulus and the Poisson's ratio, and that's to make sure that you have an appropriate stress distribution in your Finite Element model, which is a solid model.

And then the second part is you go ahead and you ratio the resulting stresses. You increase them to account for the missing material.

CONSULTANT WALLIS: So E*/E means that you modify the effective modulus?

MS. SCHLASEMAN: That's correct.

CONSULTANT WALLIS: Because of the holes.

MS. SCHLASEMAN: That's correct. So instead of being about 30 million psi, it's like about nine million psi.

CONSULTANT WALLIS: So it's considerably less. It's more --

MS. SCHLASEMAN: Correct.

CONSULTANT WALLIS: -- stretchy.

MS. SCHLASEMAN: Yes, because it's a weaker plate.

MEMBER SHACK: Yes, you change the modulus, so you get the displacements right and then you --

CONSULTANT WALLIS: But then you have got --

MEMBER SHACK: -- adjust the stresses.

CONSULTANT WALLIS: Right. And then you presumably get stress concentrations in this matrix, too, of some sort. Yes, okay.

MS. SCHLASEMAN: So then you end up increasing the stresses from the Finite Element model by almost a factor of three. Are we okay on the --

CONSULTANT WALLIS: What do you do about flaws created in the --

MS. SCHLASEMAN: -- method?

CONSULTANT WALLIS: -- manufacture of this thing? How is this made? How is this strainer made?

MS. SCHLASEMAN: It's machined.

CONSULTANT WALLIS: And when they punch holes, do they make flaws around the circumference of the holes?

MS. SCHLASEMAN: It's an ASME Code.

CONSULTANT WALLIS: Well --

MS. SCHLASEMAN: It's a -- the QA program for CCI has to confirm that the --

CONSULTANT WALLIS: With no flaws?

MS. SCHLASEMAN: -- plate meets the spec.

CONSULTANT WALLIS: Does the ASME tell you anything about how to treat flaws in this material?

MS. SCHLASEMAN: No.

CONSULTANT WALLIS: So it's assumed there aren't any?

MEMBER SHACK: It's 304, so it's --

CONSULTANT WALLIS: Right.

MEMBER SHACK: -- this is about as flaw-tolerant as a material gets.

CONSULTANT WALLIS: It's how they make it, isn't it? How they make it. If they make it brutally -- how do they make it? They punch these holes?

MEMBER ARMIJO: No, they are drilled, it looks like.

CONSULTANT WALLIS: The holes?

MEMBER SHACK: No, I'm sure they are machined.

CONSULTANT WALLIS: Machine them.

MS. SCHLASEMAN: Machined.

CONSULTANT WALLIS: They are machined. Well, these guys have burrs on them.

MS. SCHLASEMAN: Well, the one side.

MEMBER ARMIJO: Yes.

MS. SCHLASEMAN: It's --

CONSULTANT WALLIS: Okay.

MS. SCHLASEMAN: -- rough.

CONSULTANT WALLIS: I'm just trying to cover the basis here.

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: Okay.

MR. TOMKINS: Next slide?

MS. SCHLASEMAN: Next slide. The methodology in the ASME Code lists five criteria for what the geometry and the other considerations that apply to using this methodology.

The fifth criterion is a criterion that the plate thickness to the hole ratio has to be a ratio of 2 and our thickness is about a half. And so, you know, we went back to CCI on whether or not -- how they had confirmed that this methodology was appropriate for metal sheet as opposed to tube sheet like for a heat exchanger. The thick plate that the ASME Code, without any further justification, you would be able to use if you met the tube criterion.

So their response is, obviously, this came up in the past, this came up for the referenced Japanese plant and Toshiba had pressed them on this point to find out, you know, why this methodology is appropriate to use for the metal sheet.

And they -- and in addition to that, there are reports on the testing work that was done to originally confirm this methodology to set what the changes to the elastic constants are. There is a variability in how the material -- in how the perforated plates perform after you get below that ratio of 2 and then the transition region and then where the sheets are.

And so at the sheets, this methodology does apply and that was confirmed by going to the methodology, this Handbook for Perforated Metals. It's based on testing by William O'Donnell that is also the basis for the ASME Code methodology. And then in addition to that, CCI did some testing to confirm that the use of this methodology would be appropriate, that there wouldn't be something unexpected for use in this ASME methodology.

In other words, if you go ahead and prove to yourself analytically that there should be no deformation, they went back and tested to confirm that there would be no damage to the sheets using this methodology, that it would pass code.

So the testing that they did, it's based on multiples of the maximum stress that was defined for the referenced Japanese plant. And that that reference -- excuse me. The limiting load combination for the referenced plant is about half a bar, that's 7.25 psi, and that's due to a hydrodynamic load combination of chugging plus SRV plus the --

CONSULTANT WALLIS: How do you apply this pressure?

MS. SCHLASEMAN: It's a --

CONSULTANT WALLIS: How do you apply a pressure to a porous surface? I don't quite understand.

MR. HEAD: We will show you in just a second.

MS. SCHLASEMAN: It's a -- oh, the test?

MR. HEAD: Yes.

MS. SCHLASEMAN: Well, okay.

MR. HEAD: We will show you that in just a second.

CONSULTANT WALLIS: Okay.

MS. SCHLASEMAN: And then it is tested for six different cycles. They start with twice that pressure and then they go to multiples up to four times that pressure. And then the next slide is an example of the figure that they sent us from their test.

So the red -- the first cycle is running up to two times what the maximum loading condition would be on the referenced Japanese strainer for the worst case limiting load combination.

And then they go and do increased multiples after that. And, basically, what they showed us -- what they told us, even though there seems to be a very, very slight delta between the initial start point of the test and then the final on the red line, but they said, basically, there was zero deformation at --

CONSULTANT WALLIS: What is this loop then? Why doesn't it go back the way it came?

MS. SCHLASEMAN: Because --

CONSULTANT WALLIS: If there is no deformation?

MR. HEAD: There is some deformation.

CONSULTANT WALLIS: Must be.

MR. HEAD: There is for the higher pressure.

MS. SCHLASEMAN: It's very, very small.

CONSULTANT WALLIS: They take it up to the point where it yields and then they bring it back.

MR. HEAD: Right.

CONSULTANT WALLIS: That's --

MS. SCHLASEMAN: Well, they are beyond yield.

MR. HEAD: Yes.

CONSULTANT WALLIS: So saying there is no deformation is not true.

MR. HEAD: That's at the --

MS. SCHLASEMAN: It's --

MR. HEAD: -- higher pressures.

MS. SCHLASEMAN: No. Well --

CONSULTANT WALLIS: Well, no. I see a yield envelope --

MS. SCHLASEMAN: From the first level.

CONSULTANT WALLIS: -- or something up there, don't I? Am I misunderstanding?

MS. SCHLASEMAN: Are you talking about the red line?

CONSULTANT WALLIS: Any of them.

MS. SCHLASEMAN: Or the other ones?

CONSULTANT WALLIS: They go up.

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: They bend and they come back a different line.

MS. SCHLASEMAN: That's correct.

CONSULTANT WALLIS: So they are deformed.

MS. SCHLASEMAN: And so you are in the in elastic range when you are up over -- you know, when you are past the one bar.

CONSULTANT WALLIS: The orange one, the first ones don't do much.

MR. HEAD: Right.

MS. SCHLASEMAN: Right.

CONSULTANT WALLIS: Okay. So there is sort of a yield surface or something up there or whatever.

MS. SCHLASEMAN: Well, you are at four times the design pressure when you are out on the cycle 5, the purple curve and then --

CONSULTANT WALLIS: I'm just trying to understand what is happening.

MS. SCHLASEMAN: -- you are more than that.

MR. TOMKINS: And that yield for the worst case is 1 millimeter.

CONSULTANT WALLIS: I understand. What is yielding? Is it yielding and bending or what? Which way is it yielding? You have to show me the test, because 1 millimeter doesn't mean anything unless I know 1 millimeter of what.

MS. SCHLASEMAN: Well, this is -- the purpose of this test is to confirm whether or not the application of the ASME Code methodology --

CONSULTANT WALLIS: But what is the test?

MS. SCHLASEMAN: -- makes sense.

CONSULTANT WALLIS: I don't understand the test.

MS. SCHLASEMAN: Go to the next slide. Go ahead.

CHAIR ABDEL-KHALIK: Before you go, what is the displacement in this graph? How is that defined? Is it global displacement to the plate or maximum displacement at the midpoint or differential displacement between holes or what -- how is displacement defined?

MS. SCHLASEMAN: I do not know. I did not find out what -- where their strain gauges were measured on this test, so I'm not sure. I would have to ask CCI.

CHAIR ABDEL-KHALIK: Well, if you show us whether -- the sample how it was tested and whether it is bending, you know, we will be able to figure that out. I just --

MS. SCHLASEMAN: Well --

CHAIR ABDEL-KHALIK: It's not -- it doesn't -- it's probably not a tensile test, right?

MS. SCHLASEMAN: We're going to show you in a minute.

CHAIR ABDEL-KHALIK: Okay.

MS. SCHLASEMAN: No, it's an internal pressure test. Go ahead.

CHAIR ABDEL-KHALIK: Concepts.

MS. SCHLASEMAN: Okay. That's just the pocket element.

CHAIR ABDEL-KHALIK: Yes.

MS. SCHLASEMAN: And the dimples that you are seeing in it are machined in. Those are what they call bowls and those are just to make the plate --

CONSULTANT WALLIS: How do you apply a pressure to it and what do you mean by --

MR. HEAD: Here it is.

CONSULTANT WALLIS: -- displacement?

MS. SCHLASEMAN: Here it is.

CHAIR ABDEL-KHALIK: Okay.

MS. SCHLASEMAN: Okay. So what they do is they go ahead and this is a pocket --

CONSULTANT WALLIS: Yes.

MS. SCHLASEMAN: -- from a strainer.

CONSULTANT WALLIS: Yes.

MS. SCHLASEMAN: There is solid plates on either side on the near side to you. There is a very little sliver of the perforated sheet that you can see on the front right corner, edged surface, vertical surface. Thank you, Tim.

MR. ANDREYCHEK: Yes.

CONSULTANT WALLIS: Just a sliver of the perforated?

MS. SCHLASEMAN: No, you can only see it.

MEMBER SHACK: It's from the --

MS. SCHLASEMAN: It goes all the way through.

MR. ANDREYCHEK: It is basically two parallel plates with the pocket that we saw on the previous slide inside the tabs that you saw on the edge --

MR. HEAD: See that shape?

MR. ANDREYCHEK: -- are actually the tabs sticking out along here. So you, basically, have solid surface on either side with perforated in the middle like a U as it were or a V.

CONSULTANT WALLIS: Yes.

MR. ANDREYCHEK: Supply water comes in here and so you pressurize the inside.

CONSULTANT WALLIS: And the water flows through the holes?

MR. ANDREYCHEK: That's correct.

CHAIR ABDEL-KHALIK: So these are solid?

MR. ANDREYCHEK: That's correct.

CONSULTANT WALLIS: So it's a static test?

MS. SCHLASEMAN: Correct.

CONSULTANT WALLIS: So you just pump -- as the pressure drops through the holes, it creates the fault?

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: And then how do you measure displacement?

MS. SCHLASEMAN: That's --

CONSULTANT WALLIS: You don't know?

MS. SCHLASEMAN: -- the part I'm not sure where their gauges are located. I couldn't see it from this photo and I should have asked.

MEMBER SHACK: It's probably an LVDT sticking off to the side there, so I'm sort of guessing that they are measuring the deflection in the middle of the plate, would be my --

MS. SCHLASEMAN: Yes.

CHAIR ABDEL-KHALIK: Expected to be the maximum.

MEMBER STETKAR: Given that's the only other connection.

MS. SCHLASEMAN: I don't know. I mean, it's an instrument. I mean, it's clearly an instrument that is measured, because you can't measure -- I mean, 1 millimeter is just too tiny.

CHAIR ABDEL-KHALIK: I mean, given the fact that some of these displacements are several millimeters, they are about an eighth of an inch, which is twice as thick as -- twice as much as the thickness of the plate. I would assume that this is sort of a midpoint deflection or something, rather than local deformation.

MS. SCHLASEMAN: Oh, you mean, during the test? Correct.

CHAIR ABDEL-KHALIK: Right.

MS. SCHLASEMAN: Yes.

MEMBER SHACK: Is this the dimension of an actual pocket or is this just a -- this is just set up to verify the analytical model or is this the actual dimensions of a pocket?

MS. SCHLASEMAN: This would be representative. The pockets come in different sizes. Like for the RHR strainer and the high-pressure core flooder strainer, they are different sizes, because the overall dimensions of the strainers are different. But I would say that this is comparable or it is typical of the size of a standard pocket.

MR. TOMKINS: And this is really only designed to make sure that the way we are accounting for the holes is valid.

MS. SCHLASEMAN: Right.

MR. TOMKINS: Really the purpose of this test.

CONSULTANT WALLIS: So do you know how the pocket is made? In the pocket, you have to take this stuff, you have to cut it, you have to bend it, you have to weld it or something. There is all kinds of things that could fail, presumably. Are there welds in there or what? I'm just wondering how representative this is of a real pocket.

MS. SCHLASEMAN: The --

MR. HEAD: The purpose of this test is to confirm --

MS. SCHLASEMAN: That the methodology for confirming that the stresses in the holes --

CONSULTANT WALLIS: The effect of E and all that stuff.

MS. SCHLASEMAN: Right.

MR. TOMKINS: Yes.

CONSULTANT WALLIS: Yes, okay.

MS. SCHLASEMAN: And then your amplification of the stresses to account for the missing hole material.

CONSULTANT WALLIS: And then the stress analysis of the pocket is a separate thing?

MR. TOMKINS: Yes.

MS. SCHLASEMAN: Yes.

MEMBER SHACK: Well, in this case, it's really to verify that your departure from the ASME Code isn't really --

MS. SCHLASEMAN: Yes, yes.

MEMBER SHACK: -- causing the problem here.

MR. TOMKINS: Right.

MS. SCHLASEMAN: Right. It's the --

MR. HEAD: Because it's thinner.

MS. SCHLASEMAN: -- the methodology is valid.

MR. HEAD: It's thinner than what is in

the code.

CHAIR ABDEL-KHALIK: That's in the code?

MS. SCHLASEMAN: Right.

CONSULTANT WALLIS: This is a static test. Now, condensation oscillations and condensation is a big boom.

MS. SCHLASEMAN: Right.

CONSULTANT WALLIS: A big bubble collapse and a wave goes out.

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: And a wave hits this and water squirts through in a transient. A very quick squirt through the hole. That's quite different from your test, which is a static test.

MS. SCHLASEMAN: Right. And those are accounted for in the dynamic load factors.

CONSULTANT WALLIS: That's taken care of in some other analysis?

MS. SCHLASEMAN: Right. It's the initial loading to --

CONSULTANT WALLIS: I have never seen --

MS. SCHLASEMAN: It's --

MR. HEAD: And it's hitting a plate.

CONSULTANT WALLIS: You talked about it last time.

MS. SCHLASEMAN: It's in the report. It's in the design specification and in the ASME. Well, it's not an ASME Code. It's a JSME Code, but the stress report that CCI did for the RHR strainer for the referenced Japanese plant.

CONSULTANT WALLIS: RHR.

MR. TOMKINS: And that methodology is in the DCD and is approved and they follow that methodology.

CONSULTANT WALLIS: The standard methodology of some sort?

MS. SCHLASEMAN: Well, it was developed --

CONSULTANT WALLIS: That was one of my curiosities last time that you are not going to answer this time. So I have to -- I never got that. I never got that.

MS. SCHLASEMAN: Which one?

CONSULTANT WALLIS: The one that defines how they handle the transient load. I mean, the wave comes along and hits this, you know.

MS. SCHLASEMAN: The design specifications for the strainers.

CONSULTANT WALLIS: So --

MS. SCHLASEMAN: Each of the loads -- each of the hydrodynamic loads has a different methodology for establishing what it is. And it also is developed and presented in a different format.

CONSULTANT WALLIS: Okay.

MS. SCHLASEMAN: Some are time dependent, some are not.

CONSULTANT WALLIS: So did your lines that you showed in this graph verify the E* that you calculated?

MS. SCHLASEMAN: No.

CONSULTANT WALLIS: They didn't?

MS. SCHLASEMAN: These lines verify that it is appropriate to use the ASME methodology.

CONSULTANT WALLIS: Well, where is the comparison with the ASME methodology? The ASME says calculate E*.

MS. SCHLASEMAN: Right.

CONSULTANT WALLIS: Calculate nu* and then do an analysis. And I didn't see you verified anything until you've done that.

MS. SCHLASEMAN: The -- this test was to-- like I said, CCI had two parts to their approach to answering Toshiba's questions about whether or not since the ASME fifth criterion was not met, the geometry for the plate thickness was not met. How is it acceptable to use the ASME methodology, which is where you define there is a lot of test data that goes into defining --

CONSULTANT WALLIS: So what's the criterion for acceptability that is verified by this graph?

MS. SCHLASEMAN: The way this graph assures that it makes sense, that it's appropriate, is that the -- in the stress analysis report that CCI did for the referenced plant, they concluded that the JSME -- ASME is -- actually, it's slightly more conservative than ASME, but that the stress criteria for membrane plus bending, local membrane stresses, the criteria were met for this geometry for the maximum worst case pressure loading.

CONSULTANT WALLIS: And so what are the criteria? And why does this graph meet them?

MS. SCHLASEMAN: I'm trying to explain that.

CONSULTANT WALLIS: Okay.

MS. SCHLASEMAN: The -- so by proving that you meet the stress allowables in the JSME Code and the maximum stress that was evaluated was half a bar, so that's the peak load. That's the worst case load including all the hydrodynamic load factors. And then they ran a test to confirm that if you went to twice that value, you still stay within the elastic range.

CONSULTANT WALLIS: You don't.

MS. SCHLASEMAN: You have no permanent deformation, that's the one bar. And then to go ahead and check further, they went out and they went to four times that and, again, no damage to the perforated plate.

CONSULTANT WALLIS: So you are proving that they are within the elastic range? That's what you are proving? You are not verifying an E* or a nu* or any of those things?

MS. SCHLASEMAN: That's correct.

CONSULTANT WALLIS: Just proving it's in the elastic range, okay.

MS. SCHLASEMAN: Yes.

MEMBER ARMIJO: But wouldn't that be confirmed only if you can adequately or exactly duplicate the boundary conditions?

MS. SCHLASEMAN: The geometric boundary conditions?

MEMBER ARMIJO: Correct.

MS. SCHLASEMAN: Well, the geometric boundary conditions, this test is a pocket. That is a representative pocket.

MEMBER ARMIJO: But --

MS. SCHLASEMAN: It is the right geometry.

MEMBER ARMIJO: But, you know, the exact way in which supported?

MS. SCHLASEMAN: That is how it's supported. It's supported -- the perforated plate is supported continuously by the tabs along its -- you know, it's a U-shaped piece. And it is supported on either side by the plates that are part of the strainer overall structure.

And so the tabs then put into those plates, so it is continuously supported along this edge as shown in this test. And then that's consistent also with the analytical model, the Finite Element Analysis.

CONSULTANT WALLIS: And this bounds with--

MEMBER SHACK: When I saw the pictures of this, I always assumed those pockets were perforated on all sides. You are telling me that it is really two solid plates and a porous U? Which comes back to Said's question of whether this is really totally representative of the geometry.

CONSULTANT WALLIS: They are perforated on the sides. They are perforated on all sides.

MS. SCHLASEMAN: They are perforated.

MEMBER SHACK: That's -- yes, that's sort of --

MS. SCHLASEMAN: But for the test, they didn't use the side plates. That's correct, they are perforated on the sides. But in this test fixture, they did not do it that way.

MEMBER SHACK: So to answer Said's question, this is really --

MS. SCHLASEMAN: Right.

MEMBER SHACK: -- representative of the real situation only if you size that solid plate the right amount to, essentially, represent --

MS. SCHLASEMAN: By plate. That's correct.

MEMBER SHACK: -- the same stiffness as you would get for the perforated plate, which we don't know whether they did or didn't.

CONSULTANT WALLIS: Right.

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: But it's also a question of how you -- what you did with these tabs. I mean, this thing is fixed to the other plate with these tabs.

MS. SCHLASEMAN: Yes.

MEMBER ARMIJO: Well, let's give her a chance to answer that first question.

MS. SCHLASEMAN: The first question, like I said, these are going up to twice and up to four times the multiple of the allowed stresses. The question about whether or not -- but --

MEMBER ARMIJO: The deformations and the stress levels that you would get are highly dependent on the geometric boundary conditions. And you are using this data to say we take it all the way to four times what the expected load is going to be and nothing happened. And well, this is a different problem.

MS. SCHLASEMAN: But I think considering how the -- if the plates were -- on the side had been the perforated sheets, and, obviously, they would be weaker, I mean, surely they would be weaker, but because of the way you are loading it, you are loading it like a membrane. And so I'm still thinking that the load -- you know, the question about the holes tearing open and the pockets -- I mean, that was your original question about whether or not the pockets would tear open, and I'm not seeing how it would necessarily tear open differently.

MR. TOMKINS: Remember, this is to simulate --

MS. SCHLASEMAN: This is --

MR. TOMKINS: This is to determine whether how we are accounting for the holes was done properly, not to necessarily simulate the exact geometry of the pocket.

CHAIR ABDEL-KHALIK: No, no. This experiment is aimed at sort of assuring that despite the fact that the geometry does not meet a criterion stipulated --

MS. SCHLASEMAN: A criterion.

CHAIR ABDEL-KHALIK: -- in the ASME Code--

MS. SCHLASEMAN: Correct.

CHAIR ABDEL-KHALIK: -- that the methodology is still applicable.

MS. SCHLASEMAN: Right.

CHAIR ABDEL-KHALIK: And you have done that by empirically demonstrating that even if you go to four times the load, nothing bad happens.

MS. SCHLASEMAN: Yes.

CHAIR ABDEL-KHALIK: And this can only be true or, you know, you can make that deduction if the experiment that you are running truly simulates what actually happens. And that is not the case here.

MS. SCHLASEMAN: But --

CHAIR ABDEL-KHALIK: So --

MS. SCHLASEMAN: -- if you are concerned

about opening up the holes themselves in the middle of the plate, and I agree with Dr. Shack that that is, you know, LVDT coming out the back side in the center of the plate. I'm not seeing how, even if you had a more flexible boundary condition on the outer edges, that that would be significantly different in the middle of the plate.

MEMBER SHACK: Well, I think what Said--

UNIDENTIFIED SPEAKER: It would be less.

MEMBER SHACK: -- is saying is, you know, if you did this test and you predicted a certain behavior and you verified it, that would verify the model. That would be fine. If the comparison we're hearing from you is, you know, the load on the real thing is a half a psi --

MS. SCHLASEMAN: Yes.

MEMBER SHACK: -- and now we have gone to double that and it's still elastic, well, that comparison is only true if this is really representative of the real structure.

MR. TOMKINS: Correct.

MEMBER SHACK: So, you know, I can understand an argument saying, you know, we did an analysis of this thing using our model and it worked, that would be one comparison, but the comparison that we are hearing doesn't quite get there, because you -- really that comparison sort of requires you to be semi prototypical in the structure. And you are -- as I said, you could size those plates if the thickness -- you know, but we haven't heard that those thicknesses are really --

CHAIR ABDEL-KHALIK: Matter.

MEMBER SHACK: -- sized to represent a perforated plate. I mean, there is various ways this could have been done, but the argument -- until you somehow convince us that this is a prototypical structure or that you have done the analysis of the structure and compared it, it just isn't all coming together.

CONSULTANT WALLIS: Well, there is also the tabs. I mean, it could fail where -- along the tabs, couldn't it? It's got these tabs on the side.

MS. SCHLASEMAN: Right.

CONSULTANT WALLIS: And I don't know how the real structure is, but the tabs --

MS. SCHLASEMAN: But that is handled by, you know, Finite Element techniques. I mean, that's the standard. There is no perforations in the tabs.

CONSULTANT WALLIS: Can this be a side load? I mean, the wave comes along and it propagates down the pocket, doesn't it? I mean, does it know the pocket all at the same time? I don't quite know what happens. But there is a pressure wave that comes along --

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: -- and it, presumably, progresses down the pocket and the reflections and things.

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: I just don't know how you have handled that. This isn't a dynamic test.

MS. SCHLASEMAN: This is the load factors that are in the load to come up with a half bar on this.

CHAIR ABDEL-KHALIK: Let's again give you a chance to answer this practicality question.

MS. SCHLASEMAN: This is the test that CCI ran. I don't have an answer for you on that.

CHAIR ABDEL-KHALIK: Because, I mean, there is no telling what the deformation would be if the geometry was different, right?

MS. SCHLASEMAN: Not that it --

CHAIR ABDEL-KHALIK: I mean, if --

MS. SCHLASEMAN: -- wouldn't be grossly different. The geometry would be different because the -- I agree that the edge condition at the tab --

CHAIR ABDEL-KHALIK: Right.

MS. SCHLASEMAN: -- could be more flexible.

CHAIR ABDEL-KHALIK: Right.

MS. SCHLASEMAN: Than it is with the solid plate.

CHAIR ABDEL-KHALIK: Correct.

MS. SCHLASEMAN: And so --

CHAIR ABDEL-KHALIK: Wouldn't that impact the total deformation?

MS. SCHLASEMAN: The permanent set in the plate?

CHAIR ABDEL-KHALIK: Well, if the structure --

MS. SCHLASEMAN: Like I agree with you that it potentially could on the first curve, you know, where the plots are.

CHAIR ABDEL-KHALIK: Right.

MS. SCHLASEMAN: They could go to a higher displacement.

CHAIR ABDEL-KHALIK: Correct.

MS. SCHLASEMAN: And then potentially you would have a higher, because it's a stretch and it would stretch, I would think. But as far as a permanent set, I don't know how much more deformation there would be in terms of permanent deformation.

I mean, it could be, sure. But again, we are not going into that regime in the real ASME Code space.

CHAIR ABDEL-KHALIK: You are not going into that regime in this experiment. But we don't know if that is the case in the actual --

MS. SCHLASEMAN: No, I mean, the four times the load.

CHAIR ABDEL-KHALIK: -- geometry.

MS. SCHLASEMAN: I meant that the loading condition is -- were not going to be going to four times the loading condition.

CHAIR ABDEL-KHALIK: I agree, but we don't know what the behavior is. If you were to design an experiment that is prototypical, that is consistent with the actual geometry and boundary conditions, we don't know what the behavior is going to be at .5 psi -- .5 bar loading, do we?

MS. SCHLASEMAN: No, they did not run it at .5.

CHAIR ABDEL-KHALIK: We don't know what the behavior is going to be at .1 bar loading, do we?

MS. SCHLASEMAN: Oh, um, as far as -- it's

-- correct. As far as we haven't tested a specific pocket.

CHAIR ABDEL-KHALIK: That is the point.

MS. SCHLASEMAN: But there were two parts to this. One was CCI wanted to figure out whether or not this was a standard and valid approach for using the ASME methodology for changing the elastic constants, adjusting the elastic constants. And then multiplying to account -- the final stress to account for the missing mass of the holes.

And their first thing was to go back and look at what the designer handbook that is standard for them and for all manufacturers of perforated sheets and they concluded that that methodology, again, also based on testing by Bill O'Donnell decades ago probably, is consistent for thin sheets, not just the thick sheet that ASME Code put into their appendix.

And so, you know, they -- their approach is that they have these two different ways of confirming that this is an acceptable approach to account for the holes in the sheet and to properly model them analytically. And this is not -- you know, this test was done as an added assurance that using ASME Code methodology would result in a design that would not --

CHAIR ABDEL-KHALIK: Well, what you're telling us is that you are really using the designer's handbook methodology, at this point.

MS. SCHLASEMAN: Well, that's what CCI did.

CHAIR ABDEL-KHALIK: It doesn't meet the code.

MS. SCHLASEMAN: It --

CHAIR ABDEL-KHALIK: But it does, in fact, meet --

MS. SCHLASEMAN: Correct.

CHAIR ABDEL-KHALIK: -- the designer's handbook.

MS. SCHLASEMAN: Well, it's a non-mandatory appendix. The ASME is not -- it's not that they are not meeting code, it's this is a detail that ASME does not mandate how you design for perforated holes. And so they have this guidance available to you for an appropriate methodology that they would accept no questions asked if you met the thickness criterion.

But we don't meet the thickness criterion, so then, you know, the next question is is this an appropriate methodology for the designer to use to establish whether or not, you know, what the stresses are that should be compared with the ASME allowables.

