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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

August 22, 2008

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARD

(ACRS)

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SUBCOMMITTEE ON THE ESBWR COL APPLICATION

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FRIDAY

AUGUST 22, 2008

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ROCKVILLE, MARYLAND

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

COMMITTEE MEMBERS PRESENT:

MICHAEL CORRADINI, Chairman

DENNIS BLEY, Member

WILLIAM SHACK, Member

SAID ABDEL-KHALIK, Member

JOHN W. STETKAR, Member

GEORGE APOSTOLAKIS, Member

CONSULTANTS TO THE ACRS PRESENT:

THOMAS S. KRESS

NRC STAFF PRESENT:

HAROLD VANDER MOLLEN

ERIC OESTERLE

DONALD DUBE

ED FULLER

ROCKY FOSTER

MARK CARUSO

ALSO PRESENT:

RICK WACHOWIAK

GARY MILLER

GLEN SEEMAN

JUSTIN HOWE

JONATHAN LI

LOU LANESE

P R O C E E D I N G S

(8:30 a.m.)

CHAIRMAN CORRADINI: Let's begin.

Rick, we'll just reconvene. I'm not going to remind everybody about all of the identifying, speaking, clarity, et cetera. So go ahead.

MR. WACHOWIAK: Okay. So where we left off yesterday was we were going to get in some more specific questions about things that are in the model, and we're prepared to answer as much as we can, and there were a couple of things that I think that people brought up yesterday that we thought we were going to cover.

One, I had heard that you wanted to see something on the thermal hydraulic benchmarking, that RAI that was out there from quite some time ago. We talked about whether we were going to get to it.

We have the RAI response with us and some pictures that went along with that, our response. We can talk about that.

CHAIRMAN CORRADINI: John has additional questions relative to details on some of the analyses.

MR. WACHOWIAK: Right, and I guess one other thing that we just talked about now to clear up, I mentioned yesterday that I thought that the correspondence from the reviewers in the ROAAM process was in Chapter 21 of the PRA NEDO. In fact, we didn't include that in the NEDO. That's in the SAT report that was transmitted to the staff by an RAI, and so we'll figure out how to get that report to you.

I know you've got the SAT report. It might be a faster way than us sending it again.

MEMBER BLEY: And I think you told me that's kind of the back-up document to the chapter.

MR. WACHOWIAK: Yes, and you have the SAC report?

CHAIRMAN CORRADINI: Not the SAC.

MR. WACHOWIAK: That's the SAMDA, is what --

CHAIRMAN CORRADINI: SAMDA I was told. It's somewhere in here.

MEMBER SHACK: The SAT report is a different one.

MR. WACHOWIAK: Yeah, that's the basis for the severe accident treatment, is in the --

CHAIRMAN CORRADINI: I mean, it would be nice to have so staff has it, but I don't think if it's identical to the information in Chapter 21 -- there's no point in all of us getting it unless we want to double verify that the number here is the number there.

But I think staff should have it.

MR. WACHOWIAK: Staff has it, and the thing that it does include is it does include the correspondence with the reviewers. The NEDO section we chose not to include that correspondence in our document for the design certification. It's in the SAT report.

MEMBER BLEY: That's the information on the elicitation you were talking about.

MR. WACHOWIAK: Right.

MEMBER BLEY: That's what I was looking for.

MR. WACHOWIAK: So Harold can get that from the staff.

PARTICIPANT: Go ahead. I'm sorry.

CHAIRMAN CORRADINI: So the only other thing is your list to review is you said something about the thermal hydraulic. John has some questions. There's some additional questions here. The only fourth thing on my list would be the staff want to at least give us kind of an enveloping view of where to go from here relative to their review and quality relative to a certificate advocation.

And then I think that's it.

MR. WACHOWIAK: Okay.

CHAIRMAN CORRADINI: I've been informed privately by members that there have been some flight cancellations. So I'm going to lose two or three early since their flights in the afternoon have been canceled and they have to move it up. Otherwise they don't get out and then they get mad at me.

So we'll try to wrap it up a tad earlier than noon.

MR. WACHOWIAK: Okay.

CHAIRMAN CORRADINI: John, do you want to start with questions or do you want to start with this thermal hydraulic?

MEMBER STETKAR: Let's start with questions because I think based on previous meetings if we start on the thermal hydraulic we may not end.

(Laughter.)

MR. CARUSO: Can I say something before we start? Mark Caruso.

CHAIRMAN CORRADINI: Sure.

MR. CARUSO: I think, you know, we have appreciated the benefit of the subcommittee's detailed review, and I think I would just like to reiterate it's an important -- I think it's important that we understand, you know, what your concerns are and what detailed issues there are.

We're hearing them, but I think if you can -- if there are some that are more important or the ones that are most telling, I think we want that information so that we can factor it in when we go and we visit with GE and make sure that we have your issues on our list.

So I would just mention that before we start.

CHAIRMAN CORRADINI: Thanks helpful. thanks.

MEMBER STETKAR: Let me --

CHAIRMAN CORRADINI: If you're going to prioritize your --

MEMBER STETKAR: I am. I am indeed, and I'm going to try to pull back from some of the details if that's possible.

The problem with the detail, by the way, is that for a design like this an done that's highly redundant and relies on very reliable systems, it's the old devil is in the detail problem because we do, indeed -- the risk is not something that's dominated by a single 90 percent contributor. It's dominated by 200 half a percent contributors. So getting those half percent or one percent or five percent or 20 percent contributors is important.

And 20 percent of the contribution to a ten to the minus seven or eight type number is really, really small. So unfortunately we do need to think about those details because there is not a single glaring omission in this risk assessment. That's part of the reason for the details.

