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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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MEETING OF THE SUBCOMMITTEE ON THE ESBWR DCD

(CONTAINMENT ISSUES)

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OPEN SESSION

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WEDNESDAY, JUNE 17, 2009

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ROCKVILLE, MARYLAND

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

ACRS MEMBERS:

MICHAEL CORRADINI, Subcommittee Chairman

SAID ABDEL-KHALIK, Member

J. SAM ARMIJO, Member

MARIO V. BONACA, Member

DENNIS C. BLEY, Member

MICHAEL T. RYAN, Member

ACRS CONSULTANTS:

THOMAS S. KRESS

GRAHAM B. WALLIS

ACRS STAFF PRESENT:

CHRISTOPHER BROWN

ALSO PRESENT:

M.D. ALAMGIR

AMY CUBBAGE

JESUS DIAZ-QUIROZ

HANRY A. WAGAGE

WAYNE MARQUINO

MATT SOLMOS

RICHARD WACHOWIAK

MIKE SNODDERLY

JACK TILLS

TOM WALKER

C-O-N-T-E-N-T-S

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

3:16 p.m.

CHAIRMAN CORRADINI: Just to let people know that we have deferred one of the talks because we've already done it almost extemporaneously on 182. So we're going to go directly and talk about vacuum breakers and vacuum breaker isolation.

MR. DIAZ-QUIROZ: I don't have an actual picture of the vacuum breaker. That was actually in the first presentation. It was in the closed session. If you look at that smaller picture there at the right, you will see the vacuum breaker on there with the shields, with the three shields. It's a photograph.

So, if you want a picture of a true vacuum breaker, that is an actual photograph of one. So you will be able to tell what I'm pointing at as far as on the schematic.

The leakage limits right now, when we go test vacuum breaks, individual vacuum breakers, and overall suppression pool bypass leakage, technical specifications allowed a 50 percent of a 2-centimeter limit. When I say 2-centimeter, I mean that's two centimeters squared, A over the square root of K. When I say only centimeter squared, that is what I really mean. That translates to a .3 centimeters squared.

That is for each individual vacuum breaker and isolation valve. So, when these are tested, you will test them as found. You will test the vacuum breaker as found, and then you will lift the vacuum breaker and test the isolation valve, which --

CONSULTANT WALLIS: Can you translate that into cfm or something I can understand?

MEMBER ABDEL-KHALIK: You don't like cfm though.

(Laughter.)

CONSULTANT WALLIS: CFM at these conditions.

MR. DIAZ-QUIROZ: Right.

CONSULTANT WALLIS: What sort of a flow rate are we talking about for this sort of a hole?

MR. DIAZ-QUIROZ: Right. So, if you were looking like at a 4 psi difference, it translates, and then, of course --

CONSULTANT WALLIS: It's a fair amount, isn't it?

MR. DIAZ-QUIROZ: A 4 psi difference?

CONSULTANT WALLIS: Yes.

MR. DIAZ-QUIROZ: This is where, you know, let's see, cfm, I was looking at that, actually, 137 cubic feet per minute.

CONSULTANT WALLIS: How many?

MR. DIAZ-QUIROZ: A hundred thirty-seven cubic feet per minute.

CONSULTANT WALLIS: A hundred thirty-seven cubic feet per minute, okay.

MR. DIAZ-QUIROZ: Right, and that's a .3, and that's at a 4 psi --

CONSULTANT WALLIS: So it's a fair amount of flow?

MR. DIAZ-QUIROZ: Right. So everything there is presented in this A over the square root of K because you can easily translate it and get a flow at any condition.

CONSULTANT WALLIS: But it will fill the vacuum breaker tube in a relatively short time.

MR. DIAZ-QUIROZ: Right, right.

CONSULTANT WALLIS: Which is the whole thing we're trying to get at.

MR. DIAZ-QUIROZ: Right. And actually, about 16 seconds, if you wonder. That's, again, going back to the leakage limit. So it's .3 per vacuum breaker and also isolation valve on each vacuum breaker.

You have to sum also the total leakage for each pathway, which there are three. It has to be less than .3. So that's really less than .3 times three, which gives you the .9. So, in reality, you would have some vacuum breakers be under the .3 to meet the overall for all three.

Then, for overall flushable bypass --

MEMBER ABDEL-KHALIK: Excuse me.

So, when you gave the number about cfm at 4 psi, does that correspond to the flow rate per --

MR. DIAZ-QUIROZ: That is a per --

MEMBER ABDEL-KHALIK: -- per leakage path?

MR. DIAZ-QUIROZ: per -- .3, yes.

MEMBER ABDEL-KHALIK: So, if all of them are within tech spec limits, do you get a leakage rate of about 400 cfm?

MR. DIAZ-QUIROZ: A little less than that, right.

MEMBER ABDEL-KHALIK: Four psi?

MR. DIAZ-QUIROZ: Right, at 4 psi. And 4 psi is taking the conditions where this is fairly early during the LOCA event, where you get this big difference in the pressure. So you would see lower diffentials as you move on.

CONSULTANT WALLIS: Let's see, this 2

centimeters squared is the design-basis analytical limit, and the nominal design basis is 1 centimeters squared, nominal.

I'm very confused about, when someone says, what's the design basis? Unless you qualify it with something, there is no design basis because there's an analytical limit, there is a nominal -- maybe there's something else.

MR. DIAZ-QUIROZ: But the 2 centimeters squared is what's right now used in the mixing of break analysis.

CONSULTANT WALLIS: I understand that. But when someone simply says, what's the design basis, there's no answer because it can be 1 or 2, depending on which one you're talking about, right?

MR. DIAZ-QUIROZ: The surveillance requirement, right, calls out at 50 percent of the 2 centimeters squared, which is the 1, right.

CONSULTANT WALLIS: I understand that.

MR. DIAZ-QUIROZ: Right.

CONSULTANT WALLIS: But I'm just saying, when you read some of the documents, it says the nominal design basis is 1 centimeter squared.

MR. DIAZ-QUIROZ: Right now, the DCD, the revision 5 states 2 centimeters, and it points to --

CONSULTANT WALLIS: Is it really clear now?

MR. DIAZ-QUIROZ: Yes, we straightened that out. We straightened that out, yes.

CONSULTANT WALLIS: It may be all fine chapter and verse, but, anyway, that's okay.

MR. DIAZ-QUIROZ: Okay.

CONSULTANT WALLIS: I thought I had seen nominal --

MR. DIAZ-QUIROZ: Right, right. There is some confusion as to what we were calling our 2 centimeters squared, yes.

MEMBER ABDEL-KHALIK: So let's just go back to, at 2 centimeters squared for 4 psi, your leakage rate would be 1,000 cfm, roughly, times three.

MR. DIAZ-QUIROZ: No. No, I'm sorry. What is that area you were talking about again?

MEMBER ABDEL-KHALIK: At 2 centimeters squared.

MR. DIAZ-QUIROZ: Right now, the surveillance requirement is the .3 per vacuum breaker pathway. So it's .3 -- .9.

MEMBER ABDEL-KHALIK: But I'm thinking of the design-basis analytical limit.

MR. DIAZ-QUIROZ: Right, the 270 --

MEMBER ABDEL-KHALIK: The leakage rate is about 1,000 cfm.

CONSULTANT KRESS: Four-tenths over 37.

CHAIRMAN CORRADINI: You are just 400 times two and then rounded it up. That's what I was just trying to make sure.

MEMBER ABDEL-KHALIK: If we took 137 multiplied by two, divided by .3, it's linear to the area. That's huge.

MR. DIAZ-QUIROZ: It is the total, not per valve.

MEMBER ABDEL-KHALIK: Oh, I see. Okay.

MR. DIAZ-QUIROZ: Yes, and this is for overall leakage right now that's credited in the analysis.

MEMBER ABDEL-KHALIK: Okay.

MR. DIAZ-QUIROZ: So the vacuum breakers, they are designed to a .0270 squared for a 60-year end-of-life, and there was testing that confirmed that on the vacuum breaker, that it can meet that leakage tightness.

There is, also, on the isolation valve, there's a commercially-available that can meet that leak tightness.

Here I give, for an example, it's triple offset butterflies, the Tricentric Butterfly Valve for Weir.

CONSULTANT KRESS: In reality, does this A over squared to K become available with delta P?

MR. DIAZ-QUIROZ: Yes.

CONSULTANT KRESS: Rather than being a constant?

MR. DIAZ-QUIROZ: No, it depends on the hole size. So it is sort of, if you have a bigger hole size, then at some point --

CONSULTANT KRESS: It's not like it's a fixed hole.

MR. DIAZ-QUIROZ: No, it's not. No, it's not.

CONSULTANT KRESS: It's a leakage around various positions.

MR. DIAZ-QUIROZ: Right, right.

CONSULTANT KRESS: I would have thought the delta P would influence the actual hole size that you might get or the actual amount of leakage.

MR. DIAZ-QUIROZ: Right, right.

CONSULTANT KRESS: A little more than just the delta P. It would open the thing up a little more.

MR. MARQUINO: It's tested at the delta P corresponding to the submergence of the PCC then? Is that right?

MR. DIAZ-QUIROZ: The surveillance requirements really call out, well, they don't call out, but a procedure would be, since you have the vertical vents, which has about a 2.7 psi submergence, you might call it. So it has to be tested for the overall bypass leakage; now we're talking about travel to wetwell. You would have like a 2.5 psi difference for testing.

CONSULTANT KRESS: I see. So that is specified in the ITAAC or --

MR. DIAZ-QUIROZ: It's there. Submergence has to be taken account for. You don't want to overpressurize.

LOCA need testing is you take out those outlets on the vacuum breaker, which you see in that photograph in the closed presentations. You take out the outlets. You flange them. You put a blank flange. You pump it up.

There, at that point, since it's local, you can do a little higher psi difference, but since it's has a soft seat, that makes, of course, the higher the threshold that you put on at, the tighter your seal is. So you really want to be at low, but not too low.

CHAIRMAN CORRADINI: So this actually gets to the thing I want to ask about. So you have, although not written somewhere, but it will be ITAAC-able, you have a testing procedure such that, besides closing it off, you're going to arrange through a series of delta P's and look at the leak rate?

MR. DIAZ-QUIROZ: Right now, the ITAAC calls out for making sure that they meet -- it's an overall bypass leakage ITAAC.

CHAIRMAN CORRADINI: Right, but the reason I'm asking the question is because you kind of got to it, and I just wanted to get to that point, which is, as you said, you take off the little screens; you put on your blank flanges. You pressurize, and depending on what you pressurize, the leakage will probably go through a maximum. It will probably rise up and then come back down to zero. As you pressurize enough, it simply shuts itself off.

So you're going to come to a maximum. It would seem to me, from a testing standpoint, I would want to know what the leak rate is near the maximum, so that I can properly identify what its performance is.

Am I going too far here or is that what

you are planning to do?

MR. DIAZ-QUIROZ: Right. You know, again --

MR. WACHOWIAK: Just say yes.

MR. DIAZ-QUIROZ: What's that?

MR. WACHOWIAK: Just say yes.

(Laughter.)

MR. DIAZ-QUIROZ: Yes. I would say yes, but, yes, you would want to take the maximum leakage during the testing, yes.

MR. WACHOWIAK: Okay. During our last meeting here on the vacuum breakers, which was probably more than a year ago now or more, we had talked with a testing service company. We went on through with them, their process. I think, with Mike's team, we went through that.

Those types of things that you're saying are similar to what the vendor said that they would be doing.

CHAIRMAN CORRADINI: Okay, thank you very much.

CONSULTANT WALLIS: I think the concern I would have would be that, during the early hours of the accident, when the GDCS pool comes in and cools things down, you open the vacuum breakers then. I would be concerned that there isn't some sort of sticking seal that somehow gets picked up, then it doesn't seal properly later on when you need it. That would be the thing I would be concerned with.

MR. DIAZ-QUIROZ: Right. And the vacuum breakers will cycle 3,000 times.

MR. WACHOWIAK: That will be part of the qualification program --

CONSULTANT WALLIS: Right.

MR. WACHOWIAK: -- for the vacuum breaker itself.

CONSULTANT WALLIS: But if they have been sitting there a year or two, and they haven't been operationally --

MR. WACHOWIAK: As part of the surveillance test, then, when we go in and we look at that, we will have to cycle those under some conditions somehow. The appropriate failure modes need to be addressed to make sure.

CONSULTANT KRESS: So there will be some sort of periodic testing?

MR. WACHOWIAK: Yes.

MR. DIAZ-QUIROZ: Right, right. It's a 24-month interval that's called out.

CONSULTANT WALLIS: On every outage?

MR. DIAZ-QUIROZ: Yes. Every 24 months, it obviously equates out 24, yes.

MEMBER BLEY: Remind me, will those technical specifications tests be established before the certification or is that some time out?

MR. WACHOWIAK: The procedure?

MEMBER BLEY: Yes.

MR. WACHOWIAK: Those are post-certification, post-COLA.

MEMBER BLEY: And the surveillance intervals, all of that are post?

MR. WACHOWIAK: The surveillance intervals are already fixed. The intervals are fixed; the procedure is not.

MEMBER BLEY: Okay.

MR. WACHOWIAK: So you can see in our tech specs in the DCD that interval is there now.

MEMBER ABDEL-KHALIK: Presumably, the top seal will protect against any small pieces of debris that may somehow end up on the seat.

How would you take care of that in surveillance testing?

MR. DIAZ-QUIROZ: Are you asking -- let me just go back.

MEMBER ABDEL-KHALIK: Sure.

MR. DIAZ-QUIROZ: Given the large diameter of these bounds, if you figure out how much they have to lift to give you a leakage area of 1 square centimeter or even 2 square centimeters, it's mils. It is very small.

So the idea of having debris that would somehow prevent the valve from fully seating is a concern. And you're protecting against that with, presumably, this compliant, soft seal.

MR. WACHOWIAK: And a cover.

MR. DIAZ-QUIROZ: Right. In addition, there are outlets, there's strains on those outlets, and they have perforations on them. Right now, there's a .9 millimeter, as you can see on this slide, there are perforations as far as diameter size of those holes. So to protect against up to a certain size of debris, the outlets themselves have covers.

MEMBER ABDEL-KHALIK: .9 millimeters?

MR. DIAZ-QUIROZ: Sorry?

MEMBER ABDEL-KHALIK: .9 millimeters --

MR. DIAZ-QUIROZ: .9 millimeters.

MEMBER ABDEL-KHALIK: -- yes, is probably a lot bigger than what it would take --

MR. DIAZ-QUIROZ: Right.

MEMBER ABDEL-KHALIK: -- to let this

valve, to give you an area, a leakage area, of more than 1 square centimeter.

MR. DIAZ-QUIROZ: Sure. And the outlet covers, right, they were tested. The outlet covers themselves have a way where debris itself would have to go in underneath and travel through the screens and get into that, the vacuum itself, the valve, yes.

MR. WACHOWIAK: And what was presented last time were the tests that we did many, many years ago. Part of that test was to show that it was still sealed with a .9 diameter wire across it. That was part of the test.

MR. DIAZ-QUIROZ: So, again, there's a hard seat also which provides an additional seal, not as good as the soft seal, of course.

Along with position sensors, it will be equipped with temperature sensors, and I'll show that, I believe, in the next slide.

MEMBER ARMIJO: Just a quick question: that soft seal, is it intended to last the life of the --

MR. DIAZ-QUIROZ: No.

MEMBER ARMIJO: Is it replaced every few years?

MR. DIAZ-QUIROZ: No, it has to be

replaced every four years, I believe. Now, of course, that frequency can change, depending on what touched --

Here, this is going to be an updated figure to the DCD.

As you can see, those temperature -- well, first, to get oriented, this is the vacuum breaker. This is, of course, representing the isolation valve. Then you have these dots, which represents approximate locations of temperature sensors. One is located near the outlet screen. When I say, "one," there will be several, just to make that clear, inside what we call the cavity on the wetwell side and also near the entrance to that penetration, which will be covered by the screen itself.

Then there's other temperature sensors located away from the vacuum breaker that are used to provide LOCA conditions --

CONSULTANT WALLIS: Well, the one that is in the pipe, it is really pretty indistinct because you don't show how long the pipe is and where it is in the pipe. How long is that pipe?

MR. DIAZ-QUIROZ: Right now -- if you will flip, please? Just flip them one.

That pipe right now has been modeled as a vertical pipe section in the wetwell.

CONSULTANT WALLIS: How long is it?

MR. DIAZ-QUIROZ: And it's approximately 2 meters.

CONSULTANT WALLIS: How --

MR. DIAZ-QUIROZ: Two meters.

CONSULTANT WALLIS: Two meters long?

MR. DIAZ-QUIROZ: Yes.

CHAIRMAN CORRADINI: Extending below the ceiling?

MR. DIAZ-QUIROZ: Below the ceiling, yes.

CONSULTANT WALLIS: Below the ceiling?

MR. DIAZ-QUIROZ: Right. So that right now that's how it was modeled.

MEMBER ABDEL-KHALIK: But it's now in the gas space.

MR. DIAZ-QUIROZ: It's in the gas space, right.

CONSULTANT WALLIS: What's the diameter of that pipe?

MR. DIAZ-QUIROZ: It's 24 inches. It's the same radius as the valve that's 24.

CONSULTANT WALLIS: Which is?

MR. DIAZ-QUIROZ: Twenty-four inches or nominal.

CONSULTANT WALLIS: Twenty-four inches?

MR. DIAZ-QUIROZ: Nominal.

CONSULTANT WALLIS: And where is the sensor in this 2 meters? Is it near the top or the bottom?

MR. DIAZ-QUIROZ: It's near the end, toward the end. It's about -- now we're going to switch back to meters -- it's about .3 meters from the end.

So that's where you see these temperature sensors we analyzed at LOCA conditions, where we got that 4 psi reference.

CONSULTANT WALLIS: Don't you use TRACG? Do you use TRACG to do that?

MR. DIAZ-QUIROZ: We use TRACG as a one -- we used a 1-D model that has several components you can use to model valves.

CONSULTANT WALLIS: This steam that comes in is half the density of the noncondensable. So, presumably, you just have a piston of steam that pushes out and --

MR. DIAZ-QUIROZ: Presumably, yes. That's what would occur, yes.

CONSULTANT WALLIS: So TRACG doesn't do that though. TRACG doesn't track a level between steam and noncondensables.

MR. DIAZ-QUIROZ: The effect of gas moving down, hotter gas as it heats up, of course, it takes 16 seconds to sweep out the volume --

CONSULTANT WALLIS: Yes.

MR. DIAZ-QUIROZ: -- of this whole penetration.

CONSULTANT WALLIS: And then it heats it up?

MR. DIAZ-QUIROZ: Right, then it heats it up. It heats it up. As you can see, that's what the curves show here.

CONSULTANT WALLIS: Does much of it condense on the way down?

MR. DIAZ-QUIROZ: Well, on the drywell side, when it first entered, the vacuum breaker, the isolation valve, and the body itself is not insulated. So, presumably, you're going to be at drywell temperature.

CONSULTANT WALLIS: It's a cold pipe? The tube is --

MR. DIAZ-QUIROZ: It's a hot pipe at the top, and then when you get --

CONSULTANT WALLIS: And then a cold pipe at the bottom?

MR. DIAZ-QUIROZ: At the bottom, right. So, once you get past the diaphragm 4 of the ceiling, you start cooling, yes. Presumably, you would start getting some condensation.

CONSULTANT WALLIS: So, presumably, at some point these details are worked out properly and with proper physics. It seems sensible that the piston of steam pushes out the noncondensables, and then you've got a jump in temperature.

MR. DIAZ-QUIROZ: Right.

CONSULTANT WALLIS: Then I was a bit surprised that you said, sort of between .3 and .7, or something, you could sense it, as if the implication was that below .3 --

MR. DIAZ-QUIROZ: .3.

CONSULTANT WALLIS: -- 30 percent leakage or something?

MR. DIAZ-QUIROZ: Fifty percent --

CONSULTANT WALLIS: Surely you can because that piston will still work.

MR. WACHOWIAK: You can detect it, but you wouldn't be able to reliably set the set point.

CONSULTANT WALLIS: I wonder if that's right though. Is it?

MEMBER ABDEL-KHALIK: Say that again,

Rick? I'm sorry.

MR. WACHOWIAK: What we want to be able to do is we want to be able to discriminate it in that band of .3 centimeters to .6.

CONSULTANT WALLIS: Well, you see, there's a step like this. It is just shown there on the screen. It shows that, doesn't it?

MR. WACHOWIAK: Yes.

CONSULTANT WALLIS: Then why doesn't it work at, say, .2? There's a step just later --

MR. WACHOWIAK: It would work at .2, but we don't want to always isolate all the vacuum breakers. This is going to a set point for an automatic isolation.

Having perfectly good vacuum breakers, according to our tech specs, we would not want the automatic system to think that that was a leaky vacuum breaker and isolate it.