And so CCI, to back up that this was an appropriate methodology, used the designer handbook that they put in here as a reference, and then that wasn't sufficient for Toshiba. They wanted some more proof or more assurance, not proof, more assurance that this was an acceptable approach.

And so then CCI did this test. And, obviously, there is questions about whether or not it was exactly a prototypical strainer pocket was not addressed at that time. This test was selected.

MEMBER ARMIJO: Well, it looks like the test confirmed what they wanted to confirm, but it didn't tell us whether a prototypical pocket, completely prototypical, would behave the same way, because they didn't test it. And that's really the question that is in front of us, you know.

MR. HEAD: The test confirmed what we would have expected with the prototypical --

MEMBER ARMIJO: Yes, they made sure that the deformation would occur in the perforated region, so the sides were not perforated, they were beefy and they measured what they intended to measure. It seems to me that was successful, but it doesn't tell us what the real structure will do.

MS. SCHLASEMAN: Well, depending on the Finite Element Analysis.

MR. HEAD: You run through the analysis.

MEMBER ARMIJO: You may have to maybe --

MS. SCHLASEMAN: It's done through the analysis.

MEMBER ARMIJO: It depends.

MEMBER SHACK: I mean, if the analysis -- I mean, what you said was it showed what the handbook predicted. And if you told me that the analysis using the handbook method predicted a deflection of X millimeter at .1 bar, I would be perfectly happy.

MEMBER ARMIJO: Right.

MEMBER SHACK: It's when you --

MS. SCHLASEMAN: No.

MR. HEAD: In terms of it being acceptable, an acceptable approach for --

MEMBER SHACK: It's when you say that, okay, the loading is half a bar in the real case and .1 bar in this case, therefore, it's fine. Well, that's the part that doesn't compute.

MS. SCHLASEMAN: No, I -- that -- I'm sorry. If I said that, I did not mean that. What I had said was this provided additional assurance that the methodology was acceptable and appropriate for using that methodology.

MEMBER SHACK: What was the basis for that conclusion, I guess, is what we are trying to get to. And the basis we have heard so far is that you have gone through twice the applied load and it's still elastic.

MS. SCHLASEMAN: We've gone -- well, and that we have gone to four times and no damage. I mean, that was really the bottom line is that there -- this was, like I said, an additional assurance on top of the analytical approaches and the handbook, both the ASME Code method and then the handbook method, that this would be an appropriate way to model the perforated sheets.

And that if you showed that the stresses using this methodology met ASME Code, then that would give you assurance that under the design condition hydrodynamic loads, you would not have a failure of the plates.

CHAIR ABDEL-KHALIK: The connection is still not there. I mean, you can imagine one being able to design an experimental setup that is far more rigid, far more robust than the actual system and, therefore, whatever deflections you would measure or whatever stresses you get in the experiment would be highly atypical.

So I guess the only way out of this, if you were to use the methodology to model the experiment and show that the predictions matched the experiment, then that would assure us that the methodology is appropriate, rather than saying, you know, we applied four times the load and it's still okay. Do you agree, Bill?

MEMBER SHACK: Yes. I mean, that's the absolute rigorous comparison.

CHAIR ABDEL-KHALIK: Right.

MEMBER SHACK: Now, whether you think there is enough margin here is another kind of judgment, but the rigorous comparison is that. You do an experiment, you make an analysis and you compare the two.

MR. HEAD: But I don't think that's really what we are saying here. I mean, the open item was to address the fact that this is a perforated plate. And if it was the exact right thickness, we would have said here is the ASME Code and that's what we would have used. That was not applicable here and so we did some assessments to understand what is a thinner plate. You know, what does that mean from a stress standpoint?

And we concluded that the handbook is a valid way of assessing those stresses when we do the Finite Element Analysis. This is the experiment they did. Okay. And based on their interactions and their judgment and Toshiba's interactions and their judgment, they concluded that the handbook and the stresses they were going to use is appropriate.

And I believe, you know, the connection is there. And maybe it's not the perfect experiment for the question.

MEMBER ARMIJO: Scott, look, I don't think there is any doubt the perforated plate, at least I don't have it, is going to behave the way you analyzed. The problem is the question we are asking about is what about the strainer, the whole structure?

MR. HEAD: Won't the Finite Element Analysis be the real --

MEMBER ARMIJO: Well, maybe it is. Maybe it is, I mean.

MR. HEAD: If the loads -- this is -- you know, the Finite Element Analysis as it hits structure that is pure structure, the Finite Element Analysis we already know how to model that. This is how do we model the impact of --

CONSULTANT WALLIS: Well, I haven't seen that. I mean --

MEMBER ARMIJO: It's missing. Either that or a prototypic test, either a very good analysis or--

MS. SCHLASEMAN: Oh, there is a three dimensional Finite Element model and it is in the report --

CONSULTANT WALLIS: No, but how focused is that --

MS. SCHLASEMAN: -- that we gave you guys.

CONSULTANT WALLIS: -- on this small scale when the Finite Element Analysis looks at the strainer, which is a big thing?

MS. SCHLASEMAN: Yes.

CONSULTANT WALLIS: Does it then -- we are looking at one pocket.

MS. SCHLASEMAN: It models individual components. It models --

CONSULTANT WALLIS: How precisely does it model that pocket?

MS. SCHLASEMAN: It models it with the tabs and everything. What it doesn't do is it doesn't model the holes.

CONSULTANT WALLIS: Has lots of little elements in that pocket itself?

MS. SCHLASEMAN: Oh, yes.

CONSULTANT WALLIS: It does? I haven't seen that. I don't know that I have seen it.

MR. HEAD: And it models --

MS. SCHLASEMAN: I can show it to you on the break, if you want, but it's -- yes, it's got Finite Element model of all of the key elements. It has got the ribs. It's got the -- I'll pass it around. But --

CONSULTANT WALLIS: It's got the stress distribution within the pocket itself and that sort of thing?

MS. SCHLASEMAN: Yes. Oh, yes.

CONSULTANT WALLIS: Okay. Well, that would be useful. I don't know --

MEMBER SHACK: With the elastic sheet model.

CONSULTANT WALLIS: Yes.

MS. SCHLASEMAN: Right. It's a solid model.

MEMBER SHACK: With a solid sheet.

MR. HEAD: With a solid sheet.

MS. SCHLASEMAN: That's the catch.

MR. HEAD: And then you see what the stresses are and then you use all of this to see if the holes fail or see if, you know, it fails.

MS. SCHLASEMAN: It's one of the Toshiba reports.

MR. HEAD: Yes, we can give you the number.

MS. SCHLASEMAN: Right. This is the RHR. This is for the referenced Japanese plant. This is their number PDR-2005-100210. And we can pass this around, but, I mean, this is the Finite Element model of exactly what --

CHAIR ABDEL-KHALIK: But that's how the question started, because this model uses a solid sheet.

MR. HEAD: Yes.

MS. SCHLASEMAN: Yes.

CHAIR ABDEL-KHALIK: And the question was well, how do we handle the holes? How do we account for -- potential for local failure of the holes --

MS. SCHLASEMAN: Right.

CHAIR ABDEL-KHALIK: -- say in a much bigger hole?

MS. SCHLASEMAN: Right.

CHAIR ABDEL-KHALIK: And that's where we are now.

MS. SCHLASEMAN: Right.

CHAIR ABDEL-KHALIK: And I still don't see the connection between what you are presenting here and how the actual strainer will behave under the estimated load.

MS. SCHLASEMAN: Go back a slide, two slides. Okay. Again, actually, I mean, Dr. Shack summarized it very nicely. It's ASME Code gives you a methodology for predicting what the weakened condition of a perforated plate is and how to model that so you get a good stress distribution and then how you go ahead and amplify the stresses at the end.

CCI to check whether or not that methodology was appropriate for the thin sheet or thin plate -- sheet, they used this method. This is the method that is used in this handbook for perforated metals. And so that's the base contention is that this -- you know, that even though ASME puts this restriction on it, it's use, that it is an appropriate methodology.

And then as an additional assurance, they went ahead and they ran this test at multiples of the design pressure to see whether or not there would be any tearing or any kind of damage to the holes in the middle of the plate. And the -- I agree with you that the boundary conditions for the pocket are not identical as in the -- it's more tightly constrained than it would be if the sides were also the perforated sheet.

CHAIR ABDEL-KHALIK: Right.

MS. SCHLASEMAN: But I also don't see how that changes the behavior or the potential for tearing of the holes in the middle of the plate, which is really what that purpose of that test was is to figure out whether or not this is an acceptable methodology for modeling. You know, it's a very detailed Finite Element Analysis, but it doesn't model all those thousands, yes, millions, I don't know how many holes there are. So that's how the holes are accounted for is using the ASME Code.

CONSULTANT WALLIS: Can we talk about --

MR. HEAD: What we are really challenging here is the holes.

CONSULTANT WALLIS: Said, sorry.

MR. HEAD: And we settled that.

MEMBER SHACK: Well, let me try another argument here that what you have really demonstrated with this test is that you can undergo a considerable amount of plastic deformation in this sheet and not tear locally.

MS. SCHLASEMAN: Yes.

MR. HEAD: Yes.

MEMBER SHACK: So if your analysis predicts elastic behavior of the overall structure, then you have got confidence that you are not going to locally fail the holes.

MS. SCHLASEMAN: Right.

MEMBER SHACK: I think that's sort of what you have done. So from that point of view, what you have demonstrated with the test is that you can put a lot of plastic deformation into this thing and not tear holes, which your analysis says okay, for elastic and we are not deforming it plastically, the holes are okay. So I would be willing to buy it sort of based on that kind of an argument.

CONSULTANT WALLIS: Can we look at your test theory, your picture? I don't know what you mean by pressure. You've got this water coming in through a jet, right? A hose, which is much smaller than the pocket.

MS. SCHLASEMAN: Correct.

CONSULTANT WALLIS: So there is some enormous Bernouli effects here. And if it is 2 psi in the pocket somewhere, there is a huge v-squared somewhere in that hose. And you are loading it in a very peculiar way. I mean, the pressure isn't uniform in that pocket at all. Just think about it. Where is the --

MEMBER SHACK: But try to come back to the bigger picture, Graham. You can deform this thing plastically --

CONSULTANT WALLIS: No, but I don't know what -- when she says there is a pressure applied, I don't know what she means.

MEMBER SHACK: Well, even if there is --

CONSULTANT WALLIS: Because the pressure--

MEMBER SHACK: -- pressure, all you are doing is deforming the sheet plastically.

CONSULTANT WALLIS: Yes, but the pressure is tied to the load. The half of psi is something. You know, what is --

MEMBER SHACK: Forget that comparison. Just think that all you are demonstrating is that this sheet can undergo considerable plastic deformation without local tearing.

CHAIR ABDEL-KHALIK: Right.

MEMBER SHACK: Therefore, if it doesn't undergo plastic deformation, it's okay.

CONSULTANT WALLIS: At 4 psi, yes. But what's the --

MEMBER SHACK: Well, no, no. As long as

the overall analysis shows that it is elastic and you are not deforming it plastically, we know it has a considerable capability to take plastic deformation without local tearing. That's what this test demonstrates. Forget the psi, the bars. What you are demonstrating is its capability to take plastic deformation.

CONSULTANT WALLIS: As it was mounted in this device, yes.

MEMBER SHACK: It's still plastically deformed, mounted or otherwise. It's comparison with the real pocket maybe --

CHAIR ABDEL-KHALIK: Or very substantive.

MEMBER SHACK: But the fact that it is plastically deforming and not tearing is the critical aspect.

CONSULTANT WALLIS: I think since they had psi, I want to know what that means, because it seems to me that this -- what's the flow rate and all that? I mean, this is -- a large fraction of the area is holes. So the pressure drop is all v-squared through the hole and that v-squared to me, because there are so many holes, it's got to be far less than it is in the pipe coming in, because that's a much smaller area. So the whole thing is a very strange test in terms of saying you've got so many psi on the hole.

CHAIR ABDEL-KHALIK: But again, if you use Bill's argument, it doesn't matter.

CONSULTANT WALLIS: It doesn't matter how --

CHAIR ABDEL-KHALIK: It doesn't matter. Okay. Even if you bend it by hand --

CONSULTANT WALLIS: Right.

CHAIR ABDEL-KHALIK: -- and plastically deform it by that much and the holes don't tear, your argument is that means that if you are elastic, the holes will not tear.

CONSULTANT WALLIS: well, that's quite different from -- well, so we just say the psi doesn't matter at all. Their argument here is unimportant.

CHAIR ABDEL-KHALIK: Well --

CONSULTANT WALLIS: It's just it didn't break.

MEMBER ARMIJO: As long as it's the right psi.

MEMBER SHACK: I'm just trying to get through to a conclusion.

MEMBER ARMIJO: Yes.

CHAIR ABDEL-KHALIK: Yes.

MEMBER SHACK: You know, we don't have to conclude that their test is appropriate. All we have to do is conclude whether the sheet will behave appropriately.

CHAIR ABDEL-KHALIK: Right.

MEMBER SHACK: And I think that's the question.

MR. HEAD: Whether we have found a way of appropriately determining what the holes will do, I mean, that's the question here, obviously.

MS. SCHLASEMAN: And whether the analytical methodology is acceptable.

MEMBER SHACK: Now, I take -- I mean, Bill O'Donnell did perforated sheets for his PhD thesis 50 years ago and he has been working on it ever since, so if it's in his handbook, I probably will believe it. But you might have done better just to quit there.

MR. HEAD: You know, at some point in time in the discussion, I thought well that may have been maybe where we quit, but you asked us how we did it and clearly CCI did additional work.

MEMBER SHACK: Yes.

MS. SCHLASEMAN: Yes.

MR. HEAD: And we thought this work --

CHAIR ABDEL-KHALIK: I think what started this whole discussion is the argument made that hey, we raised the loading to four times what we would expect and nothing bad happens. And that doesn't mean anything in terms of making the connection between the experiment and the real system. I think Bill's argument, to me, is plausible and acceptable.

MS. BANERJEE: So does it mean we can close this action item?

CHAIR ABDEL-KHALIK: Unless anybody objects, the fact that we have something that was plastically deformed by a significant amount without any tearing of the holes, while the actual analysis showed that you are still in the elastic regime, would suggest that the issue that was raised originally about the possibility of the holes locally tearing is not an issue.

MEMBER BROWN: Yes, not being a mechanical engineer, but having worked with this a little bit, she made the comment that not all the strainers are the same. There are a number of different sizes. I don't know what the variation in size is, but does this thought process that you all have gone through extrapolate to different size strainers?

CHAIR ABDEL-KHALIK: I think that yes.

MEMBER SHACK: The analysis is always going to show their elastic consistency.

MEMBER BROWN: I wanted to ask the question on different -- it's a matter of scale.

CONSULTANT WALLIS: But I don't understand your reasoning. I mean, the question was is the analysis valid that shows it's elastic and it's okay? I mean, if you are saying well, just -- we don't care if the analysis is valid, as long as some test showed you could get a plastic deformation. It seems to me a pretty weak way out.

MEMBER SHACK: No, I --

CONSULTANT WALLIS: Must the analysis --

MEMBER SHACK: There is all sorts of confirmation that using this elastic model gives you the right displacement. What you worry about is the fact that you get local effects.

CONSULTANT WALLIS: Of holes? When you have holes?

MEMBER SHACK: Oh, yes. I mean, you know, perforated plates have been -- as I say, you know, people have worked on this problem for a long time. You know, the question was whether you got the local failures.

CONSULTANT WALLIS: Local failures, right. Well, that's a fluid structure interaction problem. And you are concentrating on the --

CHAIR ABDEL-KHALIK: Well, unless I hear, you know, strong objections, I think, this item is closed. I think this -- the argument that even with plastic deformation, local failures do not take place is quite persuasive, to me at least personally.

MR. HEAD: Okay.

CHAIR ABDEL-KHALIK: Okay.

MR. HEAD: We'll move on.

CHAIR ABDEL-KHALIK: Let's proceed.

MR. HEAD: All right. Then we will move on to the next item.

MR. ANDREYCHEK: This particular item was to provide documentation that the concentration of zinc oxide is less than 1.6 ppm in the suppression for water.

A point of clarification. This was discussed at the last meeting. Dr. Abdel-Khalik, I believe, you and I had an exchange and we had calculated the zinc oxide mass, but had not calculated the concentration calculations. And as a consequence, I believe we have had discussions whether or not it would be less than 1.6 ppm solubility for zinc oxide.

CHAIR ABDEL-KHALIK: Right.

MR. ANDREYCHEK: We have gone back and done the calculations and the solubility limit of 1.6

is exceeded based on the minimum mass of water in the suppression pool and I want to present those calculations, at this point in time.

So go to the next slide, please. Basically, the assumptions that we used in calculating zinc oxide was we used the maximum amount of zinc oxide corrosion product. We assumed 100 percent of the inorganic zinc coatings were destroyed within the Zone of Influence 10D ZoI within the drywell. And we used the maximum amount of surface area and that was the 10 micron balls of zinc. We maintained that constant throughout the calculation.

We used the minimum suppression pool inventory, which is about 7.7×10^6 pounds of water. We looked at 2 pH values and the minimum pH of 5.3 and we calculated the pH --

MEMBER SHACK: Well, how did you come up with those pHs?

MR. TOMKINS: Those are in the DC -- that's -- those are the licensed amounts in the DCD.

MS. SCHLASEMAN: They are not the operational, but they are the licensing design limits in the DCD.

MR. ANDREYCHEK: Yes. We would expect the pH to be something greater than 5.3.

MEMBER SHACK: I would, too, but it's sulfuric acid.

MR. ANDREYCHEK: But those are the licensing limits. And so in order to --

MEMBER SHACK: The trouble with the BWR is it's not buffered, so it's --

MR. ANDREYCHEK: That's right.

MEMBER SHACK: -- very hard to tell where the pH is. I guess I --

MS. SCHLASEMAN: It's the -- operationally, it's supposed to be at 7, obviously. And --

MEMBER SHACK: Yes, but this is the -- I mean, operationally, I have no question where the pH is going to be.

MS. SCHLASEMAN: Right.

MEMBER SHACK: It's how you determine it in an accident that is a little --

MS. SCHLASEMAN: Right.

MEMBER SHACK: -- but you are saying this is what they did in the DCD, correct?

MS. SCHLASEMAN: Well, and then I said there are additional calculations. We went through several RAIs with the staff on this about -- to be able to explain what happened during the accidents and what would happen during the accident.

And so the -- so to keep it in that range, I mean, like I said, that is our licensed range. Even during accident scenarios, you know, there is potential to do -- you know, standby liquid control system and go ahead and put it as if -- as you are going through the accident and potentially forming nitric acid, you know, several days into the accident, then you would inject the sodium pentaborate from the LSC system.

MEMBER SHACK: Oh, and you use that for a buffer?

MS. SCHLASEMAN: Yes.

MEMBER SHACK: And that would be --

MEMBER STETKAR: Do operators have guidance to do that?

MS. SCHLASEMAN: It's the --

MEMBER SHACK: It's the SAMG, I would suspect.

MS. SCHLASEMAN: We put it into -- yes, it is. It's guidelines. It is guidelines. And we -- it's in an RAI. It's in that RAI. But they would be getting from technical support center, they would be getting the guidance to inject standby liquid control if they end up dropping too far in the -- with the pH.

MR. TOMKINS: All right. These are the values we used based on the DCD.

MS. SCHLASEMAN: Right. So these were our balance.

MR. TOMKINS: What we would ever see.

CHAIR ABDEL-KHALIK: Keep going, Tim.

MR. ANDREYCHEK: Okay. Thank you. So for a minimum pH of 5.3, we calculate 28.6 pounds mass of zinc oxide and for a maximum pH, that is the standby liquid control system injected that gets you to a pH of 8.9, that's 13.7 pounds. These were assumed that the standby liquid control system was initiated at time zero or you had the maximum pH starting at time zero in the event.

MEMBER ARMIJO: So those masses are the maximum amount that could be dissolved?

MR. ANDREYCHEK: That's the maximum amount that would be formed.

MEMBER ARMIJO: Formed?

MR. ANDREYCHEK: Yes, sir. We will get to the dissolved --

MEMBER ARMIJO: Okay.

MR. ANDREYCHEK: -- in just a second.

MEMBER ARMIJO: Okay.

MR. ANDREYCHEK: And so you are using the

7.7×10^6 pounds mass dividing into the mass of zinc oxide that would be -- the concentration would be 7.6 ppm at pH 5.3 and 1.8 ppm at a pH of 8.9.

So now, addressing your question specifically of, okay, how much would actually become precipitate?

Go to the next slide. Obviously, in this case, both values exceed the 1.6 ppm. So by assuming, and this is an assumption, that 1.6 ppm stays in solution and looking at the excess, what would actually come out as precipitate? And that's what this slide shows.

So for a pH of 5.3, we would get 21 kg or .6 -- 6.3 pounds of precipitate. For a pH of 8.9, we would get about --

CONSULTANT WALLIS: Different than the 1.6?

MR. ANDREYCHEK: I don't disagree, but the 1.6 ppm stays in solution. This is what is --

CONSULTANT WALLIS: Oh, that last time --

MR. ANDREYCHEK: That was --

CONSULTANT WALLIS: Last time I was wondering about the 1.6. Now, you have got a number which is very different or could be very different. I don't -- what is it at 7?

MR. ANDREYCHEK: Say again, please.

CONSULTANT WALLIS: What is it at 7 pH?

MR. ANDREYCHEK: We did not run that calculation.

CONSULTANT WALLIS: It's somewhere in between.

MR. ANDREYCHEK: That's correct.

CONSULTANT WALLIS: It's probably a lot more than 1.6 we were looking at last time.

MR. ANDREYCHEK: I'm assuming it would be.

CONSULTANT WALLIS: Yes. Okay. Thank you.

CHAIR ABDEL-KHALIK: But is this behavior really a continuous function?

CONSULTANT WALLIS: No, no.

MR. ANDREYCHEK: I'm not sure I understand what you mean.

CHAIR ABDEL-KHALIK: You can essentially assume that this is a continuous function? You only have to evaluate the two points? There are no local minimums or maximums?

MR. ANDREYCHEK: As long as you are circulating water, you are going to maintain a reasonably uniform distribution of buffering within or non-buffering. The acids will be in the pool. So I would take this to be a relatively uniform continuous function. As long as you are circulating water, you are keeping mixing, reasonable mixing, I would say that this is a uniform or continuous function. This is way outside my area of expertise.

MEMBER ARMIJO: Yes. Well, so what happens when 46 pounds of stuff --

MEMBER SHACK: I really think this is a well-mixed solution. That's a quite reasonable sort of thing to do.

MR. ANDREYCHEK: And again, we assume that we are going to take the whole thing and dump it anyway.

MEMBER SHACK: Right, right, exactly.

MR. ANDREYCHEK: If you take the 10D Zone of Influence for zinc, we are assuming that with anything within that 10D Zone of Influence --

CHAIR ABDEL-KHALIK: What I meant by local, maxima and minima, is sort of with regard to the pH.

MR. ANDREYCHEK: Yes.

CHAIR ABDEL-KHALIK: If I were to plop this on a pH, would I get a continuous function? So monotonically --

MEMBER SHACK: Oh, you mean the

solubility?

CHAIR ABDEL-KHALIK: Right. Would I get a monotonically --

MEMBER SHACK: Yes.

CHAIR ABDEL-KHALIK: -- between 5.3 and 8.9?

MEMBER SHACK: Yes.

CHAIR ABDEL-KHALIK: Hum. Okay.

MR. HEAD: You really mean would you see some spike at some pH level or --

CHAIR ABDEL-KHALIK: No. I was just wondering about whether this is a monotonic function.

MEMBER SHACK: No, I think you -- it's safe to say it's somewhere between those two values, you know. Just whether it is purely linear in pH might be a stretch, but --

CHAIR ABDEL-KHALIK: Right. Okay.

MEMBER SHACK: -- between those two values is a pretty good bet.

MEMBER ARMIJO: But the limiting problem is when you have a lot of insoluble precipitate.

MS. SCHLASEMAN: Yes.

MEMBER SHACK: Right.

CHAIR ABDEL-KHALIK: Right.

MR. ANDREYCHEK: And I think we will

address that in the next slide or so.

MEMBER ARMIJO: Okay.

MR. ANDREYCHEK: So if you would? So we have gone through the, if we could go to the next slide, calculation of zinc oxide, maxima amount assuming total failure of the coatings within the Zone of Influence. And we have done testing for other clients where we show that that is not the case, that some of the zinc stays on, so we are using a maximum amount of zinc.

We are maximizing the surface area of the zinc particles that we are dealing with. We don't assume any passivation of the zinc particles. And we are using the minimum amount of inventory to calculate a concentration.

The testing conservatively assumes the maximum amount of zinc oxide which is the 58.6 pounds mass of zinc. So we're conservatively treating whatever zinc we have. We are assuming it is all precipitate and, therefore, like if we demonstrated through this calculation that we are conservatively treating zinc oxide as a corrosion product for the ABWR at the South Texas Project.

MR. TOMKINS: So the key there is we are taking no credit for the solubility of the zinc --

MR. ANDREYCHEK: Yes.

MR. TOMKINS: -- oxide at all. And we are assuming that all of the zinc is gelatinous material as well. So we are not -- we think that really a fair amount of it would be particulate. But you know, some form of gelatinous.

MEMBER ARMIJO: Can you form a gelatinous zinc?

MR. TOMKINS: Well --

MEMBER ARMIJO: I have not seen, whatever it is, molecules.

MR. ANDREYCHEK: I have not seen it in any of the work that we have done --

MR. TOMKINS: Yes.

MR. ANDREYCHEK: -- for

MR. TOMKINS: Yes, it's not like aluminum.

MR. ANDREYCHEK: No. It's -- any of the work that we have done where we have looked at zinc in either sodium hydroxide or trisodium phosphate, we have not seen a gelatinous form of a zinc oxide product.

MEMBER ARMIJO: Yes.

MR. ANDREYCHEK: And we are treating it as a gelatinous type of material. So based on the work that we have done and the knowledge that we have today, we believe we are treating this as a very conservative approach.

MR. TOMKINS: Yes.

MEMBER ARMIJO: Very good.

CHAIR ABDEL-KHALIK: You're happy?

MEMBER ARMIJO: Yes, I'm happy.

CHAIR ABDEL-KHALIK: Good. Let's proceed.

MEMBER ARMIJO: I know where the zinc is going.

MR. HEAD: May I ask? Is this something we can close out, at this point?

MEMBER ARMIJO: I am okay.

CHAIR ABDEL-KHALIK: Okay.

CONSULTANT WALLIS: Well, it's impressive the way the numbers have changed from last time.

MR. ANDREYCHEK: Well, again, I would suggest that last time we had masses, but we did not do -- have concentration calculations. This time we are presenting the calculations.

CONSULTANT WALLIS: It just shows how things can change when you do a little bit more studying.

MR. ANDREYCHEK: I'm not going to argue with that.

CONSULTANT WALLIS: So maybe could we ask that question?

MR. HEAD: So we are going to the next one?

CHAIR ABDEL-KHALIK: Sure.

MR. HEAD: Marty?

MR. VAN HALTERN: Action Item #80. This is really a restatement of what we had before, which is to provide the basis for the acceptance criteria using the square relationship versus some other exponent such as 1.2.

Dr. Abdel-Khalik had asked us to come back with the write-up. In some of the backup slides there was a write-up, hopefully you had a chance to go through that.

The slides here are just sort of a summary. Our acceptance criteria is based on, essentially, the Darcy equation of looking at the pressure drop versus the flow relationship. The K factor here is when you are doing the test, it's essentially a compilation of several features, including the inlet losses, the debris filtering bottom nozzle, the grids, the friction on the rods and the sides of the assembly, because you are measuring the DP across the entire thing.

As Dr. Wallis had pointed out, there was an experiment for one of the other reactor types where what they did is they did a series of injections of

[

]CONSULTANT WALLIS: It's is very peculiar. I would think it would go the other way.

Member Shack: Right. Well, that was my reaction.

CONSULTANT WALLIS: Right. The more debris, the more laminar it is, the more blockage you have, therefore, it would go the other way.

MR. VAN HALTERN: But if you look at the components of the hydraulic resistance, okay, there are some which are, essentially, a form loss. Okay. And those tend to not have much dependency on velocity. If you look at Crane or any of the other ones, you -- there was, essentially, a constant, even though they have a very small Reynolds dependency.