Let's step back a little bit. The thing I'm struggling with in the whole process, I think, primarily is we keep talking about the risk assessment as it is is suitable for our purposes, and it's not clear to me yet precisely what our purposes are. If our purposes are only to demonstrate that the ESBWR design as we understand it today is not likely to present a risk that exceeds the goals that have been set, I think the answer is, yes, the risk assessment does that, and I think we have reasonable confidence to say that that's achieved with the current level of detail and so forth.

If our purpose is to understand what the risk of the plant is, the current risk assessment does not do that.

CHAIRMAN CORRADINI: The current? Please, the second part?

MEMBER STETKAR: If our purpose is to

understand what the risk is, we can say that we understand what the risk is not. It does not exceed the safety goal. It is not that big. If our goal is to understand what the risk is, the current risk assessment does not do that. It provides perhaps a lower bound to what the risk may be.

But we don't know where it really is between that lower bound and some -- you know, where it really is, and why is that? Well, it is because it's missing a lot of things. One of the examples that I'll bring up that it's missing we highlighted right at the end, and in terms of big picture things, this is relevant for the staff.

And that is the treatment of maintenance. The risk assessment by and large, as it stands today does not include maintenance, and let me talk about that. We talk about it in terms of maintenance to avoid terminology and different interpretations of that word. Let me use the term "unplanned unavailability and planned unavailability" rather than "maintenance."

Because when people talk about maintenance, everybody thinks about repairs of failures and unplanned unavailability and planned unavailability is much, much more than that.

So unplanned unavailability is things that remove a piece of equipment from service during normal operation due to things that we don't expect to happen but do happen. Those could be functional failures. They could be things like packing leaks on valves or things not operating quite as quickly enough to meet the success criteria from a test or somebody going in and needing to clean some rust off of a surface of something or to investigate high vibration on a pump or anything, that type of thing.

That happens all the time. The frequency of that is determined by the type of equipment and how we do business. The duration is determined both by the complexity of the required activity, to some extent by the type of equipment, and to some extent by the tech specs. If I'm allowed to have a piece of equipment out of service indefinitely, even though it's safety related, you know, amazingly enough the repair time is longer for that piece of equipment than if I must return it to service within 24 hours. It's just a matter of prioritizing work.

So the frequency and the duration of those things are unknown to us certainly in the design stage, but, indeed, we have 30 to 40 years of operating experience across the industry with a variety of types of equipment and a variety of tech specs so that we can estimate those with uncertainties from available fleet data.

We haven't done that. Our experience shows that on a component basis, especially for very, very reliable equipment, that unplanned, unavailability can be a large contributor to its actual unavailability.

If I have a very reliable piece of equipment, the likelihood that it fails is pretty doggone small. The likelihood that it's out of service for some tweaking or minor repairs is much, much higher. So I've missed that contribution by not including unplanned unavailability.

A bigger concern --

CHAIRMAN CORRADINI: Can I ask a question about that concern?

MEMBER STETKAR: Sure. I want to get to the bigger one though.

CHAIRMAN CORRADINI: Go ahead then. I'll wait.

MEMBER STETKAR: Well --

CHAIRMAN CORRADINI: No, go ahead. I'll wait.

MEMBER STETKAR: The bigger concern in my mind is planned unavailability. This plant is highly redundant, four-train redundancy. Its tech specs are written such that I can have a single train out of service indefinitely. Why is the plant designed this way and why are the tech specs written that way?

Well, part of it is for safety. A lot more of it is due to the fact if I'm an owner-operator of this facility, I want to do online maintenance, and I will do online maintenance. That's the selling point of this plan.

Most of the operating fleet in the United States would like to do online maintenance, but they don't have enough redundancy to do that. Plants in Europe typically do have four trains, and what they do is during power operation, they remove an entire safety train from service. They do all of their planned preventive maintenance, all of their testing inspection, everything you normally do during a refueling outage, they do on line. They typically take the equipment out of service for up to a week to ten days per train per year to do all of this work, and it's a coordinated maintenance outage.

Dennis, you're looking --

MEMBER BLEY: No.

MEMBER STETKAR: It's a coordinated

maintenance outage. So I take Train A, if you will, of all of my safety systems out, and I do everything that you normally think of doing during a refueling outage. I inspect all of the equipment. I polish it up. I do all of the preventive maintenance on it, return it to service, and then do a rolling outage with the other trains.

I'm sure that GE and the prospective licensees have this strongly in their plans for this particular design. What are the implications of that?

Well, if, indeed, that's the way the world will work when this plant is operated, if a particular train, a safety train of equipment is removed from service for a week a year, that's a two percent unavailability or if I do it rotating around the clock across all four trains, it means eight percent of the time the plant looks like a three-train plant. It doesn't look like a four-train plant.

The current PSA says the plant always looks like a four-train plant 100 percent of the time. What are the implications of an eight percent of the time that the plant looks like a three-train plant? I'll tell you from looking at multi-train plants, it's a visible contributor to risk.

The current risk assessment does not

quantify that. The implications of that are that any importance measure that I have for equipment or systems or anything because I'm missing both the unplanned unavailability and the planned unavailability will not be correct because the importance measures for those systems and equipment include all causes for unavailability, both hardware failures, testing unavailability, maintenance unavailability, planned, unplanned, human error contribution and so forth.

We don't have those big chunks. So any importance measures that I derive from the current study for a piece of equipment or even a system, a train of a system are not correct. They're correct only within the context of hardware failures alone to the current risk measure.

CHAIRMAN CORRADINI: So can I ask a question now?

MEMBER STETKAR: Yeah, now you can.

CHAIRMAN CORRADINI: Okay. I don't see anybody grimacing over there. So I assume they are on board with what you said. So my question is --

MR. WACHOWIAK: We'll grimace in a second.

CHAIRMAN CORRADINI: You'll grimace in a minute?

(Laughter.)

CHAIRMAN CORRADINI: I guess my question would be I'll grant you that. That kind of makes sense, and assuming you've characterized it correctly.