So we had to come up with a system that could discriminate leakage in the region between .3 and .6. It could be off-scale high up .6; we'll isolate it. That's fine.

CONSULTANT WALLIS: Isn't there a certain time --

MR. WACHOWIAK: We just want to make sure that below .3 we don't spuriously isolate this stuff.

MEMBER ABDEL-KHALIK: So you could set your set point for isolation based on these calculations?

MR. WACHOWIAK: That's right.

MEMBER ABDEL-KHALIK: How much confidence do you have in these calculations?

MR. DIAZ-QUIROZ: Right now, since I said it's a vertical pipe, and of course we rely on the cooling effect, the wetwells cooling and the drywell, that's how we get this temperature differential.

Depending on the final geometry of the pipe, I would say we would have to re-analyze, and, of course, testing would have to confirm that. Part of the testing, part of the instrument inaccuracy or accuracy, I should say, that would all feed into the final calculation here.

MR. MARQUINO: So we're using these initial calculations to prove the concept that there is enough space in the wetwell airspace to have this pipe extension, and the temperature measurement accuracy is close enough to discriminate an allowable leakage from an unacceptable leakage that must be isolated.

MEMBER ABDEL-KHALIK: But, you know, if I look at this, if the mechanism that Professor Wallis is describing is to have this transient happens, why would the final steady-state be different?

MR. DIAZ-QUIROZ: For a .6 to .3, why would --

MEMBER ABDEL-KHALIK: Correct.

MR. DIAZ-QUIROZ: Right.

MR. MARQUINO: Because the flow rate of steam is being cooled as it moves through the extension pipe. So the higher steam flow rate, the higher the temperature. If you pick a location on the pipe, the higher the leakage flow rate is, the higher the temperature will be.

MEMBER ABDEL-KHALIK: And the cooling is through the walls of the pipe out to the gas space and the wetwell?

MR. MARQUINO: Yes.

MR. WACHOWIAK: We're relying on the temperature difference between the drywell and the wetwell to give you that mechanism.

CHAIRMAN CORRADINI: So that's why you extended it two additional meters? I'm back at that initial point. So you had to put that extension on, you needed to put that extension, for the design? I'm still struggling as to why two meters into --

MR. MARQUINO: We needed to put some extension on, because if we measured it way at the inlet to the wetwell, no matter what the leak rate is, we still get drywell temperature indicating on the instrument. The extension and the heat transfer in that pipe allows us to infer the leakage flow rate from the temperature.

CONSULTANT WALLIS: And to make sure that you won't measure something when there's a very small leak.

MR. MARQUINO: That's right, yes.

MEMBER ABDEL-KHALIK: So, if this condition were to happen somewhere in the middle of the transient, because the conditions in the wetwell are changing and the conditions in the drywell are changing, it's possible that somewhere we would hit that set point and you would isolate the valves.

MR. MARQUINO: It is not a fixed value. It is a percent of the difference between the drywell and wetwell differential.

MR. DIAZ-QUIROZ: Right, but here this slide shows what is the difference to be compared to.

MEMBER ABDEL-KHALIK: What makes you think that is going to be linear?

MR. DIAZ-QUIROZ: Linear?

MEMBER ABDEL-KHALIK: Right, by fixing that percent.

MR. DIAZ-QUIROZ: Well, when you say linear, as far as the temperature differentials --

MEMBER ABDEL-KHALIK: Right.

MR. DIAZ-QUIROZ: -- will they vary linearly? Well, we've looked at a couple of other points, and it is still the differentials are going to increase or decrease depending upon what the drywell and the wetwell are doing. So, if they're closer together, the differentials will be small.

So the limiting as far as delta T or temperature occurs toward the end of 72 hours before the transient turn on.

So, at that point, it is a question of, do you have enough of a temperature difference to detect the unacceptable leakage? And the answer is, yes, there's enough.

MR. WACHOWIAK: So to get to I think the heart of your question, have we looked at every possible scenario that could change the temperatures in the time domain of our accidents? No, we haven't looked at everything. But we have looked at several cases where we know things would be changing. For example, during the cycling of a vacuum breaker, we know that these temperatures are going to change; it's going to reverse. That's because of all that.

MEMBER ABDEL-KHALIK: No, the basis for my question is that this mechanism for detecting a leak relies on the fact that you will get different delta T's depending on the leak rate, and you get different temperatures because you have different heat transfer rates.

MR. WACHOWIAK: That's correct.

MEMBER ABDEL-KHALIK: And the conditions that affect the heat transfer rate are totally unpredictable because those will change during the transient.

So how do you determine a priori what the set point is going to be to isolate these valves?

MR. DIAZ-QUIROZ: But, at that point, part of the set point as far as -- the location is critical, of course, of the sensor. So testing would determine exactly what we're going to get if we place it at a certain location, what differentials --

CONSULTANT WALLIS: Or you could let it leak and test it. Then you're going to get these curves that you should here. Rather than just relying on TRACG, you're going to do a test with leakage.

MR. DIAZ-QUIROZ: We have to do testing,

yes.

CONSULTANT WALLIS: I think you do have to do a test with leakage.

MR. DIAZ-QUIROZ: Yes, and those in ITAAC that we committed to, to confirm that these temperature sensors will detect leakage within a certain range.

CHAIRMAN CORRADINI: So the "X" really will depend on the testing results?

MR. DIAZ-QUIROZ: Right, and instrument uncertainty, yes.

CHAIRMAN CORRADINI: Okay.

MR. DIAZ-QUIROZ: So we want to set it enough to where we don't each that .6.

CHAIRMAN CORRADINI: But, based on your calculations, "X" could be anywhere from -- I'm looking here -- 10 to 50 percent, based on your simple, on your initial calculations?

MR. DIAZ-QUIROZ: It could be higher, you know.

CHAIRMAN CORRADINI: I understand.

MR. WACHOWIAK: I think we understand what you're saying, that we have to account for the transient conditions as well because we really don't want a spurious operation of this.

MEMBER ABDEL-KHALIK: Right.

MR. WACHOWIAK: So we need to make sure of that.

The other thing, though, during the transient portion of LOCAs, for example, we're not limited during that timeframe by the 2 square centimeter leakage. It is the long-term behavior of the containment that's being limited by the leakage, the small leakage through the vacuum breaker.

So some of that can be handled with time delays in the circuits and some averaging. We think we know how to do that, but we haven't gone through and looked at all the different transient conditions to set the set point yet.

CHAIRMAN CORRADINI: Can I ask these questions just a bit differently?

So, from a timeframe, the first 20 minutes the vacuum breakers are going to be chattering and opening. Then, from 20 minutes, from a half an hour to the first few hours is where it's critical that they seal up. That is where, if you have leakage, you are concerned. Post-72 hours, for all intents and purposes, they don't even need to be there.

MR. WACHOWIAK: It's something like that.

CHAIRMAN CORRADINI: Yes.

CONSULTANT KRESS: The proximity probes don't help you out much here --

MR. DIAZ-QUIROZ: Right.

CONSULTANT KRESS: -- because --

MR. DIAZ-QUIROZ: They're not as sensitive.

CONSULTANT KRESS: They're not sensitive, and they pretty much tell you if something is wrong before you ever enter this DBA.

MR. DIAZ-QUIROZ: Right, right. So we would rely on the proximity sensors to tell you where the position of the valve is prior to any incident, any accident.

CONSULTANT KRESS: Yes, before any accident.

MR. DIAZ-QUIROZ: Right, and they could tell you full open because that would have to let them touch that.

CONSULTANT KRESS: Until that real sensitive --

MR. DIAZ-QUIROZ: Try not to, of course --

MR. WACHOWIAK: I think the original concept on the proximity was to be able to detect that greater-than-.9 millimeter wire on the seat.

CONSULTANT KRESS: Are they that

sensitive?

MR. WACHOWIAK: That was the original concept. I don't know that we've actually set up something that really measures that yet, but that was the original concept.

MEMBER ARMIJO: Will these set points be unique to each of the vacuum breakers? In other words, the T cavity, minus T?

MR. DIAZ-QUIROZ: They may.

MEMBER ARMIJO: So you might have different set points for each, depending on the geometry and the arrangement?

MR. DIAZ-QUIROZ: Where that sensor located on the wetwell side is critical. So the final check would be where is it from the ceilings to its final -- toward the end of the pipe. So they could be different, but we wouldn't, of course, want to make them all different.

MEMBER ARMIJO: No, it would be ideal --

MR. DIAZ-QUIROZ: Right.

MEMBER ARMIJO: -- but the environment may not be suitable.

MR. WACHOWIAK: It depends on the heat transfer characteristics. Even without the transient conditions, they could be different locations, and that will have to be accounted for. That is the way we wrote the ITAAC, too, was to account for that.

MEMBER ARMIJO: Yes. In your temperature sensors, you account for drift or do you periodically recalibrate, and all that stuff?

MR. MARQUINO: Yes. There is a surveillance interval, and we consider drift between the surveillance interval. That would be rolled up into the uncertainty evaluation in the set point calc.

MR. WACHOWIAK: And for the purposes of this demonstration of the concept, we used a plus or minus 1 degree for the thermocouples?

MR. DIAZ-QUIROZ: Two and a half.

MR. WACHOWIAK: Two and a half?

MR. DIAZ-QUIROZ: We were being very, very conservative to that, Celsius.

MEMBER BLEY: Remind me, when these have to open, they all have to open, right?

MR. DIAZ-QUIROZ: No. No.

MEMBER BLEY: How many have to open?

MR. DIAZ-QUIROZ: Only one needs to open for the vacuum breakers.

CHAIRMAN CORRADINI: So you, in theory, could come into the -- actually, Dennis was going where I was thinking, too. You could, in theory, detect leakage post-half-an-hour, isolate one, isolate two, and still maintain what you need to essentially have flow back into the drywell if you go below the wetwell pressure. Okay.

MEMBER ABDEL-KHALIK: Now, if the valves were perfectly sealed, how much stratification would you have in this pipe?

MR. DIAZ-QUIROZ: The vacuum breaker being sealed?

MEMBER ABDEL-KHALIK: Right.

MR. DIAZ-QUIROZ: You would expect that at that point you are heating up the top end on the drywell side. So, if you were asking about noncondensables and steam --

MEMBER ABDEL-KHALIK: Right. How much stratification do you have in the gas space of the wetwell that would produce a temperature difference between where you are measuring and the temperature of the wetwell?

MR. DIAZ-QUIROZ: I'm sorry, could you repeat that question?

CHAIRMAN CORRADINI: He's worried about the sensor outside of the pipe, I think --

MR. DIAZ-QUIROZ: Right. Okay.

CHAIRMAN CORRADINI: -- and the wetwell.

MEMBER ABDEL-KHALIK: Right.

CHAIRMAN CORRADINI: That's your question, right?

MR. MARQUINO: Right. So that sensor should represent the conditions in the vicinity of the pipe that are producing heat transfer from the leakage flow out into the wetwell airspace.

MR. DIAZ-QUIROZ: It's a local indication of what it is next to at the end way.

MR. WACHOWIAK: So, to get an idea of this, we've got a pipe that comes down through the top and it's hanging in the airspace. Outside of the pipe, near the entrance to the pipe, let's say here, is one temperature measurement, and then approximately one foot higher on the inside of the pipe there's a temperature measurement.

So you are saying what's going to be the temperature difference and the stratification between that one-foot level. We don't expect that to be very much. If there's no leakage at all, it would be measuring, essentially, the two ambient positions at the exit of the pipe and one meter higher than the pipe or one foot higher than the exit to the pipe.

CONSULTANT WALLIS: Well, I'm wondering, suppose you had a leakage below the set point, a little leakage, which slowly heats up the top of the wetwell. Then you are corrupting that temperature in the wetwell. Then, if you get a bigger leakage later, the temperature difference is going to increase.

Now, if you go from a cold wetwell to a leak, that's one thing. But if you go from a small leak to a slowly increasing leak, it seems to me that you are going to corrupt the temperature in the wetwell, raise it during the slow leak. Then, when you get to the point where you want to set it, the temperature difference is going to be less than it would be if it were a stepped change and leak.

I'm thinking of, say, TMI when they had a leak which got bigger and bigger and bigger and bigger. If you've got a leak which gets bigger and bigger and bigger and bigger, your T wetwell that you measure would be too high. See what I mean?

MR. WACHOWIAK: Yes.

CONSULTANT WALLIS: Because you've got steam coming out of --

MR. WACHOWIAK: That's a concern that has to be looked at when we do the final design and set point of this. That's in the detail design and set point.

CONSULTANT WALLIS: Can we put ours up

first and give them an answer?

MR. DIAZ-QUIROZ: It's the placement of that temperature sensor close to the entrance.

CONSULTANT WALLIS: It would be only for a length of time --

MR. DIAZ-QUIROZ: Right.

CONSULTANT WALLIS: -- followed by just going over the set point.

CHAIRMAN CORRADINI: I hear them answering you, Graham, differently than you may hear them answering.

Somehow I think it is going to an ITAAC. I don't think they are going to give you a calculation soon.

CONSULTANT WALLIS: How can you do an ITAAC where you have a slow leak in the real system?

CHAIRMAN CORRADINI: Am I misinterpreting your response?

MR. WACHOWIAK: You were not misinterpreting my response.

CHAIRMAN CORRADINI: Okay.

CONSULTANT WALLIS: Well, how can you do the test without building a real wetwell and simulating the conditions? How can you do the test of a slow leak?

MR. DIAZ-QUIROZ: It's a type test. You would take a representative pipe penetration. You would have to set the conditions in the drywell/wetwell. Then, of course, the location of that wetwell temperature is critical. So do you put it on the pipe or do you put it near the pipe, or how far from the pipe?

CONSULTANT WALLIS: So you're going to do a test? You're going to do a test with a scaled wetwell or something?

MR. DIAZ-QUIROZ: No.

CONSULTANT WALLIS: So how are you going to do the real test? How do you know how the stratification develops in the wetwell when you have a slow leak?

MR. DIAZ-QUIROZ: That's where we will have to analyze the bigger -- of course, have a nominal --

MEMBER BLEY: Not being a hydraulics guy, I've just got to ask this. This rear wall there into the wetwell, when the accident first happens, you've got steam blowing in. That's a very complex process going on there. Couldn't there be vortexes and things and steam jets that come up and kind of equalize the temperature in some regions that might just happen to be where this pipe is sticking down? Or is that observed?

MR. MARQUINO: We don't blow steam through the main vents into the wetwell airspace. That blowdown steam condenses in the pool.

MEMBER BLEY: It's always liquid going in there?

MR. MARQUINO: Yes.

MEMBER BLEY: Always?

MR. MARQUINO: Yes. So it's completely condensed. Now there is a pool swell phenomena that we have to consider in this equipment in the wetwell airspace. If it is going to be impacted by pool swell, we have to shield it or design for that impact load.

CHAIRMAN CORRADINI: So maybe you are going to give them some length scales here. I'm going back to your figure 10. What is the depth of the suppression pool and the distance from the water level to the wetwell roof? I think that will solve Dennis' issues.

MR. DIAZ-QUIROZ: So the depth of the suppression pool is about 5.5 meters.

CHAIRMAN CORRADINI: And then the distance above that 5.5 meters to the wetwell roof?

MR. DIAZ-QUIROZ: Just give me a quick second here.

CHAIRMAN CORRADINI: That's all right.

CONSULTANT WALLIS: Say that again? Or has this business of the raising of the ceiling been addressed yet?

MR. DIAZ-QUIROZ: Let me answer his question first.

MR. WACHOWIAK: This really gets to that.

CONSULTANT WALLIS: Yes, it does get to that.

Can you have a figure on the screen or something where we can actually see these measurements and know what you mean by a ceiling and --

CHAIRMAN CORRADINI: It's your favorite picture, slide 10, the previous presentation.

CONSULTANT WALLIS: Slide 10, previous presentation.

CHAIRMAN CORRADINI: The colored one.

CONSULTANT WALLIS: Okay.

MR. SNODDERLY: This is Mike Snodderly.

Even when there's an ITAAC, they're advised that the vacuum breakers are shielded for full swell.

MR. DIAZ-QUIROZ: Yes.

MR. SNODDERLY: I'll check on that.

MR. WACHOWIAK: So your issue, it involves anything that would be actual impact from the blowdown, from the pool swell. We call it the full swell.

So the ITAAC is to locate the end of this pipe above what we calculate the pool swell to be. Then we have to have a delta to get to the roof --

CHAIRMAN CORRADINI: If you're tracking nodulization right, that is about 5.8 meters, from the water level to the top of the wetwell ceiling. That is a healthy distance.

MR. WACHOWIAK: And that is what is in the ITAAC there.

MEMBER BLEY: Take off two meters because the pipe is there.

MR. WACHOWIAK: That's right. That's why we had to change the pipe size.

MR. DIAZ-QUIROZ: So it's about 12 meters from the bottom of the pool to the top of the ceiling.

CONSULTANT WALLIS: So the physical height of this wetwell is 12 meters or something?

MR. DIAZ-QUIROZ: About 12 meters, yes.

CONSULTANT WALLIS: This pipe sticks in two meters --

MR. DIAZ-QUIROZ: From the top.

CONSULTANT WALLIS: Then it has a cage on the bottom?

MR. DIAZ-QUIROZ: Right.

CONSULTANT WALLIS: So you have to then say it's got to be protected up to nine meters from the floor or something?

MR. DIAZ-QUIROZ: Right. Right.

CONSULTANT WALLIS: That's where the nine to twelve comes from?

MR. DIAZ-QUIROZ: Right.

CONSULTANT WALLIS: They haven't changed the height of anything?

MR. DIAZ-QUIROZ: No, the height of the ceiling did not change. It was just the confirming that will protect the ceiling from full swell.

CONSULTANT WALLIS: Because the words in the --

MR. DIAZ-QUIROZ: RAI were --

CONSULTANT WALLIS: Are extraordinarily misleading. It says you raise the ceiling by three meters or something like that.

MR. DIAZ-QUIROZ: The ITAAC, the figure in the ITAAC. That was not explicitly said. If you look at, if you go to where the figure exists, it is an

ITAAC, which just confirms design.

MR. WACHOWIAK: There are multiple ITAACs that cover the configuration of the suppression pool. There's one that sets what the volume is, and there are other ones that set what the wall thicknesses are, and there's one that says what is the minimum height above the floor that you can have any structure to accommodate for the full swell.

CONSULTANT WALLIS: That's the 9.-something?

MR. WACHOWIAK: That's 9.-something. Now, because we have to extend this two meters below that; the allowable value for the structure of the roof had to move up to allow for this pipe.

CONSULTANT WALLIS: But the actual structure is okay?

MR. WACHOWIAK: It always was.

CONSULTANT WALLIS: So you've changed the allowable value, but you haven't changed the actual value?

MR. WACHOWIAK: That's correct.

CONSULTANT WALLIS: Because it looked, when I read it -- yes, okay.

MR. WACHOWIAK: We realize that the words --

MR. DIAZ-QUIROZ: Poor choice of words.

MR. WACHOWIAK: It was a choice of words that --

CONSULTANT WALLIS: So, wow, you have raised the size of the wetwell by 20 percent.

MR. WACHOWIAK: So, in this, I don't expect that we would have this thing actuate on such a fast timescale that these transient things during the blowdown would be interpreted as a need to isolate the vacuum breaker.

Once again, we are still investigating what those timescales are, but certainly we would not want to actuate this because of transient conditions, like during a blowdown.

CONSULTANT WALLIS: Well, I would like to repeat, you really need to show this thing will work with a steadily-increasing leak, because most valves leak by steadily increasing their leak. They don't suddenly leak. So that is going to change the conditions in this pipe and in the wetwell.

MR. WACHOWIAK: Yes, and I'm not sure that, with this particular vacuum breaker, that that's the condition that I would expect. I would more expect one where the vacuum breaker cycles and then it doesn't recede all the way if it leaks after a cycle.

That's what I would expect. But your failure mode is a valid one and it has been experienced.

MEMBER ABDEL-KHALIK: Now are these numbers on the figure sort of to scale? In other words, if I have 70 degrees C temperature difference between the drywell and the wetwell, I get a temperature difference of roughly 10 degrees for these two different leak rates?

MR. DIAZ-QUIROZ: Yes.

MEMBER ABDEL-KHALIK: Okay. And you're sort of allowing for a measurement uncertainty on each thermocouple of 2.5 degrees?

MR. DIAZ-QUIROZ: Right, and that was just based on other set point calculations made per, say, ABWR London project, where we went to go dig up some actual calculations made for temperature sets just detecting gas in the drywell.

MEMBER ABDEL-KHALIK: So you wouldn't want your set point to be any smaller than five degrees?

MR. DIAZ-QUIROZ: Right. And again, that goes back to what's the temperature difference between a drywell and wetwell. I expect that that decreases throughout the 72 hours.

MEMBER ABDEL-KHALIK: I'm sorry, go ahead.