CONSULTANT WALLIS: I think the --

MR. VAN HALTERN: Friction on the other hand --

CONSULTANT WALLIS: -- only way this explains to me is because you've got blowholes or something. You have got something which is now a v-squared type thing rather than a laminar flow through the bed.

MEMBER SHACK: I mean, a porous medium is the classic linear case. You know, the thicker debris bed would seem like --

CONSULTANT WALLIS: Well, but if it's got holes in it, it's got blowholes.

MEMBER SHACK: Yes, if it's got holes in it, it looks like a --

CONSULTANT WALLIS: That's probably what it is.

MR. VAN HALTERN: Yes. And going back to -- that was the behavior that was shown in that test.

Okay. Now, our acceptance criteria, what we were trying to do is determine the acceptance criteria which has a high debris load. And so I believe that the -- that test would tend to indicate that when you have a high debris loading, that exponent two is more appropriate.

And just to walk through some of the numbers, if you were to use a different exponent, if you were to start the test with a flow rate of 3 and end up after you have added all of the debris at .5, using an exponent of 2, the allowed pressure drop increase in this equation is about a factor of 33.

If you were to use an exponent of 1.5 instead, you would actually allow a larger increase in the pressure drop. So I still think an exponent of 2 or something close to that is appropriate, based on that experiment. 2, essentially, provides a smaller allowed increase in the pressure drop.

CONSULTANT WALLIS: Say that again. Why is that acceptable? I'm trying to work it out. A smaller allowed increase than what?

MR. VAN HALTERN: Than the pressure. In other words, as the -- as they run the test, they start out --

CONSULTANT WALLIS: During the test, during the test?

MR. VAN HALTERN: During the test. Okay. So I start out with a clean assembly and a higher velocity.

CONSULTANT WALLIS: Right.

MR. VAN HALTERN: Okay. And so as I add debris, my velocities decrease, but my hydraulic resistance increases. And the increase due to the debris exceeds the -- what you get from a lower flow rate.

CONSULTANT WALLIS: So you calculate the test criterion using 2, right? You calculate the allowed DP during the test, right?

MR. VAN HALTERN: Right.

CONSULTANT WALLIS: And you use -- and then that is how much? I'm trying to -- I can't follow the rationale. Minimizes the amount increased. I don't follow the rationale.

MR. VAN HALTERN: Okay. Using -- this is an acceptance criteria.

CONSULTANT WALLIS: Yes.

MR. VAN HALTERN: Okay. So if in my test I start at 3 and I go down to .5 in the flow and my pressure drop increases, okay, the acceptance criteria, if I use an exponent of 2 here, I would allow a 33 -- a factor of 33 increase in the pressure drop as being acceptable.

If I use 1.5, it actually allows a higher increase in the pressure.

MR. TOMKINS: 33 is a more restrictive mild increase in pressure.

MR. VAN HALTERN: Restrictive.

CONSULTANT WALLIS: Acceptance criteria.

MR. TOMKINS: More conservative.

CONSULTANT WALLIS: So you are really saying that using 2 --

MR. VAN HALTERN: Is conservative.

MR. TOMKINS: Is more conservative.

CONSULTANT WALLIS: -- allows -- is a more restrictive criteria?

MR. VAN HALTERN: That's correct.

CONSULTANT WALLIS: Because nothing is minimized here. I mean, you are saying one thing is less than another.

MR. TOMKINS: Uses.

CONSULTANT WALLIS: So you are saying that if you took it one way, you get another and if you do it another way, you get a lower number?

MR. VAN HALTERN: Correct.

CONSULTANT WALLIS: There's nothing minimized.

MR. TOMKINS: Reduced.

CONSULTANT WALLIS: Absolutely nothing minimized.

MR. VAN HALTERN: Yes.

CHAIR ABDEL-KHALIK: But where did the 1200 number come from?

CONSULTANT WALLIS: It came from using 2.

MR. VAN HALTERN: Yes.

CHAIR ABDEL-KHALIK: Okay.

MR. VAN HALTERN: I will walk through the process again. We used the GOBLIN Code to analyze the conditions with the five notifications. You increase the hydraulic loss, the K factor at the inlet, okay, until we got to our acceptance criteria, the .95 void fraction.

So there was a significant increase in that K factor. But given the fact that that was done in reactor conditions, in terms of temperature, pressure and everything, but when we do the test, we are doing the test in cold conditions. What we did is looked at what you would be measuring in the test, which is a DP across this test section, okay. And that is comprised of various elements.

So we took the -- one of those elements and increased it by that same factor. How much was my hydraulic resistance on increase? Because they all add up. And looked at if I -- if I start with a clean condition, I add this in, what would my final condition be in terms of that DP across the test?

And the ratio of clean K factor to a fouled K factor at that debris resistance or fouled Delta P with that K factor, I'm losing you, I can tell.

CONSULTANT WALLIS: You are. I think your argument is bogus. And I think what you have to do is use 2 all the way through.

CHAIR ABDEL-KHALIK: Yes.

CONSULTANT WALLIS: If you use 2, you use 2 to model the reactor.

MR. VAN HALTERN: Correct.

CONSULTANT WALLIS: And this gives you the 1200. If you interpret the test in terms of 2, the calculated K factor based on 2, that's compatible with what you do here. Let's follow, all you are doing is going through a comparison --

MR. VAN HALTERN: Right.

CONSULTANT WALLIS: -- but you give it a K factor. What is the K factor in the test based on 2?

MR. VAN HALTERN: Right.

CONSULTANT WALLIS: Then you compare it

with the reactor based on 2, that's completely fair.

MR. VAN HALTERN: That's what we did.

CONSULTANT WALLIS: Well, there is a power low which is different or not? Because each time you define it, it's like a friction fight. You have a friction fight based on 2 and the fact that it buries with those numbers is irrelevant, as long as you do all your calculations consistently.

But you don't use that argument. You use a bogus argument.

MR. VAN HALTERN: Well, I was trying to address the information that you provided.

CONSULTANT WALLIS: I know, but --

MR. VAN HALTERN: Which was how I partially -- related back to how a partially formed debris bed may have formed as opposed to --

CONSULTANT WALLIS: Well, we were saying how do you handle an impact exponent different than 2 on the test data? That's what we were asking.

MR. ANDREYCHEK: I think the answer is they don't know. We have used a factor of 2 --

CONSULTANT WALLIS: You have used --

MR. ANDREYCHEK: -- consistently.

CONSULTANT WALLIS: So what are you arguing here about then? Now, you're saying you use a different end?

MR. ANDREYCHEK: I think that -- if I remember correctly, the question was asked well, there has been other data that shows a factor other than 2--

CONSULTANT WALLIS: Right.

MR. ANDREYCHEK: -- exponent. And that's not what this -- the analyses that are being done for this particular reactor zone are using. They are using a factor of 2 consistently from the analysis to actually analyzing the test data.

CONSULTANT WALLIS: Well, is that the argument though? I mean, that should be the argument.

MR. ANDREYCHEK: Yes.

CONSULTANT WALLIS: But it isn't the argument. You are using some other argument, which is bogus. It doesn't seem relevant or something.

CHAIR ABDEL-KHALIK: But the question is had you used an exponent other than 2 in both analyzing the real case and interpreting the data? Would the answers be different?

MR. VAN HALTERN: We would have --

CHAIR ABDEL-KHALIK: Rather than trying to link the two. If you had --

MR. VAN HALTERN: Would the answers have been different?

CHAIR ABDEL-KHALIK: Right.

MR. VAN HALTERN: We would have gotten a-- we would have derived an acceptance criteria based on that other exponent.

MR. TOMKINS: And it would have been different probably.

MR. VAN HALTERN: Yes, again, we are not trying to analyze data here. We are trying to specify an acceptance criteria that wherever the data falls, as long as it's lower than that acceptance criteria, it's okay.

CONSULTANT WALLIS: But the question is how do you compare the test with the real reactor? And how do you scale? It's a scaling question.

MR. VAN HALTERN: Correct. And so the way we --

CONSULTANT WALLIS: Scaled with a different exponent, would it make a difference?

MR. VAN HALTERN: That's --

CHAIR ABDEL-KHALIK: Would a different exponent have been appropriate?

MEMBER SHACK: Well, in your argument that you have got a more restrictive one, did you use the 1.5 consistently for the analysis and the data?

MR. VAN HALTERN: I just plugged into it.

MEMBER SHACK: But you kept the K at 1200 and just changed the exponent?

MR. VAN HALTERN: Right, correct.

CONSULTANT WALLIS: You can't do that. The K, the 1200, depends on the exponent.

MR. VAN HALTERN: Right. But we used -- my point was we used the factor of 2 consistently. We developed this methodology and the factor of 2, I believe, is supported by the same test where -- which introduced as providing a lower factor.

MR. TOMKINS: And the factor of 2 is more appropriate for acceptance criteria, based on a highly plugged situation.

MR. VAN HALTERN: Loaded.

MR. TOMKINS: Rightfully loaded.

CHAIR ABDEL-KHALIK: But we don't know that for sure, do we?

MR. VAN HALTERN: Well, the test -- based on that test --

MR. TOMKINS: The previous test -- okay. As you load the -- the debris bed becomes more fully loaded, then the exponent relationship approaches 2.

CHAIR ABDEL-KHALIK: I guess the point is the argument that you are presenting here is not consistent, right?

MEMBER SHACK: I mean, since we don't know how your test is going to turn out --

MR. VAN HALTERN: Right.

MR. TOMKINS: Right.

MEMBER SHACK: -- it would seem that we would have to have an acceptance criteria that would-- you know, whatever your test is, then you would apply that to the analysis and you would -- you know, what you need is a consistency in the margin that we accept, rather than some exponent.

CHAIR ABDEL-KHALIK: Okay.

MR. VAN HALTERN: And so we were consistent. We had been consistent in how we derived the acceptance criteria compared to the analysis, which gave you, you know, acceptable results. And then in addition to that, because we knew that there were some variations, we added on -- took our acceptance criteria and we reduced that by a factor of 4, so we do have a significant amount of margin built into that acceptance criteria.

MEMBER SHACK: If I were to go without that -- well, I mean, I guess I would be happier if -- you have built the square into the acceptance criteria, too.

MR. TOMKINS: Right.

MR. VAN HALTERN: The standard in terms of the flow relationship.

MEMBER SHACK: But it would be better, it would seem to me, to, whatever comes out of your test, then say that you are going to apply a factor of 4 to your analysis results for your acceptance criteria. And, you know, if you get 2 in your test, you use 2. If you get 1.5, you use 1.5.

MR. VAN HALTERN: The test is not intended to develop the exponent. It's only to --

CONSULTANT WALLIS: You can't do that because the model uses 2. The whole modeling of the reactor itself is based on 2. And you can't sort of use that K criterion and then apply 1.5 to the test.

MR. VAN HALTERN: Right.

CONSULTANT WALLIS: You can't do that. You've got to interpret the test in terms of the way in which the computer models --

MR. VAN HALTERN: Right, correct.

CONSULTANT WALLIS: -- the reactor.

MR. VAN HALTERN: And that is what we have done.

CONSULTANT WALLIS: That is the argument you have got to use. I don't know where you come up with this strange roundabout mixed up different things here. I mean, you've got to convince us that you can go from the test to the reactor. You can know what number to put in the computer as a result of the test modeling, the test number. That's what you need to do.

UNIDENTIFIED SPEAKER: The other way around.

MR. VAN HALTERN: Okay.

CHAIR ABDEL-KHALIK: We'll just have to --

MR. VAN HALTERN: I apologize for confusing you. But do you -- I mean --

CONSULTANT WALLIS: I mean, this seems to be like the porous media thing. I mean, we can't solve the problem for you. You come up with a strange argument and now in discussion we may actually come up with a valid argument, but I'm not sure that's our function.

MR. HEAD: Well, it has worked once today, so, I mean, certainly, you know, a 500 batting average isn't bad right now.

I mean, you know, back to the original question, this is what we were asked and I think we took it maybe, you know, head on that what is our basis for thinking, too, is it an appropriately conservative approach? And that is what we have done.

You know, maybe we haven't addressed the 1.2 and how we would have gone back and done that, but, you know, the -- this is where we are.

CONSULTANT WALLIS: Your slide 21 says if we would use 1.5 in this W_f/W_i to the 1.5, we would have got something, isn't it? Isn't that what it said? It says the P_f/P_i is some --

MR. HEAD: To allow a larger pressure drop.

CONSULTANT WALLIS: But you can't do that, because the computer used 2 in your whole model. This is the basis of this whole thing is the 1200.

MR. HEAD: Right. Use the 1200.

MS. BANERJEE: Just cross out the last column.

CHAIR ABDEL-KHALIK: We need to think this one through.

MR. VAN HALTERN: Okay.

CHAIR ABDEL-KHALIK: Because I need --

MR. VAN HALTERN: So what do I need to bring back, if anything? And again, I guess my argument, I apologize to the Committee if I may have confused.

[

]

Okay. Which in my mind tells me that our acceptance criteria, which is a highly loaded debris, should have an exponent close to 2.

CONSULTANT WALLIS: But that goes against all porous media, Reynolds number and everything in the background, so that's not very good either. It must mean that there is something odd about the debris bed.

MR. VAN HALTERN: Maybe it's not a debris bed so much, as it's just a flow restriction --

CONSULTANT WALLIS: It's just got holes in it.

MR. VAN HALTERN: -- at -- flow restriction at the grids and at the lower tie plate and then the refiltering bottom nozzle.

CONSULTANT WALLIS: Well, I think there is a much better argument --

MR. VAN HALTERN: It's not that it --

CONSULTANT WALLIS: -- that it doesn't depend at all --

MR. VAN HALTERN: -- isn't porous --

CONSULTANT WALLIS: -- upon the exponent. I think you can make that argument. You have to make it. I'm not going to make it for you.

CHAIR ABDEL-KHALIK: I guess the process is you started out with a model, right?

MR. VAN HALTERN: Correct. Right.

CHAIR ABDEL-KHALIK: You established an acceptance criterion --

MR. VAN HALTERN: In terms of --

CHAIR ABDEL-KHALIK: -- that would reach your acceptance limit in terms of maximum void fraction.

MR. VAN HALTERN: Right.

CHAIR ABDEL-KHALIK: And then you multiply that by a factor of 4 to add conservatism. And then you said if we run a test and we pass that limit, then we should be okay.

MR. VAN HALTERN: That's correct.

CHAIR ABDEL-KHALIK: Okay. What if you had used a factor of 1.5 in the model?

MR. VAN HALTERN: I would have --

CHAIR ABDEL-KHALIK: How would the criterion be formulated?

MR. VAN HALTERN: It would have a 1.5 in the exponent.

CHAIR ABDEL-KHALIK: Right.

MR. VAN HALTERN: You may have some --

CHAIR ABDEL-KHALIK: A completely different --

MR. VAN HALTERN: -- difference in the--

CHAIR ABDEL-KHALIK: -- multiplier.

MR. VAN HALTERN: -- multiplier.

CHAIR ABDEL-KHALIK: Right.

MR. VAN HALTERN: Upon change.

CHAIR ABDEL-KHALIK: Okay. Now, if that is the case, would you end up with, essentially, the same acceptance value for the pressure drop that you would measure experimentally?

CONSULTANT WALLIS: No.

CHAIR ABDEL-KHALIK: Well, let's just --

MR. VAN HALTERN: Right. You would have a different curve.

CHAIR ABDEL-KHALIK: And that's what we are asking.

MR. VAN HALTERN: Okay.

CHAIR ABDEL-KHALIK: Because if you have a different curve, that means you, essentially, have a different margin.

CONSULTANT WALLIS: That's right.

MR. VAN HALTERN: Right.

CONSULTANT WALLIS: That's correct.

MR. VAN HALTERN: Right.

CHAIR ABDEL-KHALIK: And we are trying to find out which one reduces the margin using 1.5 consistently throughout or using 2 throughout, that was the basis for the question. And this doesn't really clarify it for me.

MR. VAN HALTERN: Okay. But again, which appear to be the more appropriate from the test?

CHAIR ABDEL-KHALIK: We don't know that, because the value varies all over the place.

MR. HEAD: Okay. Marty, I think we have something to go back and look at. And with respect --

CHAIR ABDEL-KHALIK: Has the problem been defined?

MR. HEAD: I think so. I think --

CHAIR ABDEL-KHALIK: Or the question been defined?

MR. HEAD: If we had shown this curve or this presentation and the 1200 had been adjusted with the 1.5 and if that was 1100, and if we had a 1.1 and that was 900, and we could -- then you could see that the squared is giving us the --

CHAIR ABDEL-KHALIK: That would be great. In other words, comparing apples to apples.

MR. HEAD: But then --

CHAIR ABDEL-KHALIK: In a sense that if you are comparing the 2 versus the 1.5, then by gosh use the right multiplier for the case of 1.5.

CONSULTANT WALLIS: But then you would have to go back and run your computer code with a loss factor depending on 1.5 and not with just a K.

MR. HEAD: Right.

MR. VAN HALTERN: Right.

CONSULTANT WALLIS: And that --

CHAIR ABDEL-KHALIK: And again, which one is the more appropriate?

MR. VAN HALTERN: We think 2 is more appropriate.

CHAIR ABDEL-KHALIK: Okay.

MEMBER SHACK: Well, that is a different argument, I mean, you know, but if it turns out that 2 is more conservative than 1.5, we won't have any more discussion.

MR. VAN HALTERN: Right.

MEMBER SHACK: If it turns out that 1.5 -- then we come back to the argument of which is the more appropriate? You could hope that the answer will be the two have come up with --

CONSULTANT WALLIS: But I think it doesn't make any difference to the criterion for the 9.95 percent void or whatever you are using for the limits there.

MR. VAN HALTERN: That's the same, right.

CONSULTANT WALLIS: The critical condition worked out to be the same, but the margin will be different, because you are on a different curve.

MR. VAN HALTERN: And I knew that there would be some variation and that there could be some various -- and because you are going into, essentially, a condition where your rod friction is laminar, okay, where your exponent -- your relationship to pressure drop to flow is almost linear.

Okay. And if you don't have high losses at your grids and at your form losses, then that becomes more dominant and that's why you may get an exponent smaller, you know, that is closer to 1.

But if you put a very high restriction in your form losses, then that's going to dominate.

CHAIR ABDEL-KHALIK: I think this issue will remain open.

MR. HEAD: Okay.

CHAIR ABDEL-KHALIK: You know what the question is?

MR. HEAD: I believe we have a point going on.

CHAIR ABDEL-KHALIK: Okay. Right. Thank you.

MR. HEAD: So we are going on to 47. This is Action Item #47. We view this one as sort of the one that covers the entire long-term cooling. Two points I wanted to make on it.

The way it is written, it was to provide downstream test procedure to ACRS and then all the briefings, I think, we have shown you actually how we are going to do, you know, the future work in the out years. And so I would -- was hoping you would agree that that aspect of it is not something you are going to see as part of this proceeding.

And then I was going to ask if had closed all of the open items, as to whether we had, in fact, closed the entire long-term cooling issue. But since we still have one that is open, then, you know, that aspect is moot.

So if I could at least get agreement that we are not going to be providing you any test procedures, then that aspect of the action item is -- we won't have to come back and revisit.

CHAIR ABDEL-KHALIK: Let me just go around and see how people feel about this.

MR. HEAD: I mean, we -- in our previous discussions, we have shown you how we are going to use operating experience. We are going to be working with the owner's group, other -- you know, the industry.

CHAIR ABDEL-KHALIK: Industry, to be determined.

MR. HEAD: And so those test procedures will be built years from now literally.

CHAIR ABDEL-KHALIK: Yes.

MR. HEAD: And so --

CHAIR ABDEL-KHALIK: I mean, right.

MR. HEAD: -- provided to the NRC.

MEMBER ARMIJO: I don't think they would mean anything if you gave them to us now anyway.

CHAIR ABDEL-KHALIK: Yes.

MR. HEAD: Well, yes, sir. I mean, that's just the way it was captured at early on discussions and so we have carried it through. So I wanted to address that aspect of it. And like I said, if we closed all the open items today, then we would suggest maybe this one could be closed or at least that we have done all the actions that we needed to do.

And so right now, I would say we have still got to come back and visit on #80. And so if we can just get agreement that we are not going to be doing that last sentence and that's all we want to do.

CONSULTANT WALLIS: Well, I just have a comment.

MR. HEAD: Sure.

CONSULTANT WALLIS: I mean, I don't think that the test procedures should be set in concrete. When you start doing the tests, if you find something important, you don't blindly follow some procedure which ignores that thing that was important.

MR. HEAD: I agree.

CONSULTANT WALLIS: So that I don't think, you know, test procedure just the beginning, you said we are going to do this stuff, but then you start finding things out.

MR. HEAD: Yes, sir.

CONSULTANT WALLIS: So it's a very fluid situation. And I don't think we can do anything about it today.

MR. HEAD: I'm sure we --

CONSULTANT WALLIS: But I just wanted to--

MR. HEAD: Actually, back when this was written earlier on, you know --

CONSULTANT WALLIS: I want to be sure that you don't say we will do 10 tests and if the 10 tests turn out to be so anomalous that they are meaningless, that you then stop.

MR. HEAD: I think we discussed that at an earlier meeting also.

CONSULTANT WALLIS: Because that's all I wanted to be sure about.

MR. HEAD: Yes, okay. All right. So I think we are finished with that one.

So I believe, you know, we need to -- we will come back at a later time and provide some more information with respect to Action Item #80.

CHAIR ABDEL-KHALIK: Correct.

MR. HEAD: And I believe #98 and #99 have -- we have appropriately addressed. Okay. We are done with this one then, right? Okay.

CHAIR ABDEL-KHALIK: Okay. Are there any additional questions to the applicant? Okay.

CONSULTANT WALLIS: Do you have the summary slide, do you or something?

CHAIR ABDEL-KHALIK: The summary slide I guess, you know, you don't want to go through that, because Item #2 is --

CONSULTANT WALLIS: Right.

CHAIR ABDEL-KHALIK: -- still to be demonstrated.

CONSULTANT WALLIS: Well, Item #1 wasn't shown either.

MR. HEAD: I think it was.

CONSULTANT WALLIS: Well --

MR. HEAD: Okay.

CHAIR ABDEL-KHALIK: Maybe the wording is not exactly the right wording.

CONSULTANT WALLIS: Yes.

CHAIR ABDEL-KHALIK: But with help from the --

MEMBER STETKAR: The transcript of this meeting, I think --

CHAIR ABDEL-KHALIK: Right.

CONSULTANT WALLIS: Now, what's the meaning of #3? I thought you showed that more boron zinc were precipitated than you had expected?

MR. VAN HALTERN: That the testing accounts for all --

CONSULTANT WALLIS: The testing accounts for -- will account for all of that?

MR. VAN HALTERN: Yes, sir.

CONSULTANT WALLIS: Okay.

MR. VAN HALTERN: Okay.

CHAIR ABDEL-KHALIK: Okay.

MR. HEAD: Okay.

CHAIR ABDEL-KHALIK: Thank you.

MR. HEAD: Thank you.

CHAIR ABDEL-KHALIK: Our agenda calls for a 15 minute break, so let's take a 15 minute break. We will reconvene at 10:20.

Whereupon, at 10:03 a.m. a recess until 10:18 a.m.

(Then the meeting went into a closed session until 10:29 a.m. CHAIR ABDEL-KHALIK: Yes.

MR. HEAD: Yes, this will be our presentation on Extended Station Blackout capability with respect to the ABWR and specific aspects of Units 3 and 4. Our attendees today all have briefed the ACRS before.

Before we -- I turn it over to Steve, I would like to make a -- what we are going to talk about today is our licensing basis capabilities of the ABWR and some specific aspects with respect to 3 and 4.

Obviously, the industry, the NRC, the owner's group, different applicants are evaluating or contemplating potential changes or enhancements or design changes that -- procedural changes that might come out of the lessons learned with respect to Fukushima.

The point I would like to make with this discussion, if we go into those, is that, at this point in time, for us as with everyone those are basically speculative as to what we would be doing. We will describe, you know, our licensing basis and we are more than happy to talk about other things, but I just want to make -- get on the record that those would be, at this point in time, speculation. And we look forward to the regulatory process ultimately, you know, driving towards, you know, the actions that we need to take. Okay?

CHAIR ABDEL-KHALIK: Understood.

MR. HEAD: All right. Thank you very much for that. I'll turn it over to Steve.

MR. THOMAS: All right. Thanks, Scott. Yes, I'm Steve Thomas. I'm the NINA Engineering Manager for STP Units 3 and 4. I'm trying to think, yes, we're on slide 3.

MS. BANERJEE: Hold on one second, please, because the line is not open yet.

CHAIR ABDEL-KHALIK: Okay. The line is not open. Is Dennis on the line?

UNIDENTIFIED SPEAKER: Dennis should be here.

MS. BANERJEE: Dennis is on the line. He is separate.

CHAIR ABDEL-KHALIK: Okay.

MEMBER BLEY: I am on line.

CHAIR ABDEL-KHALIK: Okay. And for the public line, that's not open yet?

MS. BANERJEE: So bear with me here.

CHAIR ABDEL-KHALIK: Okay. We'll just hold on.

MR. THOMAS: Sure.

MS. BANERJEE: Yes, it is confirmed now.

CHAIR ABDEL-KHALIK: Okay. Is there anybody on the line? Any member of the public, if so, please, just let us know, make a noise of some sort.

MEMBER SHACK: It's one-way.

CHAIR ABDEL-KHALIK: Oh, it is one-way?

MEMBER SHACK: Yes. Yes, they are muted.

MS. BANERJEE: Yes, they cannot.

CHAIR ABDEL-KHALIK: Oh, okay.

MS. BANERJEE: They can hear us, but they can't --

CHAIR ABDEL-KHALIK: Okay. Go ahead, please.

MEMBER SHACK: They are jumping and shouting right now and we can't hear them.

CHAIR ABDEL-KHALIK: Pretty frustrated.

MR. THOMAS: As you know, one of the

unique design features of the ABWR is the combustion turbine generator. That's a very significant, very significant, and important piece of equipment. And the primary means by which the ABWR design deals with Station Blackout is with the combustion turbine generator. We are going to move past that in just a minute.

CONSULTANT WALLIS: Will you give us its kilowatt rating or something?

MR. THOMAS: 20 megawatts.

CONSULTANT WALLIS: 20 megawatts. Thank you. 20 megawatts?

MR. THOMAS: Yes, sir.

CONSULTANT WALLIS: It's big.

MR. THOMAS: That's a small fraction of a Small Modular Reactor. And there is one region.

The combustion turbine generator is flood-protected and protected from external weather events. It is completely independent of the three emergency diesel safety trains. It has a black start capability. There is a small separate little diesel generator to start the combustion turbine generator without any external power supply.

It is capable of reaching rated speed and voltage and available for loading within 10 minutes.

And it can supply the ESF safety related 1E 4160 volt buses through a realignment of preselective breakers. Of course, normally since it is a non-safety related piece of equipment, it complies with the strict separation between safety and non-safety equipment and divisional separation requirements.

So again --

CHAIR ABDEL-KHALIK: Physically, how far is it located?

MEMBER BLEY: What's its fuel?

MR. THOMAS: It is basically diesel fuel, fuel oil.

CHAIR ABDEL-KHALIK: Physically, how far is it --

MEMBER BLEY: Does it come on separate trucks from the diesel fuel oil that goes into the tanks for diesels?

MR. THOMAS: Presumably, it would come from separate trucks, yes.

MEMBER BLEY: Presumably or is there some assurance to that?

MR. THOMAS: I don't know that --

MEMBER BLEY: There is a possible dependency here.

MR. THOMAS: There is a requirement that

it has separate fuel storage facilities, so if a truck comes in, it is sampled and then the tanks are sampled and so there is separation between the fuel supply for the diesels and the fuel supply for the CTGs.

MEMBER BLEY: So it's coming in on the same truck.

MR. THOMAS: Theoretically, I suppose it could.

MEMBER BLEY: Okay.

MR. THOMAS: But it would be tested separately.

CHAIR ABDEL-KHALIK: Does that answer your question, Dennis?

MEMBER BLEY: It answers my question. So at least there is some kind of dependency here. It's not totally input.

CHAIR ABDEL-KHALIK: Okay.

MR. THOMAS: I understand your point. So again, this is a very significant and important piece of equipment. In light of events in the industry right now, I think some of the questions that we are asking are what if this doesn't work?