Even if that is the case, does that impact the fidelity required for the design certification? And I don't know the answer to that because I'm back with his original question yesterday. I'm in this gray fog as to is it good enough or is it not good enough.

I sense everything you just said is probably true, possibly true, but for the design certification it's a "no, never mine." And I'd like the staff and GEH to kind of comment on that because I really don't -- personally I don't really know where we sit in that sort of issue.

Shall we let you guys take a crack first?

MR. WACHOWIAK: All right. This is Rick Wachowiak from GEH.

Let me start with I think maybe in some of the cases where you look for maintenance unavailability, you may have looked in places where we did not include it on purpose. We have approximately 167 maintenance unavailability terms on our active systems.

Now, you can look at the numbers there and say, "Ah, those are low numbers," but they came out of the URD which is where we said we were going to get our data from. So it probably doesn't reflect online maintenance of these systems. I'll say that. But the terms are in there, and we can get the importance measures from the terms that are associated with the active systems.

Our thinking on the passive systems was that because the passive systems are not going to be tested like the current plant, active ECCS systems, we're not going to be running monthly, quarterly surveillance tests, we won't be finding the slow operating squib valve or we won't be finding a little bit of rust on a contact someplace because those things weren't going to be the types of tests that were run. So then we wouldn't have to do the tweaking type maintenance.

That was our thoughts. Whether it's right or wrong in the end, that is what our thoughts were on the safety related systems.

We considered maintenance in the ICPCC pools. There's a provision in tech specs that we can take one of those pool compartments out of service. We don't know why anybody would do something like that. There's nothing -- well, if the tech specs say you can do it, we don't see any reason why you would go in there and do that when all of those inspections would be done during the outage, and they wouldn't really affect refueling.

So it's a judgment on whether we should include it for the safety related systems or not, and I would say that if we want to do some characterization to help out the human factors engineering to help determine what should be suggested for maintenance schedules, that we can modify the PRA that we have to answer that question specifically in a set of sensitivities and provide that to the HFE.

So I think we can do that, but I just want to make sure everybody understands that we do have for the active systems maintenance contributions in those. Granted the numbers may not be what you would expect for online maintenance, but they come from --

MR. LI: Can I add a little bit more?

CHAIRMAN CORRADINI: yes.

MR. LI: For the simplicity of this model, we modeled unavailability to the train level, not component level.

CHAIRMAN CORRADINI: You what?

MR. LI: To the train level.

MEMBER STETKAR: But that's okay because that's typically the way the maintenance is done.

CHAIRMAN CORRADINI: So before you start, I want to hear the staff.

MR. WACHOWIAK: Well, I think I want to get through all of the points --

CHAIRMAN CORRADINI: Yeah, get through it.

MR. WACHOWIAK: -- especially considering the one about what do we expect the design PRA to do, the design cert. PRA to do.

So when we were looking at what it was that we were trying to answer with this design certification PRA, we were more looking in the area of is the plant safe enough to build rather than what are the specific risks, and the things that we tried to target were the things that from existing plants we knew were issues and we tried to through design, through adding redundancy, adding diversity, we tried to eliminate those risks.

Are there things that we didn't think of? I'm almost positive there's things that we didn't think of. I guess maybe I could be positive, but I won't go there.

(Laughter.)

MR. WACHOWIAK: That is positive. I'm

almost positive it's --

MEMBER STETKAR: You almost know what you don't know.

MR. WACHOWIAK: Yeah. But there's things that we didn't cover, but in terms of what we tried to cover in making the risk profile balanced, I think we have a pretty good shot that if there was something we didn't think of, we probably did something that might address that, probably.

That's why I'm saying it's not perfect.

So that's what we were trying to do with the PRA, and we weren't trying to set up a maintenance schedule.

Now, some of the things that we had talked about with this is we recognize that for the operating plant, and we talked about this yesterday, they're going to have to have a PRA that supports doing online maintenance. So there's a requirement in (a)(4); 50.69 says prior to changing the configuration of the plant for maintenance, you have to do a risk assessment of that configuration, and whatever PRA they use, whether it's this one -- and this one could be modified to do that by picking those components and doing that -- you may not get the results that you like, and I'll get into that in a minute, but they will have a PRA that can do that.

Some of the things where we found insights, if you will, to what should be done and not be done during maintenance, we could find with this PRA. There was a specific question asked of us from the customers: can we relax our control of fire barriers during outages? Well, you know, if it's a safe plant, ten to the minus eight, you know, we may want to be able to -- or so. That right. Actually when you add everything up, it's a little more, but anyway, can we do that?

And we went in and looked to see what would happen if we allowed fire barriers to be disabled and left disabled during outages, and the answer was no. That's not a good idea for this plant, and we wrote in Chapter 19 that fire barriers must be controlled during outages. It's a requirement.

We were able to do that one, and I think on some of these other things, and specifically in the digital I&C area where we do expect them to take some thing out of service for a long time to do battery discharge testing, at least until the standards for batteries change so that you don't have to do full discharge testing.

But while that's in place, we knew that we would have to do that. So we looked at what happens in the PRA if we make it a three-train digital I&C system and look at the results, and we didn't see an impact.

MEMBER APOSTOLAKIS: I have a question.

MEMBER STETKAR: That is a sensitivity study.

MR. WACHOWIAK: It is. It is.

MEMBER APOSTOLAKIS: I have a question of clarification. When you say, John, that they didn't include maintenance and when they show this log table, what am I missing?

MEMBER STETKAR: Well, I think you're missing part of the fact that what I did was a spot check review, and I didn't find maintenance in anything that I looked at.

MEMBER APOSTOLAKIS: So you were not aware of --

MEMBER STETKAR: And I wasn't particularly looking at the so-called active systems. I see a lot of feedwater. I see feedwater, CRD. I picked GDCS for, example. There's no maintenance in GDCS.