CONSULTANT WALLIS: This green line, this

T wetwell, all the gas spaces are only at 100 degrees C?

MR. DIAZ-QUIROZ: Right. This is taken from LOCA conditions for the main steam line --

CONSULTANT WALLIS: Then if you had a leaky valve putting steam in there, that green line at the top of the wetwell could creep up to 130 or something.

MR. DIAZ-QUIROZ: Correct.

CONSULTANT WALLIS: Then your whole baseline is wrong.

MR. DIAZ-QUIROZ: Well, again, these are based on main steam line break analysis, which have a built-in 2-centimeter squared leakage in them. So, if you go back and remove that, well, then your wetwell is actually much cooler to start with. So, if you do start to leak, say from zero to two, you would increase your wetwell temperature.

But, again, this is the conditions were taken from the 2-centimeter squared leakage analysis, which they showed the wetwell heatup because of that leakage.

So, if you didn't have any leakage, say, .3 for each vacuum breaker, eventually, you would heat up the wetwell, just like it is predicted in the LOCA analysis, in the containment analysis. I don't know if that makes sense or not, but --

MEMBER ABDEL-KHALIK: What we're saying is, okay, let's say you have a valve just barely at tech specs.

MR. WACHOWIAK: Right.

MEMBER ABDEL-KHALIK: And you will measure this temperature difference continuously, which is the difference between 100 and roughly 130-something.

MR. WACHOWIAK: Right.

MEMBER ABDEL-KHALIK: And what you are hoping is that you will be able to, if a leak were to increase to .7, you will be able to detect an increase in that delta T that corresponds to that 10-degree increase. What we are saying is that probably the leak can increase from .3 to .7 without you knowing it.

MR. WACHOWIAK: That's what we're looking -- we will look into that. What we want to be able to do is be able to detect it between the .3 and .7, and be able to recognize leaking in that sort of an increment. So that is what we are attempting to do.

Once again, you postulated a condition here that is not on our slides, and we are going to want to look at that.

I think that there's time constants and things that you can't see on a 600-something plot here that's not going to --

CONSULTANT WALLIS: Now, as the steam comes wafting out of this pipe, it is going to raise up this temperature on this T wetwell's thing which is nearby, isn't it?

MR. WACHOWIAK: Yes.

CONSULTANT WALLIS: So the green line is going to go up?

CHAIRMAN CORRADINI: I don't know -- can I just make a point of clarification for Graham? He's assuming.

Of your three sensors, are both of those in the wetwell, that is, within the mouth of the pipe and outside the pipe? Is the one outside far away or right next to it, or is that yet to be determined?

MR. DIAZ-QUIROZ: Well, you're right, it's yet to be determined because of the screen size itself on the inlet side. On the wetwell side, there's a screen there as well.

CONSULTANT WALLIS: This is going to be a long way away because in the figure it is just at the mouth of the pipe, which makes no sense at all.

MR. WACHOWIAK: Right. It was intended to indicate the wetwell temperature.

CONSULTANT WALLIS: Yes, but, see, when you show a figure like this, somebody might install it there.

(Laughter.)

CHAIRMAN CORRADINI: We bring good things to light. No problem.

MR. DIAZ-QUIROZ: Yes, it is shown there. Why it is shown there, it is to show that it is local; it is not like the other drywell temperature, where it is away, where you could be too far away from that entrance.

CONSULTANT WALLIS: But you're going to sort all of this out?

MR. DIAZ-QUIROZ: Yes.

MR. WACHOWIAK: And that's part of the optimization of all this. We had to have the 2-meter pipe to make sure we have room to optimize.

MEMBER ABDEL-KHALIK: And there are two concerns. No. 1, that you won't be able to detect it and, No. 2, you would get a spurious actuation and isolate all the valves.

MR. WACHOWIAK: Those are the concerns.

MEMBER ABDEL-KHALIK: Right.

MR. WACHOWIAK: So, once again, designing a control system that has two safety positions that are diametrically opposed to each other, the nature of a passing point.

We are up to the isolation valve.

MR. DIAZ-QUIROZ: Right.

So, as I mentioned before, we have looked at some butterfly valves for isolating the vacuum breaker, and there is a commercially-available design section to provide the leak tightness once you close them. That is provided by a metal-to-metal hard seat. As it sets, there are concentric metal rings with graphite spacers. They have tested it. It's Class VI leakage, meaning it is more than -- it meets our design requirements for leakage.

MEMBER ABDEL-KHALIK: What is this used for now?

MR. DIAZ-QUIROZ: These are used as isolation valves currently, containment isolation valves. That is what Weir sells them as. So it would provide -- and in most cases, they need to be fast-acting. In this case, it is not an issue of acting, a matter of just two seconds.

CONSULTANT WALLIS: It's this rotating butterfly valve?

MR. DIAZ-QUIROZ: Yes, it is.

CONSULTANT WALLIS: So the seal has to be on one side, on one side; on the other side, on the other side?

MR. DIAZ-QUIROZ: Yes.

CONSULTANT WALLIS: I'm not sure how you seal it so well then?

MR. DIAZ-QUIROZ: Again, just moving onto here --

CHAIRMAN CORRADINI: I'm glad you are a second person. I've been struggling on this picture.

CONSULTANT WALLIS: This picture doesn't make sense, does it? It has to come around and seal on the top and on the bottom, doesn't it?

MR. DIAZ-QUIROZ: It's offset from the axis of the pipe. It's offset from the seat. Then what they call the third offset is the seat itself. It's not one angle, you might say.

So, when the valve is rotated, it only makes contact when it is fully turned just about. Then that is when --

CONSULTANT WALLIS: So it does seal along on one side? It wasn't away from that --

MR. DIAZ-QUIROZ: Right. Right.

So what occurs then is you have this seat there at the bottom, which you notice on this picture.

Then you have the metal rings with the graphite end which flexes to provide that seal.

CHAIRMAN CORRADINI: So can we go back to the -- no, no. Graham already understood it. I'm not here yet.

CONSULTANT WALLIS: I don't fully understand it yet.

CHAIRMAN CORRADINI: So does it seal on one side or on two sides?

MR. DIAZ-QUIROZ: This seals on one side.

CHAIRMAN CORRADINI: So it has got to come and cock into place, and then sit down on top of it?

MR. DIAZ-QUIROZ: Right, that's what it ends up doing. That is why pretty much toward the very end of the floatation --

CHAIRMAN CORRADINI: Have you seen one of these things?

MR. DIAZ-QUIROZ: What's that?

CHAIRMAN CORRADINI: Have you seen one of these things?

MR. DIAZ-QUIROZ: Besides that?

(Laughter.)

No, no, we spoke to a vendor and, no, I have not seen it myself personally.

MEMBER BLEY: You can kind of see it on

that one. It comes in and then it has to drop. And how it does that is pretty clever. I've never seen one --

CONSULTANT WALLIS: If you look at the next figure, I don't understand how you could ever rotate it because it is held on both sides. How can you rotate that thing? It has to sort of pick up one side at a time and then --

MR. DIAZ-QUIROZ: It's going to tilt in place while it is seated or --

CONSULTANT WALLIS: Well, you start to rotate it. It picks up on one side?

MR. DIAZ-QUIROZ: When it starts to rotate, it actually lifts the whole -- that off the seat initially.

CONSULTANT WALLIS: But the axis is fixed, isn't it? Or the axis -- because the axis has to move --

CHAIRMAN CORRADINI: It's a cone, it's a cone-shape. So it moves up and into position and back down.

CONSULTANT WALLIS: Is it anything like a jam closure with a little top on it?

MR. WALKER: Is the phone on mute? This is Tom Walker from GE.

CHAIRMAN CORRADINI: No. We want your advice. Jump in.

MR. WALKER: Okay, you have to realize this is a cutaway view of a three-dimensional component, okay? And the seat is machined, as essentially all valves are, most valves are, the seat is machined as a cone. But, in this particular case, it is machined in a cone which has an axis which is not parallel with the pipe axis. So picture the thing going all the way around.

At the bottom of the figure, which is one degree out of 360 degrees, it is very close to being flat. But all the way around the rest of it, of course, it is at an ever-increasing angle as you approach the top.

So the thing doesn't -- you know, it's got a fixed shaft. It doesn't move on the shaft. It doesn't pivot. It doesn't drop or anything like that. It doesn't slide or drop or shift. It's fixed.

It is just that, by machining the seat that way, you essentially don't get any contact between the disc and the body seat until you reach the zero degree, fully-seated position, as opposed to most other butterfly valves, where as you approach 5 or 10 degrees, you start to get rubbing sort of toward the top and bottom, where the stem penetrates the body.

MEMBER BLEY: Can you explain that offset No. 2?

MR. WALKER: Offset No. 2 is that the center line of the shaft is offset from the center line of the pipe. That just allows it, that offset, along with the tilt of the seat machine cone, allows it to fit into, the disc to fit into the seat properly.

CHAIRMAN CORRADINI: So may I ask a question? Since you talked about the seat rubbing, if you look at your figure and you turn it so that you are looking from right, is at the bottom of the page, and up is at the top -- or I'm sorry. Left is at the top.

So on the one seal plane which is angular, versus the seal plane which is at right angles, is there any torque or stress put on the seat, on the seal point itself? Because it seems, the way you described it, since it doesn't move on the axis, it just turns, you put some stress as it is opening up or as it is closing down, but it's not putting any stress on the seal?

Do you know what I'm asking? I'm sorry, that's not a very good explanation.

It just seems to me like you're putting stress on the seal joint. You said, you made a very big point about it not putting stress as it is coming to closure. I'm trying to figure out how it doesn't.

MR. WALKER: Well, for a typical butterfly valve, as you start to approach the seated position --

CHAIRMAN CORRADINI: You get, essentially, stress or a rubbing, a frictional effect, yes?

MR. WALKER: Right. On the top and bottom, if you have a vertical stem. But, for this one, because of the angle of that seat cone, and because of that second offset, which makes the pivot point of the disc shifted from the centerline of the pipe, for all practical purposes, the disc just sort of eases into the seat because the geometry works out.

It isn't something that is easy to visualize, especially in three dimensions when you're looking at a two-dimensional figure. But it is because of that geometry and the pivot point of the disc that you don't get any rubbing between the disc and the seat.

MEMBER BLEY: Everything is only aligned when it is closed?

MR. WALKER: Right.

MEMBER BLEY: When it opens, things get

more out of whack.

CONSULTANT WALLIS: I don't understand how you open it fully without moving the axis.

MR. WACHOWIAK: So, Tom, the gray rectangles on the right side of the valve, those are not the seating surface, right?

CONSULTANT WALLIS: The red ones.

MR. WALKER: Oh, no, the red is the seating surface.

MR. WACHOWIAK: Okay. So the gray parts move along with the disc and the valve.

CONSULTANT WALLIS: No.

MR. WALKER: I think that gray is just shading to show the inside surface of the body.

MEMBER BLEY: Does the disc open perpendicular to the flow or is it like in that photograph, that it is only partially open when you're essentially getting full flow?

MR. WALKER: It rotates a full 90 degrees, so that you essentially get full flow.

CONSULTANT WALLIS: So the gray parts do move?

MR. WACHOWIAK: The gray part -- let me try this again. So, Tom, is the gray part just the wall of the body that is behind the disc?

CONSULTANT WALLIS: No, it must be --

MR. WALKER: Yes. Yes. Then the white part is the disc itself. So the disc has a sort of -- on the white side of this figure.

MR. WACHOWIAK: This shading is an extension of the shading back behind the --

CONSULTANT WALLIS: Say that again?

MR. WACHOWIAK: This shading is an extension of the shading on the sides. That's not part of the disc.

CONSULTANT WALLIS: Doesn't that stop the disc from rotating?

MR. WACHOWIAK: No. This is where the seat is here, where it comes on the diagonal. So that gray, it's material that's not there.

CONSULTANT WALLIS: There's no material there? Okay. So it can rotate.

MR. WACHOWIAK: See, that's not something that stops it. That is just showing a cutaway. It's the background and whatnot there.

CONSULTANT WALLIS: Okay, now I understand that. So the sealing looks good at the top. The sealing of the bottom, though, just has to sort of match up nicely with the surface.

MR. WACHOWIAK: Correct.

CONSULTANT WALLIS: That's tricky because it is coming in at 90 degrees, and it has to somehow slide in and just fit.

CHAIRMAN CORRADINI: The just-fit part is why one side is angular, as Dr. Ryan has pointed out to me.

CONSULTANT WALLIS: Okay. That's good.

MR. WACHOWIAK: Once again, it's commercially-available today.

MEMBER BLEY: Like the next picture? It's only seating right at the bottom there?

MEMBER ARMIJO: These look pretty exaggerated, these angles? Are they that big, you know, that angle there?

MR. DIAZ-QUIROZ: That angle?

MEMBER ARMIJO: Or is that kind of exaggerated just to show us?

MR. WACHOWIAK: Tom, do you know? That is, this on page 10, is that the real angle of that surface or is that --

MR. WALKER: I'm sure this is just a cartoon. It looks more representative of the angle that you would see at the top of the figure on page 9. I think it's closer to -- you know, it is a much shallower angle at the bottom of the disc, of the body.

MR. WACHOWIAK: So, at the bottom, it's still an angle; it's just a shallow --

CONSULTANT WALLIS: But what is it pushing on? The top is pushing on the surface by going to the right here. But it seems to me that the stuff at the bottom is coming in from -- when it is swinging around, it is going to be pushing on something to the left of it to seal.

Anyway, it works. This works. So let's forget it.

MR. DIAZ-QUIROZ: Well, Tom, if I'm not mistaken, these are qualified for LOCA conditions, is that true, as far as for continued isolation?

MR. WALKER: Yes. These valves are used in containment isolation applications in existing nuclear power plants.

MR. DIAZ-QUIROZ: So that concludes the total number of slides as far as the vacuum breaker isolation valve presentation.

We will have to, of course, look at the questions you posed and see what we come up with.

MS. CUBBAGE: Okay, we're going to go to the staff presentation now.

MR. SNODDERLY: This is Mike Snodderly

from the staff.

I had an action item from Dr. Corradini to get the AP-1000 pressure curve. So we've just handed that out to you.

This may be proprietary. So let's mark it as such. I just grabbed it off of our internal site.

MS. CUBBAGE: Well, that would be fine. It's from the DCD.

MR. SNODDERLY: That's what I thought, but, for some reason, it is not showing on Mike's public available version. But, anyway, we will work with Chris on that.

But, to answer Dr. Corradini's question, you can see that they go up to 58 pounds because, as you remember, they don't have a suppression pool. So what was really limiting them was they dump all that energy into containment, and they are waiting for the external flooding system to flood the outside of the containment.

But, once that occurs, they lower the pressure to less than half, and they hold it there for three days. Then, once they refill, they can continue to maintain that pressure.

CONSULTANT WALLIS: It's psig. So they have actually reduced the pressure rapidly to a low value.

MR. SNODDERLY: Yes, but the other thing to remember, Graham, is their design pressure is 59 psig.

CONSULTANT WALLIS: Yes, but they produce it --

MR. SNODDERLY: So they come within 1 percent of that. We found that acceptable for GDC 50, and then, yes, they made GDC 38, because they reduced it to less than half and held it.

But, and Hanry is going to talk about this, that assumption allows you to take advantage of it in your dose calculation. You can reduce the amount leaking out, and that's one reason they did that.

For the BWRs, and for the ESBWR, they said, okay, we won't take advantage of that; we will take the hit on our disc calculations and keep it at a higher pressure.

But, if they had reduced it to half, then they could have requested that reduction in their dose calculations.

Anyway, if there's any more questions, I will -- hopefully, this --

CHAIRMAN CORRADINI: This is very helpful.

MR. SNODDERLY: Is this what you were looking for, Mike?

CHAIRMAN CORRADINI: Yes. I just wanted to get kind of a historical comparison.

MR. SNODDERLY: Yes, I think it is a good idea, I mean that we can see what we have done for the other passive designs. So it is probably a good place to start.

Dr. Hanry Wagage is a senior member of my staff. What he is going to walk you through is some positions that we are taking with this design.

As I said, these are just to notify the staff, I mean to notify the ACRS so there aren't any surprises when we come back. So any feedback you can provide, we would appreciate.

CHAIRMAN CORRADINI: So, just to give the members, to get you orientated to where we are, we are officially at 3:15. All right? Officially, by government standards.

(Laughter.)

And Hanry is not going to necessarily take his whole hour and 50 minutes. He probably will take less. Then we will go into a comment period where the members can ask additional questions.

Hanry, go ahead.

DR. WAGAGE: My name is Hanry Wagage. I'm going to talk about how GE addressed GDC 50 and GDC 38, given that often issues are resolved.

I'm going to talk about how the complete issue is applicable to ESBWR and the suppression pool bypass issue, identified at the beginning, was an important issue for ESBWR. I am going to talk about how that affects us.

First, GCD 50, on a containment design basis, to ensure the containment and design to accommodate LOCA-generated pressures and temperatures, that is the issue.

When we look at three days containment analyses provided in DCD, Revision 4, we found that containment pressure was rising during the first 72 hours, and we had a concern what would happen beyond that, beyond that initial dose. There is a possibility that pressure will rise above. That is how we have more interest in this issue and possibly to address that.

During our evaluation of this issue, we issued RAI 6.2-140. You may have seen the GE responses to that.

GDC 50 does not refer to any time limit. However, we determined that a 30-day time limit was sufficient, based on operating a reactor analysis. We looked at Grand Gulf, which analyzed containment pressure after 30 days; dose analysis, which is performed for 30 days, and also we want to ensure that it is unlikely that pressure will rise above the design pressure beyond 30 days. Those are the three conditions we have.

MEMBER ABDEL-KHALIK: So this is not a conclusion? This is an objective? The last bullet there?

DR. WAGAGE: The last bullet is how we decided on 30-day analysis because, as I said, GDC 50 does not refer to any time limit. We decided on testing on 30-day containment analysis to find whether the ESWBR met GDC 50. During that time, you are going to find --

MEMBER ABDEL-KHALIK: But if your predicted pressure is continually increasing even at the 30-day point --

DR. WAGAGE: That's right. I am going to come to that. Because, as I said, the last point, the pressure is increasing; that is your concern. We have a concern that we have to resolve the differences, but we have found that the GE analysis done with TRACG does not show that pressure increasing. The pressure was stable at 30 days. The MELCOR analysis, with six fans operating, we found it was stable, but with four fans operating, it was a concern. The pressure was rising. We need to resolve those issues before we cross this --

MEMBER ABDEL-KHALIK: Again, the point I was making in the beginning, this is not a conclusion?

DR. WAGAGE: No.

MEMBER ABDEL-KHALIK: Okay.

CONSULTANT WALLIS: I thought that the answer was that you use active systems up to 30 days. You cross-connect and do all kinds of stuff.

You have to assure yourself that this thing will work after 30 days somehow.

MR. SNODDERLY: Graham, this is Mike Snodderly.

As I said before, the applicant would have two options: use their accredited active systems or to continue out the analyses to show eventually they hold it steady or turn it around.

So, right now, again, it depends on whether we go by the GE curve or the current curve that Jack Tills has. But we think we are starting to understand the differences, and we are going to come back to you with a curve.

DR. WAGAGE: The following systems were created during the analysis: PCCS is created throughout the accident. The suppression pool is used to condense steam. During the blowdown, steam is blown into the suppression pool and it is condensed there. It minimizes the initial pressure rise.

After three days, these three systems that were created, the PCC tank is going to be refilled, and the drywell gas recirculation fans are going to start at three days. And the passive autocatalytic recombiner system is always available right from the beginning. So we decided to credit it at three days.

MEMBER ABDEL-KHALIK: Why would you assume that in a confirmatory analysis that you are doing?

DR. WAGAGE: We are doing confirmatory analysis for the calculation which assumed that this was going to be operating.

MEMBER ABDEL-KHALIK: But what is the purpose of doing a confirmatory analysis? Is it to duplicate the applicant's results?

DR. WAGAGE: Confirm the applicant's results, given the same assumptions. If you change the assumptions, the results are going to be different. But you want to confirm the applicant's results using the same assumptions.

MEMBER ABDEL-KHALIK: I understand that that's valuable in and of itself. But if you were to eliminate unreasonable assumptions from your analysis and convince yourself that the system will perform acceptably, wouldn't that be an appropriate use of confirmatory analysis?

DR. WAGAGE: That will be coming to a more realistic place, and what we were looking after was bounding analysis, bounding calculations.

CONSULTANT WALLIS: How do you assure yourself that bounding is bounding without doing a lot of other calculations?

DR. WAGAGE: Bounding is bounding based on the assumptions we used in the bounding --

CONSULTANT WALLIS: Well, it seems to me you ought to start relaxing some assumptions and see if it stays bounding or goes down.