This was considered in the original ABWR design certification document and the material I'm going to summarize for you today is in the design certification document, Chapter 19(e) and I'm just going to kind of go through the scenario that is evaluated there for a Station Blackout, what we are calling an extended Station Blackout situation, basically, a station blackout, how the ABWR respond to that without the combustion turbine generator.

MEMBER SHACK: This is not seismically-qualified though, right?

MR. THOMAS: It is not.

MEMBER SHACK: Steve, is it in a seismic-qualified building?

MR. THOMAS: It is not.

MEMBER STETKAR: And that 10 minute response time is based on manual operator actions to start the combustion segment?

MR. THOMAS: It will automatically start on loss-of-power --

MEMBER STETKAR: Oh.

MR. THOMAS: -- and realign itself to the non-safety buses.

MEMBER STETKAR: But the operators have to strip loads, if I recall, to --

MR. THOMAS: The operators would have to de-energize those loads and realign breakers to align the combustion turbine generator to the safety buses, that's correct.

MEMBER STETKAR: Okay. Thanks.

MEMBER ARMIJO: Is it in a separate building on the site?

MR. THOMAS: As stated in the DCD, the combustion turbine generator is located in the turbine building.

MEMBER ARMIJO: In the turbine building?

MR. THOMAS: In the turbine building.

MR. HEAD: Which is a 2-over-1 structure and there is some, even though it's not seismic, obviously, we could do some studies and define the possibility of it surviving different seismic events.

MR. CHAPPELL: And there is a Tier 1 requirement that it not be located in the same building as the diesel generators, which is the reactor building.

MR. THOMAS: Yes. So let's consider that case. Again, on Slide 4 now, even without the combustion turbine generator, if we assume a loss of off-site power, a loss of all three safety trains of diesel generators and the loss of the alternate ac power source, the combustion turbine generator, we also have two of these and they -- which is different from the DCD design.

But in the COLA we say that there are two of these, one for each unit. And there is a cross-connection capability. But again, we are not going to take credit for that capability. We are going to assume that both combustion turbine generators are unavailable, perhaps we have an event in both units.

And in this beyond Design-Basis scenario, the ABWR has several defense and depth features, which provide the capability to prevent fuel damage and maintain containment integrity and that's what we would like to walk through here briefly.

In this event, the reactor core isolation cooling, the RCIC turbine pump is assumed to operate for eight hours and maintain core coverage and permit core damage.

Now, if, at that point, ac power is still unavailable, we assume that, in the analysis, the reactor core isolation cooling is no longer available. We think that it probably would be, but the analysis assumes that after eight hours RCIC is no longer available. And the operator then switches to ac-independent water addition system to maintain core level.

And then the containment over pressure protection system or COPS system, this is the hardened vent system for the ABWR which prevents the loss of containment integrity.

CHAIR ABDEL-KHALIK: Now, what sets the eight hours for your case?

MR. THOMAS: There is really no specific requirement.

CHAIR ABDEL-KHALIK: It's not a requirement.

MR. THOMAS: No specific limit.

CHAIR ABDEL-KHALIK: What is the constraint that makes it eight hours?

MR. THOMAS: Again, no specific constraint. The requirement in the DCD is that we will perform an analysis that looks at the environmental conditions in the RCIC room and make sure that those conditions still are capable of supporting RCIC operation.

CHAIR ABDEL-KHALIK: What does that analysis tell you?

MR. THOMAS: That analysis is something that needs to be done as part of the detailed design. It has not been done at this point.

CHAIR ABDEL-KHALIK: So you really don't know how long it takes for that room to heat up to whatever the temperature qualification of whatever equipment you have in that room?

MR. THOMAS: That's correct. For eight hours, that's correct.

MR. HEAD: But as part of that, we would probably be defining other actions that we could take to ensure, you know, opening doors and other things that we could take to, you know, even get past eight hours.

CHAIR ABDEL-KHALIK: Right, right. In a sense that, you know, you don't have active cooling, you will open doors or whatever to try to lengthen that time period.

MR. THOMAS: Correct.

CHAIR ABDEL-KHALIK: Before you get to that temperature limit for room heat up.

MR. THOMAS: And again, I want to point out that the eight hours was just an assumption. It's just so here is a period of time and since we are assuming this in this analysis, then we have the requirement to confirm the environmental conditions for eight hours.

I think that probably when we do that, we will be able to demonstrate that the RCIC turbine pump is capable of operating for a considerably longer period of time than eight hours. We have had some discussions with the vendor that would lead us to that discussion. But, at this point in time, we have not determined the specific limitation.

MEMBER STETKAR: Steve?

MR. THOMAS: Yes, sir?

MEMBER STETKAR: Yes, please, excuse me because I get mixed up on all of the details of the designs. This RCIC turbine is the one that basically has two flow setpoints. Is that right?

MR. THOMAS: That's correct.

MEMBER STETKAR: And on loss of dc power, it reverts to the low flow setpoint. Is that correct?

MR. THOMAS: Um, I'm not sure that that's right. I think you -- I think dc power is required to switch it from the high setpoint to the low setpoint.

MEMBER STETKAR: Right. So it will maintain the high? Is that --

MR. THOMAS: That's correct. That's one of the things I was trying to remember the design and which way it went on loss of dc power. It's normally on the high setpoint.

MEMBER STETKAR: Normally on the high setpoint.

MR. THOMAS: And there is a dc solenoid that is required to extract the load --

MEMBER STETKAR: To switch it to the lower setpoint. So on loss of dc -- I'm thinking about after two hours. If it were on the low setpoint, it would revert to the high setpoint at that time, right?

MR. DALEY: You would have to manually switch it.

MEMBER STETKAR: No, I'm thinking about if it had throttled back -- I don't know how the control system works on it in that level of detail. It starts off at high flow. I don't know what switches it to low flow. What tells the system it is going to now go to its low flow condition. I don't know whether it is --

MR. DALEY: Are you energizing a dc solenoid?

MEMBER STETKAR: I understand switching logic. I don't understand the control logic. When in geologic time would some signal come in to say okay, turbine you need to go to low flow?

MR. DALEY: Manual.

MEMBER STETKAR: It would be manual.

MR. DALEY: Manual switch.

MEMBER STETKAR: Oh, it's strictly manual.

MR. DALEY: Correct. That's the only driven manual operation.

MEMBER STETKAR: Okay. Thanks, thanks, thanks. So it will stay at high flow basically.

MR. DALEY: Right.

MEMBER STETKAR: Unless the -- but if the operators do set it to low flow, which they may very well do, because you are going to be overfilling --

MR. DALEY: Right.

MR. THOMAS: Correct.

MEMBER STETKAR: -- it will go back to high flow and fill you up faster?

MR. CHAPPELL: Now, that's assuming a loss of all dc.

MEMBER STETKAR: Dc.

MR. CHAPPELL: And we also, as Steve alluded to, have some things to look at to extending the time to eight hours and beyond. And part of that is to extend the life of the Division 1 batteries.

MEMBER STETKAR: Oh, the Division 1 batteries are only two hours.

MR. CHAPPELL: Right. There is actions to take under these types of situations to look at extending those lives under these conditions to --

MEMBER STETKAR: Get out to eight hours.

MR. CHAPPELL: -- extend out and using manual operations and other options to do so. So we would be cognizant of the limitations of the battery and cognizant of what could happen under the conditions where you have the highest flow setting for RCIC injection.

MR. HEAD: Which is what plants do now.

MEMBER STETKAR: I'm just thinking of getting into a situation of, you know, cycling the thing on and off a lot.

MR. CHAPPELL: We had a few action items associated with that and I think we showed in the analysis that even if you did nothing, it was about four times.

MEMBER STETKAR: Yes. Okay. Thanks. Some of this is trying to refresh my memory on the design.

MEMBER SHACK: So just to come back, if it's in low flow and you lost dc power, you can get back to high flow?

MEMBER STETKAR: It will go back to high flow.

MEMBER SHACK: It will go back?

MEMBER STETKAR: It's an internal pneumatic little thing.

MEMBER SHACK: Okay.

MEMBER BROWN: So you don't have to -- I

thought he said you had to manually select it back to high flow and then that's what confused me.

MEMBER STETKAR: That is --

MR. CHAPPELL: You manually select it to the half flow setting and then you can manually take it back to the full flow setting. But if you lose power, dc power, it just fails to the high flow setting.

MEMBER BROWN: Oh, okay. All right. I'm sorry. I misinterpreted that.

MEMBER STETKAR: If I remember, there is a little solenoid and kind of an internal hydraulic thing that sets the flow setting.

MEMBER BROWN: I just -- it's a mechanical way to mechanical just fails to the other position. I just -- that wasn't what I got out of that.

MEMBER STETKAR: I couldn't remember which way it went when you lost dc power. That's what I forgot. Thanks.

MR. THOMAS: Okay. And again, the --

CHAIR ABDEL-KHALIK: When would you expect to do that RCIC room heat up analysis?

MR. THOMAS: I'm sorry?

CHAIR ABDEL-KHALIK: When would you expect to do that RCIC room heat up analysis?

MR. THOMAS: Probably when we, again, do the detailed design, get the final design information from the vendor after the equipment is procured and get, you know, their heat loads and things, the final piping runs and so forth, so you can calculate the heat inputs to the room.

MEMBER BROWN: Well, doesn't this scenario -- though it's whether it operates for four hours or eight hours, doesn't this scenario play the same way or is there a dependency on the eight hours to achieve some downstream cooling effects?

MR. THOMAS: Ah, not really.

MEMBER BROWN: Maximum temperature.

MR. THOMAS: No.

MEMBER BROWN: So whether --

MR. THOMAS: I think if they can see --

MEMBER BROWN: Your analysis comes out of four hours as opposed to eight hours or more for the RCIC. You -- the scenario --

MR. THOMAS: The scenario could be played out that way as well, yes, sir.

MEMBER BROWN: Okay. With no change in the end result?

MR. THOMAS: It would actually be a better end result, but if you initiated ac-independent water addition earlier and some other things, it would probably be a better result.

MEMBER BROWN: Okay. All right. Thank you.

MR. THOMAS: That accident sequence, again, is -- provided the reference here in the DCD where this is discussed.

MEMBER BROWN: When you boil the rupture disc, you say it prevents loss of containment integrity?

MR. THOMAS: Yes.

MEMBER BROWN: Where is it boiling off to?

MR. THOMAS: This is venting through the stack.

MEMBER BROWN: Outside?

MR. THOMAS: Yes.

MR. CHAPPELL: That is scrubbed.

MR. THOMAS: And scrubbed.

MEMBER BROWN: Scrubbed?

UNIDENTIFIED SPEAKER: From the wet load side.

MEMBER BROWN: So it is effectively open through the scrubbers?

MR. THOMAS: Essentially open containment. You do have the ability to isolate that with the isolation valves for that system. The containment over-pressurization system isolation valves and this is somewhat different than the current vintage of design for these hardened vents.

Some of the earlier ones, I know that I have looked at, have gone to great actions to prevent initiation of this system. It requires a positive action on the operator's part to open isolation valves.

MEMBER BROWN: Okay.

MR. THOMAS: To then allow the ruptured disc to open.

MEMBER BROWN: So these are open during operation?

MR. THOMAS: These isolation valves are normally open. They fail open and as a consequence, we have a somewhat higher set pressure for those rupture discs than some of the earlier designs. But again, if the ruptured disc opens, at some later time, it would require dc power and pneumatic power to close those isolation valves, to close that vent path. But again, the containment has not ruptured.

MEMBER BROWN: But you are blowing up to the atmosphere?

MR. THOMAS: You are venting to the

atmosphere.

MEMBER BROWN: Okay. I just wanted --

MR. THOMAS: After scrubbing through the suppression.

MEMBER BROWN: Media of integrity is sort of what you're saying.

MR. THOMAS: That's a good question.

MEMBER BROWN: Thank you.

MR. THOMAS: On Slide 6, this is a summary of a table in the DCD. Just to kind of quickly walk you through this scenario, of course, following initial loss of off-site power, the reactor scrams and main steam isolation valves close in a very short order.

Approximately, 52 seconds into this scenario, as the reactor level begins to decrease, to lower, at Level 2, the RCIC system automatically initiates injection. Steam is discharged through the safety relief valves to the suppression pool and this cycle continues. RCIC making up core inventory.

Again, eight hours, we assume that RCIC is no longer available and fails. This particular analysis assumes a considerable period of time, at this point, for the operator to realize what is going on, realize he is not going to get ac power back and then align the ac-independent water addition system and depressurize with the safety relief valves.

And the analysis then assumes that at 9.8 hours, 1.8 hours after RCIC is assumed to be lost, that water level -- the injection begins and level is eventually restored.

MEMBER BROWN: So the manual operations to get you lined up, you had done some type of a human hand-eye coordination, people got to go places to do things or is it all done from the control room?

MR. THOMAS: It requires some manual operator action. Again, going to the ac-independent water addition system, normally, that would be from a diesel generator fire pump.

MEMBER BROWN: So you have to line stuff up?

MR. THOMAS: You would have to line stuff up. That would not --

MEMBER BROWN: Did you walk through? I mean, I presume the 1.8 hours, you have made an assumption as to when that comes on-line?

MR. THOMAS: We have not done that. That is just an assumption that was used in this analysis.

MEMBER BROWN: So it has to be -- it would have to be verified?

MR. THOMAS: It would have to be verified at some point in time. Again, I think it is a pretty conservative period of time, but we haven't done time-motion studies to --

MEMBER STETKAR: This is while they are hooking up the batteries with the jumper cables, so that they can get the --

MR. THOMAS: Well, at this point, I don't know that that would necessarily be required. I mean, you would have to have, basically, one safety relief valve to depressurize.

MEMBER STETKAR: Batteries are dead.

MR. THOMAS: Correct.

MR. DALEY: And as Coley mentioned in response to Action Item #100, we will develop procedures and walk through those procedures by operations as well.

CONSULTANT WALLIS: This water level type of active fuel, that's the expanded water level? That's not the collapsed water level?

MR. THOMAS: Yes.

CONSULTANT WALLIS: It's the expanded water level, which is a little bit uncertain, because it voids in there, isn't it? It's 9.9 hours?

MR. THOMAS: I don't have the details of

the computer analysis.

CONSULTANT WALLIS: I was just wondering how soon. You've got to get water injection pretty soon after that, presumably. I don't see how those two events are related there. You've got to depressurize enough to get the water injection.

MR. THOMAS: Correct.

CONSULTANT WALLIS: Before the expanded water level falls below the top of active fuel.

MR. THOMAS: Not necessarily. In fact, the analysis assumes that the water level does go below top of active fuel.

CONSULTANT WALLIS: So what do you mean by water level then? It's boiling and splashing and stuff, I'm not quite sure what you mean by water --

MR. THOMAS: I'm assuming it means the liquid water level.

CONSULTANT WALLIS: The collapsed water level or the single phase water level or what?

MR. THOMAS: I believe it means the single phase water level. There is, of course, boiling taking place at this time.

CONSULTANT WALLIS: Okay.

MR. THOMAS: And as the water level drops below top of active fuel, you still are getting some cooling from steaming going past the fuel.

MR. CHAPPELL: This is based on an analysis, so they used calculated volumes in the vessel and they determined where the level of the bottom of active fuel and the top of active fuel.

CONSULTANT WALLIS: So there is some assurance that the water injection will begin only enough before the water level is too low to cause damage?

MR. THOMAS: That's correct.

CONSULTANT WALLIS: All right.

MR. THOMAS: And we will show that here in just a second on the next slide.

CONSULTANT WALLIS: Okay.

MR. THOMAS: And then, approximately, 32 hours --

CHAIR ABDEL-KHALIK: Is there a question? Okay.

MR. THOMAS: Approximately, 32 hours after -- into this event, the containment over-pressure protection system rupture disc ruptures and containment pressure, you know, rapidly reduces at that point in time. There are several plots from the computer analysis shown in Chapter 19 for this event.

We have just picked two of them out here basically.

CHAIR ABDEL-KHALIK: What is the setpoint for this containment forward pressure?

MR. THOMAS: It's .72 megapascals or about 90 pounds.

CHAIR ABDEL-KHALIK: 90 pounds.

MR. THOMAS: I've got my cheat notes here.

CHAIR ABDEL-KHALIK: So it's roughly seven atmospheres?

MR. THOMAS: Yes.

CHAIR ABDEL-KHALIK: Okay.

MR. THOMAS: On the next sheet, this just shows the plot of the fuel temperature throughout this transient. As you can see, when RCIC injection ceases, you get a pretty significant spike in fuel temperature. The peak is 1610 degrees from the analysis, which is below the -- it's the level at which we anticipate fuel damage.

And once alternate ac-independent water addition begins and the core is recovered, the fuel temperature rapidly comes back down.

What is interesting from this graph is apparently from -- it should be readily apparent that after this begins, the fuel temperature remains relatively steady state for a considerable period of time.

Likewise on the next sheet, if you look at containment pressure, when RCIC fails, of course, containment pressure starts to increase pretty dramatically until the rupture disc opens again at 90 pounds. It decreases rapidly and again approaches equilibrium for a considerable period of time.

CONSULTANT WALLIS: So this just -- excuse me. This Slide 7 is responding to my question, isn't it? This is over-raced, but we getting the firewater going and the water level falling in the vessel?

MR. THOMAS: Yes, sir.

CONSULTANT WALLIS: And that is what is shown by this spike?

MR. THOMAS: Yes, sir.

CONSULTANT WALLIS: Okay. So it's pretty important that things do happen on time?

MR. THOMAS: Absolutely.

CONSULTANT WALLIS: All right.

MR. THOMAS: One of -- this analysis assumes that -- a considerable delay.

CONSULTANT WALLIS: Right. This is a conservative sort of thing? Because the operator seems to be doing something just before the water level falls beyond top of active fuel. And you would think they might do it before that.

MR. THOMAS: You would think so.

CONSULTANT WALLIS: Yes.

MR. CHAPPELL: Well, they would. I mean, you're talking about lining up the ac-independent water addition system and you would already be doing that and determining the appropriate time to depressurize the vessel.

And another consideration in the analysis is that it assumes the depressurization from rated reactor pressure, whereas other options are to reduce pressure in order to minimize the time before the injection.

CONSULTANT WALLIS: So --

MEMBER STETKAR: We understand. Yes, I mean, that spike would look a lot more -- a lot different if --

MR. CHAPPELL: Very much --

MEMBER STETKAR: -- the operators try to control the depressurization.

MR. THOMAS: If they were anticipating this event --

MR. CHAPPELL: That's right.

MR. THOMAS: -- you would expect a much less severe transient.

MR. CHAPPELL: The minimum pressure at which you can operate RCIC is very near the shutoff of the ac-independent water addition pump. So, conceivably, you could have a much smoother transition than what is shown here in the analysis.

MR. HEAD: These are out of the DCD, right?

MR. CHAPPELL: This is what was provided in the DCD, right.

MR. HEAD: Okay.

MEMBER STETKAR: This presumes that you are at the safety valve, the relief valve setpoint and then you blow it down.

MR. CHAPPELL: That the operators are manually controlling reactor pressure at about 1000 pounds.

CHAIR ABDEL-KHALIK: Rather than sort of hanging at the lowest setpoint of the SRV.

MR. CHAPPELL: The depressurizing and operating at a lower pressure band which does a lot of things in terms of --

MEMBER STETKAR: Well, when you say manually controlling, you are basically limited to whatever scheme RCIC is pulling off and whatever the relief valve setpoints are.

MR. CHAPPELL: My understanding for the analysis is that RCIC steam alone will not maintain that the operators will have to periodically use operation of SRVs to maintain a pressure band.

CHAIR ABDEL-KHALIK: So they --

MEMBER BLEY: Can I ask a question?

CHAIR ABDEL-KHALIK: -- would automatically open.

MR. CHAPPELL: If you were at a high setpoint.

MEMBER BLEY: Looking at Slide 6, which lays things out, and then it's your Slide 7 with the pictures, those things don't seem exactly aligned with each other.

MR. CHAPPELL: No.

MEMBER BLEY: The analogy in the picture assumes some different timing than on the previous slide? I mean, over there it's eight hours, RCIC failed. Almost two hours later, the operator lines up the ACIWA and depressurizes the vessel. And it seems not quite aligned with what we are seeing on the analysis picture.

CHAIR ABDEL-KHALIK: Slide 7.

MR. CHAPPELL: That's eight hours on ten.

MR. THOMAS: Yes. I'm not sure that the

pressure entirely, you know, scientifically is accurate grasp. But the intent is and the analysis assumes that these time sequences follow.

MEMBER STETKAR: I suspect that RCIC fails should be moved to the left where the little hook is and that fuel temperature remains constant because you are just boiling off through the relief valves --

MR. THOMAS: Yes.

MEMBER STETKAR: -- for that period of time.

MR. THOMAS: That makes sense.

MEMBER STETKAR: And when you depressurize, you are now losing mass and starting to uncover fuel, which is why your fuel temperature goes up and spikes until you start getting injection. I suspect that's what that transient is trying to tell us.

MEMBER BLEY: That sounds reasonable. I guess I'm trying to read too much into that figure.

MEMBER STETKAR: Yes. I think the reason it's flat there, you know, from eight hours to ten hours is you are just -- you filled -- it probably presumes you are full from RCIC and you just basically -- that's boil off at whatever that decayed heat is through the relief valves.

If you saw primary pressure applied, it probably would explain a lot of the reason that this thing looks the way it does.

CONSULTANT WALLIS: And then the spike goes on until after 10 hours, because it takes a bit of time to depressurize to the point where --

MEMBER STETKAR: Yes, because it's a low head injection.

CONSULTANT WALLIS: So it looks as if it makes a difference of -- you know, if you move this thing by 10 minutes one way or the other, you can change that spike quite a bit.

MEMBER BLEY: That's what I was worried about.

CONSULTANT WALLIS: Right.

MR. THOMAS: If we just go to the summary slide on the next sheet, again, what we are calling an extended loss of all ac or Station Blackout without the combustion turbine generator, the capabilities of the current ABWR design can be implemented to avoid fuel damage and still maintain containment integrity under these circumstances for a period of, on the order of, 72 hours and probably longer.

I mean, the analysis was concluded at that point in time, but our approaching equilibrium conditions under these circumstances.

CHAIR ABDEL-KHALIK: So nothing here about spent fuel pool. And I assume that the heat up time for the spent fuel pool is greater than 72 hours?

MR. CHAPPELL: I have -- I'll get into that on the next two slides.

MR. THOMAS: Perfect segue. Actually, that was going to conclude my comments.

MEMBER STETKAR: I know ACIWA is part of the -- can we talk about it in open session very much?

MR. THOMAS: I think so, yes.

MR. CHAPPELL: Yes.

MEMBER STETKAR: Is it not -- is the water supply for that nominally minimum 72 hours? I don't remember the water supplies and I didn't go back and look at the design.

MR. THOMAS: I think -- you know, what we haven't done is calculated -- do the decayed heat calculations and -- quite to the volume -- I think the inventory is 300,000 gallons minimum from that tank. There are two tanks. We take credit for one.

CHAIR ABDEL-KHALIK: The minimum inventory is what? I'm sorry.

MR. THOMAS: 300,000 gallons.

CHAIR ABDEL-KHALIK: 300,000 gallons.

MR. THOMAS: Again, there are two tanks. We take credit for one.

CHAIR ABDEL-KHALIK: And the capacity of those pumps is what?

MR. THOMAS: I had that. I'm not --

MR. DALEY: The fire pumps, really the largest fire area are your transformers plus a hose reel. So it's usually around 1,000 to 1,200 gpm.

MR. THOMAS: I think that's right.

MR. CHAPPELL: But there is a -- generally, for ac-independent water addition function, you are talking about a 500 gpm injection rate.

CHAIR ABDEL-KHALIK: Okay. And that is controllable?

MR. CHAPPELL: That's controlled, yes.

CHAIR ABDEL-KHALIK: Thanks.

MR. THOMAS: Okay. And there are some other design features as I segue over to Coley and address the spent fuel pool. There are some current design features of the ABWR which provide us, again, some defense and depth capabilities for spent fuel pool makeup and I'll let Coley address those.

MR. CHAPPELL: And as Steve did, what I'll start for fuel pool makeup is with the capabilities of the ABWR and then walk through what is available if the CTG is available and then without CTG.

So the fuel pool cooling and cleanup system for the ABWR provides the normal removal of decayed heat as well as filtration for the spent fuel pool. There are connections. The suppression pool cleanup system allows for makeup water using either the suppression pool or the condensation storage tank.

The normal makeup supply is through these interconnections from the condensate system. Either the fuel pool cooling and cleanup system or the suppression pool cleanup system can be powered by the CTG power supply.

The ABWR standard design had two trains, RHR, that were capable of providing Class 1E diesel-powered makeup from the suppression pool to the spent fuel pool, as well as augmented pool cooling.

The STP 3 and 4 application included a Tier 1 departure to -- so that all three trains of RHR, three different divisions, are capable of providing this function.

Now, the reason that we did that was to assist in outages and for maintenance flexibility, but it has the advantage here as well that it provides an additional form of redundancy.

In the case of an extended loss of all ac, in which the CTG is not available, the primary makeup is through the fire protection system. Inside the reactor building, there are standpipes up on the refuel floor in which hoses can be used to run over to the fuel pool, which you are probably familiar with that capability. The --

CONSULTANT WALLIS: These fire hoses, someone has to lay the hoses?

MR. CHAPPELL: Yes. Someone would have to lay those hoses and the connection.

In the second bullet, I talk a little bit about the sources. You have a separate water source, as we've discussed, other than the suppression pool or the condensation storage tanks for makeup. And you have diverse monitoring pumps that were also perceived to provide power from the CTG, but, as I said, in the case of CTG not being available, the fire protection system has an install diesel as well as a portable diesel that any portable diesel pump can be connected to.

And we have also -- we also have hose connections at the -- at grade external to the reactor building that run up and are hard piped.

The ABWR spent fuel pool design features I wanted to highlight a couple. The analysis shows that under maximum load and with minimum water inventory, meaning the gate is closed, that it is estimated that you wouldn't reach boiling for 16 hours and that should give some time for operators to recognize such a situation and take some action.

So any manual actions that might be associated with the diesel pump or using the fire protection system in a reasonable time.

CHAIR ABDEL-KHALIK: Abnormal heat load meaning full off-load?

MR. CHAPPELL: Full off-load, design limit off-load.

MEMBER ARMIJO: How long would it take under those conditions to boil down the water to the top of the fuel?

MR. CHAPPELL: After you have -- after 16 hours?

MEMBER ARMIJO: Yes.

MR. CHAPPELL: I don't know.

MEMBER ARMIJO: How many days?

MR. CHAPPELL: A long time. It's many, many feet to -- I mean, that's --

MEMBER ARMIJO: We are talking about 10 days, 15 days?

MR. THOMAS: Probably not that long. Some number of days. I think there is 20 feet of water over top of active fuel.

MEMBER ARMIJO: It's a lot of water.

MR. THOMAS: So it's quite a volume of water. I would say something on the order of one to two days perhaps. Maybe not quite that long.

MEMBER ARMIJO: I think the numbers for Fukushima were much longer than that.

MR. THOMAS: I'm really guessing, so --

MEMBER ARMIJO: Yes.

MR. THOMAS: -- I hate to speculate --

MEMBER ARMIJO: Okay.

MR. THOMAS: -- much further. But it's a considerable volume of water.

MR. HEAD: I mean, obviously, what we are trying in this slide is that we have a significant amount of time to not get where there is no makeup to the --

MEMBER ARMIJO: Right, right.

MR. CHAPPELL: And if you are talking about, you know, reacting to an event, the significance of reaching the blowing point is the source term. So if you can take action before then, that's preferable to maintaining capability throughout the reactor.

MEMBER ARMIJO: Sure.

MR. CHAPPELL: And another point is that for the spent fuel pool, there are no piping penetrations approximately 10 feet above the top of the active fuel in the fuel racks. So --

CONSULTANT WALLIS: Well, the fire hose--

MR. CHAPPELL: -- there is not --

CONSULTANT WALLIS: -- is connected to a pipe that is immersed in this --

MR. CHAPPELL: There are multiple fire protection --

CONSULTANT WALLIS: -- spray?

MR. CHAPPELL: -- connections.

CONSULTANT WALLIS: Does it spray above or is it immersed in some way?

MR. CHAPPELL: There is two types of fills that are installed. There is a spray connection and a fill connection that are at the pool.

CONSULTANT WALLIS: Well, for the spray connection, you don't really care where the piping connection is outside, it could be anywhere.

MR. CHAPPELL: There's a single connection outside at grade that would hook the hose up and then it would run up to the pool. And then there is alternate ways that you could hook hoses up on the refueling fuel.