MEMBER APOSTOLAKIS: I see, right.

MEMBER STETKAR: There is no maintenance in any of the actuation systems, the safety related

DCIS. There is maintenance of battery chargers. There is not maintenance of DC power.

Now, when you talk about maintenance, when I talk about planned unavailability, that is not represented by independent maintenance on a pump powered from Bus A in System X and independent maintenance on a pump in System Y powered from Bus A. It is a coordinated -- both of those pumps are out of service at the same time for two percent of the year.

In addition, the DC power, in addition the AC power, in addition -- the model does not have that type of thing in it at all. Now, I didn't --

MEMBER APOSTOLAKIS: That's not as bad as I thought.

MEMBER STETKAR: Okay. I didn't find anything GDCS pool maintenance.

MEMBER BLEY: I looked at IC.

MEMBER APOSTOLAKIS: So the passive systems they didn't do.

MEMBER BLEY: That isn't right. We --

MEMBER APOSTOLAKIS: Maintenance on passive systems.

MEMBER BLEY: I'm not sure.

MEMBER STETKAR: But I didn't find any maintenance on availability of the vacuum breakers, for example.

CHAIRMAN CORRADINI: Wait a minute. There's too many people talking. Can you repeat?

MR. MILLER: I think there would not be eight percent unavailability annually on our passive systems. For instance, GDCS, we won't be in the containment. ICS, PCCS, no moving parts.

MEMBER STETKAR: I'm not -- I'm not -- don't get system design oriented on me. I'm stepping back. I've worked with plants in Europe who do the online maintenance, and they have four-train redundancy. They have multiple signals to individual valves and things like that, but anywhere from a week to ten days per year per train they remove the entire safety train from service.

That means AC power, DC power. If a valve has multiple -- let's say if a valve has two signals, has one signal left. So that valve can still work, but it only had one signal left, and they do that, and it's a week to ten days per division, which means eight percent of the year the plant looks like a three-train plant.

Now, your plant design is good because you do have the multiple signals for those passive valves. However, the risk assessment doesn't account for the fact that some fraction of the time you're only going to have three signals instead of four.

How much difference does that make? I don't know.

CHAIRMAN CORRADINI: Let me just interject. Do we have your full at least first thoughts on this?

MR. WACHOWIAK: Yes. Our thoughts were we thought of those things. We looked internally at whether it would make a difference and should be put into the model, and our answer was no. The question now is how do we translate that information to you.

CHAIRMAN CORRADINI: But can I just get to but there's an underlying conclusion was as you consider some of this stuff, you included certain things based on the EPRI document, other things you chose not to, but from your perspective this was good enough for a certification purpose.

MR. WACHOWIAK: Yes, for certification purpose, knowing that under the maintenance rule, the unavailability of those systems will need to be monitored, and that will be clear to any inspector if you're going to have eight percent of your safety systems out of service all the time.

MEMBER STETKAR: I didn't say that. I

said that -- don't say that. This is a public meeting. I did not say that.

MR. WACHOWIAK: If you're going to have a safety system out of service eight percent of the time --

MEMBER BLEY: effectively.

MR. WACHOWIAK: -- effectively, unless that was already analyzed and said that that's okay to have that then the maintenance rule monitoring would put the system into an (a)(1) condition where they would need to correct that.

MEMBER APOSTOLAKIS: They issued a --

MEMBER ABDEL-KHALIK: Let me just follow up on that. So your decision to write tech specs at this stage saying that one train can be out of service is based on what? Intuition?

MR. WACHOWIAK: It's based on --n and how you're moving a little bit out of my area here. It's based on the way tech specs have been historically derived from the plant design basis calculations.

CHAIRMAN CORRADINI: So it's really engineering judgment. It's not necessarily --

(Simultaneous conversation.)

CHAIRMAN CORRADINI: But if they have to meet their accidents, it doesn't have a PRA basis. It has to do with a basis relative to the design basis requirements, period.

MR. WACHOWIAK: Yes.

MEMBER APOSTOLAKIS: A related issue that I think it's very difficult to clarify is this. Even what both John and Rick have said, when the staff certifies a design, what is it that is certified? The design itself and the supporting analysis? Can somebody come back to me three years, four years down the line and say, "Hey, this fault tree you're not going to touch because it was part of the design certification, and you guys said it was okay."

If they can say that, then I think every detail that John is raising should be addressed. If they cannot say that, which is what Rick is saying, but now when they go and apply the maintenance rule, there is (a)(4), blah, blah, blah, blah, blah, so we will revisit the PRA. That gives me a better feeling that maybe I can go along because what it means to use a PRA in design certification is a little bit fuzzy.

So what exactly --

CHAIRMAN CORRADINI: Before we ask the staff to respond, can you say that again? Because I want to make sure I interpret the --

MEMBER APOSTOLAKIS: There are things that should be improved in the PRA, modified, whatever, you know, some of the stuff or a lot of the stuff that John has raised.

The other side here is saying we believe that what we have done is good enough for certification, and Rick acknowledges that when they want to do something related to maintenance later, they will have to revisit the PRA and bring it up to date.

And my question is when the staff certifies the design, is the PRA part of that? So later on I cannot go back and start asking questions like John's questions when they want to actually do maintenance.

If I can go back and do what Rick says, no, no, no, no, no. You will revisit the PRA and bring it up to date and put on the D date (phonetic).

And I see Don Dube there waiting anxiously to tell us what this time is.

(Laughter.)

CHAIRMAN CORRADINI: Well, somebody on the staff is going to actually tell. So I'll turn to the table and you point to who you want to start.

MEMBER APOSTOLAKIS: He's asking from the floor.

MR. OESTERLE: Eric Oesterle from the staff.

I yield the floor to Don Dube.