MS. CUBBAGE: I think one of the key points with the staff doing confirmatory calculations, getting back to your point, is we are able to look at some of the phenomenon, some sensitivities, and it helped formulate our RAIs and target where we question the applicant's analysis to get a better understanding and comfort level of their ability to model the plant. That is the fundamental reason why we do the analyses.

I think the bounding question we can come back to again later, but I think we probably ought to go on with these slides.

CONSULTANT WALLIS: One thing, you should confirm that bounding is bounding. That's one thing you could try to confirm, by trying to do something to get something bigger.

MS. CUBBAGE: And that's what I was alluding to with the sensitivities, and that is where we discovered the sensitivity to bypass leakage was very important. That's what led to a number of RAIs on the vacuum breakers.

MR. SNODDERLY: I guess I'm a little either confused or disappointed in our presentation then today. Then we haven't communicated that.

Because I think what I would hope is that, after everything we have gone through today, you can see that we have gone in, looked at their assumptions, and tried to match them, and put conservatism in. So that we understand that this is a reasonably conservative analysis and supports that the peak pressure is below the design pressure, and that we have looked at their decks; we have looked -- we have come up with our own model.

As Amy said, we have identified that, yes, bypass leakage was an important part to this design. Fan flow is going to be important to this design. All of these things gave us confidence that we did a good job in trying to understand this design and that, indeed, that curve that is going to be their design basis is --

CONSULTANT WALLIS: You mean what Jack presented?

MR. SNODDERLY: Yes. Right.

CONSULTANT WALLIS: That confirms GE's analysis?

MS. CUBBAGE: Not yet.

MR. SNODDERLY: Well, not yet. It's getting there. I mean it doesn't right now, but I think this way we are giving the Committee a glimpse into how fair we were or were not.

So prove that bounding is bounding, again, what I was hoping to do is give you an idea of the thoroughness of our investigation and that there is a quality to the confirmatory analysis that we have done. If that's not the case, then I would like that feedback.

But I think that, again, when we come back with the final analysis, and we're going to tell you what we have changed to either confirm GE's analysis -- but, right now, I don't think it does.

MEMBER ABDEL-KHALIK: Mike, I'm satisfied with Amy's answer as to the purpose of the confirmatory analysis.

MR. SNODDERLY: Okay, thank you.

DR. WAGAGE: Design pressure of this containment is 411 kilopascals, and the design temperature for the drywell is 171 degrees Centigrade, and for the wetwell it is 121 degrees Centigrade.

These calculations, which are TRACG for the six-fans case, show that containment pressure stays below the design value for all 30 days. The design value is shown on the top horizontal line, 411 kilopascals containment pressure driving and make the water stay below the design value.

As we talked earlier, our confirmatory analysis showed different results for the four-fan case. GE is going to use the four-fan case. So we have to resolve the differences.

Containment temperatures are shown in this picture. The top red curve is containment temperature of the driver. This is also for the six-fan case.

The design value is 170 Centigrade for the drywell. The drywell temperature is 10 below the design value.

However, this red curve temperature, right away the design temperature is 121 degrees Centigrade. We see that calculated temperature goes above that, about 126 degrees Centigrade, just before 72 hours.

CONSULTANT WALLIS: So you're presenting like GE? You are saying GE shows these, and they meet the regulations?

DR. WAGAGE: GE showed this, and we have confirmatory analysis. We need to come to --

CONSULTANT WALLIS: Right, but you're talking as if you were GE, right?

DR. WAGAGE: This is going to be the design-basis analysis. What we are doing is confirming this calculation, and we have to resolve the differences. But, finally, this is going to be the design basis. That's why I'm picking one. This is how we are to make our determination.

CONSULTANT WALLIS: But by your presenting these curves, it implies that you believe them?

DR. WAGAGE: These --

CONSULTANT WALLIS: You are presenting GE's results here. Does that imply that you believe them?

MS. CUBBAGE: We don't because these

aren't even their final curves.

DR. WAGAGE: And also, we need to confirm our analysis. We have some differences. We have to resolve the differences.

MS. CUBBAGE: This is illustrative, just to show, if a curve like this were to be approved, how it relates back to conformance with the regulations.

DR. WAGAGE: I was talking about this temporary device, about the design value. GE has shown with analysis, with structural analyses, the pre-temperature in the containment rising to slightly above the design value would not cause temperatures to reach the design value. So this should not be a concern.

As we talked about this morning, indeed, we have MELCOR confirmatory analyses. We need to resolve the differences between their two analyses.

CONSULTANT WALLIS: But your second bullet says that it is okay.

DR. WAGAGE: Given that we resolve the differences.

CONSULTANT WALLIS: It's okay based on the MELCOR analysis or the TRACG analysis?

MR. SNODDERLY: It's okay based on the TRACG analysis. The TRACG analysis will be the design basis. Once the DCD is granted, what will be controlled by the COL applicant and the COL in operation --

CONSULTANT WALLIS: I was wondering, so that if GE shows a curve and MELCOR shows a curve which is different by a factor of 50 percent, or something --

MR. SNODDERLY: Right.

CONSULTANT WALLIS: -- then what's to say that the Dartmouth model wouldn't give you another 20 percent? I mean, if two curves give you this difference, what do you think is the reliability of either of them?

MR. SNODDERLY: Well, the curve that governs would be the TRACG curve. That's what the control --

MS. CUBBAGE: But we are not just going to leave it with MELCOR shows one thing, TRACG says something else; we are going to believe TRACG. We are going to resolve the differences between the two and assure ourselves that TRACG is an appropriate conservative model that meets the regulations.

CONSULTANT WALLIS: The second bullet is not a conclusion.

DR. WAGAGE: No, because --

CONSULTANT KRESS: That's the GDC criteria.

CONSULTANT WALLIS: Okay. But this has always bothered me. But, I mean, if I had a lot of runs of computers, I could say, okay, I'm going to look for some 95 percent confidence or something, but I won't exceed something. But you only have two, and they are very different. I don't know how much confidence I have in either one of them.

MR. SNODDERLY: Well, I think you will see confidence because, as GE put up in the first slide, that TRACG SER was presented that said, based on modeling and tests, you guys looked at that and you wrote a letter saying that that's okay, and so did we. They have an evaluation. So that gives TRACG a pedigree.

Then, also, we have MELCOR that has been benchmarked against the CVTR experiments, and we have done a lot of work there.

So that's what gives us confidence that, if MELCOR confirms what TRACG says, then that's the curve that we are going to say we are going to license that plant to.

MS. CUBBAGE: But, at this point, both of those curves are showing, both MELCOR and TRACG are showing the calculated pressure to be below design pressure. There may be additional conservatisms in MELCOR that are causing the differences between the two. But I think that if both staff and GE both are calculating results that are acceptable, even if they don't match, if we understand the differences, we can move forward.

MEMBER BLEY: The second half of that is crucial. You've got to understand the differences.

MS. CUBBAGE: You do have to understand.

MEMBER BLEY: One of those is still going up, though, which isn't very comforting.

MR. SNODDERLY: Right, and that's why we spend so much time on that in this presentation, and we are going to come back to you with that presented.

But, for right now, the position, let's take a look at the first 72 hours, which is really where I think, hopefully, we all agree that the peak occurs for this plant. Right now, that peak is below the design pressure, and we confirmed that with MELCOR. So, therefore, we would say that they meet GDC 50, if they show that the peak pressure stays below the design pressure.

Then what will be their design basis will be what TRACG calculates and what is in the DCD.

MEMBER BLEY: I've got to tell you, I hope you don't end up with that as your final point because I really agree with what Graham said. If you have two that don't agree, there could be a third one that doesn't agree, either, and it might be higher than either of those two.

MR. SNODDERLY: For the first 72 hours, they agree.

MEMBER BLEY: Finding that agreement is really crucial rather than saying that both of them --

MR. WACHOWIAK: In the first 72 hours, we agree. They co-agree for the first 72 hours. They diverge following that.

MEMBER ARMIJO: Yes, and just one thing, this PCC efficiency, makes all the difference in the world for post-72 hours. So, if that turns out to be resolved, then it's not that far apart.

MR. SNODDERLY: That's right. Right now, they have more noncondensable gases in the drywell than we do. So, therefore, we needed a higher fan flow to mimic the results.

CONSULTANT WALLIS: So this PCC efficiency is not so important in the first 72 hours because, if it's a little bit less efficient, you just build up more pressure, and it works better. It controls itself. But now it doesn't after 72 hours. That's more disconcerting, that the efficiency really matters. I thought it didn't matter. I mean if it's over 50 percent, it just sort of corrects itself, but apparently it doesn't after 72 hours. It really matters.

DR. WAGAGE: Building pressure is not always good. If the drywell pressure rises, then there will be a bypass leaking during 72 hours, then representing increases as a result of --

CONSULTANT WALLIS: What you might do is require bigger fans or something.

CHAIRMAN CORRADINI: I think he's not even to his fun slides yet.

(Laughter.)

So let us move on.

MR. SNODDERLY: Yes, this is the easy one.

DR. WAGAGE: On GDC 38, there is a system to remove heat from the reactor containment cell that will be provided. The system safety function shall be reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss of cool accident and maintain them at acceptably-low levels.

CONSULTANT KRESS: Could you explain that middle line to me, the one that says, "consistent with the functioning of other associated systems"? What does that mean?

DR. WAGAGE: What I understand it, that any other systems, when assuming this containment system works, any other systems have to operate at what the systems --

MR. SNODDERLY: So, for example, you use sprays or fan coolers, and they've got to be redundant, single-failure-proof and have similar qualifications. So it's more for active systems.

CONSULTANT KRESS: The general statements for any containment system.

CONSULTANT WALLIS: Does the word "rapidly" mean anything?

DR. WAGAGE: "Rapidly" means, "rapidly" designed for PWRs plates, given in SRP Sections 6.2.1.1.A and 6.2.1.1.B. For example, for PWR dry containment, it is our position that peak pressure has to be dropped to half its value building in 24 hours; it's clear. But, for BWRs, there is no definition as such in SRP.

CONSULTANT WALLIS: But the GDC applies to all reactors, presumably.

DR. WAGAGE: Right. The reason could be

that BWRs have a suppression pool which takes care of the initial pressure rise. I mean if there is no suppression pool, the pressure would rise significantly, just like PWR. Because of the suppression pool, the pressure will not rise. That may be the reason that they pose a major concern for BWRs.

CONSULTANT WALLIS: But this may be okay to you, but if you've got a courtroom and you had a jury, I don't know how you explain "rapidly" to them.

MS. CUBBAGE: I think we also need to keep in mind when the peak happens with this plant. It happens at three days, as opposed to another plant that might have their peak immediately, and you want it get it down. Well, this doesn't go up immediately. It creeps up. Then, when it gets to the top, they are bringing in systems at three days that bring it down rapidly at that time.

CONSULTANT KRESS: "Rapidly" depends on the timing, I guess.

MS. CUBBAGE: The timing and the need. If you don't have a peak early --

CHAIRMAN CORRADINI: But if we're talking at the end of 30 days, then this argument is --

MS. CUBBAGE: That's a different story.

We need to have GE, the staff approve GE plots ultimately that support this argument, but I do think the factor in when the peak occurs has a big role in when the rapid reduction needs to happen.

DR. WAGAGE: For PWRs, I was talking about PWRs. PWRs, they reduce pressure by half of the value in 24 hours. Then they take credit for that reduction in pressure for those. For ESBWRs, there is no credit for any reduction in pressure that --

CONSULTANT WALLIS: I guess I'm sort of guided by management and public relations. If you have the pressure up for a month, someone is going to be concerned, right?

MR. WACHOWIAK: This is Rick Wachowiak from GE.

It sounds like this is the appropriate time to talk about nuclear accidents. In an operating plant today -- we'll stick in my area, the BWRs -- if there is an accident, the containment pressure goes up rapidly; the suppression pool reduces the pressure rapidly, and then, because they have to, the suppression pool cooling system comes on. Within an hour it needs to be turned on. Because if you don't turn it on within an hour, then the containment pressure will go above the main pressure.

So, in order to make sure that it can come in an hour, you have to have everything set up to work exactly right at the time of the accident, which you don't know when that is. It could be anytime, and it has to cover all sorts of things, seismic, and all of these sorts of scenarios. So it is a timing sort of thing.

And one last thing: in order to make that system work, the suppression pool cooling system, you have to take water out of the containment, the sealed can that is supposed to hold everything, and run it around your buildings and through heat exchangers, and then back into the building. Things can leak in the building. Things can leak in the heat exchangers, which then can get out into the public.

But in the existing plants, we take that necessary step to somewhat increase the chance of a release because we're moving water and things around, because we know we have to turn that system on now, to turn pressure around in about a day.

Okay. In ESBWR, we have a completely different philosophy here. Our containment is sealed up. The water that is needed to cool the core is inside the containment. The PCCS heat exchangers will keep the containment within its design pressure, and when we turn the fans on later, it reduces in case we have this issue with the vacuum breaker leakage path, that we would need to do the reduction.

Under all these scenarios, we don't have to open the can. Everything stays inside. We don't have to take that extra risk of moving potentially contaminated water outside of the sealed chamber that could take it one step closer to the public because we don't need to.

The licensing basis will now say keep it bottled up until all your conditions are right. You verified that your water in the suppression pool isn't necessarily radioactive. You verified that the pipes aren't leaking out in the buildings. You verified that your clean-up systems are working to clean up the atmosphere in the building.

So what we are trying to do with the licensing basis is keep the plant in an ever-safer condition and not have to take the rash actions of moving things outside the containment, just so that we can save the containment later.

So, overall, we think this philosophy is a better philosophy that does more protection for the public than what has been done in the past.

CONSULTANT WALLIS: So they do have the

backup, that if you need it --

MR. WACHOWIAK: If we need it, it's there.

CONSULTANT WALLIS: -- for this cooling of the --

MR. WACHOWIAK: If we need it, it's there. But we don't have to do it until the conditions are appropriate and continue on a lower-dose level to the public.

MR. SNODDERLY: Hanry, can you please put up your slide five again? Thank you.

So what we are saying is that, at 72 hours, active systems come on, and that is defined as rapid reduction, and then maintaining control unit pressure consistent with hot standby for this plant. So we now we are bringing in SECY 94-084 that says the safe, stable state for the passive plants is hot standby. So we are arguing that these active systems come on and then control pressure corresponding to the safe, stable state, which is hot standby.

CONSULTANT WALLIS: So the "rapidly" is after three days?

MR. SNODDERLY: Yes. Well, two cases -- initially, through the suppression pool, it is rapidly reduced, and then rapidly reduced again after 72 hours. Because the way we are interpreting the GDC is it doesn't say when that rapid reduction has to take place, but it must take place at sometime. So we're saying that it takes place initially through the suppression pool and then again at 72 hours, when the PCCS is refilled, or it begins to be refilled, and the drywell gas recirculation system comes on.

CONSULTANT KRESS: I've always interpreted hot standby as being conditions describing the core and primary system. I never have associated it with containment pressure.

Can you fill me in on that gap?

MR. SNODDERLY: Yes.

CONSULTANT KRESS: I always thought hot standby related to --

MR. SNODDERLY: Okay. So we have a break. Now the core is steaming with decay heat through the brick into the drywell. Then that steam is condensed by the PCCS.

CONSULTANT KRESS: Under accident conditions?

MR. SNODDERLY: Conditions, right.

CONSULTANT KRESS: That's the difference in --

MR. SNODDERLY: That is the way I am interpreting this GDC, that there would be steaming into the drywell. The PCCS will remove that heat, condense it, and send it back to the GDCS, back into the core.

Then they can operate like that in continuum. That, to me, is how I am interpreting the hot standby state, as opposed to taking it into the cold shutdown.

So the way the design basis for this plant would be, that cold shutdown, eventually, they would have to get there for investment protection, to do things, to make repairs. But, if they had to, they could just stay and steam into containment and remove the heat, as we've just discussed.

CONSULTANT KRESS: Where is it specified that hot standby is the --

MR. SNODDERLY: That's in SECY 94-084. That position was first introduced as part of the EPRI utility requirements document for passive plants. Then that position went to the Commission, and there is an associated SRM. They found that acceptable.

So it really is an important position. We have to meet -- that's one thing that is different than what you have seen before.

MS. CUBBAGE: And these policies are consistent with the Commission's Policy for Advanced

Reactors. We're encouraging inherent and passive means of safety.

DR. WAGAGE: We talk about SRM to SECY 94-084, which said that safe shutdown condition is 420 degrees Fahrenheit, that this plant can maintain that.

The systems created, we discussed the system created before. We did TRACG and MELCOR analysis.

CONSULTANT WALLIS: So now the intent, the way this GDC is written, is there some kind of explanation of what the intent is that goes with it?

MR. SNODDERLY: Graham, it's just the explanation that I just gave. It's just like this curve looks different than every other curve that we have licensed prior.

So, in other words, one could say that that is the expectation of what it means to meet GDC 38, all the curves that we have looked at before. What we are saying here is this curve has another rapid reduction at 72 hours and normally occurs much earlier.

What we are saying is GDC 38 doesn't specify when that rapid reduction has to occur. It just says it has to occur.

CONSULTANT WALLIS: To me, reading it, it means right away.

MEMBER ARMIJO: Right away, but, no, when you're near your design limit, why would you -- if you were --

MS. CUBBAGE: You don't need to reduce it when you don't need to reduce it.

MEMBER ARMIJO: Why would you do anything rapidly if the pressure wasn't built up? So, if you are up at 90 percent of your design limit, maybe that's the time to figure out --

CONSULTANT WALLIS: I think if you asked 100 citizens, 99 of them would say at least do it in a day; don't wait three days, I would say.

MR. SNODDERLY: Okay. So now we are going back -- I'm sorry, Graham. I hate to interrupt. But now we are going back to Amy's point. Don't forget the passive plant philosophy, which is no credit for active systems.

CONSULTANT WALLIS: I understand.

MR. SNODDERLY: And we do have active systems that could be actuated earlier than this. So, most likely, no one is going to wait 72 hours. But the design specification was that you would be able to walk away from this plant for 72 hours or, I'm sorry --

MEMBER ARMIJO: Hang around the plant.

(Laughter.)

MR. SNODDERLY: I'm sorry. Hang around. Hang around, but not have to turn on any active systems. That doesn't preclude you from it. In fact, we don't expect them to do that. So that would be the message I would give to the public.

MEMBER RYAN: So, sort of from a different point of view, you don't have to wait three days to do something, but you have three days to figure out what's going on before you do something stupid. That's the way I look at it.

MS. CUBBAGE: Right. And another thing, I think this comes back to a comment I made last year when we were discussing this. Sure, we could make them bring on LIPC early, make it safety-related, and they will, great, we'll take out the PCCS. Why do we have these passive systems if you're going to make us have active safety-related systems?

CONSULTANT KRESS: I'm still a little bothered about the hot standby. It seems to me like it is a circular position. The condition of containment depends on how you design the containment heat removing system. So I could get hot standby and I can get almost any pressure I want in there. So I don't see how that defines an acceptably-low pressure by itself. Because it depends on how you design the containment. I'm not quite sure it is a closed argument is what I am saying.

MR. WACHOWIAK: This is Rick Wachowiak again.

I don't think it says that.

CHAIRMAN CORRADINI: I don't think it is necessarily the question. I just think that's the Commission policy that they are required to follow.

CONSULTANT KRESS: I understand that. That's always the case.

MR. WACHOWIAK: I don't believe it uses the word "hot standby". I think it uses safe, stable state.

CONSULTANT KRESS: Safe, stable state?

MR. WACHOWIAK: Then it says, parenthetically, I think this is defined as some number of degrees. I think it is 420 degrees.

CONSULTANT KRESS: Okay, now that's closed.

MR. WACHOWIAK: That's what the SECY actually says.

CONSULTANT KRESS: Okay.

MS. CUBBAGE: So that SECY paper, just to make sure everybody is on the same page, was not specifically talking about containment. So we have taken that position and used it consistently in this case. That was talking about RHR in the SECY paper, right?

CONSULTANT KRESS: Well, it seems like it is probably because --

MS. CUBBAGE: It wasn't specifically talking about a containment pressure.

CONSULTANT KRESS: It's a little bit precedent. I would rather see a better definition of what "acceptably low" is.

MR. WACHOWIAK: This is Rick Wachowiak again, since I'm not up in front with my name tag.

We have to recognize with this, that if we are going to use a passive system, there has to be a driver to get the heat out. For a passive system, that is a delta T. So you can't have a passive system that operates at ambient conditions. It has to have that. So, if we are going to do passive, we have to accept this elevated temperature.

CONSULTANT KRESS: Oh, sure. I'm not worried about accepting an elevated temperature. I would just like to see the definition be one that is closed and still conforms with the policies. No, I think you do need a delta T, yes.

DR. WAGAGE: Based on SECY 94-084 and TRACG and MELCOR analyses, provided that it is because the determination is that the ESBWR meets GDC 38.

CONSULTANT WALLIS: So the issue is closed.