CONSULTANT WALLIS: Yes.

MR. HEAD: There is a single connection, but there is actually two connections.

MR. CHAPPELL: There are --

MR. HEAD: A third --

MR. CHAPPELL: -- multiple connections externally.

MR. THOMAS: The third bullet on Slide 11 talks about two standpipes that are approximately 180 degrees apart in the reactor building. The interior has not -- does not require operator action to get water in the pool. That sprays into the pool and there are connections at grade for fire connections outside the building.

MR. CHAPPELL: Right. Okay. And that gives us an overview of the makeup for the spent fuel pool.

CHAIR ABDEL-KHALIK: Are there any questions? Thank you for --

MR. HEAD: Was that your desired outcomes from the --

CHAIR ABDEL-KHALIK: Right. And of course, you know, the comment you made at the beginning, whatever comes out of Fukushima, you know, you will just have to respond to it.

MR. HEAD: Sure.

MR. THOMAS: That's right.

CHAIR ABDEL-KHALIK: That's -- okay. Any additional questions?

MEMBER BLEY: Yes. I just have one. Way back in the beginning, I think, Scott said that although this -- the CTG is not seismically-qualified nor is the building, I thought you said, Scott, that it was qualified as 2-over-1. And most plants, when they get to that point, just make it Class 1. Is there a real distinction for you guys?

MR. HEAD: Yes, sir. We will leave it as 2-over-1 as a potential threat to the, you know, reactor building and I don't envision us making it seismic Category 1.

MEMBER BLEY: Okay.

CHAIR ABDEL-KHALIK: It's in the corner. It's over in the corner of the turbine building, right?

MR. HEAD: Yes, sir.

CHAIR ABDEL-KHALIK: Yes. Are there any additional questions or comments? Okay. Thank you.

Now, we are, approximately, 50 minutes ahead of schedule. And we have time for public comments after the next item on the agenda. So let's just continue with the discussion of Action Items #87, #101, #62 and #63 and we will stop when we get to 12:00 for lunch.

MR. HEAD: Okay.

CHAIR ABDEL-KHALIK: Okay. Thanks.

MR. HEAD: Okay. Thank you. Yes, we appreciate the opportunity to go ahead and continue the briefing, at this point. And we did want to cover these four action items. We felt like we had developed a response to them and felt like we should have briefed ACRS at this meeting.

The first one was addressing failure of speed sensors. We had discussed this one at a previous briefing, but wanted to come back to this one to cover it in some more detail.

The 30 minute operator response time on failure of RSW piping that was in one of the previous meetings. The basis for RSW pump NPSH and the suppression pool heat-up with respect to the 77 degree RCIC limit.

So we will be discussing those items.

Our attendees have been involved with briefing the ACRS before. I'm going to turn it over to Tom on Action Item #87.

MR. DALEY: Good morning. I'm Tom Daley, NINA's Mechanical Engineering Supervisor for STP 3 and 4.

As Scott mentioned, the first action item to address is the failure of the speed sensors and the primary over-speed protection subsystem for the main turbine. And this is a follow-on from our June presentation where we discussed the turbine generator over-speed protection subsystem.

This is a subsystem which we consider highly safe and reliable and yet it protects against unwanted and unnecessary turbine trips. And it has a number of separate redundant and diverse subsystems.

We talked about the fact that the active speed sensors which control -- provide inputs to the normal speed control and the emergency over-speed trip system and any failure of those active components will result in a turbine trip. And that's because of the fact that it is feeding the normal speed control system.

The passive speed sensors, a diverse system, they feed the primary over-speed trip system. We didn't point out in our submittal that a failure of these passive sensors does not result in a turbine trip. And we feel that because these sensors do not control the normal speed control function, that that is appropriate.

It does provide an alarm in the control room.

CONSULTANT WALLIS: I don't understand Bullet 2. You have to have some sensor to know that the turbine is over-speeding, wouldn't you? Otherwise, you can't have over-speed protection. You have to sense over-speed some how.

MR. DALEY: Well, we do. We have two separate sets --

CONSULTANT WALLIS: So failure of the speed sensors doesn't affect emergency over-speed protection?

MR. DALEY: These speed sensors.

CONSULTANT WALLIS: Isn't this an important integral part of the over-speed protection to have a speed sensor that works?

MR. CHAPPELL: That bullet only refers to one of the two sets of speed sensors.

CONSULTANT WALLIS: What does the speed sensor mean?

MR. CHAPPELL: The primary over-speed subsystem and passive speed system.

CONSULTANT WALLIS: But you didn't say

that. You mean some of the speed sensors?

MR. CHAPPELL: That is the design.

CONSULTANT WALLIS: So what you are meaning is failure of some speed sensors? Failure of all of them wouldn't be acceptable, would it?

MR. CHAPPELL: It would not be acceptable and it would --

CONSULTANT WALLIS: So these --

MR. CHAPPELL: -- be continual turbine trip.

CONSULTANT WALLIS: So these meant all?

MEMBER ARMIJO: I think these meant passive.

MR. DALEY: Right. This bullet refers really --

CONSULTANT WALLIS: These meant passive.

MR. DALEY: That's correct.

CONSULTANT WALLIS: Okay. That clarifies it, otherwise, I didn't understand it.

MR. DALEY: Yes, right. Yes, and you are correct that's not --

CONSULTANT WALLIS: So these means passive.

MR. DALEY: -- clear the way it is worded right there.

CONSULTANT WALLIS: Oh.

MR. DALEY: Well, let me continue on with the third bullet.

CHAIR ABDEL-KHALIK: Go ahead.

MR. DALEY: Okay. I did say again with the passive speed sensor failures, you do have an alarm in the control room, which would allow for timely operator action as directed by procedure, which ensures a very low potential for turbine over-speed event to occur.

MEMBER BROWN: What type of operator action? You made that statement in your -- I read that in the transcript from the 6/21 presentation, which I had to leave, I apologize for having to leave on that one.

MR. DALEY: Right.

MEMBER BROWN: But I did, that's a fact. So when I read back, you talked several times about timely operation, appropriate actions, etcetera, etcetera. But I had no idea what you meant by timely or appropriate. And, obviously, you developed those thoughts probably not at this point.

MR. DALEY: Right, right. I would be speaking extemporaneously --

MEMBER BROWN: Yes.

MR. DALEY: -- without --

MEMBER BROWN: I want to try to cut to the bottom line of this, since I brought up this issue in the first place. It might be better to let me frame my point to make sure we at least address the fundamental issue.

The active sensors feed two systems. They feed your normal control. They feed your emergency over-speed. They each have separate processors dealing with each of those functions. And that's based on slides that you all presented in an earlier-- back in February or something like that meeting.

MR. DALEY: That's correct.

MEMBER BROWN: Each active sensor feeds all six channels effectively. The three control functions and the three monitoring functions.

MR. DALEY: Right.

MEMBER BROWN: Okay. I just wanted to make sure. Each of the active sensors is powered. So there is power supplies involved with each one. And, therefore, they talk, each sensor talks to every emergency -- each of the emergency monitors, each of the three and each of the control channels. I just wanted to fix that picture.

The passive sensors are for the primary

over-speed protection completely independent. Each of those passive sensor feeds each of its three monitors, because you evaluate those, and they are completely independent of all the other items.

They operate at 110 percent, based on your -- at least on the numbers you -- in the DCD that I saw. The emergency one goes at 111 percent.

My point of the question where you have the turbine tripping on failure of the -- some combination of the active sensors --

MR. DALEY: Two or more.

MEMBER BROWN: -- two or more, was aimed at your primary system, which is passive ones, did not have a trip. All it had was an alarm. If you are taking appropriate action and you are trying to fix something on the passive system, it's effectively out of service. And you talked about that it could be out of service for some time, the way your conversation went in the last transcript.

And you would be operating on the normal and the emergency. You now have a circumstance where you have no independence of your over-speed trip from your normal control function from the sensor signal conditioning, all those things, and the power supplies. The common cause failure circumstance while you are operating, you no longer have -- and my point is you no longer have an independent over-speed trip system.

I find that counterintuitive to operation, just based on experience where, in this case, one power supply could affect all six of your control flow, three control and your three monitoring channels. You could have a failure which told the control system to speed-up and disable the monitoring over-speed trip function.

That's not theoretical. It actually happened, okay, in my experience. It was an unfortunate experience. Unfortunately, it was stopped before it over-sped, but it happened very quickly. If an operator had not been standing within about 5 feet of the turbine generator set, it would have -- because he tripped -- he manually tripped the throttle valves. There would have been serious consequences.

It hit close -- about -- I can't give the -- use the numbers, but it was about 1 percent away from its over-speed condition. So that's the point of the whole question is that operation without your independent over-speed trip function seemed to be counterintuitive, but I'm going to allow myself to operate with a system that is subject to a common cause failure, which could take out -- which could result in a specific over-speed for trip -- excuse me, over-speed driven situation and compromise my over-speed trip system. That's what I found counterintuitive.

And I, fundamentally, don't think that is a good idea. So that's why I raised the point.

MR. DALEY: Okay.

MEMBER BROWN: So all the other stuff you can go through all the other shenanigans and that's my concern, because I would have thought, quite frankly, if I had a problem with my -- I'll put this on the record.

If your emergency -- say you had a problem with a couple of your emergency over-speed trip functions that are fed by the active sensors, the normal control circuits are all working just fine. You have still got an independent passive, totally independent over-speed trip set. And you have got some time there. That's better than the old days when you had one, you know, centrifugal switch, some type of centrifugal switch more than likely, on your turbine over-speed function, so that would have been an acceptable mode.

I just don't see it to be an acceptable --

this is me. This is not the committee. This is me, okay, under the circumstances which I just described. So that's kind of where I came down. I tried to explain it as crisply as I could. And I -- so I kind of -- that's where my heartburn was.

Was I clear in the description?

MR. CHAPPELL: I think we understood that to be the question.

MR. DALEY: Right.

MEMBER BROWN: Okay.

MR. DALEY: And I tried to format our response on this --

MEMBER BROWN: Yes, I read it. I just didn't see it solving --

MR. SMITH: Yes.

MEMBER BROWN: -- the problem.

MR. DALEY: First, the first part of the situation, as you describe, is the loss of a function of two of the three passive speed sensors. So we have talked about that situation occurring. And as we have stated, you won't get a trip on that. You will get an alarm in the control room.

There is guidance on probabilities that allows you certain LCO-type recommendations that says, okay, if you have got a probability of a turbine trip between this value and this value, you can operate for this amount of time in order to fix that problem.

MR. CHAPPELL: Well, the reduction in over-speed protection.

MEMBER BROWN: Well, hold it just a minute. In your comments last time, you were asked is there a tech spec LCO associated with this and you said no.

MR. DALEY: There is nothing in the tech specs.

MR. HEAD: That doesn't mean we won't be taking actions.

MEMBER BROWN: Well, I --

MR. HEAD: The procedures won't have that information available in there.

MEMBER BROWN: Well, how long? What do you mean by actions? I mean, is that 32 -- is it 72 hours? Is it --

MR. CHAPPELL: Well, the operator actions that you alluded to earlier based on alarm response procedure. So an operator -- if there is a problem with the over-speed protection system, one sensor fails, two sensors fail, something else, some common cause failure disables it, there will be indications go look at this, figure this out, call this, figure out how long you might need to -- how much time you have to take certain actions.

So there would be recommendations that would be based on the whole station getting together and looking at those inputs. They would say well, how long can I go before I have to take this turbine off-line to make these corrections? And the LCO-type time frame, as Tom mentioned, are based on a more likely over-speed condition that goes from 10^{-7} to say 10^{-6} probability. And you say well, I have a week or I have two weeks or I can go and troubleshoot this or maybe I have longer or less time.

MEMBER BROWN: So we are going to operate for a couple of weeks based on your probabilities.

MR. CHAPPELL: Well, I think Tom is going to get to that in the next point as to why that is -- may not be as relevant under the conditions when you are on-line.

MR. DALEY: Yes. So we have a failure of our passive speed sensors and now we are going to say we have a failure of our active speed sensors. And, of course, if you have got two out of three failures there, that will give you a turbine trip.

MEMBER ARMIJO: Tom, could you explain what failure means in the passive sensor? Is it loss of all signal? Is it an indication that speed is faster than what the active systems are telling you or slower? You know, what are the failure modes?

MR. DALEY: On the sensor side, I would be hard-pressed to come up with --

MR. CHAPPELL: An invalid signal.

MR. DALEY: -- a failure. But then it feeds into a black box. And so --

MEMBER ARMIJO: So how can you define failure?

MR. DALEY: -- then that black box goes--

MEMBER ARMIJO: Just loss of --

MEMBER BROWN: Well, typically, with the passive sensor, which -- at least the ones I'm familiar with, you -- it's more than likely a broken wire in the system. I mean, the sensor is --

MEMBER ARMIJO: No signal?

MEMBER BROWN: There is no signal.

MEMBER ARMIJO: Okay.

MEMBER BROWN: It's very hard to get a more signal out of a passive signal -- sensor, because they are self-generated. It's difficult.

MEMBER ARMIJO: Okay. So it's --

MEMBER BROWN: Probably a way --

MEMBER ARMIJO: -- just the loss of signal is --

MEMBER BROWN: It's a loss of signal more than likely. And then you have got the signal condition circuitry down or -- up -- down, excuse me, downstream of that feeding before you go into all of the processing circuitry.

MEMBER ARMIJO: Okay.

MEMBER BROWN: So there is some ways and then you have got the inputs to the actual processors themselves where there is more ways to do things. So there is a few places along the lines where you can lose that, a single piece of information.

MEMBER ARMIJO: But I'll let you go ahead, but I mean --

MR. DALEY: Now, again, given this next common mode failure of the active speed sensors, that will give us a turbine trip. But let's suppose that doesn't -- that turbine trip doesn't take place.

Now, in your normal situation, your generator is parallel to the grid. The speed control doesn't really control the position of the governor valves. It is -- the turbine speed is controlled by the grid. It doesn't go any faster than 60 cycles or 61 cycles.

Now, you could say, okay --

MEMBER STETKAR: The speed control to try to open the governor valves.

MEMBER BROWN: That's not true.

MR. DALEY: I'm sorry, John.

MR. CHAPPELL: It's a low voltage gate though, that type situation, and so you would be in dome pressure control mode.

MR. DALEY: But I want to hear your --

MEMBER BROWN: My point being is that the control system is telling you to open the throttles --

MR. DALEY: Yes.

MEMBER BROWN: -- independent. It's telling the turbine to open the throttles. So whether you are paralleled or not, the TG set will -- the TG set I was talking about was paralleled and it over-sped.

MR. DALEY: It would over-speed if the breaker tripped, but it will pick up more real load until maybe the generator breaker will trip because of an overload, but it's not going to go any faster.

MR. CHAPPELL: If you look at an analysis --

MR. DALEY: It can't go faster than what you are hooked up to.

MR. CHAPPELL: If you open all the control valves wide open, you are going to reduce your steam pressure. You might get a reactor scram that way, but you are not going to over-speed because it's locked to the generator.

MEMBER STETKAR: However, if that occurs, the over-speed protection from that emergency trip system, since it is now seeing a false high -- I'm sorry, a false low speed, will not close the stop valves. The speed sensors so that the protection system knows that the turbine is running at precisely zero rpm, that's what the protection system knows.

MR. CHAPPELL: It knows that it's going to close the stop valves.

MEMBER STETKAR: I'm sorry. It knows that the turbine is rotating at precisely zero rpm. The control system wants to open the control valves. It will try to do that. You will then go into some sort of load mismatch probably. You will probably get a signal to trip the reactor or a signal to trip the turbine from some other condition.

MR. CHAPPELL: Okay.

MEMBER STETKAR: However, if you trip the reactor, you open up the generator output breaker, at that point, the turbine is not -- is going to want to speed up. It has now lost its connection to the grid.

MR. CHAPPELL: Yes.

MEMBER STETKAR: It has lost its load. It is going to want to speed up. The protection system knows that its speed is precisely zero. That's what it knows. It is not going to control to close the stop valves, because it knows that the turbine is not rotating.

MR. CHAPPELL: The --

MEMBER STETKAR: So if you trip the reactor, if you open up the generator output breaker, the only thing you have left is the primary over-speed protection system with the passive sensors. That's the only thing you have left.

MR. DALEY: We have our core load unbalanced, which measures the generator output and measures the steam flow. And a mismatch of more than 40 percent there will open your fast acting solenoids and trip your --

MEMBER STETKAR: That might help, yes.

MR. DALEY: -- and more directly a turbine trip --

MEMBER BROWN: Where are they? Are they in the same circuits?

MEMBER STETKAR: No.

MR. DALEY: Well, when you say where are

they, the --

MEMBER BROWN: Where are they in the control -- are they part of the control system?

MR. DALEY: They are part of the normal speed control.

MEMBER BROWN: What did I just say? The normal speed control system has been told. You have no idea what is going on in this normal speed control system right now.

MR. DALEY: Through your speed --

MEMBER BROWN: There could not even be processing.

MEMBER STETKAR: Part of, I think, what Charlie is trying to get at is when you say fail, I mean fail, that the system -- the speed control system is absolutely 100 percent positively certain that the turbine is stationary. That's the failures. Those are the common mode failures. So if there are other ways of controlling -- of closing the turbine stop valves independent from the normal speed control processing stuff, because you don't know where those faults are.

I mean, we have been talking about speed sensors, but they could be in any part of the chain. If there are other ways of closing the turbine stop valves under those conditions, well, you know, that's worthy of thinking about.

MEMBER BROWN: Right.

MR. CHAPPELL: That is the case if you have -- I mean, no matter what the speed is, a mismatched trip closes to the fast acting solenoids, the stop valves. That will be the same --

MEMBER STETKAR: And that's a separate processing logic outside of the --

MEMBER BROWN: If it's not in the normal control circuits, that would be another thing. But you -- if it's -- if that imbalanced calculation is done as part of the normal control processors, then it probably is not working right.

MEMBER STETKAR: I don't know.

MR. DALEY: But I think it's all part of the electrohydraulic control system. Now, what black box that resides in, I'm not sure. But I do know that the sensors are completely -- it senses your electric power output and senses your steam flow. And if there is a 40 percent mismatch, it trips your fast acting solenoid bounce which shuts your -- all your control valves.

MEMBER STETKAR: In many traditional plant designs, those tend to be separate. They tend to be in separate boxes.

MEMBER BROWN: I don't know.

MEMBER STETKAR: If you want to use the black box analogy.

MEMBER BROWN: I don't know. I don't remember anything in --

MEMBER STETKAR: At least this one.

MEMBER BROWN: -- the discussion that discusses this.

MEMBER STETKAR: No, that's separate turbine protection.

MEMBER BROWN: Yes.

MEMBER STETKAR: They are a separate turbine trip, reactor trip --

MEMBER BROWN: And I have not seen that written up anywhere.

MEMBER STETKAR: -- protection modules.

MEMBER BROWN: If there is an alternate system that will trip those things, independent, be careful, of your normal speed control in an emergency controlled processing system and your primary over-speed trip system, there is another circuit that will trip these things.

MEMBER STETKAR: And that would be worthy of saying --

MEMBER BROWN: It's worth looking at. It's the other turbine trip signals. It has nothing to do with speed control.

MEMBER STETKAR: Absolutely. There is something there that will protect it. It's just it just --

MEMBER BROWN: Whatever other signals come into trip the turbine that are not just opening up the generator output breaker, because that's -- that makes this situation worse.

MEMBER STETKAR: Yes.

MEMBER BROWN: You know, it has got to be a primary turbine trip signal that comes in.

MR. CHAPPELL: I think when you are looking at the type of control signal failure that would happen, anything that would normally drive the turbine speed is only during startup. When you are talking about on-line operation, for example, when most likely something like this, even though it's low probability, could occur, then you do have the speed being controlled by the generator.

And if you had some kind of fault in your speed control that would tell the valves to open or do something else, the only way that could have an effect is it would tell it to close. And what you would then have in that particular case is you would end up with certain scrams. You would have either a high pressure reactor scram or you would have a low steam line scram or you would add load to the generator. You would get -- in either case, you would you end up in a result of a turbine trip. And that turbine trip is a signal to close the valves.

So even if the turbine sitting at zero rpm and rpm indicates whatever it is or infinite, that speed signal, whatever signal is going to it, there will be a control signal that says close the stop valves and close the control valves. And that would stop the over-speed condition on a turbine trip.

MEMBER BROWN: Well, right now, that's not explained anywhere.

MR. CHAPPELL: Okay.

MEMBER BROWN: And right now, from what I can view, there is a situation where you can end up in a situation with a non-conservative and unsafe mode of operation with your normal speed and emergency trip system. So unless -- I mean, as John points out, if there are some other --

MR. CHAPPELL: Sure.

MEMBER BROWN: -- circumstances --

MEMBER STETKAR: Let's see if we can think about something here. If -- I'm trying to think, you know, if there is a take-away from this, what would help us to have a little more confidence that there is some degree of, you know, additional protection, let's say.

If they could show that there are other turbine trip signals independent from anything to do with the word speed --

MEMBER BROWN: Yes.

MEMBER STETKAR: -- that would close the turbine stop valves under a condition where the turbine speed control system, for whatever reason, tries to speed up the turbine, would that provide reasonable assurance that the passive system then could be, you know, out of service for some period of time?

And they do. I looked up the table in DCD. There are -- you know, you can argue with numbers and things like that, but there are COL requirements that they have to evaluate probability of turbine over-speed and under degrading conditions, they are allowed to have things out of service for a period of time.

They are not tech specs in the same way, but they will be implemented through --

MEMBER BROWN: Procedures.

MEMBER STETKAR: -- procedures or maintenance, you know, your stuff important to safety or whatever it's called. Would that --

MEMBER BROWN: If there is something else, that would be fine. I'm just right now operating without an independent over-speed trip system for, you know, more than, I hate to use the words, a few minutes. I'm not going to argue whether it is a few minutes or an hour or whatever, but days or weeks starts -- we are not in a double to failure. You know, we are not doing that.

You are still down to single failure modes at that point. So that -- there are some other systems, I would agree with you, John.

MEMBER STETKAR: It strikes me that on this slide in the second line down, the last two bullets, I mean, it's true, you know, parallel to the grid, it's a pretty hard 60 hertz thing out there. The speed actually is not going to increase. Perhaps measurably if you have a really small grid, but -- which you tend to have on ships.

MEMBER BROWN: I don't disagree with that.

MEMBER STETKAR: The -- you know, in any kind of reasonable grid. However, it is going to try to pick up load. Now, how much load it is going to try to pick up is where your governor valve is set at.

The question is then what protections exist to trip the turbine under those conditions that are independent of the emergency trip system?

MEMBER BROWN: I understand.

MEMBER STETKAR: The over-speed stuff, because, you know, if you do just open up the generator breaker if it's a turbine generator, you know, electrical reactor or however you measure the stuff, that's not so good because the turbine is then going to want to go real fast. And then you are just relying on the, you know, passive -- the primary trip system.

So you need to think about things that would actually give you a turbine, you know, signal to close the turbine stop valves first or simultaneous with, you know, opening the generator breaker, hopefully first. And I don't know if they -- you know, and I don't know what they are. I haven't thought about the problem enough. And then the question is do they live in a separate box from whatever turbine control system you have there.

MR. CHAPPELL: We were talking about an over-speed protection system that goes to a different way --

MEMBER STETKAR: No, not over -- it can't be over -- you can't use the word speed. You need to word -- use words like some sort of pressure sort of imbalance nuclear power versus electrical load that says hey, turbine stop valves, you know, go closed.

MR. CHAPPELL: So that first part that I said and then what you have also is the turbine protection system. So you have -- you also have a number of other turbine trips that close the fast acting solenoid.

MEMBER STETKAR: True.

MR. CHAPPELL: And what Mr. Brown was asking about was examples and you look at failure of speed sensors, that's a list of 10 or some turbine trips that are in there. If you are talking about, you know, that would give you something that doesn't use the word speed in another list, so it's a turbine trip. It's independent of that.

MEMBER BROWN: So if you have a generator fault, for example, or you have something else that would --

MR. CHAPPELL: With the generator fault, you have the output breaker. That one is not a good--

MEMBER STETKAR: Go back and listen to the scenario. The scenario is the turbine speed sensors that are controlling turbine speed, but are not actually controlling real turbine speed because it is at 60 hertz, the turbine speed sensors suddenly know, all of them, the active ones, that the turbine rotor speed is precisely zero rpm.

And, therefore, the control system will then react to that, however the turbine speed under normal operating conditions will react to that signal and say, hey, I'm not supposed to have zero rpm when I'm putting out 100 percent power from my reactor or I've got a 100 percent load demand from my generator. I'm supposed to have, you know, 1,800 rpm or whatever it is.

So the only way I can get that is to open up the governor valves, which are mostly open. So it's going to try to do that.

Now, in truth, the governor valves are fully open right now, so you are now going to be putting more steam into the turbine, which means you are going to be putting more electricity out from the generator and you are going to see some types of load imbalances and some types of pressure imbalances. How much? I don't know.

MR. HEAD: They're going to see those,

right?

MEMBER STETKAR: Huh?

MR. HEAD: I mean, that won't be -- I mean, operators will become aware of that situation.

MEMBER STETKAR: I would like to know whether the automatic operator will be aware of that situation and whether the automatic operator will initiate a turbine trip, dump the hydraulic fluid under those conditions.

MR. CHAPPELL: I think the control valve position would be dominated by the pressure control model and that the signal, whatever signal that might go to the control valves for the sensor --

MEMBER STETKAR: Yes, and I don't know how that works on this.

MR. CHAPPELL: -- would not override that. It would maintain the control valve position to control reactor pressure in your low mode. And so that signal would exist. It would give you a failure, but it wouldn't actually cause -- it wouldn't override the signal that maintains the control valve.

MEMBER STETKAR: That might be the solution. I mean, if the pressure control is going to fix, essentially, that control valve position, the governor valve position, regardless of what signal might be coming from, you know, a faulty speed control input, which would, you know, tend to try to drive it open. You know, that might be the solution. You might not get a trip.

MR. CHAPPELL: Yes, you might not get a trip.

MEMBER STETKAR: But not getting a trip is no big deal under these conditions.

MR. CHAPPELL: Well, I think one of the things we -- when we think -- the part about not getting a trip, it's no big deal, is that one of the reasons probably you might ask well, why do you care? Why don't you just put a turbine trip in because of these passive sensor failures? One of the --

MEMBER BROWN: Remember, it's not -- you are operating without the passive -- the primary system right now.

MR. CHAPPELL: Yes.

MEMBER BROWN: So they are gone. You are not operating. You are taking your two weeks of time or whatever your analysis is, so you could take --

MR. CHAPPELL: Right.

MEMBER BROWN: -- and a single power supply failure in the other system can create these two problems. It's not just the sensors in the other

-- in the normal system. It's a power supply. You are telling the processors via the sensoring lines that in one case speed up and in the other case disable the trip.

MR. CHAPPELL: But you agree while on-line, nothing happens with the turbine.

MEMBER BROWN: I didn't say that.

MR. HEAD: Which we will --

MEMBER STETKAR: If either nothing happens when the active -- now, I'm putting some words in Charlie's mouth here so, I'm sure he will correct me. If either nothing happens in the real-world, if the active speed sensors suddenly, and I don't like using the words speed sensors, so if the --

MEMBER BROWN: It's the input. It's the input.

MEMBER STETKAR: So if the active speed control system suddenly knows that the turbine rotor speed is precisely zero during full power operation, if that suddenly happens, if then nothing happens to move the turbine control valve as a consequence of that, because either some other control function, you know, is overriding, you know, dominant or overriding or dominant or whatever you want to call it, that's fine, you just stay at 100 percent power, you know.

And you've got -- you know, in Charlie's-- the passive things, it's not a good situation to be there, but I'm confident that there will be some guidance to the operators.

Or if, indeed, the integrated control system does react and for some reason opens up the governor valves under this condition, is there another trip that comes in to trip the turbine independent of anything to do with the word speed?

MR. CHAPPELL: Yes.

MEMBER STETKAR: You know, and if the answer to that second part is yes, it would guide, you know, I'm hearing a couple different stories, either nothing would happen because there are other control functions that would prevent the governor valve from opening --

MR. CHAPPELL: Even if it were to open, even if it were to cause an opening of the control valves and try to add load or try to pickup speed, try to pickup load, even if it were trying to do that, it would eventually end up in, most likely, a scram, a reactor scram which would then result in a turbine trip.