MR. DUBE: Let me just read from Reg. Guide 206. That's the reg. guide that the staff uses in the street for a combined application, and there's a corresponding standard review plan section, and C.I.19.2. It's very short for design certification. This is uses of PRA in severe accident evaluations. It's like a page and a half, but Part A is for the design phase and there's only three major portions. So let me just read them, and I can give you a copy afterwards.

During the design phase, (i), identify and address potential design features and plant operational vulnerabilities where a small number of failures could lead to core damage, containment failure or large releases. For example, assumed individual common cause failure could drive plant risks to unacceptable levels with respect to the Commission's goals as presented below.

(ii) Reduce or eliminate the significant risk contributors of existing operating plants, and there's a footnote -- and I'll get to that in a second -- that are applicable to the new design by introducing appropriate features and requirements.

And then finally, (iii), select among alternative features, operational strategies, and design options.

I think one has to look at the PRA process as basically four phases. There's the design and the design certification PRA, which meets these three major objectives. Then --

CHAIRMAN CORRADINI: Which it needs to.

MR. DUBE: Right. Then the applicant, the licensee comes in for a combined license, has to take that PRA and make it a design specific, site specific in case there are sites, design specific features, plant specific features, and external event issues particular to that site.

Then the third phase is before fuel load they have to -- the PRA has to meet the NRC endorsed standards that are in effect one year before, which would include the ASME standard.

And then the fourth phase is -- and it's a requirement by regulation -- they have to maintain the PRA consistent with the ASME standard and upgrade it at least every four years to whatever new standards have come along.

So I think you have to look at this as a marathon and not a spring. It's a large process.

MEMBER APOSTOLAKIS: But the specific question is this, now. If during those phases the licensee comes ten years down the line and says, "I have not touched the gravity driven cooling system. The fault tree and the analysis I did, you know, in 2006 or '07 and you guys approved is still valued."

You shouldn't even be asking me a question about this analysis.

MR. DUBE: No, they couldn't say that --

MEMBER APOSTOLAKIS: Why couldn't they?

MR. DUBE: -- because it wouldn't meet the ASME standard, which means that the PRA has to reflect the as designed, as constructed, and as operated plant.

MEMBER APOSTOLAKIS: I designed it the way I promised.

CHAIRMAN CORRADINI: But if I could just interject, unless I misinterpreted the way Don was saying it, there's four phases. In any one of those four phases it will be re-reviewed for another set of applications, not necessarily design applications.

So to answer your question, I think it is, yeah, we have a few more cuts at this as we march through these other phases.

MEMBER APOSTOLAKIS: If that is the consensus, then I would feel much better.

CHAIRMAN CORRADINI: I'm creating nervousness. I'm getting grimaces over there. So I want to make sure, but that's my interpretation.

MEMBER STETKAR: If that's the staff's interpretation, then I would feel much better about --

MEMBER APOSTOLAKIS: That's the whole point.

MR. DUBE: But let me clarify. There is no requirement in these three phases for the staff to go back, the last three phases for the staff -- let me back up.

You have the fuel load and then operating. There's no requirement for the staff to necessarily go and do a review all over again unless the licensee comes in with a risk informed application, such as risk informed tech specs, in which case the staff would have perhaps another crack at it, although Rick has some thoughts.

MR. WACHOWIAK: Yeah, and there are other things, too, that will be happening. The plant will get, I would guess, a maintenance rule baseline inspection; is that true?

MR. DUBE: Yes.

MR. WACHOWIAK: And the PRA that's used for maintenance rule is part of that inspection, and basically from what we've done here in this review of the design PRA and the things that are brought up about maintenance, I would expect that they keep track of these sort of things and say that that's something that wasn't covered in the design certification.

When you go do your maintenance rule baseline inspection, make sure they've got maintenance addressed adequately in the PRA because if I remember my maintenance rule baseline inspection at Cooper from however many years ago, it looked like it was a PRA inspection instead of a maintenance rule inspection, and I think almost everybody here has had that same inspection.

John may have had that same inspection.

MR. CARUSO: One additional point if I may make. Mark Caruso.

In order to meet the standard, then they will need to do a peer review of that PRA.

CHAIRMAN CORRADINI: At which phase?

MR. CARUSO: At the phase of when you're prior to fuel load.

MR. WACHOWIAK: That's a requirement. The other significant application that Gary was bringing up now is the SDP, which has yet to be developed for passive plants or for ESBWRs you can't take -- well, it's real simple if you just want to take what BWRs use and use it in ESBWR to still have those systems.

MR. CARUSO: I might make one -- oh.

MR. WACHOWIAK: But for that purpose there is likely to be performance indicators on safety related equipment out of service, and planned and unplanned would go into that performance indicator. I'm just extrapolating from what the existing plants have done.

So I'm kind of hoping that we're all moving toward this phased understanding of what we're using the PRA for now and how do we make everybody comfortable that there is more work to do later and that that work will, in fact, be done?

So I'll yield the floor to Mark.

MR. CARUSO: Do you have a plan to make what you think is important and actually go to some of Dr. Apostolakis' -- Apostolakis' --

CHAIRMAN CORRADINI: Can you say that three times?

MR. CARUSO: -- and that's what the Commission requires. Somewhere in references this dying certification, the Commission requires that they start with this PRA. In other words, they couldn't come along later on and say, "Oh, we didn't like what they did. Here's a brand new one and we don't have to give it to you to review at all."

They have to start. So as Don said, we are in phases here. There's been a lot done to this point, and it will move forward.

CHAIRMAN CORRADINI: But just to repeat for my understanding purposes, to ease John and Dennis' and George's mind -- my mind is eased already on this -- is that there will be additional chances for the Committee to review as these other phases are unfolded. I want to make sure I mention "Committee" in the review, not just staff review.

MEMBER APOSTOLAKIS: Well, the most important theme is really staff review.