DR. WAGAGE: Closed, given that we resolve the differences, understand the differences between analysis --

CONSULTANT WALLIS: But you might never understand them.

DR. WAGAGE: I think that we, just earlier today --

CONSULTANT WALLIS: They might reveal some bigger concerns when you start looking at them in detail. How can you close an issue if you still don't understand what's going on with MELCOR and TRACG?

MS. CUBBAGE: There are other open RAIs associated with the analysis. There was some particular RAI that Hanry is indicating is closed. But it's closed pending acceptable resolution of a graph that everybody understands that shows the pressure that is acceptable.

MEMBER ABDEL-KHALIK: I think, for the record --

MS. CUBBAGE: What is closed here is the staff has a position on what it takes to meet GDC 38 for this passive plant. That's what's closed, not whether or not GE has met it. I hope that makes more sense.

CONSULTANT WALLIS: Yes.

DR. WAGAGE: Debris strainers, actually, the issue is to ensure the availability of water sources for decay removal following loss-of-cooler accident.

During our evaluation, we showed RAI 6.2-173 and 6.2-196 --

CONSULTANT WALLIS: What are your thoughts about this?

DR. WAGAGE: Through analysis, we have shown that decay heat removal from the containment can be performed for 30 days without using a FAPCS system.

CONSULTANT WALLIS: Well, do you believe this magical eighth-of-an-inch thickness on the strainers? Do you believe their statement that there are no downstream effects, with no technical analysis? Do you believe their statement that there are no chemical effects, with no supporting analysis?

DR. WAGAGE: No, that comes next.

CONSULTANT WALLIS: It comes next?

DR. WAGAGE: First of all, we need to decide whether there is a regulator requirement. If the applicant shows that, without using a FAPCS system, the containment can be --

CONSULTANT WALLIS: Oh, so you go with that argument?

DR. WAGAGE: -- only for 30 days.

CONSULTANT WALLIS: You go with that argument?

DR. WAGAGE: Then there is no --

CONSULTANT WALLIS: That's separate from saying, will it work?

DR. WAGAGE: That's right.

How will that be an issue I am going to talk about later on downstream effects.

CONSULTANT WALLIS: Okay. So it's that second bullet, that they don't really need the system anyway, so they don't have to worry about it?

DR. WAGAGE: That's right. They are going to use that for investment protections, but we don't have any regulatory basis for that.

What GE's position is, that because they can keep the containment cool for 30 days without using FAPCS, Reg Guide 1.82, Rev 3, is not applicable. We determined that there is no regulatory basis here enforced in Guide 1.82, Rev 3.

CONSULTANT WALLIS: What does the last bullet mean, this guidance about 1.82?

DR. WAGAGE: The last bullet --

CONSULTANT WALLIS: What does that bullet mean?

DR. WAGAGE: Which page? Page 11 or the last slide?

CONSULTANT WALLIS: Page 10. The last bullet on the previous slide, what does that mean? It says evaluation. Did you use that guidance or --

MR. SNODDERLY: We made sure there wasn't any confusion because I think I saw a comment from a Committee member that said that, does this mean -- so are they meeting Reg Guide 1.82, Rev 3, or not? Because we asked in the RAI, they had asked them to look at the guidance and compare their design.

So what we are trying to make clear here is that they have a strainer design, and they have considered the criteria of Reg Guide 1.82, Rev 3, but they have not committed to it. So it will not be part of their design basis. They could change that strainer design. They can make changes without NRC approval.

CONSULTANT WALLIS: I was wondering why

you put it up on the slide. What do you conclude from it?

MR. SNODDERLY: Well, they conclude, they have argued, as Hanry said, that it does not apply, and we are finding that acceptable.

CONSULTANT WALLIS: So you agree with them that they don't have to use RG 1.82, Rev 3, guidance? You agree with that?

MR. SNODDERLY: Well, if we can come to an agreement that they don't credit the FAPCS system for 30 days, then we're going to go that this is clearly a system that is there for investment protection.

CONSULTANT WALLIS: So what happens later? I mean, are they going to turn the system on later?

MR. SNODDERLY: Okay. Well, now you just brought up a good point, which is adverse system in action.

Hanry, please go to the next slide because let's consider some important things before we get to that. Because I think one of the important points the Committee has made about this issue is, if you can remove the sources, and that's one of the advantages that this plant has, is they have not been built yet. So let's look at some of the commitments they have made in their design basis.

They are going to use all RMI insulation and qualified coatings, and they are going to have stainless steel liners on the GDCS and the suppression pool up to the water level. So that is going to take care of your rust for BWRs and that is going to take care of fibrous insulation. So that is going to go a long way.

Now, also, and it is not part of their design basis, but they have done calculations with the net positive suction head that show that they have substantial margin. I think it was something like 25 feet. So that is in that RAI 173.

CONSULTANT WALLIS: But, doing that, they have used, I think, that method which is now discredited. They have used this 6.2.2.4 thing, which is no longer accepted for PWRs. They have assumed something about the fibrous debris which is typically picked out of the air.

Now is this all acceptable? I know it's a much better system. It just seems to be so uncertain what they have done.

MEMBER ARMIJO: There's no fibers there --

CONSULTANT WALLIS: That's right, but they have assumed fibers are there.

MR. DIAZ-QUIROZ: The analysis that was

conducted to show -- the role of RMI in the suppression pool, the amount of pressure drop across the inner strainer would be minimal. So to show --

CONSULTANT WALLIS: That doesn't mean anything.

MR. DIAZ-QUIROZ: All right. Well, then we took a typical PWR, what they would see as far as fibrous insulations fiber, and that's what we evaluated our strainer design against.

CONSULTANT WALLIS: You put in the amount of fibers that you have in a different system altogether?

MR. DIAZ-QUIROZ: In a typical BWR, yes, that's the --

CONSULTANT WALLIS: You have no basis for using those numbers.

MR. DIAZ-QUIROZ: Right. Well --

CHAIRMAN CORRADINI: Unless I misunderstand their argument, they are saying that is a bounding number to what they expect to be generated.

CONSULTANT WALLIS: But why would you apply the number from some other -- use the bounding number for what you generate, not the number that applies to another reactor system?

MR. DIAZ-QUIROZ: We don't have any

fibrous debris. Then that is a minimal condition for a lot of these strainers and --

CONSULTANT WALLIS: It's hard to get to your argument. I just don't think that arbitrarily using something from an SBWR for an ESBWR, it doesn't make any sense.

MR. SNODDERLY: Graham, see, that's where we are trying to make things gray and they're fairly black and white here. Again, the Committee may not agree, but the position is that Reg Guide 1.82, Rev 3, would not be part of the design basis for this plant. In other words, for design-basis accidents, they do not credit any active systems. So, therefore, their systems don't have to be analyzed.

But, as you brought up, there is the issue of adverse system interaction from a witnessed standpoint. So now there is nothing that precludes, as we talked about earlier, if you have these systems, there is nothing that precludes the operators from using them. So you turn on FAPCS. Now you are going to recirculate that system with some debris source term. Would that clog up the fuel? That issue is still open, and it is RAI 6.2-196. So we're going to have to --

CONSULTANT WALLIS: Get to that.

MR. SNODDERLY: I think we're there right now.

MS. CUBBAGE: We're waiting for GE to respond.

MR. SNODDERLY: Yes. So that is a major issue, and that is something -- they are considering that and putting that story together. But that is where we are on 1.82, Rev 3.

So I just want to make sure the Committee understands that this is what's coming. We know how important this issue is to the Committee and to us, the staff, for operating plants. But it is going to be different than what you are going to see for AP-1000, for APWR, and for the ABWR. Okay?

But, again, those are systems that rely on reactive systems for heat removal. So that is the big difference here between ESBWR and all these other designs. So we want to make sure that you guys are aware of what's coming.

CHAIRMAN CORRADINI: That helps a lot.

CONSULTANT WALLIS: Are you going to ever tell us about whether or not you accept their analysis of the strainers?

MR. SNODDERLY: I think we just did, which is yes.

CONSULTANT WALLIS: It's so qualitative. I mean numbers appear from --

MS. CUBBAGE: That wasn't the point. The point was we're not reviewing them for compliance to 1.82, Rev 3.

CONSULTANT WALLIS: So it doesn't matter, anyway, what they do?

MR. SNODDERLY: From a design-basis standpoint. It would be there from a witness --

CONSULTANT WALLIS: Are they going to turn the system on?

MS. CUBBAGE: We need to be concerned about whether they are going to inject debris into the core, not whether the system is going to work.

DR. WAGAGE: If they turn on the system, we end up crediting a -- the water comes from the suppression pool. So it doesn't matter.

But our only concern was that --

CONSULTANT WALLIS: But, at sometime, they are going to turn those pumps on. They aren't going to leave it just sitting there without turning the pumps on.

MR. WACHOWIAK: This is Rich Wachowiak from GE.

The idea here is that, No. 1, this Reg

Guide was written for plants that need to turn the pumps on immediately without regard for what's going on in the plant. They have to turn them on or things are going to fail. So the criteria in the Reg Guide are geared toward designing a system that has to be turned on immediately without much thought.

We think that, by the time we're done with our detailed design of this, that some of those things may apply and some of those things we may have a better way of doing it because we have time.

So, for example, our diesel generators that we're going to use to power these pumps, we don't have to start them in 12 seconds. We can start them up in three days, if we want to, or seven days, and they can be much more reliable pieces of equipment because we treat them nicer.

CONSULTANT WALLIS: But, eventually, you do have to run them, don't you?

MR. WACHOWIAK: That's correct. We're not saying that we're not going to have high-quality strainers or a system for FAPCS. What we are saying is we are going to design the system to operate in the conditions that we expect it to operate it in.

This Reg Guide was not designed or was not written for those specific conditions. We have time to -- we can run the system in a recirculation mode without going to the core for a while and see if we're blocked. We can put in some sort of a backwash function, if we think we need to, to unclog the strainer. Because we don't have to run the pump to keep the core cool.

CONSULTANT WALLIS: Eventually, you have to run them.

MR. WACHOWIAK: So that's when we do --

CONSULTANT WALLIS: After three days or ten days or thirty days, or something, you're going to run them.

MR. WACHOWIAK: So the requirement, then, is to make sure that, when we do run them, we don't make things worse.

CONSULTANT WALLIS: That's right.

MR. WACHOWIAK: That's the fitness evaluation that Mike's talking about, and we're doing that.

CONSULTANT WALLIS: And you're going to claim that, after a month, all the debris is on the floor, or something like that?

CHAIRMAN CORRADINI: I think what they haven't claimed -- I mean I feel like we can move on. That was, I guess, my first observation.

My second thing is I think they are trying to say that they have no basis to assume any debris other than a worst-case debris from current situations, and in that situation they still feel they're all right. It doesn't fit in the design basis. This is within the litmus evaluation, which has to be taken up later.

I think that's what I heard.

CONSULTANT WALLIS: It's going to be taken up later? On vague safety assumptions, we don't expect any chemical effects. Will it be less vague than that?

MR. WACHOWIAK: The requirement for with this equipment, that it must be designed and procured so that it can operate in the environment for which it was intended. So those things need to be answered. They are answered through not an Appendix B program, quality program, but they are answered through an ISO 9001 program. That's the main difference, is that we get to use different codes and standards to accomplish the same thing.

Why would you want us to apply a code or a standard for a system that needs to operate in one condition when our system operates under different conditions?

CONSULTANT WALLIS: Well, I thought, actually -- what is it, 18.2, or something? -- says how you should evaluate strainer performance in there, but they didn't really tell you when during the accident. It just said how to do it.

So, if you have to do it in three months, it still applies, doesn't it?

CHAIRMAN CORRADINI: I don't think, Graham, that the staff is ignoring it. I just don't think, given how they are approaching the design base, it needs to be covered within this situation. I think it has to be covered in a different evaluation.

CONSULTANT WALLIS: A different context?

CHAIRMAN CORRADINI: In a different context.

CONSULTANT WALLIS: Well, that would make more sense then, to leave it out of this, because the vague statements are red flags to me. If you left it out entirely and then did it right later on, that's fine. That's fine.

But the vague statement about we don't expect any downstream effect, or something, that doesn't mean anything to me.

MEMBER ARMIJO: They could expand on that and give all their reasons why the chemistry is different, and et cetera.

CONSULTANT WALLIS: So things really don't belong there. The thing will probably work, but it's those vague things that sort of smack of just sort of dismissing the whole issue that I don't like.

MS. CUBBAGE: You also have to keep in mind that this issue is going to evolve. There was a lot of back-and-forth. There was some expectation we had that they would meet it, and then it wasn't until they demonstrated they didn't need to credit these systems that we have come to the current staff position.

CONSULTANT WALLIS: Let's stop there. We don't need to --

MS. CUBBAGE: So there may have been some information docketed that didn't need to be docketed at this point.

DR. WAGAGE: That brings me to my last item on suppression pool bypass leakage. We had three issues.

Bypass design leakage capacity is a requirement, test acceptance criteria, and vacuum breaker leakage detection during LOCA.

On the last item, you heard more during the previous presentation.

We issued two RAIs, 6.2-145 and 6.2-148 on these.

On suppression pool bypass leakage, when you compared this ESBWR for forced bypass leakage, 2 square centimeters, it looked like more than the operating BWRs. It is the guidance for Mark II simulator, using 46.5 squared centimeter for bypass leakage.

However, during our evaluation, we determined that this ESBWR can have significantly lower bypass leakage because of the following conditions. These vacuum breakers, vacuum breakers take on some of the leakage, the bypass leakage. Vacuum breakers were to be tested every two years, and total bypass leakage is going to be tested every two years, too.

And vacuum breakers have double barrier seals --

CONSULTANT WALLIS: In the response to RAIs, GEH kept saying that some experience with the Mark I, II, and III showed that they had slower leakages, and so on. But that seems to be irrelevant. I mean this is not the same plant. They didn't have vacuum breakers. So I would think that any arguments about experience with Mark I, II, and III are irrelevant.

DR. WAGAGE: But it comes, I think, later on on the site. If you could wait, I can talk about that when we come to that.

CONSULTANT WALLIS: Okay.

DR. WAGAGE: I have those plans.

CONSULTANT KRESS: Could you tell me how below the 24-month frequency testing is an acceptable frequency? What's the basis for that?

DR. WAGAGE: That is what other plants, operating plants use, and that is in the standard technical specifications --

MEMBER BLEY: They don't have a valve anything like this in another plant.

DR. WAGAGE: What?

MEMBER BLEY: You're talking about the vacuum breaker 24-month frequency?

CONSULTANT KRESS: Yes. That's what I'm --

MEMBER BLEY: There's no valve like that in any other plant. You can't refer to the check valves in other plants, I don't think, as a basis for this. It's very unique.

MR. WACHOWIAK: Rich Wachowiak again.

The basis for this is that that's the only time you can get to it. It's inside the drywell, so that's as frequent as it can be done. That's the basis for that.

(Laughter.)

MS. CUBBAGE: So then you have to assure yourself that the acceptance criteria is sufficient, so that you're not going to exceed the design in the 24 months.

CONSULTANT KRESS: There's not some sort of risk criteria that won't invoke?

MS. CUBBAGE: I'm sorry, I didn't hear that.

CONSULTANT KRESS: There's not some sort of risk-based criteria that one could invoke, to say if that risk-based frequency --

MR. SNODDERLY: Well, I think GE was trying to make arrangements that they may use that for 10 years, and we didn't accept it.

CONSULTANT KRESS: But if you did use the risk-based, it is likely to be a longer period than that. So this is an acceptable frequency.

MS. CUBBAGE: It is as frequent as it can be without making them shut down.

CONSULTANT KRESS: But that's not a good reason --

MS. CUBBAGE: Right. Then you have to assure yourself that the acceptance criteria is acceptable and that you're not expecting to exceed the design within that 24-month period.

CONSULTANT KRESS: Yes, I would have been happier with risk; you wouldn't exceed some risk criteria.

But I think they just said they had made such an analysis. It's like 10 years.

MS. CUBBAGE: Right. And because of the lack of operating experience, that was not acceptable.

MR. WACHOWIAK: Yes, that's a later thing. When we have operating experience with these, then we will revisit the length between surveillances.

CONSULTANT KRESS: On what basis do you guys accept this 24 months?

MR. SNODDERLY: Past precedent. I mean it would either be that or they would need to shut the plant down just for this specific test. We found that the only way they could do it reasonably was every two years.

CONSULTANT KRESS: Is that a reasonable position?

MS. CUBBAGE: If you have confidence that over the 24-month period that it is not going to exceed --

CONSULTANT KRESS: How do you get the confidence? That's part of what I'm saying right now.

MR. WACHOWIAK: We could do a thought experiment on a risk-based analysis with this, using the DCD PRA. The instantaneous core image frequency and larger frequency is higher during shutdown than it is during full-power operation. So we would justify an infinite timeframe for this test if we put it on a risk basis.

CONSULTANT KRESS: They just said they don't buy --

MR. WACHOWIAK: Right. Because in order to test this vacuum breaker, which is there to protect the containment, you would have to break the containment to go inside and test the vacuum --

CONSULTANT KRESS: Well, we don't want to do that. That's for sure.

MR. WACHOWIAK: So it's one of these things where when we get to the point where we are going to use risk arguments with this, we will find that the 24-month cycle probably should be relaxed, but only after we have sufficient baseline to show that the degradation between tests is not an issue.

With operating experience with these

valves, we will be able to show that. But we're not there right now.

CONSULTANT KRESS: You're going to base the results of the 24-month testing as you go along --

MR. WACHOWIAK: Yes.

CONSULTANT KRESS: -- to give you reasonable assurance that 24 months is a reasonable frequency?

MR. WACHOWIAK: Or too short of a frequency, and that a longer frequency should be different -- but it will take codes, operating experience, that sort of thing to do that.

MEMBER BLEY: There wasn't any kind of -- I remember the test program, but there wasn't any testing of using some elevated temperatures or fluence or anything on the seals in there, was there?

MR. WACHOWIAK: Yes, there was.

MEMBER BLEY: Okay. I don't remember that. Was that in the test report?

MR. WACHOWIAK: Yes, it was in the test report.

MEMBER BLEY: Okay. That could be useful.

CONSULTANT WALLIS: And the durability of these seals over many years, how do you evaluate that? Is the material good for 10, 20, 30, 40 years under these conditions? You're testing it until they fail, and then you replace the seal?

MEMBER BLEY: They at least said they would do accelerated testing on it.

MR. WACHOWIAK: Before we lose too much, we probably did ourselves a disservice by not doing our presentation on the strainers because many of the questions that you are asking are on the last three pages of our presentation. You have the hard copy. So we won't revisit that, but take a look at the slides.

DR. WAGAGE: The last item I have on this slide is diaphragm floor penetrations. The ESBWR has a lesser number of diaphragm floor penetrations.

On this table, I am showing the circumference, the length of those penetrations, to determine how the total length of the penetrations, because penetrations you have the building and the tendency to leak, other than directly to a vacuum breaker seal.

The ESBWR has 10.9 meters for penetrations length compared to 50 for ABWR. So this we can say that this has minimal number of penetrations causing possible leak.

GE and our computer analyses, used the

centers to simulate bypass leakage so that containment pressure would stay below designed value. Based on the these, I determined bypass leakage capacity of 2 square centimeter is acceptable.

CONSULTANT KRESS: Question: is there other possible leakage bypass besides the vacuum breakers? Do they test the whole containment?

DR. WAGAGE: When they test total bypass leakage, they pressurize the containment and find the values.

(Simultaneous speakers.)

CONSULTANT KRESS: Yes, I understood, but I just thought I would check.

DR. WAGAGE: The next item, surveillance test acceptance criteria for ESBWR, GE was asking for 50 percent of the design capacity as acceptance criteria, which comes to 1 square centimeter. During surveillance testing, the test took a fraction of the design value to ensure that later on, before the next test, that bypass leakage would not exceed the design value.

If you compare this value to operating a PWR, Mark I has several test criteria of leakage to 1-inch diameter opening, which comes to about 3 squared centimeters bypass, which is about 16 percent of the design value. The Mark II and Mark III is 10 percent of the design value.

Operating a plant, data taken from many years, this plant, several plants observed that what they measured as actual bypass was much smaller than their textbook value. The textbook value, for example, for Mark II is 10 percent of the design value. What they measured was about 10 percent of that, and 100 percent. That would mean 1 over 100 of --

CONSULTANT WALLIS: What does that tell you about how these vacuum breakers will work?

DR. WAGAGE: A vacuum breaker is one part of the leakage. Vacuum breaker is --

CONSULTANT WALLIS: You're sort of extrapolating. I'm just wondering why operating plant data is relevant to the behavior of this new design of vacuum breaker, which dominates everything here. That's all I'm asking.

DR. WAGAGE: The total leakage is about two vacuum breakers and any other leakage part. The vacuum breaker, we talk about design leakage of 2 squared centimeters that is based on design, and I believe there was a presentation from GE on the design of a vacuum breaker, I think a few months ago.