MEMBER STETKAR: And that's -- I think, if you had some -- an example of that, why, you know, that would occur, I think that would provide some confidence about why you can operate, you know, for some nominal period of time with the passive sensors, you know, out of service.

MR. HEAD: Yes, but that's not the same. I don't think we are saying that we would operate some nominal period of time with the passive out and knowing that these have failed also.

MEMBER STETKAR: No. No, no, no, no, no. It's --

MEMBER BROWN: Nobody is saying that.

MEMBER STETKAR: It's -- the problem is, Scott, that if you are sitting there in that period of time with the passive out and these things go --

MR. HEAD: And the second says --

MEMBER STETKAR: If you were then guaranteed to over-speed the turbine, that's not a good situation.

MR. CHAPPELL: But we are talking about a separate diverse set of sensors.

MEMBER STETKAR: That's true.

MR. CHAPPELL: We are talking about independent common mode failures. And what we are talking about are systems that are capably testing on-line quite frequently shiftily.

MEMBER BROWN: Hold it. We are not talking about an independent common mode failure. Once you are in the normal -- in the emergency system, one failure that --

MR. CHAPPELL: Right. That's the second--

MEMBER BROWN: -- we -- they are not in -- no, it's not a second one. If you are out of service for -- if I'm operating for a week, I'm no longer in a double failure. I'm back into the single failure operation mode. One power supply feeds all six monitoring processors, all of them. It has happened before.

MEMBER STETKAR: But I think, Charlie, the first failure was what got you into the condition.

MEMBER BROWN: Yes, I understand that.

MEMBER STETKAR: You had the passive.

MEMBER BROWN: But that's -- once you decide to -- no. Once you decide to operate like that without doing anything, now I have made a decision I'm willing to accept. I have to deal with the consequences of a single failure. I admit two things happening within close proximity in time, like seconds or maybe a minute or two, that's a double failure. I'm not going to deal with that. We don't have to consider those.

But once I have said, oh, I know it's broke, I'm going to operate without it, one week, two weeks, whatever the time is, now, I have to deal with the circumstance that we are discussing. That's the only point.

MR. CHAPPELL: Well, that's why we talked about the LCO-type arrangements that there is an acceptable reduction of risk before you can go in and make those types of adjustments.

MR. HEAD: Well, otherwise, you are saying we should immediately take some action immediately on the failure in the first place.

MEMBER BROWN: Scott, if it had been me and if I had had a failure in my primary system, I would turn it off. Okay? Now, that's just -- I would trip the TG set. If I -- if my primary system --

MEMBER STETKAR: That's not by the way necessarily the safest thing to do in a nuclear power plant.

MR. HEAD: I think if that's the way we had designed --

MEMBER STETKAR: Just to get that on the record.

MR. HEAD: If that's the way we had originally designed the plant, then 10 years after operations, we would be looking for ways to change that design, because it's more of a risk, because we would be tripping the plant unnecessarily.

MEMBER BROWN: Right.

MR. HEAD: As a way -- is why we're up here defending this design.

MEMBER BROWN: I have told you -- in my comments to you I said you have got a nice system for ensuring the plant stays on-line. I made that point. I have no disagreement with the fact that you have got a fairly reliable system for keeping everything running. It's just --

MR. HEAD: And --

MEMBER BROWN: -- it may not be running safely.

MR. HEAD: Well, and keeping it on-line, but keeping it and then, you know, the staff, operations, engineering and management have the opportunity to make the appropriate decisions instead of those decisions being taken out of their hands. And some of those decisions may be, you know, shutdown. Some of those decisions may be additional monitoring. Some may do additional testing to make sure the other equipment is reliable.

So at least you have the opportunity to

make those decisions instead of, you know, like I say, those decisions being taken out of our hands if this failure were to happen. So, you know, we are -- you know, Mr. Chairman, I see -- as I think we are hypothesizing that we have this and and then something else has happened now since the, you know --

MEMBER STETKAR: It's a combination of the two. It's clear.

MR. HEAD: It's another end that now because the turbine -- what I'm saying is I don't think the turbine knows it is sitting there. And so now we need something else to happen and we need to tell you what is going to happen, what reactor trips are going to happen, so the turbine stop valves will close, I think, to say that we don't know -- we are not going to end up in an over-speed situation.

MEMBER STETKAR: I think, you know, from my perspective, I'll push the passive stuff away. If I knew what happens to the turbine, just normal plant operation, if the turbine speed control system suddenly knows that the turbine rotor is rotating at zero rpm, what then happens? What is the response of the turbine control system to that condition?

Will it open the governor valve or not? I don't know. I'm not a turbine control guy, so I'm certainly not -- you are a turbine control guy. Will it open the governor valve or not? I don't know. If the answer is no it won't, because there are other control functions that override, you know, that spurious speed sensing thing, that's fine.

If, indeed, the governor valves will open, then I would like to know, you know, is there another independent turbine trip that will come because of the way the whole plant works, whether it is from a pressure, you know, or a load imbalance or what is it.

CHAIR ABDEL-KHALIK: I'm going to ask --

MEMBER STETKAR: The answer is that, yes, there will when it comes in and that's an added measure of confidence that even if the passive system wasn't even there, you have some sort of protection that will trip the turbine.

CHAIR ABDEL-KHALIK: Dinesh?

MR. TANEJA: Yes. This is Dinesh Taneja, staff. You know, my understanding of the design, the way I understood it, it might help in this discussion. One thing is I think the way I understood it is that during normal operation in a BWR, the turbine is running in a pressure control mode not on a speed control mode. So really, the speed sensors are not actively involved in the turbine control system.

And the other thing that I understood that the power load imbalance PLU controls, they reside in the controllers, in the normal speed controller boxes. Whereas, the emergency over-speed controller boxes are independent of the normal speed control boxes.

So the PLU condition that would trip the turbine is independent of the emergency over-speed trip circuits and controller boxes. And, Charlie, there is redundant set of power supply in the system, so really we didn't see --

MEMBER BROWN: Not a redundancy of power supplies.

MR. TANEJA: There is.

MEMBER BROWN: Well, no, that's not the issue. The system which we had the problem with had redundant power supplies.

MR. TANEJA: Okay.

MEMBER BROWN: They were both operating in parallel and when they went -- they watched it chugging away and they went to troubleshoot and guess what happened when they did their troubleshooting? That's when they had the over-speed. So the redundancy doesn't fix the problem when you are trying to figure out what is going on.

MR. TANEJA: Okay. No, I think I heard

that there was a single power supply.

MEMBER BROWN: No, this was not --

MR. TANEJA: Okay.

MEMBER BROWN: Well, it was a single power supply failure. And when they went to troubleshoot, they took out -- they disabled the wrong power supply in terms of what was the source of the problem as they walked through their troubleshooting steps.

MR. TANEJA: And then also the normal speed control system is a fail-safe design, the way, you know, we see it? It's -- you know, so if you do have a multiple failures in a normal speed control, that will result in turbine trip.

I just wanted to add my understanding.

MEMBER BROWN: I understand the normal -- I understand if you have failures in the normal speed control, you will get a turbine trip. I understand that. It's very plainly stated that was my point. And I saw the primary system, nobody seemed to care. And then when I saw the discussion where it can be out of service, that just triggered the additional thought processes.

MEMBER ARMIJO: I've got a question for clarification. I'm not a turbine guy by a long shot, but the way your chart says if you lose a signal from two of the three passive speed sensors, there will be no automatic turbine trip and you are relying entirely on your -- what happens if you lose all three of the passive speed sensors? Will that trip the turbine?

MEMBER BROWN: No.

MEMBER ARMIJO: So that won't do it either?

MEMBER BROWN: Yes, that's what raised my question before.

MEMBER ARMIJO: Yes.

MEMBER BROWN: The fact that there are no trips on the passive --

MEMBER ARMIJO: Other than information, what use are these passive speed sensors?

MEMBER BROWN: Well --

MEMBER ARMIJO: I mean, they are not really protection, are they?

MEMBER BROWN: Okay, Sam, let me -- we got into this before.

MEMBER ARMIJO: Why put them in there if they don't do anything?

MEMBER BROWN: My understanding based on what I -- from previous meetings is that there was an expectation initially that you would have a mechanical over-speed trip.

MEMBER ARMIJO: Yes, yes.

MEMBER BROWN: And an electrical over-speed trip. Well, they came in and said no.

MEMBER ARMIJO: What do --

MEMBER BROWN: What would it do to electrical?

MEMBER ARMIJO: Right.

MEMBER BROWN: Well, if you had -- this whole argument, this whole discussion is moot if they had -- or irrelevant if they had a mechanical over-speed trip system.

MEMBER ARMIJO: But they don't.

MEMBER BROWN: They could do whatever they want to with the other system. I'm just saying if it was mechanical, why isn't the passive one treated similarly to the mechanical? It's the mechanical one that is out of service and they knew the centrifugal switch was busted, would they operate? I have no idea. And John is shaking his head yes.

MEMBER STETKAR: Probably.

MEMBER BROWN: That's --

MEMBER STETKAR: Because you don't basically know it won't work.

MEMBER BROWN: Well, that's because you can't test them the way we can --

MEMBER STETKAR: That's right.

MEMBER BROWN: -- the other stuff. So I fundamentally like the electrical approach. I don't have any problem with that. It's just that I don't understand the passive system saying hey, I'm going to operate for two or three weeks without it or a month or two months, whatever my probabilistic assessment says.

MEMBER ARMIJO: If it fails --

MEMBER BROWN: It just doesn't make any sense.

MEMBER ARMIJO: You get them signaled. I failed, please, worry. I don't know what you do with it.

MR. DALEY: But then you have to fail the other one, too.

MEMBER ARMIJO: Right.

MEMBER BROWN: Yes.

MR. DALEY: It doesn't --

MEMBER BROWN: Well, I understand that.

MR. DALEY: Which is why I put the and there in bold and underlined.

MEMBER BROWN: Hold it. You know, you keep mixing these as if they are occurring within milliseconds or seconds or minutes of each other.

Once I'm operating for a couple of weeks, I can't -- that's not a double failure mode. I made a decision to operate with something broken.

MR. HEAD: There is no time there.

MEMBER BROWN: I'm sorry I get --

MR. HEAD: We are saying that has to happen.

MEMBER BROWN: -- excited every now and then.

MR. CHAPPELL: I think it's analogous to ECCS systems being out of service. I can run continuously. Well, if I lose a train, I don't have to shut down because there might be some problem with the other ones. I have to do -- I have a limited amount of time which I can run under those conditions.

MEMBER BROWN: No, but you could have a -- but you can handle single failure in those other ones where each of the other -- one of the other trains will operate. In this case, you can have a single failure which doesn't allow any more trains to operate. Different circumstance, so your analogy is not very good.

MR. HEAD: You're not -- you can't handle single failure with all tech specs, you know, LCOs. I mean, that's -- your outside design basis at that point in time. So that's not -- for some configurations, some three train plants, you can be like that. But if you are in tech specs, that means you are already outside design basis and single failure is not. So that is somewhat analogous to this.

MEMBER BROWN: Well, actually, I don't agree with that just because you are not quite within the design basis, still doesn't mean that the system won't work and you won't minimize effects. Here you can't minimize any effects. You just throw blades through the housing.

MR. HEAD: Well, I don't -- I think if that's the conclusion, then we, obviously, you know, need to come back and discuss this some more. And I would think --

CHAIR ABDEL-KHALIK: Yes, I'm not sure we are converging at all.

MR. HEAD: No.

MEMBER BROWN: No, we are not converging right now. I just -- I won't say that. John's point is valid. If there are other controlled functions --

MR. HEAD: Yes, and that's what we are going to --

MEMBER BROWN: -- within this --

CHAIR ABDEL-KHALIK: If you can demonstrate that then --

MEMBER STETKAR: For take-away, you know.

MEMBER BROWN: That is what I -- that's what my take-away would be.

MEMBER STETKAR: If there are other things that will intervene to trip that turbine?

MR. CHAPPELL: And they are described in Section 10.2. You know, we could --

MEMBER BROWN: Relative to this circumstance?

MEMBER STETKAR: No, no, no, no.

MEMBER BROWN: I'm sorry, John.

MEMBER STETKAR: Under the circumstance where the normal speed control system knows that the turbine rotor speed is zero, so just take that as your initiating event. Don't take a generator fault, don't take, you know, any of the other turbine trip signals out there. Take as your initiating event a condition where the normal speed control system knows that the turbine rotor speed is zero.

Now, then what will happen? I don't know, you know. The first question is will the governor valve open or not? And if it is totally under pressure control and it only looks at electrical load versus, you know, don't -- reactor dome pressure to control the governor valve position, probably the answer is nothing is going to happen.

If that's not the case, if, indeed, the governor valve is going to come open from that condition because speed also factors into it to control, you know, algorithms, then the question is if the governor valves now do go wide open, what trip will come in and open the hydraulic fluid valve?

MR. DALEY: Realizing there is another and in that, because if you have a sensor failure in your active sensors, you get a turbine trip.

MR. CHAPPELL: That causes a turbine trip in itself, but --

MR. DALEY: But you've got to say that doesn't happen.

MEMBER STETKAR: Well, and that's -- I'm trying to get -- I know that. And I'm trying to get past -- a little bit past the word sensors to try to help some of Charlie's concern, because it might not--

MEMBER BROWN: It's input to the processes.

MEMBER STETKAR: I was using the term the turbine speed control system knows however it gets to know that.

MR. HEAD: I guess back to an aspect, clearly, if you are in this failure and you in your response procedures, the operators are going to be aware that they are in a degraded position and they are going to be observing the plant. And if any of the things that you are talking about happen, then they are going to be required to make decisions based on that also.

And so we will attempt to go to the automatic action, but I don't think that is what is going to happen first. I think you are going to have operators seeing things happen that they are going to then react to.

And so I don't want to leave this discussion with thinking that these -- you know, the control room would not be already taking some action if this second failure happened.

MEMBER STETKAR: You can see the fluctuations.

MEMBER BROWN: That's not the point.

CHAIR ABDEL-KHALIK: They may be distracted with something else at the time.

MEMBER STETKAR: Well, you know, if that action is trip the turbine, that's good. If it is trip the reactor, that's probably okay. If it's open

-- if the first thing they grab for is the generator breaker, that's not so good.

CONSULTANT WALLIS: I agree.

MR. CHAPPELL: Typically, in this condition if you are going to do that -- you know, I think, we get in this condition if you're going to trip the turbine, you're going to trip the reactor first, with the turbine.

CHAIR ABDEL-KHALIK: So you have an understanding of how you are going to proceed to try to find out --

MR. HEAD: I visualize --

CHAIR ABDEL-KHALIK: -- there is something in the design that would allay that concern?

MR. HEAD: Yes.

MR. CHAPPELL: If we come back with that level of detail, would that give us enough common ground where we could --

CHAIR ABDEL-KHALIK: Yes.

MS. BANERJEE: Can I just say something, please?

MEMBER BROWN: Yes, as long as it is articulated somewhere. Just not let up in the ether.

MS. BANERJEE: So we can --

MEMBER BROWN: The point being is you want to make sure there is something within the design space with which you are designing the plant that actually achieves what you talk about when you come back. If it is not written down, that means it can be whatever happens three, four or five years from now.

CHAIR ABDEL-KHALIK: We will just leave this action item the way it is.

MR. HEAD: Sure.

MS. BANERJEE: Okay.

MR. HEAD: Absolutely.

CHAIR ABDEL-KHALIK: Okay. We will just leave it the way it is.

MR. HEAD: Understood.

CHAIR ABDEL-KHALIK: Let's break for lunch --

MR. HEAD: Let's take discussion on this.

CHAIR ABDEL-KHALIK: -- at this time. We will reconvene at 1:00.

(Whereupon, the Open Session meeting was recessed at 12:00 p.m. to reconvene at 12:58 p.m. this same day.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

12:58 p.m.

CHAIR ABDEL-KHALIK: We are back in session. Before we get back to you, Don Dube would like to make a comment.

MR. DUBE: Yes, thanks. Thanks. Is this working?

CHAIR ABDEL-KHALIK: Yes.

MR. DUBE: Thanks, Mr. Chairman. Don Dube, Office of New Reactors, Division of Safety Systems and Risk Assessment.

Really, just a couple comments more in the line of observations, because this is the first time I had seen the extended Station Blackout analysis. If I can contribute to the discussion, if it would be worth your effort.

Something -- a comment was made or a discussion was made regarding the importance of dc battery life. And I just want to note, you know, we have the ABWR SPAR model, which is a very close PRA model to the applicant's design control document PRA model.

And there it is noted that, you know, the ability to extend dc power especially to keep open, for example, the safety relief valves in the long-term when one is using ac-independent water addition is highly critical and at least is modeled in the SPAR model sequences where there is an ability to maintain the safety relief valves open for an extended period of time and recover off-site power and contribute about 18 percent to the internal events core damage frequency.

So it's a very -- my point is, it's a very important aspect of extended Station Blackout is the ability to restore dc power to be able to keep a safety relief valve open.

Another observation is with regard to the setpoint for the ruptured disc on the containment over-pressure system or event capability. On the whole, the advantages of a passive feature like that far outweigh that of a hardened vent or a venting capability that relies on a lot of manipulation of valves, because there is a lot of dependencies on ac power, dc power, maybe even pneumatic. And so passive design offers a lot of features.

The only thing I will note is that the setpoint of 104 psia or normally 90 psig it's quite a bit higher than what you see in the current fleet. Now, there is advantages and disadvantages. Obviously, one advantage is to avert -- to avoid or prevent an inadvertent actuation of containment venting.

But the other thing is that it does delay containment depressurization and, under some circumstances, there can be some disadvantages such as, you know, the back pressure resulting from such a high setpoint may preclude certain options for ac-independent water addition if you look at the hydraulics of the fire protection system, the back pressure and the pressure drops for various piping locations.

In some circumstances, it may be advantageous or one may have wished that one had a lower setpoint to not preclude certain options. And I'll just make a note the one passive plant that I'm aware of in a currently operating reactor Vermont Yankee, has a design pressure of 56 psi gauge and the setpoint for the ruptured disc is 59, plus or minus 3 psig. So they vent pretty quickly.

And so, you know, one of the lessons learned that I guess we will still be learning these lessons from the Fukushima accident is that, you know, delaying containment venting was a big disadvantage in that particular accident because it precluded a lot of ability to get low pressure systems in.

So just a couple of observations. I don't think it's going to change any conclusions, but I think we will hear more about that in the future.

CHAIR ABDEL-KHALIK: Thank you, Don.

MR. THOMAS: I'll just comment on your comment, I suppose. This is Steve Thomas again, Engineering Manager for STP 3 and 4.

That's an excellent observation. Our earlier presentation, of course, was what has already been evaluated for the ABWR. And certainly in like of Fukushima, we are looking at other enhancements to the containment over-pressurization systems, such as bypasses, which would require active systems or lowering setpoints and things like that. We are just not at that point.

CHAIR ABDEL-KHALIK: Yes, it was very clear from Scott's comment that this is where we are now.

MR. THOMAS: We will come to understand and agree with your observations.

CHAIR ABDEL-KHALIK: Thank you.

MR. DUBE: Sure.

CHAIR ABDEL-KHALIK: There's another comment?

MR. FULLER: Yes. This is Ed Fuller from

the Office of New Reactors. I'm sorry I wasn't here this morning. I had conflicting meetings. I'm looking at the slide where you looked at the sequence of events for the case where you had a Station Blackout without the CTG, but then you were bringing up the ac-independent water addition system to depressurize the vessel.

I noticed that you are saying that it would take around a little less than two hours to line it up and do the depressurization. And during that period of time, it is pretty apparent from events that have transpired within the last six or eight months that you would have core damage before you got to that point.

Suppose for some reason you had not been able to line it up quickly enough and it took you another hour or two, have you folks assessed what the consequences might be and what you might want to do with the ac-independent water addition system if the vessel failed?

MR. TONACCI: Excuse me, Mr. Chairman, I'm not sure where we are in process here.

CHAIR ABDEL-KHALIK: Well, these two gentlemen were not able to attend the presentation on the extended SBO Mitigation and they requested time to make a comment just for the Committee's enlightenment.

MR. TONACCI: Okay.

CHAIR ABDEL-KHALIK: So with that, that's why I allowed these comments. So if you will, please, continue?

MR. FULLER: I finished the comment, the question.

CHAIR ABDEL-KHALIK: Okay. Thank you.

MR. FULLER: You were --

CHAIR ABDEL-KHALIK: You may or may not answer this question.

MEMBER ARMIJO: You were referring to Slide 6?

MR. FULLER: Yes.

MEMBER ARMIJO: Okay.

MR. HEAD: Well, as to the second comment, you know, what Steve has said in the industry, we are going to be looking at all aspects of it. I did want to say though in the scenario that we were presenting, there was no core damage.

CHAIR ABDEL-KHALIK: Right, yes.

MR. HEAD: I believe there was a -- you mentioned that we could have -- we would have --

UNIDENTIFIED SPEAKER: A little bit longer.

MR. HEAD: Right. So I just wanted to clarify that.

CHAIR ABDEL-KHALIK: Right. He is talking about what if it took longer. And we haven't been surprised --

MR. HEAD: We haven't done that evaluation.

MR. FULLER: There wasn't core damage, but if you say there wasn't, there wasn't.

MR. HEAD: That first eight hour RCIC is still operating.

MR. FULLER: No, I mean between eight hours and 9.8 hours.

MR. HEAD: Yes, go ahead.

MR. THOMAS: We have not evaluated. I certainly agree with you. As Dr. Wallis pointed out, there is certainly some time-dependent assumptions in that analysis and if those time things aren't met, then there may be different results.

A point of our presentation was simply to demonstrate the as-designed current capabilities and what has been analyzed to date.

MR. FULLER: Right.

MR. THOMAS: Certainly, we are going to reevaluate many of those things as the industry events provide us further insights.

CHAIR ABDEL-KHALIK: Let's get back to the agenda.

MR. FULLER: Okay. Thank you very much.

CHAIR ABDEL-KHALIK: Thank you.

MR. FULLER: Thanks for letting me comment.

MR. HEAD: Okay. We are on to Action Item #62. I'll turn it back over to Tom.

MR. DALEY: Good afternoon. Action Item #62 involved the question about how the ultimate heat sink water storage basin design volume, as described in DCD, accounts for a pipe crack that might occur during the 30 day duty time, specifically, DCD states that a single passive failure of reactor service water piping is considered and the water loss is based on a 30 minute response time.

Now, I don't know if it was our last meeting or the meeting before when we discussed this. We talked about the fact that the DCD Subsection 19 allows this 30 minute response by a control room operator to locally isolate a leak.

And we also talked about if there was a leak in the reactor service water piping in the pump house, there would be some indication of that either through a sump alarm or we have flooding monitors in that area as well.

And we also mentioned that the inventory in the basin accounts for this 30 minute response time. It has an additional 25,000 gallons to allow for the operator to get and isolate the leak. Well, that all assumes that you can isolate the leak. And really the question came down to what do you do about a leak that you can't isolate? Meaning between the basin itself and the first isolation valve on the pump suction.

And really it doesn't account for that amount, however, we have accounted for it in the design. Now, that is we have exercised the capability of designing this piping to very low stress levels, such that we don't have to postulate a crack in the pipe. We designed super-pipe, is what it used to be termed. And the DCD and SRP allows us to do that.

If you look closely at it --

MEMBER STETKAR: So this pipe can't break?

MR. DALEY: This pipe -- and it's designed as Seismic Category 1, so it can't --

MEMBER STETKAR: Oh, as is the whole RSW.

MR. DALEY: As is the whole RSW. So as the pipe can break --

MEMBER STETKAR: Does this pipe break?

MR. DALEY: As is the ultimate heat sink basin, so we design it to those higher standards so it's not subject to those.

MEMBER STETKAR: But if the pipe -- if none of the pipe can break, why do the analyses say that if a pipe break occurs, I have 30 minutes to isolate it? And why does the design account for that 30 minute inventory for isolable breaks if the pipe can't break?

MR. DALEY: That's a good point. We don't design all of the pipe using this crack exclusion criteria.

MEMBER STETKAR: Okay.

MR. DALEY: We just design the non-isolable portions to this lower level of stress levels.

MEMBER STETKAR: In -- and I'm not a materials guy, so I'm going to keep quiet about the crack exclusion stuff, because I don't know what that means.

MEMBER ARMIJO: Well, yes, I was going to ask you about your -- you use the word leak. I mean, this has got to be a fracture of the pipe --

MR. DALEY: Right.

MEMBER ARMIJO: -- to be -- to have any impact on you guys as opposed to a little leak, a pitting leak or a stress corrosion cracking-related leaks. So those are --

MEMBER STETKAR: They use -- for reference, the reason I stumble over this, it says in Section 92.5.5.2 of the FSAR, it says "A single passive failure of the RSW piping is considered in the system. A crack is assumed with a leakage flow based on a circular orifice with flow area equal to one-half of the piping outside diameter multiplied by one-half of the nominal wall fittings."

So it's not just a drip leak.

MEMBER ARMIJO: It's a big leak.

MEMBER STETKAR: It's a big leak. They have 30 minutes to isolate the leak. So I originally asked what's the basis? How do you know you have at least 30 minutes for a leak anywhere? And there are sections of this piping that you cannot isolate.

MEMBER ARMIJO: Right, right. So for those sections, you have designed them as Seismic Category 1?

MR. DALEY: The whole system is --

MEMBER ARMIJO: The whole system is Seismic Category 1?

MR. DALEY: Those portions were designed for the stress levels that are less than, off the top of my head, I believe it is, 40 percent of the allowable stress levels for that kind of pipe. And that leakage is right from the guidance. The guidance -- when you partially have a leak, here is how to --

MEMBER ARMIJO: Okay. Okay.

MEMBER STETKAR: Tom? Tom, the second bullet on this slide, I always get careful when I see a lot of qualifiers. It says the non-isolable piping in the RSW pump rooms is designed using crack exclusion criteria. What about the non-isolable piping between the basin and the pump room?

MR. DALEY: Yes.

MEMBER STETKAR: And how much -- how long is that piping run? And is it also designed to be non-isolable, the crack exclusion stuff? Or are they -- I didn't have a good -- I see. Never mind.

MR. DALEY: Okay.

MEMBER STETKAR: Thank you. I see the answer to my question.

MEMBER ARMIJO: Where do you see it?

MEMBER STETKAR: It's isolable.

MEMBER ARMIJO: You can isolate it?

MR. DALEY: No. The key is it's

immediately adjacent. I didn't know whether there were -- the basins were separated by, you know, 25 or 30 yards of underground piping or something like that.

MEMBER STETKAR: They are right at the basin. The pump and the basin, so it's not --

MEMBER ARMIJO: Okay. Thanks.

MEMBER STETKAR: -- as far as it used to be, but it's still pretty far.

CHAIR ABDEL-KHALIK: Okay.

MEMBER ARMIJO: Thank you.

MR. HEAD: Does this address this question?

MEMBER STETKAR: Yes. That addresses the non-isolable part of it. And the 30 minutes you have done analyses to show that in any of the isolable sections that a leak that large we will give you a 30 minute time window to isolate it and still maintain enough inventory in the basin.

MR. DALEY: Yes, we have included that inventory in the basin.

MEMBER STETKAR: That extra inventory in the basin.

MR. DALEY: That's correct, yes.

MEMBER STETKAR: Okay.

MR. HEAD: And you almost said that the

other way around. We assume the 30 minutes. And then you add that amount of leakage to the heat sink --

MEMBER STETKAR: Yes, okay. Either way you get to the answers.

MR. HEAD: Yes, right.

MEMBER STETKAR: Either way you say it.

MR. HEAD: So that's water you assume that has got to be there, but it isn't going to be there for you.

MEMBER STETKAR: You have accounted to the largest isolable section.

MR. DALEY: And that's good so that if you ever noticed, they do have a packing leak or something, you don't get into some tech spec limit or anything like that.

MEMBER STETKAR: Packing leaks, I'm not so concerned about.

MR. DALEY: Right.

MEMBER STETKAR: A break -- you know, this says that the design is tolerant of a break this large.

MR. DALEY: Yes.

MEMBER STETKAR: Of this amount of leakage, so --

MEMBER SHACK: What is this material for

this piping?

MR. DALEY: It's stainless steel.

MEMBER SHACK: But I mean, it's not AL6X or some super type alloy?

MR. DALEY: Not yet, it's not. But as --

MEMBER SHACK: You know, the trouble with this crack exclusion is it's a criteria set up by mechanical engineers, obviously.

MR. DALEY: Yes, right.