CHAIRMAN CORRADINI: Right, but if the staff reviews it and says, "Yeah, for fuel load and the year before it seems" -- I don't know whatever in the hell it's supposed to meet, but --

MEMBER APOSTOLAKIS: As long as --

CHAIRMAN CORRADINI: -- whatever it meets, will we have a chance to comment on that or is that an internal staff decision and moves on without coming back to the Committee?

MR. CARUSO: No, I believe that the Committee will be very involved. When a plant is being licensed you have opportunities to review the staff's review of the licensing application.

CHAIRMAN CORRADINI: I thought so. I just want to reiterate that because I want to make sure there's comfort here that if things are left out knowingly and purposefully because it was not necessary for design certification, then when they're included or updated, we have a chance to discuss it.

John? I'm sorry. George, you had --

MEMBER APOSTOLAKIS: No, that's fine.

MEMBER BLEY: One thing that would make me more comfortable on all of this is if something were done, if you guys did something like is done when you do the peer review, and that is have that catalogue of things that are knowingly absent from the PRA and need to be added later.

The catalogue is not anywhere that I've seen.

MR. WACHOWIAK: And let me bring that piece up because just like any other submittal to the NRC, what you see are the summary reports, and as much as we sent with a very large document -- a lot of it included fault trees -- there's much more documentation back at GEH in our archival system that contains things like that, and results of reviews that we've done to the models and other things that are not submitted, but if you need to look at those, they could be looked at.

MEMBER BLEY: Okay. Just to follow up --

MR. WACHOWIAK: And that's consistent with every other application that goes into the NRC on any topic. The entire body of work is never submitted.

MEMBER BLEY: I understand. It seems to me that would be a thing that I would think staff would want to have, that list of what's here and what's not here, knowingly what's here and what's not here and what you need to look for the next time around.

MEMBER APOSTOLAKIS: Up front, in fact. You know, the purpose of this analysis is to achieve this, and this is done this way.

MR. CARUSO: Well, let me address that. Mark Caruso.

I think we had worked very hard in our review of Chapter 19 of the PRA to be successful in this area. The mechanisms that we have are the CRL action items and ITAACs, although as you k now, ITAACs are not really a big deal for this.

But in addition, we have the DCD, which the applicant will adopt, and there's a table in Chapter 19 -- I think it's 19.218 -- and we have been badgering GE to make sure that we incorporate in that table the important assumptions, the key operational programs, and the assumptions there in an attempt to make sure that when this is passed off or handed off to the licensees that they're aware of what's really important.

You know, what are the things that have to be true when you take over for this PRA to have the fidelity that is promised?

In addition to that, one of the things that we had looked at in terms of looking at quality was to look at the design QA process that's used at GE and how that applies to the PRA, and we were happy with that because they have one design engineering QA process. They don't have, well, you know, ECCS systems and equipment design and this or, you know, have hard, strong procedures, but we're over here with the PRA which isn't a requirement, and it has something less. It's all together. They have one process, one procedure so that they are very coupled in with the design process.

One question that we did have for them,

which there's one concern I have remaining, which we will need to address with the applicants, is does that process carry along with the PRA, and I don't think we have an answer to that question yet. It's not a requirement.

MEMBER BLEY: Okay. I'm glad to hear that. I missed the questioning on that, but that table being filled in, I think, would go at what I'm asking.

MR. OESTERLE: This is Eric Oesterle from the staff.

I just wanted to piggyback on what Don Dube had mentioned, and just for the benefit of the subcommittee members for the record, the citation for the PRA update requirements that Don was talking about is in 10 CFR 50.71(h), and I can read them

MEMBER APOSTOLAKIS: Will you send them to us?

MR. VANDER MOLLEN: I can. I have the citation. Once again, 10 CFR 50.?

MR. OESTERLE: Fifty, point, seventy-one (h).

MEMBER APOSTOLAKIS: I'd like to see that, not the whole 10 CFR.

CHAIRMAN CORRADINI: I'm trying to check

off things. I think we've gotten the staff's opinions on what I wanted at the end. Now, this kind of gives us a framing. Do you have more questions?

MEMBER STETKAR: In a generic sense, no.

CHAIRMAN CORRADINI: Generic.

MEMBER STETKAR: No.

CHAIRMAN CORRADINI: High level.

MEMBER STETKAR: No.

CHAIRMAN CORRADINI: Do we dare go to the thermal hydraulics?

MEMBER APOSTOLAKIS: No. I have one.

CHAIRMAN CORRADINI: Okay.

MEMBER APOSTOLAKIS: I have just one. I don't know. Danny's standards might help.

Okay. Just out of curiosity -- oh, are you done?

MEMBER STETKAR: High level, yeah. Other technical --

MEMBER APOSTOLAKIS: Okay. Go ahead.

MEMBER STETKAR: No, if you have a high level question, do it, George.

MEMBER APOSTOLAKIS: Well, it's not -- I don't know how high level it is. I mean, I checked something --

MEMBER STETKAR: Ask it. It will be

faster.

MEMBER APOSTOLAKIS: Okay. That's fair.

PARTICIPANT: Common cause?

MEMBER APOSTOLAKIS: Well, common cause seems to dominate in a lot of these things.

MEMBER STETKAR: Oh, it's important.

MEMBER APOSTOLAKIS: Table 4.2-4, page 4.2-31. It has -- did you find it? Yeah. There is a common cause failure of two solenoid valves, which is given as, I guess the number is 4.38 ten to the minus six.

There is another table somewhere else, Table 5.2-2, that gives a failure rate of ten to the minus three for the individual. I may be missing something here, but did you find it?

MR. LI: Four, point, two, dash, thirty-one is that page, right?

MEMBER APOSTOLAKIS: Four, point, two, dash, thirty-one is the page.

MR. LI: Oh, okay.