Considering why we think that this value acceptable, this vacuum breaker, one of the important features of this vacuum breaker is that during a LOCA it can be isolated using an isolation valve. That's an important feature. We notice that it does very well.

If the vacuum breaker is leaking and directed by temporary sensors, then the operator can isolate and it can be already isolate.

The issue on these, we were determining that 50 percent of the design capacity as acceptance criteria is acceptable.

That brings us to our last item on suppression pool bypass leakage, vacuum breaker leakage detection during LOCA. Typically, a discussion took place during the last presentation from GEH. This received --

CONSULTANT WALLIS: This is the old one? It's changed.

DR. WAGAGE: Changed the picture. Did the picture change? Yes.

MR. WACHOWIAK: In the RAI response that we recently submitted, that's what changed it. That what was shown in the presentation.

DR. WAGAGE: Okay. This is that isolation matter.

CONSULTANT WALLIS: Well, I don't know, but I guess it's okay. I read through the responses, and they seem to be always the same response, and you kept asking more specific questions and you kept getting the same response. Eventually, you gave up asking the questions.

Did I say that unfairly? Or did I get the wrong impression?

DR. WAGAGE: I think GE gave the basis for what they were proposing; that's what we were trying to get, why it is 2 squared centimeters.

CONSULTANT WALLIS: It seemed to me you kept asking more specific technical questions on this issue, and then you got the same answer every time, which was a repetition of the previous answer. So you haven't really revealed any new technical information.

Maybe I got the wrong impression of this. I didn't have the time to read it very carefully. I got the impression you just gave up asking.

DR. WAGAGE: We did not give up. Right now, we identified that isolation valve closure is important. We have an outstanding RAI on that.

The other two, we determined that bypass leakage capacity and certain test criteria were acceptable based on the information provided by GE and operating plant information.

And the last item on isolation valve closure, we have not given up. It is open because of that.

MEMBER ABDEL-KHALIK: On the very last slide, I was just wondering, what is it that you find acceptable, given the fact that we don't know whether this leak detection system or the set point is going to be able to detect a slowly increasing leak, and whether this system would actually prevent spurious actuation altogether? Was is it that you are accepting?

DR. WAGAGE: Accepting -- are we talking about --

MEMBER ABDEL-KHALIK: Right there, the status, open item, first bullet.

DR. WAGAGE: Design bypass leakage capacity, sir, is a requirement, it is acceptance criteria. Bypass leakage capacity proposed is 2 squared centimeters, based on the design, which tends to cause lesser leakage than the other operating reactors.

MEMBER ABDEL-KHALIK: But whatever they are proposing, if it proves, upon careful examination, that it is not able to detect a slowly increasing leak or it is not able to preclude spurious actuation of these valves, what is it that you're accepting?

DR. WAGAGE: That part, we are keeping it open. Start reviewing their response to RAI 6.2-148, that is, to detect the leakage and then isolate the valve. But that part we aren't accepting. We are accepting only the first two design bypass leakage capacity of 2 squared centimeters and 50 percent of that as the surveillance test criteria. That's all that we are accepting. But we aren't accepting what you are --

CHAIRMAN CORRADINI: Can I say it differently?

DR. WAGAGE: Yes.

CHAIRMAN CORRADINI: You're saying that their set points you are okay with. You are still withholding judgment on their method of determining if leakage is above their set points?

DR. WAGAGE: Meaning the set points -- the limit, that's our limit, yes.

CHAIRMAN CORRADINI: But you are with withholding judgment whether or not their leak detection system is capable of identifying and isolating? That's what I thought I heard you say.

DR. WAGAGE: That's during an accident. That's right. During an accident, we have a concern whether they will be able to --

CONSULTANT WALLIS: That's a separate issue altogether. I mean, during an accident, leakage detection is quite different from leakage detection during an inspection.

DR. WAGAGE: Leakage detection during inspection, they are testing and they can identify that, and the operating reactors do that. We don't have any --

CONSULTANT WALLIS: But the thing that seemed to bounce to and fro in the RAIs was this 50 percent. You kept saying, why 50 percent? And they kept saying it's 50 percent because we like 50 percent. And you went around like this, and I never thought there was any good rationale for why you accepted 50 percent.

DR. WAGAGE: Actually, it's our guidance for Mark II and Mark III. The 10 percent, there is no rationalized, no technical justification why that 10 percent was accepted, either. But the conservatism ensures that by taking a fraction of the design value, we ensure that it cannot exceed before --

CONSULTANT WALLIS: So if they had said 40 percent, you would have accepted that, too, or 60 percent, you would have accepted that?

DR. WAGAGE: Forty percent, we would accept that. Sixty percent, we would have had concerns.

CONSULTANT WALLIS: It's a judgmental thing, isn't it? There's no technical basis?

DR. WAGAGE: There's no technical basis for even 10 percent. Also, this is not a significant safety concern, I would say, because this is only for surveillance testing. During an accident, they can isolate the valve after detecting --

CONSULTANT WALLIS: So between zero and 100, and 50 seems reasonable? That's the sort of argument that --

DR. WAGAGE: Well, see --

MR. SNODDERLY: Hanry, if you could just go back for a second, where we have the addendum from operating plants?

I think that played a big part here where we were saying that 10 percent of 1 centimeter squared was you're getting down into the noise or into the ability of tests to be able to affirm that.

So 50 percent gives us assurance that I'm not going to be greater than 1 centimeter squared.

That's the main thing. So there's some margin there for the as-left and what's reasonable for testing.

So, when you have larger allowable leakages, then 10 percent of that, to me, gives one a lot of assurance, right? But, for this plant, 50 percent gives me adequate assurance, because when I look at the test data, I realize I'm starting to get down into the noise of the instrument to measure this, and it's the tightest --

CONSULTANT WALLIS: But any rationale that says, if you measure it and it meets 50 percent, you have a certain confidence that it will meet the design requirement -- I didn't see any connection between the test and the functional requirement. But the tests meet it, but the 50 percent, 5 percent, or something else, in order to get better confidence that it will meet the design requirement, that's the kind of thing that is missing.

MR. SNODDERLY: Okay. And again, what we didn't do in our presentation, and we'll do the next time we come back, is we'll give you the actual data from those operating plants. I think that will help give you the assurance, because it gave us the assurance that that 10 percent was unreasonable for this design, and that, therefore, 50 percent was acceptable.

CHAIRMAN CORRADINI: That's one of the supplements we have, that was sent to us, the actual data from the plants. But that's fine.

MEMBER ABDEL-KHALIK: Ten percent of 900 square centimeters allowable leakage is very easy to measure.

CONSULTANT WALLIS: I think so.

MEMBER ABDEL-KHALIK: Ten percent of 2 squared centimeters might be very difficult to measure.

CONSULTANT WALLIS: That's what they argued about, yes.

DR. WAGAGE: I'm done now.

CHAIRMAN CORRADINI: Other questions for Hanry?

CONSULTANT WALLIS: Well, this goes back to the whole philosophy of testing, doesn't it? I mean, if they do one test and it meets some criterion, what's your confidence that under accident conditions it will do the same thing? It's a very iffy and difficult question.

MEMBER ABDEL-KHALIK: Because you have a --

CONSULTANT WALLIS: You don't have the

basis of statistics or anything to go on. If you test it and it works once, what's the probability it will work next time? You know, all those things are very iffy.

DR. WAGAGE: This plan has three vacuum breakers, and doing an accident analysis, they credited only one. That means one maybe also failed, and another can fail. Only one has to work -- or to fail.

CHAIRMAN CORRADINI: So, if you are done with Hanry's presentation, I would like to go around the table. So let me set the stage.

So we have not completed the issues that we were concerned about relative to containment. We have only settled on a couple of the RAIs. So I would like to get the members' comments about that.

My intent this time is to generate two categories of issues. One is things that we are going to hear back, such as we're going to hear back from the staff and the applicant resolving their calculations, the audit calculation with the TRACG calculations for the ESBWR.

But there's probably not going to be another letter generated. Rather, we are going to let the staff resolve them, and if they want to come back to us and tell us what's going on, or you want to hear about it, that's fine. We will fit into additional Subcommittee meetings. We are not going to purposely come back and revisit these topics, unless you feel something in Category 2, which is something that really gives you pause, that we have not already identified.

To remind you, that was essentially we were asking about audit calculations; we were asking about the vacuum breakers. Those were our two big things we got in a letter.

So let me start with Dennis and just work around, and see people's impressions. And I'll put things in the two different categories.

MEMBER BLEY: Other than the things that still have to be resolved, I guess I don't really have anything to add to what we've talked. But the issues that were agreed would be resolved are the key ones here.

CHAIRMAN CORRADINI: Sam?

MEMBER ARMIJO: Yes, I think the staff has got a good way to close on the issues between the audit calculations and the GEH calculations. No matter what happens, they have a way to close it, either by crediting active systems and putting the necessary controls on it. So I don't see a problem there.

I think the vacuum breakers are a very tough engineering problems. These are very small temperature differences. Temperatures are low to begin with. Thermocouples, you know, maybe thermocouples are better than when I used to do lab work.

So I think it's a big engineering problem. I would like to hear more about it, but I don't have any fundamental reason to believe they can't make it work, but I think it's going to be tough.

CHAIRMAN CORRADINI: Mario?

MEMBER BONACA: Not much. I can echo what Sam has said.

As you know, I'm a not a member of the Subcommittee. I came mostly to learn something.

CHAIRMAN CORRADINI: You're always welcome.

MEMBER BONACA: No, but I was particularly impressed with the quality of the responses and some of the closures being proposed. I think the vacuum breaker issue is a big issue. I don't know. Right now, I've been thinking about, you know, I don't know what kind of testing or other information would be sufficient to justify the numbers they are presenting. But I think the staff is following that issue.

MEMBER ABDEL-KHALIK: Let me just list the issues that I'm concerned about.

No. 1, the differences in the long-term pressure histories predicted by GEH versus the staff. The rapid drop in pressure between 72 and 76 hours versus what the staff predicted. The continuing increase in temperature and pressure after 30 days versus what GEH predicted. That's the first issue.

A second issue is TRACG model nodulization and whether that truly represents the actual physical geometry.

The third issue is leak detection and the vacuum breakers. You must be able to detect the leak even if it is a slowly increasing leak, and also show that this leak detection system is capable of preventing spurious isolation. And I don't think what was presented today would convince me that either one of these two conditions is actually met.

The fourth issue on my list is hydrogen mixing. I am not sure if the model is capable of predicting local variability of hydrogen concentration and showing that it is below the flammability limit. I haven't seen the argument that you have good enough mixing so that that condition is precluded.

The fifth issue on my list is the time constant of the reactor building being 12 hours, and long after more than six time constants you are still showing that there is presumably a large temperature difference between the suppression pool and the reactor building wall, so that you still have significant heat transfer to the reactor building.

Finally, the sixth issue on my list is the fan characteristics. I would like to know more about that and how that affects the calculations.

MEMBER BONACA: Excuse me. On the first issue presented, you measure the increasing pressures.

MEMBER ABDEL-KHALIK: Right.

MEMBER BONACA: And the argument was made of not taking credit for the active systems. I thought that that would be credible for me.

MEMBER ABDEL-KHALIK: No, there's a difference in trend. GEH calculation shows that the pressure is decreasingly stable. The staff calculation shows that the pressure is still continuing to increase even after 30 days. And that will have an impact on how the staff interprets the performance of the system. And I would like to see a recognition of this.

CHAIRMAN CORRADINI: Thank you.

Mike?

MEMBER RYAN: I'm like Mario. It's my first full meeting with this design.

But just listening to the discussion, it appears really clear to me that the difference between the passive design and the designs that are currently in use needs to be very carefully quantified as to what the expectations are for this period of time where you don't have to do anything versus a period of time where nothing actually is expected.

I guess that has design implications and equipment choice implications, and I imagine there are uncertainty implications that have been a large part of today's discussion. So I just urge you to mine the transcript and think about how to make that a topic of education, if nothing else, for everybody that has to interact with this design.

Several things that Mike Snodderly and Amy said, they understand those issues well, I'm guessing, but it's not clear how to effectively communicate how safety is inherent in a design when you have to do nothing for three days and still be okay. That's not thoroughly articulated to the uninitiated. So that's really the only thing I could add to the technical discussion today.

Thank you.

CONSULTANT KRESS: Yes, first off, I liked Jack Tills' presentation. I think it was good of the staff to have such confirmatory analyses.

Like you said, I think they have a process by which they can resolve the differences in the two calculations. I don't know what the resolution will be.

But, in both calculations, the pressure is pretty high for a long time. Now I understand the regulatory criteria, but that doesn't seem to be a good thing to do.

I would like to see somewhere along the line a way to get that pressure down. I don't know what it looks like for 30 days or 500 days or 600 days. You need to get that pressure down sooner or later, and I don't know how it is done, other than just wait it out, and I don't know how long we have to wait.

MR. WACHOWIAK: That's in the DCD. In Rev 5, that was the post-seven-day calculation that we presented. We used a combination of shutdown, cooling, and FAPCS. That calculation, although it will not be the licensing basis, it will still be shown in the DCD, Rev 6, and it's in the DCD, what would happen if you were to turn it on.

MR. SNODDERLY: Yes, but I think we need to make one point so that there is no confusion. I think that that curve needs to be in chapter 19 and not in chapter 6.

Because the point is now those systems are now defense in-depth litmus systems needed to support the PRA, and they are not credited in chapter 6. So they are not there for design-basis accidents and they are not part of the design basis. They are part of the defense in-depth written systems for passive plants.

I think that's got to be a key distinction so that you guys understand that that's a different treatment; it's a different barrier, and it's not a chapter. So they are very important systems, but they are written systems.

MR. WACHOWIAK: And we'll talk about the specific placement of that, and there's issues about where design information can actually go in the DCD. But we will want it there because we want to be able to show you and the public that, yes, we do have a way to do this. It is designed into the plant. It's just not part of the DBA accident analysis.

CONSULTANT KRESS: That wasn't part of the DBAs?

MR. WACHOWIAK: Yes.

CONSULTANT KRESS: Okay. I'll buy that.

I'm still not thoroughly convinced about knowing the distribution of hydrogen and other noncondensables in there.

I would like to see some -- you know, I think under most of the accidents, you are under well-mixed conditions, but I would like to see some criteria for whether or not it is well-mixed and some calculations that show that.

And of course, I think a key issue is these vacuum breakers, but I think I was more concerned about them than I am now. If you can actually measure those flow rates, fine. I think you're okay.

But I think we do have to resolve these differences in the heat transfer and the PCC heat exchanger.

So those are my comments.

CHAIRMAN CORRADINI: Graham?

CONSULTANT WALLIS: Well, I feel I'm somewhat behind all of you because I'm still at the point where I see some curves and I try to figure out what they mean, where they came from, what kind of physics went into them, what assumptions, why is it conservative or not conservation. Then I look at them and I say, well, is this really physically reasonable, what's being predicted here and what's being shown here? Then I read the text and I find the text uses words which aren't consistent with the figures and things like that.

So I'm at the level of trying to get some real confidence, which I think I used to have to a greater extent, in what GE has done by way of analysis. I am still wrestling with what they have really done, and do I really think that's adequate.

When Jack Tills comes up and shows that he can get quite different results, that makes me less secure than I was a few months ago.

So I am going to be careful and look at these curves again and see where things might be changed.

Now, basically, the thing looks like a good design and it ought to work, but the details, when you start probing the details, things come up which surprises. So it just doesn't make sense.

I would like to be able to remove the things which don't make sense when you look at the details and say I've really got confidence that the job is being done right and it will work. I think that can be done.

Some of it, though, I think has to be done in the way that the arguments are presented, a way that is consistent and physically believable, and agrees with what other people do by way of analysis.

So I'm at that sort of level. I'm not thinking like a regulator. I'm just thinking about it as a technical guy looking in from the outside, do I sort of accept the way they've gone about analyzing this and is it good enough? I'm still at that level, and I'm going to write some things about that.

But I think, in your rush to resolve things, you gloss over that. You just accept a curve because you've seen a curve. And I'm back to the point of saying, well, why does it have this sudden change and is that a reasonable thing? That's the level I'm at.

MR. SNODDERLY: Well, I apologize if it came out that way, but my intent was to make sure that I didn't want to surprise the Committee with positions that may be controversial. So I wanted to make sure that you had early notification of where we were heading with this design.

But I agree that we have work to do to reconcile those differences in the curves, and we're going to do that, and we'll come back. If we need to come back before we bring the final SER, we will do that.

CONSULTANT WALLIS: Just the differences in the codes, I mean there are sometimes when the two codes make the same assumption and, therefore, get the same answer. One can say, was that a reasonable assumption to make? Just because the codes differ doesn't mean that one necessarily has great confidence in the basis of them.

Do you see what I'm meaning? I mean you shouldn't just rely on the fact that Jack can get a different answer for part of the sequence. You should look at it.

MR. SNODDERLY: Well, I like the way that Jack went back and benchmarked it against the PANDA 2.2 test. That gave me some confidence.

CONSULTANT WALLIS: A good job, I agree.

MR. SNODDERLY: I think we need to do, you know -- that's a key step to understanding these things.

CONSULTANT WALLIS: There is this big difference in the efficiency of the PCCS, which was a real eye-opener to me. I never knew that before. I never knew that it had so much effect.

MR. SNODDERLY: But, in that case, that's an important phenomena that we to understand the sensitivity. So are they overly conservative or are they not conservative enough? We are going to do some investigation of that.

I think the answer is going to be that, if you increase the fan flow, then it can address that, that uncertainty.

CONSULTANT WALLIS: But he came along and did that analysis.

MR. SNODDERLY: I agree.

CONSULTANT WALLIS: You pretty much accepted what you saw.

MR. SNODDERLY: I think that that was government --

CONSULTANT WALLIS: So that sort of questioning attitude is revealing things.

MR. SNODDERLY: Thank you, Graham.

CONSULTANT WALLIS: I wonder what else might be revealed.

MR. SNODDERLY: Agree.

CONSULTANT WALLIS: I'll give you my written report.

MR. SNODDERLY: Okay, good.

CHAIRMAN CORRADINI: So let me just give some summary to what I have heard.

I want to first thank GEH for the time they spent in preparing for this. We were waiting for all sorts of interesting containment and thermal fluid issues that we had already asked questions about in the previous year.

I also thank the staff. We had asked them a couple of times to see some of the MELCOR audit calculations, so we could do a one-to-one comparison. And I think this was a good starting point, as we go through and settle some of the issues.

I don't hear anything that requires us necessarily to have another special Subcommittee meeting on this, but we haven't finished with containment issues. We're still owed calculations relative to what I will call gas-binding. I'm trying to come up with a better word, but, essentially, GDCS discharge into the vessel, and that's coming up in September at a Subcommittee meeting.

So I probably will ask that a lot of these smaller issues that we brought up -- and I think I caught all of them from all of those folks: the rise is pressure, if there was a steady pressure level;

rapid decrease versus slow decrease; TRACG versus MELCOR nodulization. And particularly I think GEH is going to come back after getting the back-up slides from Dr. Tills, to get clear exactly how the nodulization was versus how he is interpreting nodulization.

Fan modeling, et cetera, and in particular, some other things, and try to roll it up in a presentation and we capture some of the other parts of the containment performance, and come back together, so we can hear an update from what staff is going to do.

CONSULTANT WALLIS: Can we bring back something like the drain pan? We've got this drain pan, which to me is a new thing, which has been --

CHAIRMAN CORRADINI: Well, you had your chance, I'm sorry to say.

(Laughter.)

CONSULTANT WALLIS: No, but just think, when you start looking at the details, you find there isn't enough information to figure out what goes on. And this is just an example. So we need to have that.

CHAIRMAN CORRADINI: So I guess I have an immediate response. I think when they come back, the most important thing, I think, of everything I have heard today is that there is a pressure rise versus steady pressure level. And that's got to be understood. All right?

CONSULTANT WALLIS: But, you see, it's something like they put a drain pan in there, and they've got a fan and they've got this PCCS, and there's various interactions between those systems in a dynamic sense when they operate.

I have seen nothing that says how it works together as a system, except we're supposed to accept that they will work.

CHAIRMAN CORRADINI: Yes, but I guess it doesn't rise to the level of some of the other stuff. So, if they can answer the bigger issues which I think we are concerned about, and come back and explain those design issues, I guess I would welcome it. But, in particular, I am most concerned about the rising pressure versus steady pressure and understanding rapid versus slower decrease.

Mike has already committed on the side, but he's on the record, essentially, committed to try to resolve this with the GEH. We will hear about that when we get back together for the next containment discussion.

We have two big issues left in

containment, the GDCS performance particularly, so we'll feel better about gas binding, and also the controlling halvability relative to DBA calculations and heating versus cooling extremes, right? I think that's scheduled for October, I think. I don't have it in front of me.

So, at this point, I'll just thank everybody.