MEMBER SHACK: Where it all depends on stress level. Whereas, it's probably the most likely failure here is corrosion. And, you know, it's a little tougher to guarantee it won't corrode if it's, you know, ordinary stainless steel --

MR. DALEY: Yes.

MEMBER SHACK: -- in a muggy environment.

MR. DALEY: In the certified design, it is stainless steel, but we are looking at other materials on the side in preparation for potential possible changes in the future HDPE, chrome-moly.

MEMBER SHACK: Yes.

MR. DALEY: That sort of thing.

MEMBER SHACK: Plain carbon steel.

MR. DALEY: Yes.

MEMBER ARMIJO: But all of this piping

would be cathodically protected if you had -- if you-- or not?

MR. DALEY: No, it's stainless steel.

MEMBER SHACK: No, because this --

MR. DALEY: None of this is buried. None of this is buried. It's not buried.

MEMBER STETKAR: Oh, that's what that second drawing --

MEMBER ARMIJO: So where is the corrosion going to come from?

MR. DALEY: Pardon?

MEMBER ARMIJO: Where is the corrosion concern?

MR. DALEY: We will have ultimate heat sink water running in this thing for 60 years, so we will be inspecting this pipe on a regular basis.

MEMBER ARMIJO: Okay.

MR. DALEY: Wall thickness, measurements.

MEMBER ARMIJO: Yes.

MEMBER STETKAR: But it's an open element system, you know. It's exposed to the air.

MR. DALEY: Yes.

MEMBER STETKAR: It's got -- you know, so it's --

MEMBER ARMIJO: Circulate, right? It's

not stagnant.

MEMBER SHACK: No. This is just plain old garbage water.

MEMBER ARMIJO: Oh, wait a minute. You should take exception there.

MR. DALEY: Yes, we do.

MEMBER STETKAR: Okay. I'm sorry.

MEMBER ARMIJO: We didn't mean that.

MEMBER SHACK: But it's not reactor cooling system water.

MEMBER STETKAR: Yes, right.

MEMBER SHACK: Nor is --

MEMBER STETKAR: Yes, and it's not a river either.

MEMBER SHACK: It's not a river. It's not the Gulf of Mexico, that's true.

MR. DALEY: Exactly, yes.

MR. HEAD: Okay. With that clarification, have we addressed this?

MEMBER STETKAR: Yes. I mean, as long as people who know about material things are happy with the crack exclusion stuff.

MEMBER ARMIJO: I'm happy.

MR. HEAD: You know, it's used in a couple of places on 1 and 2, you know, Units 1 and 2. I mean, it is --

MR. DALEY: Containment isolations, areas have used that criteria for many years.

CHAIR ABDEL-KHALIK: Okay. Let's proceed.

MR. HEAD: #63.

MR. DALEY: Action Item #63 has to do with the available net positive suction head calculation that was -- that's in the DCD. Originally, we had some of these numbers in here based on 100 degrees centigrade.

And so the question of the -- looking at the equation itself and the numbers in the equation came up and so what we have done here is we have listed the available NPSH calculation and we have shown -- we have listed the values for the various parameters here on this slide.

And it's a simple matter of adding these all up. And it comes out, if you consider the static head, which is shown on the drawing Coley had flashed up here earlier, which has to do with the level in the basin, and we do this calculation at the end of the 30 day period. Go ahead and bring it back, Coley, so I don't have to do this from memory.

And you consider the atmospheric head, which is on the water as well.

CONSULTANT WALLIS: Well, that could vary by plus or minus 10 percent or something, too.

MR. DALEY: That could.

CONSULTANT WALLIS: Could come with 28 inches of water or 28 whatever and so 30, then you have got to think different.

MR. CHAPPELL: We have some -- that last line alludes to some of the additional conservatisms.

MR. DALEY: Yes. And then, of course, you subtract away the vapor pressure and you subtract away the frictional losses and that's what you have available for NPSH to the pump.

In our situation, we have applied a 10 percent margin on that value. So we are saying that there is less available than what there actually is. And that number 15.9 meters is consistent with the value that we have listed in the DCD, in the COLA now.

MEMBER STETKAR: I guess this shows -- okay.

CHAIR ABDEL-KHALIK: Can I just ask a question while you are thinking about it, John?

MEMBER STETKAR: Yes.

CHAIR ABDEL-KHALIK: Is there a tech spec limit on the 95 degrees?

MR. DALEY: On the 95 degrees? Yes, there is.

CHAIR ABDEL-KHALIK: Okay.

CONSULTANT WALLIS: It's kind of roundabout listing, because if there is no flow because of gravitation, there is no frictional loss either. So it's intermittent. If it's beginning to cavitate, you won't get the flow, so you won't get such a high friction loss.

MR. DALEY: So it will stop cavitating and then it will go --

CONSULTANT WALLIS: There is no way -- well, that's the whole NPSH. You will get an error coming out of solution.

MR. DALEY: Yes.

CONSULTANT WALLIS: Probably that doesn't matter enough to be considered.

MEMBER STETKAR: I'm still -- well, I think -- help me out on this, because I'm trying to process -- I didn't see this calculation before hand, so I'm trying to process this and look at numbers that originally prompted this question.

In the FSAR it says "The minimum water level in the ultimate heat sink basin, after a 30 day operation, following the design basis accident is set at 1.83 meters above the suction lines center line, above the pump suction center line."

1.83 meters is about --

MR. DALEY: 8 feet.

MEMBER STETKAR: -- 8 feet. So I'm not sure where the static head of 31.17 feet comes from in your calculation here if, indeed, it is 1.89 meters.

MR. CHAPPELL: It's the 22 plus 8 plus 1.

MR. DALEY: This is --

MEMBER STETKAR: Because the ultimate conclusion in the FSAR is that you meet -- there is a table that says at the end of 30 days, you have an available net positive suction head of 16.9 meters, which is kind of close to the numbers that you have on that slide, but --

MR. DALEY: Yes. This slide here shows the center line from the pipe to the top of the --

MR. CHAPPELL: No, the minimum water level is -- the minimum water shown is 17 feet there.

MR. DALEY: Right.

MR. CHAPPELL: And then you have -- where you have this sump that comes in as berm, that's -- there is a flow to the top of that and then it shows the distance as 8 feet to the top of the center line of the suction and then another 22 feet and 2 inches that goes down to the pump center line suction.

So stepping that up, it gets 22.2 plus 8 plus 1 and that gets you to the 17 foot minimum, which is the minimum water level.

MEMBER STETKAR: But that's not -- my interpretation of the pump suction center line is down --

MR. SMITH: By the pump.

MEMBER STETKAR: -- by the pump.

MR. CHAPPELL: Yes, right.

MR. DALEY: It's called the suction.

MEMBER STETKAR: That's right.

MR. DALEY: The center line really is that pipe that is at 8 feet below the --

MEMBER STETKAR: Right.

MR. CHAPPELL: Right.

MEMBER STETKAR: And that's what you are calling the pump suction center line.

MR. DALEY: That's what the DCD --

MEMBER STETKAR: Oh, okay.

MR. CHAPPELL: And then another 8 feet up.

MR. DALEY: It's the difference in what we are interpreting as the pump suction center line.

MEMBER STETKAR: Yes. But that means one of suction piping as it goes through the --

MR. DALEY: I've got it. Thank you.

MEMBER STETKAR: I was looking at the pump suction center line down there in the basement of the building where the pump suction center line is and adding up 1.83 meters above there and trying to figure out where the water was.

MR. DALEY: Okay. Okay.

MEMBER STETKAR: I understand.

MR. DALEY: Okay.

MEMBER STETKAR: That's fine.

CHAIR ABDEL-KHALIK: Okay.

MEMBER STETKAR: We can close this out. Thanks.

CHAIR ABDEL-KHALIK: And the 10 percent margin should account for any variability --

MEMBER STETKAR: Yes.

CHAIR ABDEL-KHALIK: -- in the atmospheric pressure.

MEMBER STETKAR: Yes, yes.

CHAIR ABDEL-KHALIK: Okay. Let's move on.

MR. DALEY: #101. And we might cover some things that we talked a little bit about this morning in the course of this discussion as well. And this action item results from a discussion we had a couple of meetings ago about the 77 degree C and when under Station Blackout how long do we have until we get to

77 degrees?

Well, now under Station Blackout considerations, RCIC will start off by taking suction on condensation storage tank. And it will switch over to the suppression pool when the level in the suppression pool gets a little bit higher. But then we -- by the EPGs, we override that and put it back on the condensation storage tank.

And that condensation storage tank will provide about eight hours of water supply. And a backup source, as I mentioned, is a suppression pool. That suppression pool continues to heat up as a result of SRV discharge and the RCIC pump discharge to the suppression pool. And then it will reach 77 degrees in approximately six hours.

So but in this situation, we don't -- we won't switch off RCIC at that point. It will still run, because actually in the containment as the suppression pool heats up, it maintains saturation conditions with the rest of primary containment. So the pressure and primary containment is increasing as well along with the temperature.

And the level in the suppression pool is increasing as well and both of those will contribute to the NPSH for the pump. So the pump will really run as long as we keep pressure in the reactor vessel to drive the turbine.

And that will stay in there until we depressurize. Now, there are some other limits that might cause us to secure the RCIC pump. We talked about this morning what happens if the temperature in the RCIC room heats up and some equipment in there starts to fail?

Well, DCD says that temperature needs to be above 151 degrees and you will reach that in about eight hours. I think Steve mentioned that this morning that DCD states that we have got about eight hours for the room to heat up to where all the equipment is qualified.

The emergency procedure guidelines will have us depressurize if the suppression pool temperature gets above a certain degree, a certain temperature. And right now, that says if it gets up to about 275 degrees fahrenheit, you need to depressurize the reactor. And that will occur in about 16 hours.

Also, if we reach the pressure in the containment where the COPS rupture disc ruptures, now we no longer have this pressure in containment that is maintaining the NPSH. So we might lose NPSH to turbine at that point. And as we mentioned this morning, that point will happen around 32 hours.

In our discussions with the RCIC pump manufacturer, he states that the bearings in here are rated -- bearings for the pump are rated for 250 degrees fahrenheit and will reach that in about 12 hours.

So you can see just from these various limits on things other than the pump just running, we will be able to operate it from anywhere from eight to 32 hours.

CONSULTANT WALLIS: So for RCIC you are allowed to use containment over-pressure?

MR. DALEY: Not in a design basis situation.

CONSULTANT WALLIS: Not in the design basis?

MR. DALEY: You're right. But this is beyond -- this is --

CONSULTANT WALLIS: Beyond the design basis.

MR. DALEY: -- beyond design. So we -- this is reality as we know now. So we can run that thing as long as we can run it. However, what we talked about this morning and mentioned is what we really want to do is get on ac-independent water addition.

So we are going to use the time-run RCIC to get ready and switch over onto ACIWA. So that's the real answer to how long will we run RCIC. We will run RCIC until we get on ACIWA.

CONSULTANT WALLIS: By depressurizing?

MR. DALEY: Pardon?

CONSULTANT WALLIS: By depressurizing?

MR. DALEY: By depressurizing and hooking up the --

CONSULTANT WALLIS: If you're in doubt, you might want to depressurize earlier.

MR. DALEY: Absolutely.

CONSULTANT WALLIS: All right.

MR. CHAPPELL: I think we'll look at options as we get into that and how we are trying to respond to keeping the RPV control and primary containment controls. We will look at options there.

MR. DALEY: And I think that covers it.

CONSULTANT WALLIS: The last thing you want to do is hang on to the RCIC long, long, long, then you find you don't have time to depressurize effectively before, you know, something happens.

MR. DALEY: Yes. Well, we will -- the way we envision it is we will have ACIWA all lined up and someone will say depressurize and we will start the pump up.

MR. HEAD: Or we will be assessing whatever has caused the Station Blackout and if that's, you know, about to be addressed, we may head down that path, you know. So there will be a number of options available to us as we go through that and clearly the eight hours is the analysis, but clearly in the event, you know, we will be exploring all of those options.

MEMBER STETKAR: And that's part of the concern that you only have a limited number of people to explore a large number of options. And some folks might be reluctant to depressurize because although everybody knows the RCIC turbine will run on, you know, puffs of air --

MR. HEAD: You say a limited amount of people, but within an hour we will have a technical support center.

MR. DALEY: Yes, and I think --

MR. HEAD: And we will have personnel from the other unit, unless there is multiple units, so there is going to be quite a bit of assessment ability and decision making ability on station right before we get to the eight hour point.

CONSULTANT WALLIS: There is something to be said about having a conservative option where they don't have to think too much about too many things.

MR. DALEY: Well, and I think the guidance that is going to be available to us when we start it up is going to be sufficiently, you know, sophisticated that we will have some pretty clear guidance as far as what we should be doing under different situations.

CONSULTANT WALLIS: Well, I'm thinking about TMI. TMI, the problem there was that several things went wrong.

MR. DALEY: Right.

CONSULTANT WALLIS: And they had -- didn't manage to resolve it all in their minds and did the wrong thing. So this is okay unless something else is happening at the same time.

MR. DALEY: Well, and certainly there will be something else, that's why I'm saying I think the guidance will be developed sufficiently to provide some clear direction.

CONSULTANT WALLIS: But something else unexpected like someone having left a valve closed or something.

CHAIR ABDEL-KHALIK: Yes.

MR. DALEY: That's correct.

CHAIR ABDEL-KHALIK: Yes, John?

MEMBER STETKAR: I was going to say, you know, back to -- pulling back to the original question that I asked was at least the heat-up analyses that we just heard about gives me confidence to have at least six hours before you get to that nominal 77 degrees C, hands off, five hours, six hours, something like that, without even taking credit for any extra pressure in the suppression pool and things like that, so it's not an hour. It's not 30 minutes. It's not --

CHAIR ABDEL-KHALIK: Okay.

MEMBER STETKAR: -- you know, an hour and a half.

MR. CHAPPELL: And also, if you are not considering that the condensation storage tank gets your suction source during the eight hour time frame, so that just says up until that six hour point, the suppression pool is the option.

MEMBER STETKAR: And I wasn't because the condensation storage tank might not be there.

MR. CHAPPELL: Yes.

MEMBER STETKAR: So I was sort of thinking about taking the suction from the suppression pool, so that's fine.

CHAIR ABDEL-KHALIK: Okay. So you are happy with closing this item, John?

MEMBER STETKAR: Yes, I think so.

CHAIR ABDEL-KHALIK: Okay.

MEMBER STETKAR: Yes.

CHAIR ABDEL-KHALIK: All right. Are there any additional questions to the applicant? Okay. I don't hear any.

Could you, please, make sure that the bridge line is open?

MS. BANERJEE: Line is open?

CHAIR ABDEL-KHALIK: At this time, we are --

MR. HEAD: Do we want just a recap of everything?

CHAIR ABDEL-KHALIK: Yes, sir.

MR. HEAD: Is that okay?

CHAIR ABDEL-KHALIK: Let's do that.

MR. HEAD: From earlier this morning, #98 and #99 were closed. #80 we have got some additional understanding of what we want to do on #80, which was the exponent. #49 we had a further understanding, but it's still open. So #80 and #49 are still open.

CHAIR ABDEL-KHALIK: Oh, you mean #47.

MEMBER STETKAR: #47.

MR. HEAD: #47. Okay. Sorry. #100 is closed. I believe we answered all your questions on Station Blackout. #87 the turbine speed control, I believe we have some additional understanding and we will look forward to getting back to you on that one. And then #62, #63 and #101 are all closed.

CHAIR ABDEL-KHALIK: Yes.

MR. HEAD: Okay.

CHAIR ABDEL-KHALIK: So could you, please, open the bridge line?

MS. BANERJEE: I'll go check.

MEMBER ARMIJO: Is Dennis still on?

CHAIR ABDEL-KHALIK: He has a separate line, so if he is on, he should be on.

Before we get to that point, are there any members of the public who wish to make a statement?

Is the bridge line open?

MEMBER STETKAR: You have to be more specific. If there is anyone out here who can hear us speaking, please, say something. Just anything.

PARTICIPANT: Here I am.

MEMBER STETKAR: Thank you.

CHAIR ABDEL-KHALIK: Okay. Are there any members of the public who wish to make a statement?

Okay. All right. At this time, I guess the agenda calls for us to just summarize any discussions. Are there any additional comments that people would like to make? And I'll start with Charlie.

MEMBER BROWN: Nope. I've had my say.

CHAIR ABDEL-KHALIK: Bill?

MEMBER STETKAR: Nothing.

CHAIR ABDEL-KHALIK: John?

MEMBER STETKAR: Nothing. Thank you.

CHAIR ABDEL-KHALIK: Sam?

MEMBER ARMIJO: No.

CHAIR ABDEL-KHALIK: Graham?

CONSULTANT WALLIS: I think we covered it.

CHAIR ABDEL-KHALIK: Okay. Well, thank you very much.

MEMBER STETKAR: Thank you.

CHAIR ABDEL-KHALIK: Appreciate it.

MR. HEAD: We enjoyed it.

CHAIR ABDEL-KHALIK: It was very informative. We appreciate your response to our request for the presentation on Station Blackout. It was added sort of late in the game, but we appreciate it.

MR. HEAD: Okay.

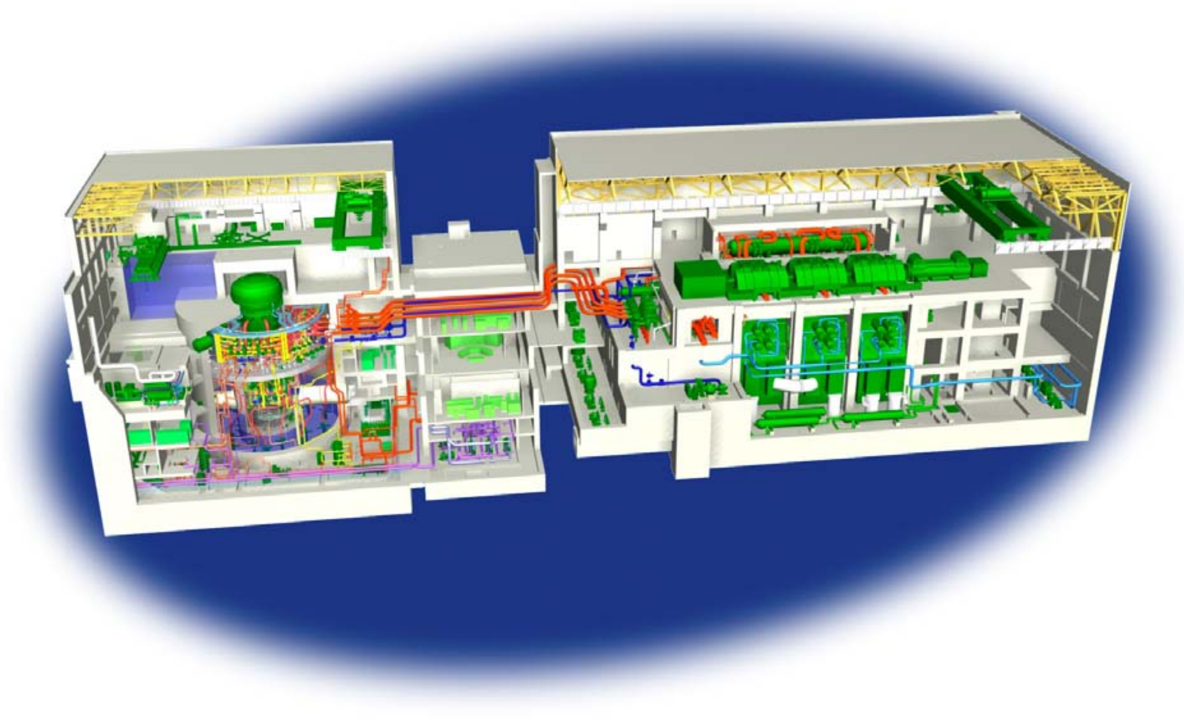
CHAIR ABDEL-KHALIK: Thank you very much for an informative meeting.

Are there any comments from the staff before we close the meeting? Okay. Thank you. We are adjourned.

(Whereupon, the Open Session meeting was concluded at 1:35 p.m.)

South Texas Project Units 3 & 4 Presentation to ACRS Subcommittee

Chapter 6 Long Term Cooling Follow-up



Attendees

Scott Head	NINA Manager, Regulatory Affairs, STP 3&4
Steven Thomas	NINA Manager, Engineering, STP 3&4
James Tomkins	NINA Licensing, STP 3&4
Tom Daley	NINA Engineering, STP 3&4
Caroline Schlaseman	MPR/TANE
Dale Wuokko	TANE
Martin Van Haltern	Westinghouse
Tim Andreychek	Westinghouse

Desired Outcomes

- Review the action items from the June 21, 2011 meeting
- Review action item # 47(a)
- Discuss our response to each item

Follow-up Action Items

- Action Item # 98 – Strainer Screen Loading
- Action Item # 99 - Zinc Oxide Concentration
- Action Item # 80 – Pressure Drop vs. Flow Relationship Exponent
- Action Item # 47(a) – Briefing on Downstream Fuel Test and Analysis

Action Items

- Action Item # 98
  - Follow-up to Action Item # 72
- *Address modeling of perforated strainer screen loading. Provide evidence of no local damage to strainer pockets due to loads imposed during vent clearing, condensation bubble collapse, and condensation oscillation.*

Action Item # 98 – CCI Strainer Structural Analysis Method Recap

- June 21 ACRS meeting reviewed the following steps in structural analysis of CCI cassette-type strainer:
  - Hydrodynamic loads defined by Toshiba in accordance with DCD-prescribed methodology; included in ASME Design Specification
  - Loads combined in accordance with DCD Tier 2 Table 3.9-2, and applied to Finite Element model of strainer to determine stresses in perforated sheets, flange plate, internal ribs
  - Resulting membrane, local membrane, membrane + bending stresses compared to applicable ASME B&PV Code Section III Service Level A, B, C & D allowables for limiting load combinations
  - ITAAC will confirm acceptable ASME Code Design Report exists for all ASME components, including these ECCS strainers

Action Item # 98 – Overview

- The second sentence in Action Item # 98, “provide evidence of no local damage to strainer pockets due to loads imposed during vent clearing, condensation bubble collapse, and condensation oscillation,” is satisfied by meeting ASME B&PV Section III, Subsection NC, design requirements for local membrane stresses for the required load combinations
- The first sentence of Action Item # 98, “address modeling of perforated strainer screen loading,” is addressed in the following slides

Action Item # 98 - Perforated Metal Sheet Analysis Method

- Stress analysis methodology for perforated metal sheets accounts for holes by applying the non-mandatory ASME B&PV Code, Section III, Appendix A-8000 methodology
- This methodology includes two parts:
  1. Elastic modulus E and Poisson's ratio ν are replaced by the effective elastic modulus E* (E*/E=0.334) and effective Poisson's ratio ν* (0.343) of the perforated sheet to determine appropriate stress distribution in solid (no holes) model
  2. Resulting stresses are increased by ratio of pitch/ligament width (P/h = 2.78) to account for missing material

Action Item # 98 - Validation of Method Applicability

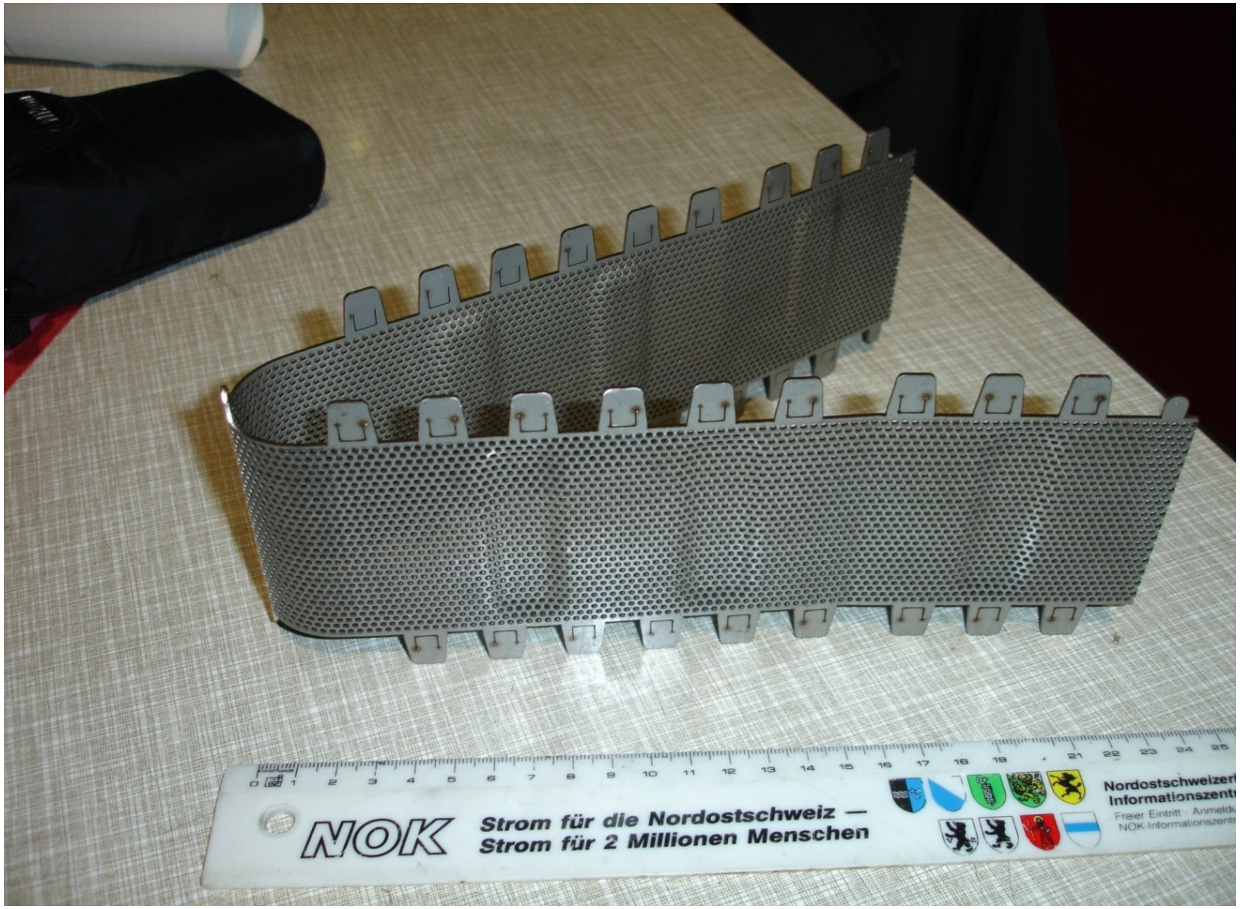
- ASME A-8110(a) lists 5 criteria for using this analysis method; Criterion (5) on plate thickness to hole pitch ratio is not met by metal sheet
- CCI confirmed the applicability of the ASME A-8000 methodology by:
  - Confirming essentially same method for determining effective elastic constants in *Designers, Specifiers and Buyers Handbook for Perforated Metals* (article based on testing by W. J. O'Donnell)
  - Performing pressure tests at multiples of limiting load combination pressure for RJ-ABWR

Action Item # 98 - Validation of Method Applicability *(continued)*

- RJ-ABWR limiting load combination pressure ~0.5 bar (7.25 psi)
- Tested 6 cycles *(see figure, next slide)* starting with 1 bar up to 2.25 bar
  - At 1 bar: deformation within elastic regime
  - At 2.25 bar: no damage; permanent deformation ~1.0 mm

Action Item # 98 - Validation of Method Applicability *(continued)*

Action Item # 98 - Validation of Method Applicability *(continued)*



Nuclear Innovation North America LLC

Action Item # 98 - Validation of Method Applicability *(continued)*

Action Items *(continued)*

- Action Item # 99
- *Provide documentation of << 1.6 ppm ZnO in suppression pool water*

Action Item # 99 – Zinc Oxide Concentration in Suppression Pool

- Clarification:
  - As discussed at the last meeting, calculations of the ZnO concentration had not been performed
  - The calculations have been performed and the ZnO is NOT << the solubility limit of 1.6 ppm
  - The calculations are summarized and presented in this presentation
  - Both the calculation of ZnO concentration and the treatment of the ZnO products provide for a conservative loading of ZnO

Action Item # 99 – Zinc Oxide Concentration in Suppression Pool

- Assumptions in calculation of zinc oxide (ZnO) corrosion :
  - Maximum zinc corrosion products provided for:
    - Assumes 100% of IOZ coatings destroyed within ZOI
    - Maximum surface area assumed throughout corrosion calculation
  - Minimum suppression pool inventory
  - 30-day time period
- Two pH values evaluated[1]
  - Minimum pH = 5.3 26.6 kg (58.6 lb_m)
  - Maximum pH = 8.9 6.2 kg (13.7 lb_m)
- Resulting range of ZnO concentration
  - Minimum pH = 5.3 7.6 ppm
  - Maximum pH = 8.9 1.8 ppm

(1) Transmitted to NRC in response to RAI 06.02.02-29, pH values are the licensing basis as described in the DCD

Action Item # 99 – Zinc Concentration in Suppression Pool

(continued)

- Solubility of ZnO is 1.6 ppm
- Calculated ZnO concentration exceeds solubility limits for pH range evaluated
- Some ZnO would be expected to form precipitate
- The amount of precipitate that would form is small
  - Minimum pH=5.3 21.0 kg (46.3 lb_m) of precipitate
  - Maximum pH=8.9 0.68 kg (1.51 lb_m) of precipitate

Action Item # 99 – Zinc Concentration in Suppression Pool *(continued)*

- ZnO concentration conservatively calculated > 1.6 ppm
  - Maximum Zn from assumed failure of drywell coatings
  - Maximum surface area
  - No passivation of Zn surfaces
  - Minimum water
- Testing conservatively addresses ZnO
  - Maximum ZnO generation (26.6 kg/58.6 lb_m)
  - No credit for ZnO solubility
- Therefore ZnO is conservatively addressed

Action Items *(continued)*

- Action Item # 80
- *Provide the basis for test acceptance criteria utilizing square relationship, vs. use of some other exponent such as 1.2 for debris bed.*

Action Item # 80 – Pressure Drop vs. Flow Exponent

- Acceptance Criteria based on Darcy equation

$$\Delta P = K * \rho * \frac{V^2}{2 * g_c}$$

- Test data showed lower exponent dependency for partially formed debris bed at low flows
- Higher Debris loads resulted in exponent closer to 2 even at low flows.
- Acceptance Criteria corresponds to high debris load

Action Item # 80 – Pressure Drop vs. Flow Exponent *(continued)*

- Test Acceptance Criteria minimizes the allowed increase in DP during the test

$$\left[\frac{\Delta P_f}{\Delta P_i}\right]_{(Test-Measured)} \leq 1200 * \left(\frac{W_f}{W_i}\right)^2_{(Test-Measured)}$$

W_f/W_i (W_f = 0.5, W_i = 3.0)	$\Delta P_f/\Delta P_i$ (exp = 2)	$\Delta P_f/\Delta P_i$ (exp = 1.5)
0.167	33.3	81.7

Action Items *(continued)*

- Action Item # 47(a)
- *Provide a future briefing on test and analysis (Licensing Condition) for the downstream test. Provide downstream test procedure to ACRS.*

Action Item # 47(a)- Downstream Fuel Test

- A downstream test will be performed as a condition of the license at least 18 months prior to fuel load
  - This test will use the fuel planned for the initial cycle
- The test analytical basis, the test plan, and the debris amounts and addition protocol are described in detail in FSAR Appendix 6C
- The test plan and protocol will reflect industry downstream testing experience between now and the time the test is performed
- Test procedure will be provided to the NRC 6 months prior to performance of the test

Summary

- Strainer perforated sheets are strong enough to withstand suppression pool loads during a LOCA
- Pressure Drop vs. Flow exponent of 2 is appropriate and conservative
- Some zinc oxide will stay in solution, but no credit is taken for this in the amount of zinc precipitate assumed in the downstream test
- A conservative downstream test will be performed 18 months prior to fuel load
  - This test will reflect industry experience with such tests
  - The downstream test procedure will be available 6 months prior to the test

Appendix to Presentation

- This appendix provides a written response to Action Item # 80, the use of an exponent of 2 in the pressure drop vs. flow relationship.