MEMBER APOSTOLAKIS: So go up a little bit. It's B32 SOV.

MEMBER STETKAR: Now, there's a number for you.

MEMBER APOSTOLAKIS: Yeah, there it is,

4.30 -- yeah, that's the one, 4.3. Okay?

So if I divide this common cause failure probability by the individual failure rate, I should get the beta factor?

MR. WACHOWIAK: No.

MEMBER APOSTOLAKIS: No?

MR. WACHOWIAK: You should get something that's the fraction of the beta factor that's correlated to one of many, many combinations of two.

MEMBER STETKAR: This got combinatorics multiplied in it. It's one over -- it's the one of n combinations of three that are three and not four. So it's --

MEMBER APOSTOLAKIS: It says CCF of two components, and identifies the components.

MR. WACHOWIAK: Right. So in the multiple Greek letter thing, if there's -- there's only one this way.

CHAIRMAN CORRADINI: This is only four of them.

MR. WACHOWIAK: If there's four components, there's one, two, three, four, five, six combinations of two. So the beta factor times the basic probability divided by six would be this.

MEMBER APOSTOLAKIS: Okay. So if I

divided --

CHAIRMAN CORRADINI: And then there's all six of those are in there.

MEMBER APOSTOLAKIS: So if I divide this number by the individual failure rate, I get 4.3 ten to the minus three, and you say I should multiply that by six.

MR. HOWE: This is a 24-value --

MEMBER STETKAR: It's a large number.

MR. HOWE: There's a l ot of combinations of two.

MEMBER STETKAR: This is a particular combination of those three. If you had four valves, you'd have to take -- if this was a population of four, you'd have to take this number, divide it by the individual failure rate and multiply it by four because there would be four combinations of three.

MEMBER APOSTOLAKIS: But it doesn't say that. It doesn't say --

MEMBER STETKAR: It doesn't say that, but it's --

MEMBER APOSTOLAKIS: It's not any two. It names them.

MEMBER STETKAR: That's right, and that's why you have to multiply it by that number. If it said any two or any three, then doing what you did would be correct.

MEMBER APOSTOLAKIS: So what is the number I should multiply by?

MR. WACHOWIAK: Could you do 24 factorial.

CHAIRMAN CORRADINI: No, it's not 24. It's 24 factorial divided by two factorial and 20 --

MR. WACHOWIAK: it's a very --

CHAIRMAN CORRADINI: -- all possible combinations.

He's not going to be able to follow this. So you do it.

MR. WACHOWIAK: Do we have the equations handy for how you calculate this MGL in terms? Is that --

MR. LI: I don't know if we have it here though.

CHAIRMAN CORRADINI: Can you answer Dr. Apostolakis off line later?

MR. WACHOWIAK: Yes. We can get the specific factor that that one is multiplied by.

MEMBER APOSTOLAKIS: So I don't understand why this is happening. Can you explain it to me?

MEMBER BLEY: I get lost in it all

MEMBER STETKAR: I can. I can. Take a

population of four components. Okay? That's my common cause group. That's not this group, but take the simple one, four. I can have failures of one. I can have failures of two, three or four. Beta says I have failure of two or more.

Now, out of a population of four, there are, indeed, six combinations of two, A and B, A and C, A and D, B and C, B and C, and C and D. There are six specific combinations of two within that population of four.

Now, if I look at A particular combination, A and B, that is numerically one-sixth beta lambda times one minus gamma because it's two and only two. That's numerically what it is.

If you're looking at the value for the common cause failure of A and B and only A and B, not anymore than that, not any less than that, numerically it's one-sixth, because that's one of the six possible combinations, beta lambda, which is the component failure rate, times one minus gamma, because it's two and not anymore than two.

So if you have that value for that A and B fails together and you have lambda to figure out what beta is, you have to take that value, divide it by lambda and multiply it by six in that particular case.

If you're looking at a combination of three, there are four combinations of three. It would be one-fourth beta gamma lambda, one minus delta.

CHAIRMAN CORRADINI: Does that help? It helped me.

MEMBER STETKAR: Numerically. If you have a big population of 24, it's a big numerical value.

MR. WACHOWIAK: So that's why these individual values don't contribute. It's failure of all solenoids.

MEMBER APOSTOLAKIS: This is the probability; 3.348 ten to the minus six is a probability that any two --

MEMBER STETKAR: No, a particular. That two. That is the probability of, in my construct, A and B, period. Any two would just be beta. It would be all six combinations.

MR. LI: This is Jonathan Li from GEH.

You know, the way we model in CAFTA, CAFTA have a tool which is very similar to SAPHIRE. What we do is the tool will add all of these single combinations under that component instead of you have any two or any three under the system level or train level. That's different approach.

In this approach, you know, every single CCF combination is awed (phonetic) with independent failure of their component.

PARTICIPANT: Is what?

MEMBER STETKAR: I'm not sure it does the math right, by the way. Did you check it?

MR. WACHOWIAK: Let me finish up with this thought. We have to use this method to address what we were talking about yesterday with specific lines going to specific places for the success criteria. In Revs. 0 and 1 of the PRA, we used what we called the alpha factor method, which you try to figure out what all of these combinations are and put in at the system level what the combinations are, but it gets extremely complex when we try to do this line only goes to this plan. So we have to do it this way. So that's why we're there.

And one of the things like we found yesterday is one of our old things that we didn't remove from the alpha method was still translated through.

But to get back to what the code does is it will calculate all of these things and assign the numbers and we're given the option of whether we need to modify the base number.

MEMBER STETKAR: Ah, you don't do the one minus.

MR. WACHOWIAK: Right.

MEMBER STETKAR: Okay.

MR. WACHOWIAK: And if we do the one minus, that's an option. We can pick that, but if you pick that option, it's a destructive operation, and it changes the database, and you can never undo it.