Tomorrow we are not talking about the design certification; we are assuming we have a design certification, and we are moving on to the bigger and better pastures of the North Anna Combined Operating License. So we are going to have a different group in here talking about the COL.

I assume everybody has looked at all that are included by reference sections. I think more tomorrow will be an education of what that means as we walk through the first few chapters. Okay?

We will do that again in July and then do it again in August.

MEMBER BLEY: Question?

CHAIRMAN CORRADINI: Yes.

MEMBER BLEY: RTNSS raised its head today. Where in this whole Part 52 process does RTNSS get thoroughly defined and the requirements on RTNSS equipment get defined?

MR. SNODDERLY: I would answer 94-084.

MR. WACHOWIAK: How about 95-132, because you clarified in 95-132?

CHAIRMAN CORRADINI: Don't start throwing numbers at us. I think he's looking for a place in the future that we talk about it.

MR. SNODDERLY: Oh, sorry.

MEMBER BLEY: Yes, and where does it fit in the design and the COL, and all of that?

CHAIRMAN CORRADINI: So, Mike, can you take a starting --

MR. SNODDERLY: Chapter 19?

MR. WACHOWIAK: Yes, the staff calls it chapter 22 of their SER, but it's usually lumped in with the chapter 19 stuff.

MEMBER BLEY: And that will include the NRC's requirements on RTNSS equipment, whatever they shall be?

MR. SNODDERLY: Right.

MEMBER BLEY: It's fuzzy.

MR. SNODDERLY: Right. As Rick said, it's going to be contingent upon the availability, how it's modeled in the PRA. So there may not be availability controls that are described in the DCD and then reviewed in chapter 22.

MEMBER BLEY: And where in calendar time does that crop up?

CHAIRMAN CORRADINI: I will have to get back to you on that.

MEMBER BLEY: Okay.

CHAIRMAN CORRADINI: I will have an answer for you, hopefully, tomorrow. Okay?

MEMBER BLEY: Fantastic.

CHAIRMAN CORRADINI: Chris and I have to kind of caucus. All right?

With that, we're adjourned. See you tomorrow at 8:30.

(Whereupon, at 5:53 p.m., the above-entitled matter was concluded for the day, to reconvene the following day, Thursday, June 18, 2009, at 8:30 a.m.)

Presentation to the ACRS ESBWR Subcommittee

ESBWR Design Certification Review

SER Section 6.2 Containment Systems

Presented by
Hanry A. Wagage
NRO/DSRA/SBCV

June 17, 2009

Presentation to ACRS ESBWR Subcommittee
ESBWR Design Certification Review
SER Section 6.2 Containment Systems

- GDC 50 – Containment Design Basis
- GDC 38 – Containment Heat Removal
- ECCS debris strainers
- Suppression pool bypass leakage

GDC 50 -- Containment Design Basis

Issue:

- Ensure the containment is designed to accommodate LOCA-generated pressures and temperatures
- 3-day analysis (DCD Rev. 4) indicated a possibility of containment pressure exceeding the design value after 3 days if no active intervention took place

Evaluation:

- RAI 6.2-140
- 30-day analysis
  - Precedence from operating reactors
  - Dose analysis
  - Unlikely to cause concerns beyond 30 days

GDC 50 -- Containment Design Basis (contd.)

Evaluation (contd.):

- Systems credited:
  - PCCS
  - Suppression pool
  - Credited after 3 days:
    - PCC tank refill
    - Drywell gas recirculation fans
    - Passive autocatalytic recombiner system
- Comparison to containment design pressure (411 kPa) and temperature (drywell - 171 °C, wetwell 121 °C)

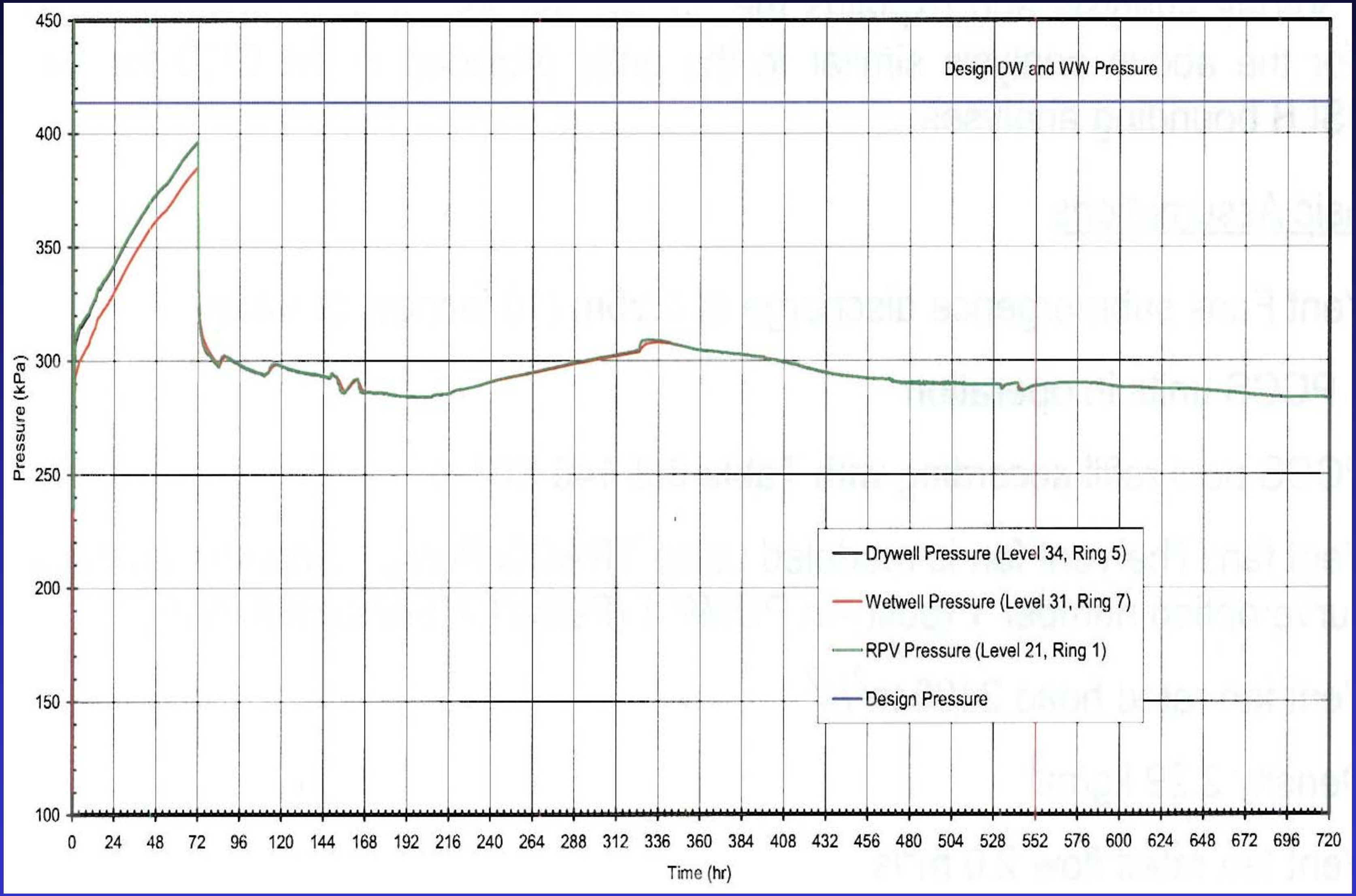


Figure 1. MSLB, 1 DPV failure (bounding case) – containment pressure (30 days) (RAI Figure 6.2-140 S04-C1)

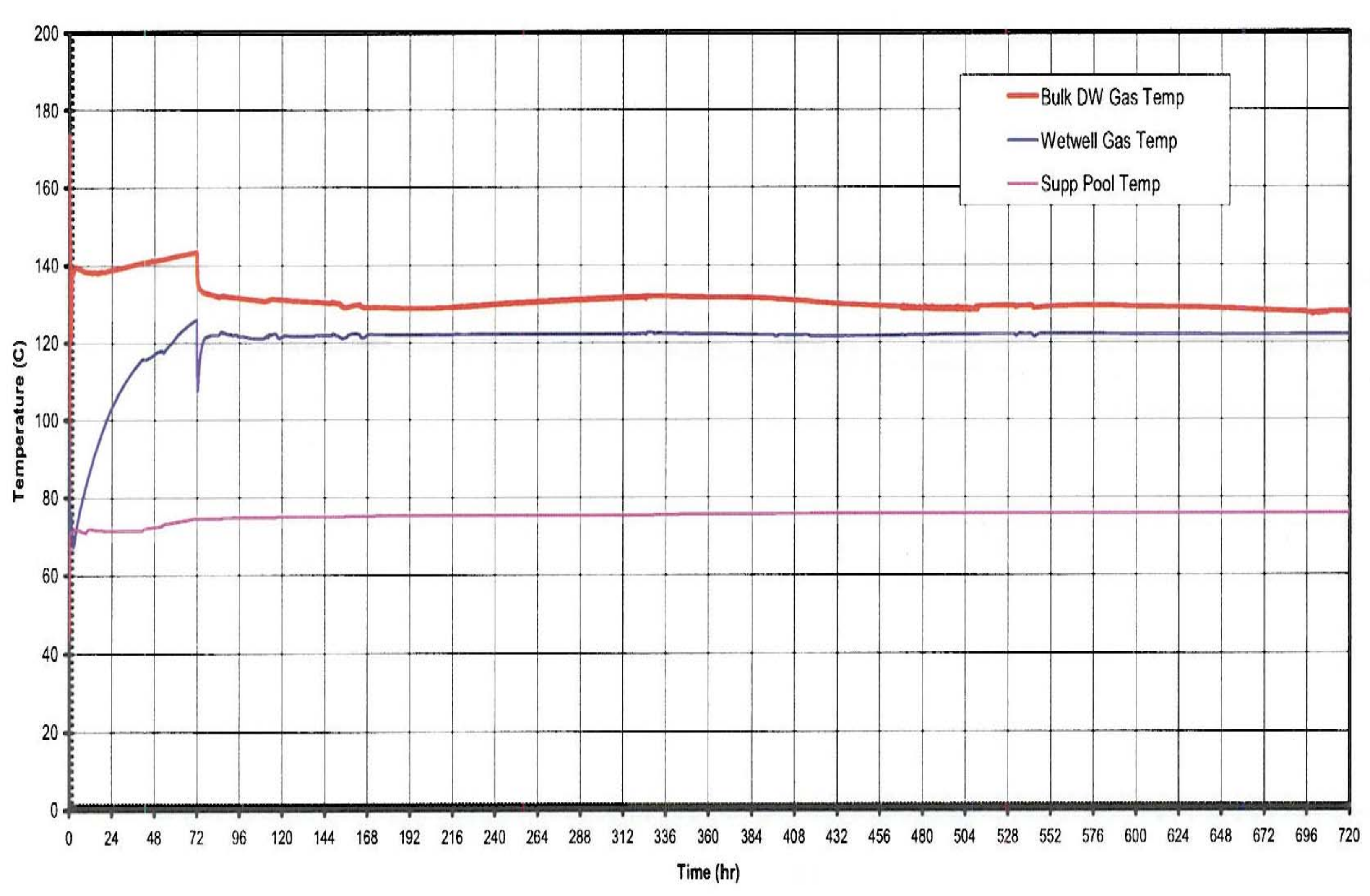


Figure 2. MSLB, 1 DPV failure (bounding case) – containment temperature (30 days) (RAI Figure 6.2-140 S04-C2)

GDC 50 -- Containment Design Basis (contd.)

Evaluation (contd.):

- MELCOR confirmatory analysis – differences with TRACG
- ESBWR containment can accommodate LOCA generated pressures and temperatures without exceeding containment design conditions

Status/open items:

- Issue is open (TRACG and MELCOR differences)

GDC 38 -- Containment Heat Removal

Issue:

- A system to remove heat from the reactor containment shall be provided. The system safety function shall be to reduce rapidly, consistent with the functioning of other associated systems, the containment pressure and temperature following any loss-of-coolant accident and maintain them at acceptably low levels.

Evaluation:

- RAI 6.2-139
- SRP Sections 6.2.2, 6.2.1.1.A, 6.2.1.1.B, and 6.2.1.1.C
- SRM to SECY 94-084 – cold shutdown (93.3 °C (200 °F)) versus safe shutdown (215.6 °C (420 °F))

GDC 38 -- Containment Heat Removal (contd.)

Evaluation (contd.):

- Systems credited
  - Same as discussed under GDC 50
- TRACG and MELCOR analysis
- ESBWR meets the intent of GDC 38

Status/open items:

- Issue is closed

ECCS Debris Strainers

Issue:

- Ensure availability of water sources for decay heat removal following a LOCA

Evaluation:

- RAIs 6.2-173 and 6.2-196
- Decay heat removal for 30 days w/o FAPCS cooling function
- RG 1.82 Rev. 3 guidance

ECCS Debris Strainers (contd.)

Evaluation (contd.):

- Improvements
  - RMI insulation and qualified coatings
  - Debris screens (PCC inlet, GDCS)
  - SS liners (GDCS, suppression pool)
- Downstream effects on fuel – adverse system interactions (RAI 6.2-196)

Status/open items:

- Issue is open (RAI 6.2-196)

Suppression Pool Bypass Leakage

Issue:

- Design bypass leakage capacity
- Surveillance requirements test acceptance criteria
- Vacuum breaker leakage detection during a LOCA

Evaluation:

- RAIs 6.2-145 and 6.2-148

Suppression Pool Bypass Leakage (contd.)

Evaluation: Design Bypass Leakage Capacity:

- ESBWR (A/√K) - 2 cm^2
- SRP 6.2.1.1.C guidance (A/√K)
  - Mark I – 18.6 cm^2 (0.02 ft^2)
  - Mark II – 46.5 cm^2 (0.05 ft^2)
  - Mark III – 929 cm^2 (1 ft^2)
- ESBWR features
  - Vacuum breaker and total leakage testing at 24 month frequency
  - Vacuum breakers with double barrier seal design (soft seat and hard seat)
  - Upstream isolation valves
  - Diaphragm floor design
  - Diaphragm floor penetrations

Table 1. Comparison of ESBWR Diaphragm Floor Penetrations with Previous BWR Containment Designs

Design	Penetration				Circumferential Length (m)		
	Type	No.	Diameter (cm)	Diameter (in)	Vacuum Breakers	Lines	Total
ABWR	Vacuum Breaker	8	50.8	20	12.8	37.3	50.1
	SRV discharge Line	18	66.0	26			
Mark II	Vacuum Breaker	4	45.7	18	5.74	201	206.
	DW to WW Downcomer	84	61	24			
	SRV discharge Line Downcomer	18	71.1	28			
ESBWR	Vacuum Breaker	3	60.9	24	5.74	5.11	10.9
	PCCS Vent Line	6	25.4	10			
	ICS Vent Line	4	2.54	1			

Suppression Pool Bypass Leakage (contd.)

Evaluation: Design Bypass Leakage Capacity:

- Containment analysis
- ESBWR design bypass leakage capacity ($2\ cm^2$ ($A/\sqrt{K}$)) is acceptable

Suppression Pool Bypass Leakage (contd.)

Evaluation: SR Test Acceptance Criteria:

- ESBWR - 50% of the design capacity (1 cm^2 ($A/\sqrt{K}$))
- SRP 6.2.1.1.C guidance
  - Mark I – leakage thru 1 inch diameter opening
  - Mark II and III – 10% of the design capacity
- Operating plant data:
  - Nine Mile Point Unit 2, 1996
  - Susquehanna, 1996
  - Columbia, 2006
  - Clinton Unit 1, 2006
  - LaSalle Units 1 and 2, 2001
  - River Bend, 1996
- ESBWR SR test acceptance criteria is acceptable

Suppression Pool Bypass Leakage (contd.)

Evaluation: VB Leakage Detection during a LOCA:

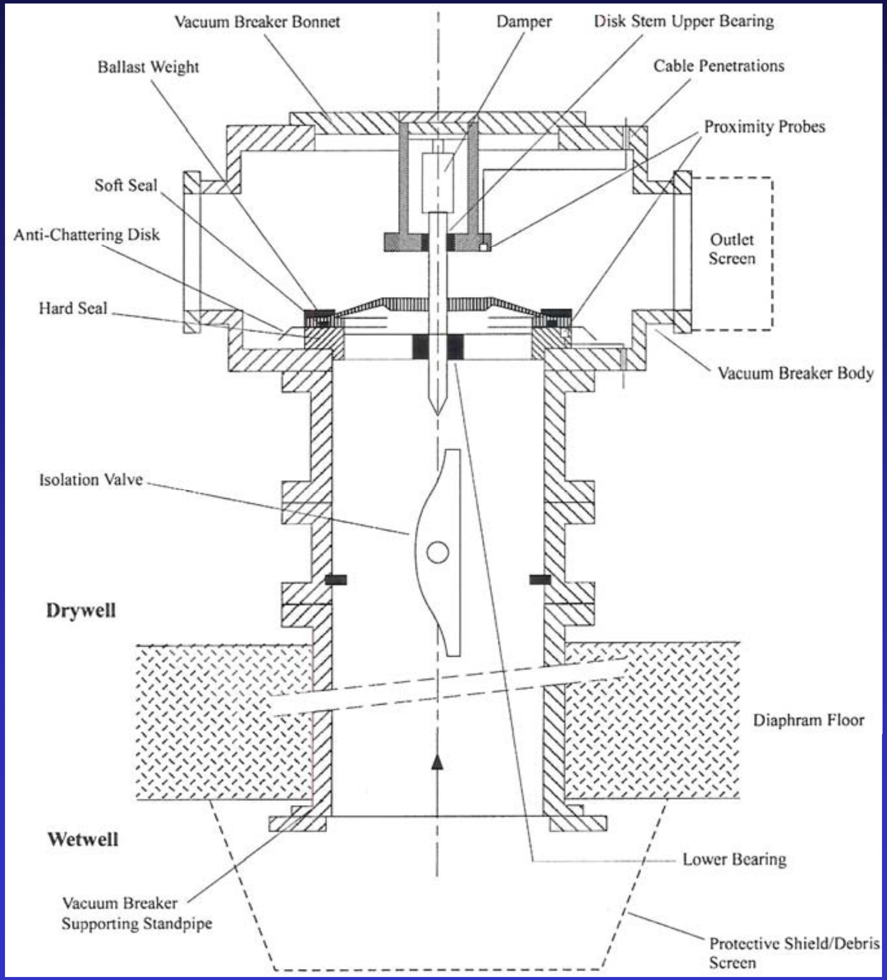


Figure 3. Wetwell-to-drywell vacuum breaker (DCD Figure 6.2-28)

Suppression Pool Bypass Leakage (contd.)