Exponent Issue

The ACRS Subcommittee has requested additional description of the proposed downstream effects fuel test acceptance criteria in light of Dr. Wallis's question concerning the observation that during another fuel test results showed that the exponent of the flow relationship to pressure drop could be close to 1. The ABWR acceptance criterion uses an exponent of 2 in the flow to pressure drop relationship.

The ABWR acceptance criterion is developed from the analyses of the response of the ABWR to increased fuel hydraulic resistance. The resulting criterion is based upon a highly blocked inlet that still yielded adequate core cooling. This criterion provides the acceptable increase in the hydraulic resistance of the end state of the test compared to the initial resistance of the assembly. Providing the acceptance criterion in this form accounts for the effects of temperature and flow rate on the acceptable pressure drop.

Exponent Issue *(continued)*

The downstream test results from a fuel test for another reactor type that yielded pressure drop to flow rate relationships with different exponents came from a test of increasing amounts of debris. During the test as debris was added, flow sweeps were performed to characterize the pressure drop to flow relationship. The initial debris additions demonstrated lower hydraulic resistance and a flow relationship with a low exponent, closer to a value of 1. As debris was added and the test continued, the hydraulic resistance increased and the exponent of the ΔP to flow relationship increased. For the last debris addition with the bed fully formed, the exponent of the flow relationship was slightly less than 2.

Although the performance of the partially formed debris bed is interesting, we are at this point specifying the acceptance criteria and not trying to predict the behavior of varying debris amounts.

Exponent Issue *(continued)*

The pressure drop measured during the test is made up of several constituent components. It includes losses from the entrance to the test assembly, through the lower tie plate, the debris filter, the grids, and the friction on the test rods and assembly and sub assembly walls. Previous tests have shown that the debris accumulates primarily at the tie plate, debris filter and / or fuel grids causing blockages and a reduction in the flow areas at these components. The hydraulic losses for the grids, filter, and tie plate tend to follow a Darcy type relationship with a resistance coefficient K that is relatively independent of Reynolds number.

$$\Delta P = K * \rho * \frac{V^2}{2 * g_c}$$

Exponent Issue *(continued)*

At low flows, the frictional component of the pressure drop can transition to a more laminar relationship where the pressure drop is almost linear with flow (exponent slightly above 1.0). However, as the blockage at the other components increases and dominates the measured pressure drop, the overall relationship will tend towards a flow squared relationship.

$$\left[\frac{\Delta p_f}{\Delta p_i}\right]_{Test-Measured} \leq 1200 * \left(\frac{w_f}{w_i}\right)^2_{Test-Measured}$$

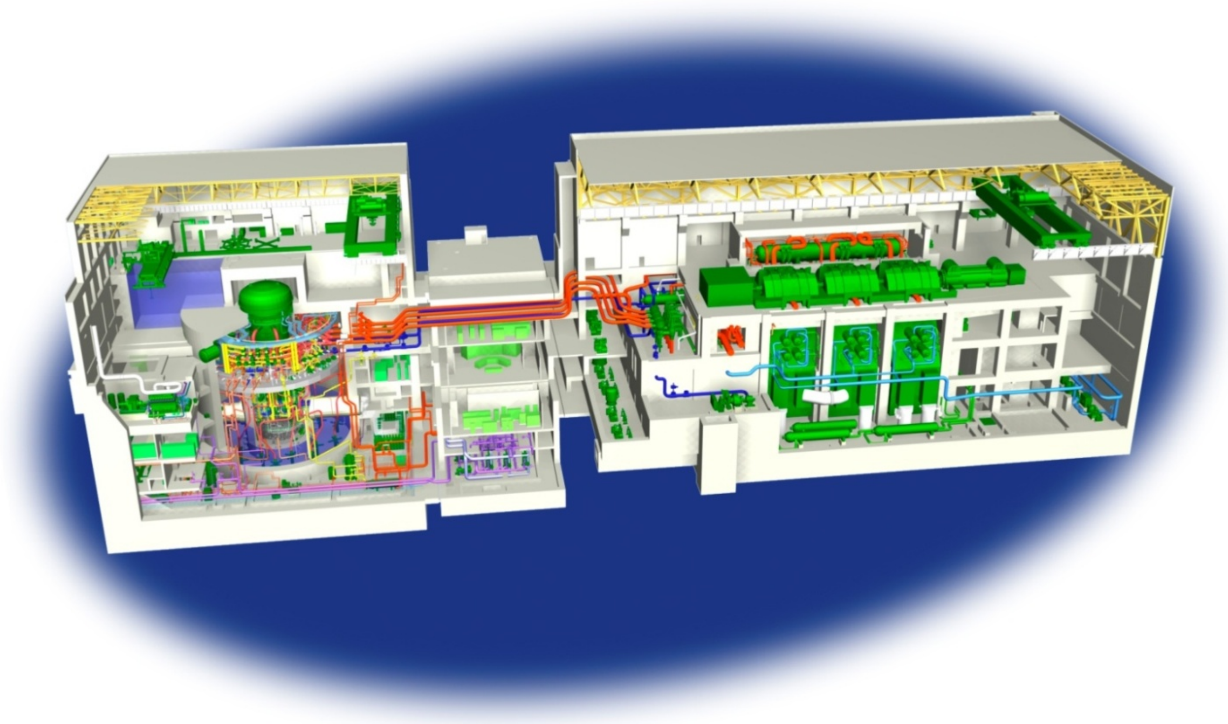
Exponent Issue *(continued)*

By specifying an exponent of 2 for the flow relationship we are bounding the flow changes for partially formed debris beds. The final flow rate will be less than the initial flow so the ratio of final to initial flow rates will be less than one. Specifying a larger, bounding exponent for this relationship will result in a smaller acceptable ratio of final to initial pressure drops than if a lower exponent was used. The following table illustrates the impact of the flow exponent. For a test that has an initial flow rate of 3 kg/s and after all of the debris is added has a final flow rate of 0.5 kg/ s the allowed increase in test section pressure drop is shown

W_f/W_i (W_f = 0.5, W_i = 3.0)	$\Delta P_f/\Delta P_i$ (exp = 2)	$\Delta P_f/\Delta P_i$ (exp = 1.5)
0.167	33.3	81.7

South Texas Project Units 3 & 4 ACRS ABWR Subcommittee Presentation

Extended Station Blackout



Attendees

Scott Head	NINA Manager, Regulatory Affairs, STP 3&4
Steve Thomas	NINA Engineering Manager, STP 3&4
Tom Daley	NINA Engineering, STP 3&4
Coley Chappell	NINA Licensing, STP 3&4

ABWR Station Blackout (SBO) Response Capability Combustion Turbine Generator (CTG)

The primary means by which the ABWR copes with a station blackout is use of the CTG, which has the following features and capabilities:

- The alternate AC power source during an SBO event.
- Protected from flooding and weather events.
- Independent from the three safety-related diesel generators.
- “Black start” capability.
- Will reach operational speed and voltage and will be available for bus connection within 10 minutes.
- Can supply 4.16kV Class 1E buses through the realignment of pre-selected breakers during SBO events.

ABWR Response Capability

ABWR has the capability to withstand a loss of all AC power:

- Offsite
- Emergency Class 1E diesel generators (DGs)
- Alternate AC power (CTG)

In this beyond design basis scenario, the ABWR has several defense-in-depth design features which provide the capability to

(1) Prevent core damage; and

(2) Maintain containment integrity.

ABWR SBO Response Capability without CTG

- The ABWR can withstand an extremely unlikely event of a loss of offsite power, the loss of all three safety-related trains of diesels, and the loss of the CTG (both units).
  - For a period of approximately 8 hours using RCIC.
  - No core damage or loss of containment integrity.
- If AC power is still unavailable beyond this period, core cooling by the RCIC system is assumed to be lost.
  - However, the ACIWA system is capable of preventing core damage.
  - Containment Overpressure Protection System (COPS) prevents loss of containment integrity.
  - This accident sequence is discussed in DCD Subsection 19E.2.2.3.

ABWR SBO Response Capability without CTG

Sequence of Events:

- 0.0 MSIV Closure
- 4.2 s Reactor Scrammed
- 52.0 s Level 2, the RCIC system initiates injection, steam discharged to suppression pool through SRVs
- 8.0 h RCIC assumed to fail
- 9.8 h Operator lines up ACIWA and depressurizes the vessel
- 9.9 h RPV water level falls below Top of Active Fuel (TAF)

  Pressure reaches the shutoff head of ACIWA, water injection begins, core cools rapidly, core temperature peaks before fuel damage occurs
- 32.3 h COPS rupture disk opens, containment pressure drops

Station Blackout, RCIC Runs Eight Hours, Firewater Addition Prevents Core Damage, Rupture Disk Opens

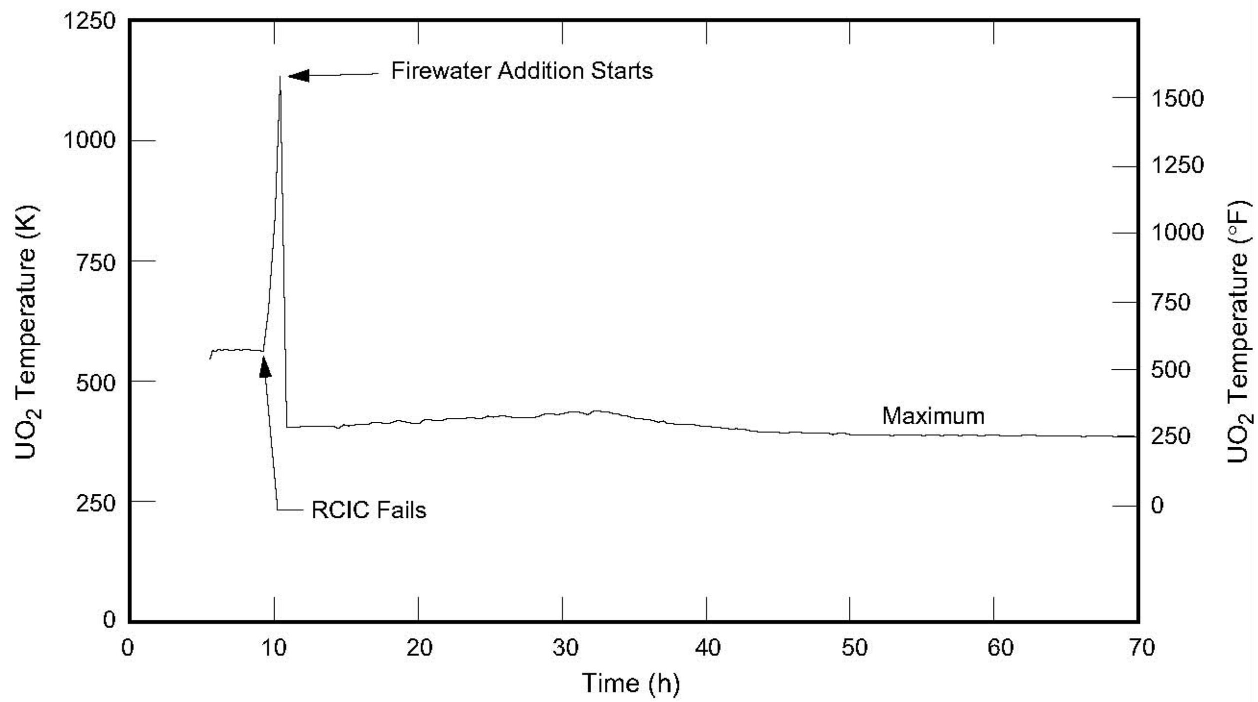


Figure 19E.2-6a: UO_2 Temperature

Station Blackout, RCIC Runs Eight Hours, Firewater Addition Prevents Core Damage, Rupture Disk Opens

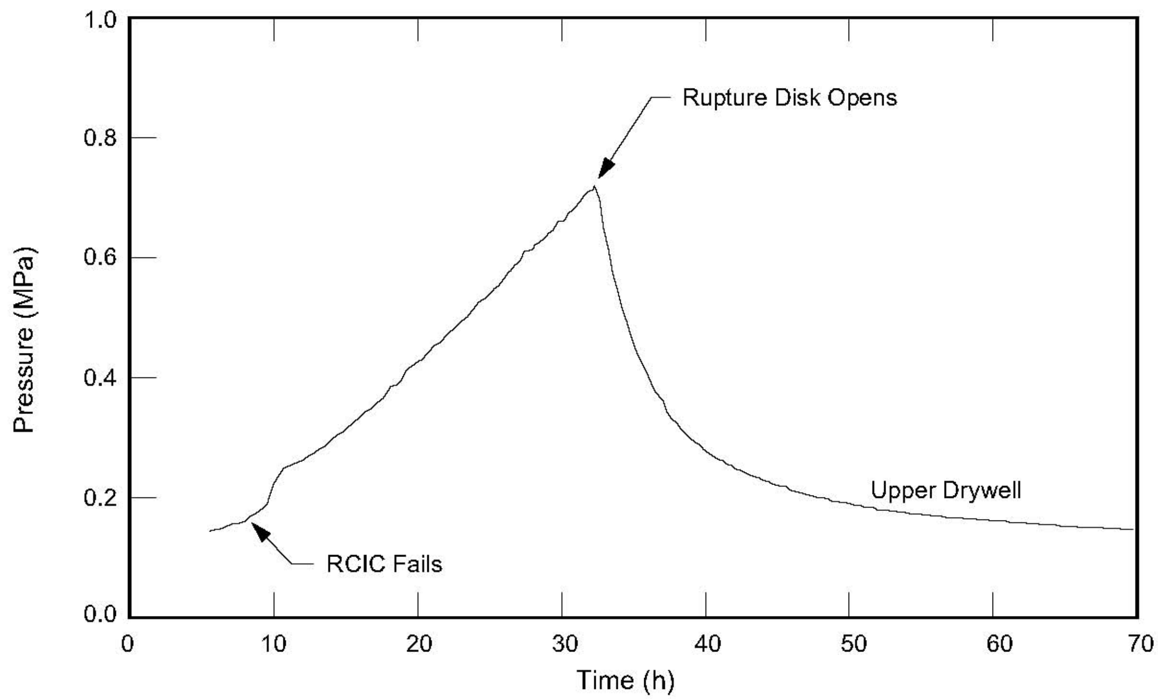


Figure 19E.2-6a: Drywell Pressure

ABWR Response Capability without CTG

For extended loss of all AC:

- The current ABWR design is capable of withstanding a beyond design basis, extended loss of all AC event for at least 72 hours.
  - Without core damage and
  - Without loss of containment integrity.
- Loss of offsite power circuits, loss of three trains of safety-related diesel generators, loss of CTG's of both units

Fuel Pool Makeup

- ABWR design includes several systems capable of providing makeup to the spent fuel storage pool
  - Fuel Pool Cooling and Cleanup (FPC) System – normal means of removing decay heat in the spent fuel storage pool.
  - Suppression Pool Cleanup (SPCU) System – source of makeup water using either the SP or the CST.
  - Powered by buses with a CTG power supply.
- The safety-related (Class 1E) makeup water source for the spent fuel storage pool is provided by the Residual Heat Removal (RHR) System from the suppression pool.
  - STP 3&4 design provides capability from all three RHR trains.
  - Manual valves for aligning RHR System are accessible.

Fuel Pool Makeup

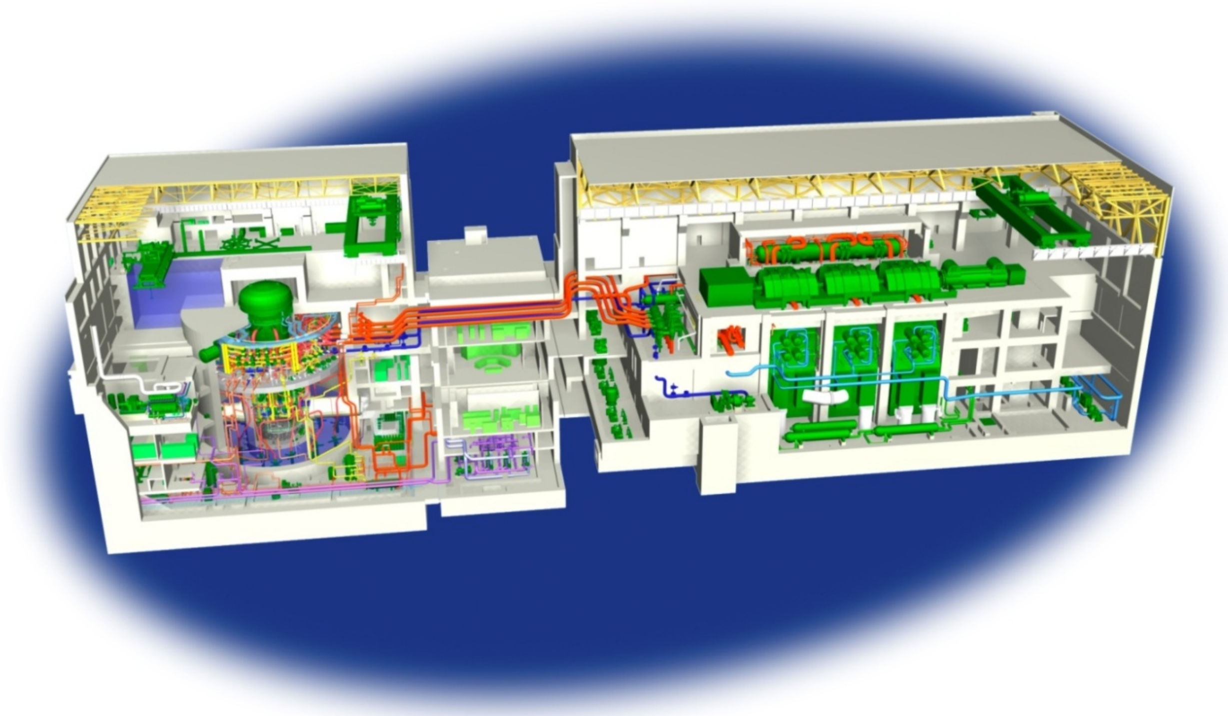
- For an extended loss of all AC event, additional capability is provided:
  - Fire hoses can be used as an alternate makeup source, and fire protection standpipes in the Reactor Building are seismically designed.
  - Fire Protection (FP) system provides makeup from a separate water source using diesel-driven pumps (installed and portable), and a motor-driven pump capable of being powered from the CTG.
  - Hose connections to FP system standpipes at ground elevation external to the Reactor Building, used to provide makeup (Part 11, Figure 9.2).
- Other ABWR spent fuel storage pool design features:
  - Analysis indicates that, under maximum abnormal heat load with pool gates closed and no cooling, temperature will reach ~100°C in ~16 hrs.
    - Adequate time for reasonable operator action to establish makeup.
  - There are no piping connections located below a point approximately 10 feet above the top of active fuel located in the spent fuel storage racks.

Conclusion

Questions and Comments

South Texas Project Units 3 & 4
ACRS ABWR Subcommittee Presentation

ACRS Action Items 62, 63, 87 and 101



Agenda

- Introduction/Attendees
- Action Items:

  #87 Address failure of speed sensors for the main turbine primary overspeed protection subsystem (follow up from 6/21/2011)

  #62 Basis and application of 30-minute operator response time for failure of RSW piping on UHS 30-day supply

  #63 Basis for RSW pump NPSH

  #101 Suppression Pool heat-up during Station Blackout, time to reach RCIC operation 77°C limit
- Conclusion

Attendees

Scott Head	NINA Manager, Regulatory Affairs, STP 3&4
Steve Thomas	NINA Manager, Engineering, STP 3&4
Tom Daley	NINA Engineering, STP 3&4
Coley Chappell	NINA Licensing, STP 3&4
Dale Wuokko	TANE Licensing

Action Item # 87

Address a failure of the speed sensors in the primary overspeed protection subsystem for the main turbine.

<u>Response</u>: The following is a summary of the 6/21/2011 presentation:

- Indications and alarms will be provided in the main control room.
- Failure of these speed sensors does not affect the redundant emergency overspeed protection function or normal speed control.
  - Speed sensors are <u>separate</u> and <u>diverse</u>.
- Timely operator action, as directed by procedure, ensures a very low potential for a turbine overspeed event to occur while the primary overspeed protection is degraded.
- Since this failure does not require an automatic trip, no FSAR revision is required.

Action Item # 87 (cont'd)

- Response to ACRS comments on previous presentation:

SITUATION	RESPONSE
Loss of signal (function) from two of the three passive speed sensors of primary overspeed protection function.	• Speed sensor failure alarms in main control room. • No automatic turbine trip. • Guidance recognizes possibility of malfunctions that increase the risk of continuing operation, and provides LCO-type recommendations (see SRP 3.5.1.3, DCD Table 3.5-1).
and Common mode failure of the active speed sensors of redundant emergency overspeed protection function.	• Automatic turbine trip due to speed sensor failure. • With the main turbine on-line, the normal speed signal is not controlling, since control valve position is determined by steam dome pressure (low-voltage gate). • With main generator paralleled with the grid, turbine speed is determined by grid frequency, generator load is limiting. • Power load unbalance function senses mechanical power and generator current in case of a load reject.

Action Item # 62

Discuss basis and application of the 30 minute response time upon a single passive failure of the Reactor Service Water (RSW) piping and how the analysis justifies a 30-day supply for the Ultimate Heat Sink (UHS) while accounting for the pipe failure.

Response: The question is about how the UHS water storage basin design volume, as described in Subsection 9.2.5.5.2(8), accounts for a pipe crack that might occur during the 30-day duty time:

A single passive failure of RSW piping is considered.
The water loss is based on a 30 minute response time.

- DCD Tier 2 Subsection 19R.4.1 allows a 30-minute response by control room operators to locally isolate a leak.
- If a leak occurred in RSW piping in the pump room, sump/flooding alarm would alert operators.
- RSW leakage during this time is included in the UHS basin inventory.

Action Item # 62 (cont'd)

- The possibility of a non-isolable leak between the intake line and the first isolation valve in the RSW pump room is not considered credible based on the design requirements:
  - RSW system is classified as Seismic Category I, and designed accordingly.
  - Non-isolable piping in RSW pump rooms is designed using crack exclusion criteria per DCD Tier 2 Subsection 3.6.2.1.5.3.2.

Action Item # 63

Discuss basis for approximately 17 meters (16m – COLA Rev. 4) RSW pump NPSH and how it was calculated, specifically at the end of the 30-day supply.

Response: (Refer to FSAR Table 9.2-17 and Figure 1.2-35)

Available NPSH for RSW pumps:

$$NPSH_a = H_{st} + H_{sys} - H_{vap} - H_f$$

Where: H_{st} = static head = 31.17 ft. (min. water level 17 ft.)

H_{sys} = system (atmospheric) head = 34.1 ft.

H_{vap} = vapor pressure = 1.89 ft. (at 95°F)

H_f = frictional losses = 5.48 ft.

$$NPSH_a = (31.17 + 34.1 - 1.89 - 5.48) \text{ ft} = 57.9 \text{ ft. } (17.6\text{m})$$

57.9 ft. x 0.90 (10% margin) = 52.1 ft. (15.9 m)

Action Item # 101

Time for Suppression Pool temperature to reach 77°C under Station Blackout conditions.

Response:

- Station Blackout (SBO)
  - RCIC suction remains on condensate storage tank (CST) per ABWR DCD Emergency Procedure Guidelines (EPGs):
    - 8-hour supply from primary water source CST.
    - Backup source is the suppression pool (SP).
  - Suppression pool temperature reaches 77°C in approximately 6 hours.
    - RCIC will continue to operate automatically for approximately 8 hours (battery life), with the suppression pool heating up and the containment pressurizing.

Action Item # 101 (cont'd)

- Long term containment conditions:
  - RCIC will operate manually since required NPSH is maintained by containment pressure and SP level.
  - RCIC will maintain reactor water level until:
    - RCIC room environment faults equipment (> 151°F, > 8 hours).
    - EPGs require RPV depressurization (SP > ~ 275°F, ~ 16 hours).
    - COPS rupture disc actuates (NPSH may be lost, ~ 32 hours).
  - RCIC turbine-pump bearings are rated to 250°F (~ 12 hours).
  - SRVs will maintain RPV pressure until batteries are depleted ("many days" per DCD Tier 2 Subsection 19E.2.1.2.2.2).
  - Depressurize RPV and initiate ACIWA preventing core damage.

ACRS Action Items - Conclusion

Questions and Comments

Action Item # 101 (Backup Info)

- Design basis - Main steamline break:
  - Suppression pool temperature reaches 77°C in ~ 15 minutes.
  - RCIC mission time is complete due to RPV depressurization in approximately 4 minutes (suction from CST).
  - Basis for 77°C: BWR – effectiveness of steam condensation (limit for the end of the LOCA blowdown based on the Bodega Bay and Humboldt Bay tests). ABWR – Question 440.52, degrade RCIC lube oil viscosity.