Evaluation: VB Leakage Detection during a LOCA (contd.):

- GEH’s response to RAI 6.2-148

Status/open items:

- Design bypass leakage capacity and SR test acceptance criteria are acceptable
- Staff is reviewing GEH’s response to RAI 6.2-148

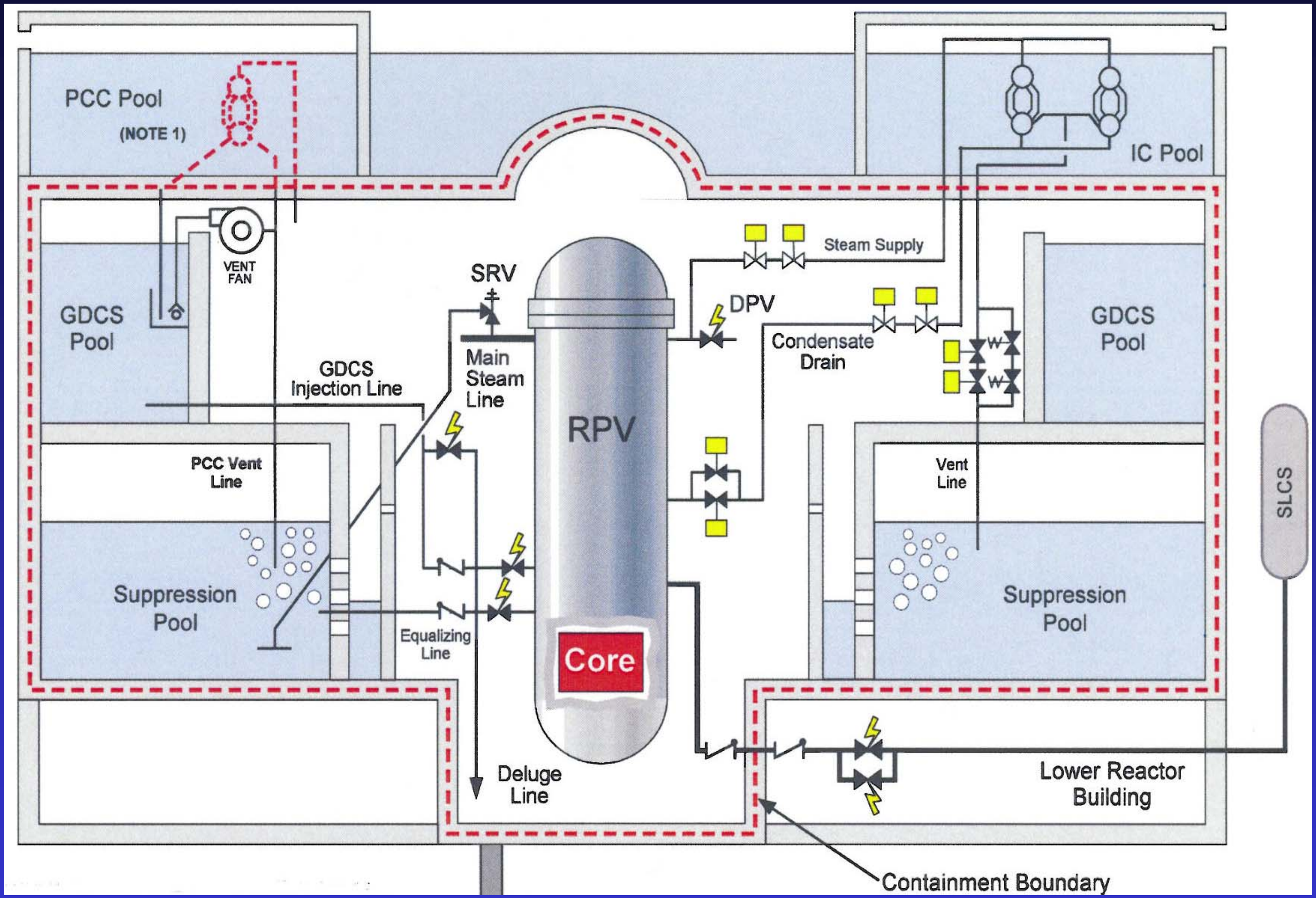
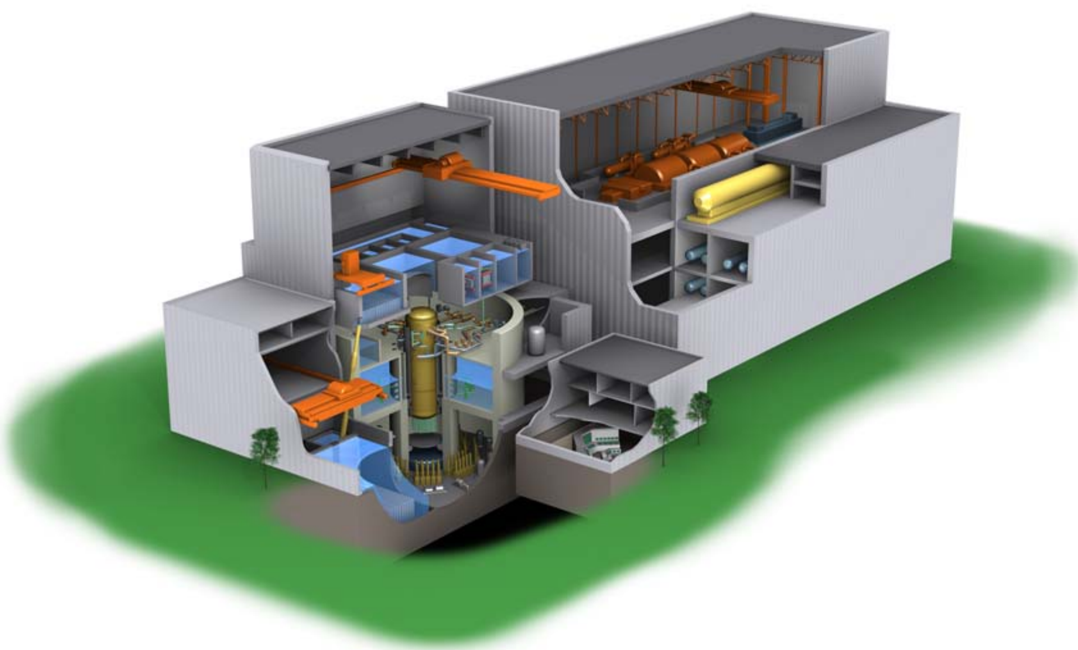


Figure 4. A schematic of SBWR containment (DCD Figure 6.2-15)

ESBWR -
Vacuum Breaker / Vacuum Breaker Isolation
ACRS Meeting



Jesus Diaz-Quiroz

June 17, 2009

HITACHI

Leakage Limits

Technical Specification (TS)

- TS Surveillance Requirements (3.6.1.1.3, 3.6.1.1.4, 3.6.1.1.5)
  - Leakage of ≤ 0.3 cm^2 (A/√K) for each individual Vacuum Breaker (VB) and VB Isolation Valve
  - Leakage of ≤ 0.7 cm^2 (A/√K) for total VB/VB Isolation Valve pathway (max of each pathway)
  - Overall Suppression pool bypass leakage of ≤ 1.0 cm^2 (A/√K)
  - Design Basis analytical limit of 2 cm^2 (A/√K)

Design

- Leak Tightness of less than 0.02 cm^2 (A/√K)
  - VB testing confirmed leak tightness
  - VB Isolation Valve commercially available to meet leak tightness (e.g. Weir Tricentric Butterfly Valve)

Vacuum Breaker

The details of VB valve design to meet criteria:

Double barrier seal design – non-metallic seat (Elastomeric EPDM) and backup hard seat (See Figure 1)

  - Provides protection from debris lodging on either seat and still maintains leak tightness – provides seat single failure protection
  - Either seal provides leak tightness requirements – VB test program demonstrates leak tightness < 0.02 cm^2 $(A/\sqrt{K})$

- Equipped with inlet and outlet debris screens with 0.9 mm perforations
  - Prevents entrance of LOCA debris particles that can create leakage
- Temperature sensors along with disk position sensors provide signal to close a leaking vacuum breaker

Vacuum Breaker & Isolation Valve

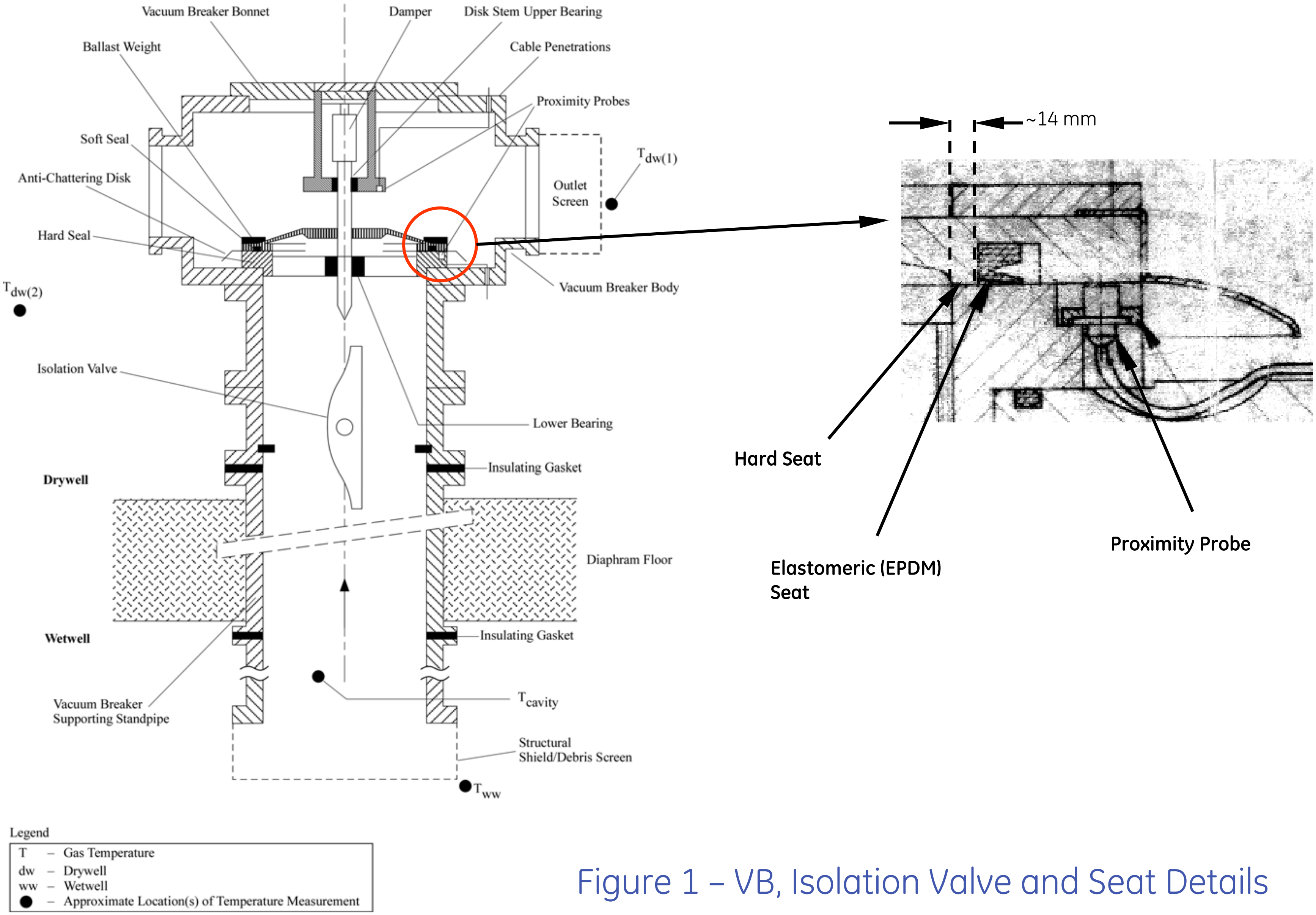


Figure 1 – VB, Isolation Valve and Seat Details

Closing Isolation Valve on VB Leakage

VB Isolation will close ≤ 0.6 cm^2 (A/√K) VB leakage

- Assures analytical limit of 2 cm^2 (A/√K) is not exceeded
- Temperature differential setpoint will be able to discriminate vacuum breaker leakage

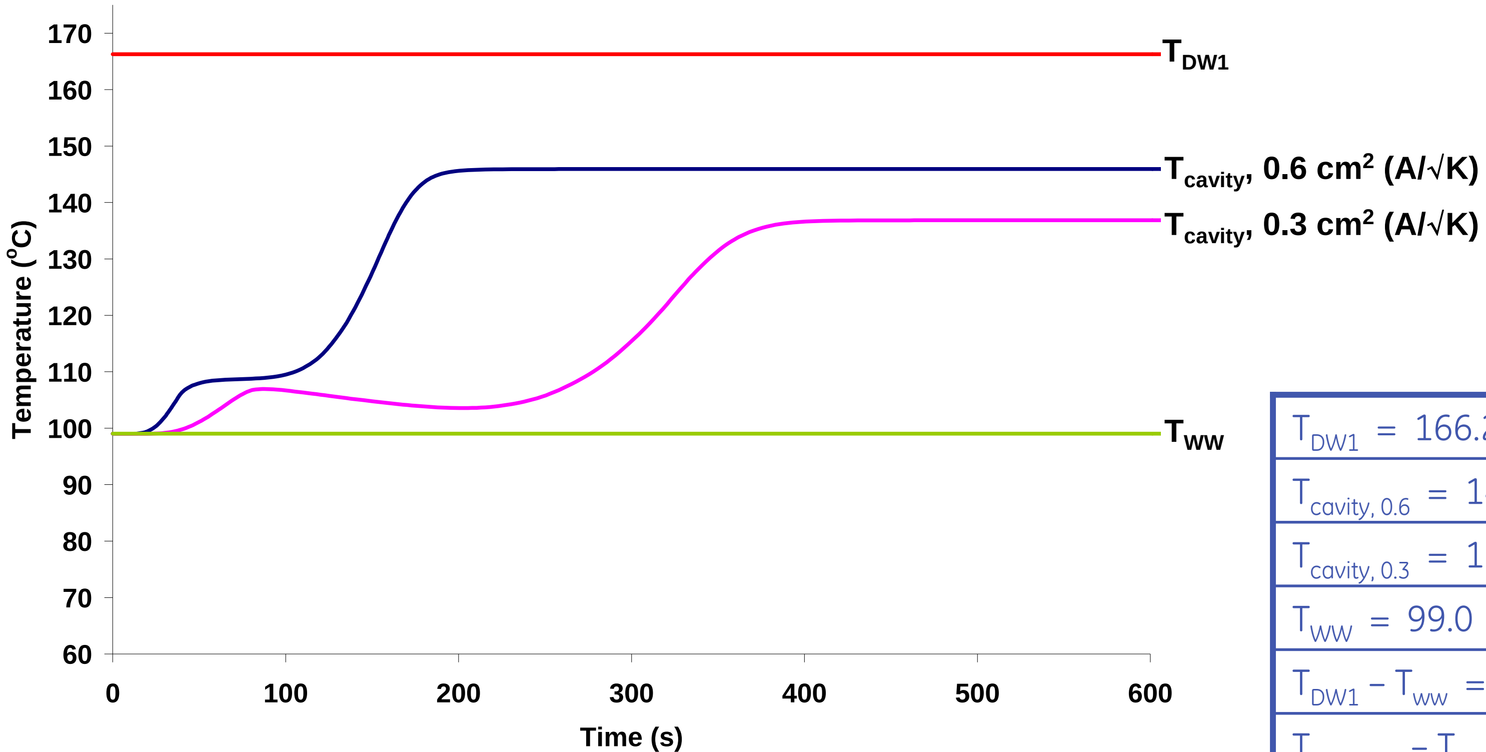
Signaling Isolation Valve to Close

- When cavity-WW difference exceeds a fraction of the DW-WW difference the VB Isolation Valve will be signaled to close

$$(T_{cavity} - T_{ww}) \geq X\% \text{ of } (T_{dw} - T_{ww})$$

Temperatures 0.3 and 0.6 cm^2 (A/√K) Leakage

- DW and WW Boundary: Main Steam Line Break Conditions
- 1-Dimensional Model of VB/VB Isolation Valve Assembly (See Figure 1 for Locations)



T_{DW1} = 166.2 °C
$T_{cavity, 0.6}$ = 145.5 °C
$T_{cavity, 0.3}$ = 136.4 °C
T_{WW} = 99.0 °C
$T_{DW1} - T_{ww}$ = 67.2 °C
$T_{cavity,0.6} - T_{ww}$ = 46.5 °C
$T_{cavity,0.3} - T_{ww}$ = 37.4 °C
$T_{cavity,0.6} - T_{cavity,0.3}$ = 9.1 °C

Vacuum Breaker Isolation Valve

The details of VB Isolation Valve design to meet criteria:

- Triple offset butterfly valve - Weir Tricentric Butterfly Valve (See Figure 2, 3, 4)
- Metal-to-metal seating (hard seated)
  - Concentric metal rings with graphite spacers
- Zero leakage (Class VI) – bi-directional
  - "Bubble-tight" after 50,000 cycles
- Tricentric design minimizes seat wear by eliminating disk-to-body interference

Weir Tricentric Butterfly Valve

Figure 2

Triple Offset Design

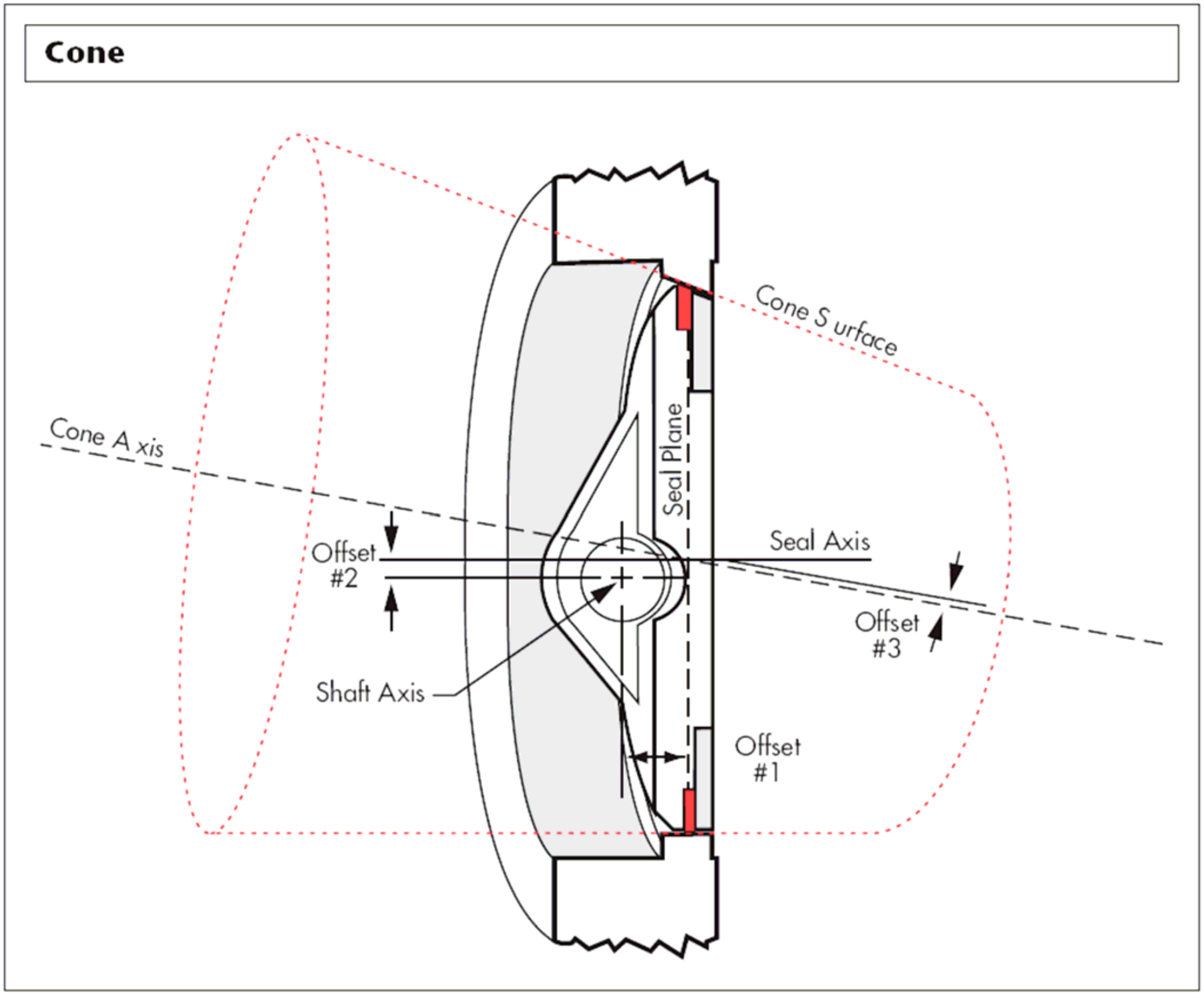
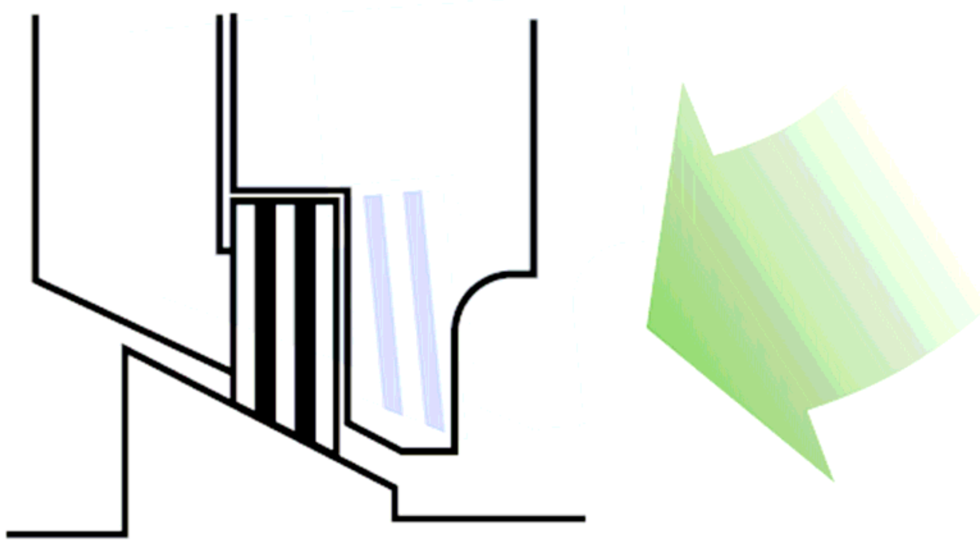


Figure 3 – VB Isolation Valve – Offset Details

Seat Design

Seat Contact



Seat contact does not occur until the disc is seated closed.

On opening the seal lifts cleanly off the seat at all points allowing long life and quality sealing for many cycles.

Figure 4 – VB Isolation Valve – Seat Contact