MEMBER STETKAR: Really?

MR. WACHOWIAK: If we don't select that option, we can turn common cause on and off, and then when we want to add a new valve to a group and turn common cause off, add a valve and then turn it back on, and we're done. Otherwise it would be very complex.

So it adds extra stuff. It leaves off the one minus beta on the initial valve. So we're always going to get a higher total common cause value, and we find that that's acceptable in this PRA because we have to have so many combinations of valves to get to the failure.

MEMBER STETKAR: Numerically it's a little higher than it should be, but that's fine.

MR. WACHOWIAK: But that's what it is.

MEMBER STETKAR: That explains why it

didn't add up.

MR. WACHOWIAK: Yep.

MEMBER STETKAR: Or why it added up to more.

CHAIRMAN CORRADINI: George, any other high level questions?

MEMBER APOSTOLAKIS: I don't understand this.

(Laughter.)

MEMBER APOSTOLAKIS: I really don't understand.

CHAIRMAN CORRADINI: He told me to ask that. No.

MEMBER APOSTOLAKIS: I know that this combination stuff is taken care of in the alpha factor, but the definition of beta is if I have two components, I don't care if I have 20 more. If I have two and one is a failure rate of ten to the minus three, beta will tell me that beta times ten to the minus three is the probability of the second one.

MEMBER STETKAR: No. Two or more will fail.

MEMBER APOSTOLAKIS: Two or more.

MEMBER STETKAR: Out of the group, two or more, not -- if you have A fail, beta will tell you that it's the sum of A an d B or A and C or A and D or B and C or B and D or C and D because beta is just given a single failure, what's the conditional likelihood that two or more components within that group, within that population will fail. That's the definition of beta.

That's numerically how beta -- it's important to define it that way because that's numerically the way it's derived also from the actual underlying data. When you look at the way the data are treated, by the way you count failure --

CHAIRMAN CORRADINI: Teasing aside, so the table from your understanding is defined differently than you had understood it.

MEMBER APOSTOLAKIS: Yeah.

CHAIRMAN CORRADINI: Okay. Are you cleared up now though?

MEMBER APOSTOLAKIS: I'll have to go back and look at it again, but I guess it's okay.

MR. WACHOWIAK: Well, we'll try to find the reference for you.

MEMBER APOSTOLAKIS: Yeah, I'd like to see that.

MR. WACHOWIAK: If you've got one.

MEMBER BLEY: well, the Idaho report.

CHAIRMAN CORRADINI: High level questions?

MEMBER STETKAR: Not as high as his.

(Laughter.)

CHAIRMAN CORRADINI: I didn't say that. No, seriously though, are there other questions? If we want to dig into the details, I'd rather get to the third topic, which is the thermal hydraulic discussion, at least begin it before -- I don't want to take a break just yet, but that's the third and last one of the general things, and we can always go back and pick up more detailed questions.

MR. WACHOWIAK: And do those as long as we need to.

CHAIRMAN CORRADINI: Right. Shall we change topics to that?

MEMBER SHACK: John, are you going to ask your question about the risk significance of components? That seems like a high level one.

MEMBER STETKAR: Okey-dokey. Thank you. I will.

CHAIRMAN CORRADINI: That will take us to break.

MEMBER STETKAR: No, let me ask it this way. Has -- and I'll ask both GE and the staff because I hope I get the same answer from both of them

CHAIRMAN CORRADINI: Don't give them a heads up of what you're asking for. Just ask the question.

In the design certification, in decisions that you've made internally in the whole design certification process, have you used explicitly risk importance measures from the PRA to justify design decisions or analysis decisions, you know, either positively or in a negative sense so that we don't need to look at this because the risk importance, you know, Fussel-Vesely importance, risk achievement worth from the PRA is?

Have you used that type of information explicitly?

And if the answer is yes, where have you used it?

MR. WACHOWIAK: To answer what you first said, in making design decisions have we used those importance measures on their own to make decisions, and the answer is no. We can use that to point us in a direction to what we want to look at, but I think in all of our cases for design decisions, we've done a modification to the model and explicitly calculated what the change would be, given that change. We used the importance measures to try to hone in on what we want to look at, but then we would make that change.

Where we are using the importance measures explicitly are in what's called the design reliability assurance program, which is an interesting process, but it's a set-up for an operational program, if you will. What was envisioned back in the late '80s, early '90s, when the DRAP program, which is kind of redundant, but the DRAP was established, said we're going to have this design PRA that we base our decision on, and if we have all of these component reliabilities in there, how do we know that the component reliabilities that when you actually build the plant are going to match what's there?

And back then I think the thoughts were we'd be building plants like a second Riverbend or Grand Gulf, you know, something that was in the range of what was being looked at, and that would have been important. We don't want to claim a very high reliability of a component and then put something else in that doesn't meet that because if its importance factor is high enough to give you ten to the minus five or ten to the minus six delta CDF, it would be an issue.

We're struggling with what to do with those importance measures in DRAP because what we're finding is that the specific reliabilities of the components themselves are not what is driving our risk. It's how we assemble the systems into a combination.

So if we are wrong on all of them, yeah, it may have an impact, but if we are randomly wrong on some of them, we're not going to come out with anything different.

So because there is written guidance on how you're supposed to do DRAP, we used the importance measures there to identify a list of components that would be subject to this DRAP. But what do we do with those? We don't change the design of any of those components. All we're doing right now is saying that those components are going to be monitored as like high risk significant components in the maintenance rule program. That's essentially the outcome of DRAP, is saying that they have to be monitored to that level.

So it wasn't for a design change. It was for how we monitor the components in the PRA. So we tried to give some examples of what we looked at. There was questions about whether we should put -- this is back to the design area now -- questions of whether we should put isolation valves on the PCC heat exchangers. Okay?

Well, we would start out by looking at the importance of the PCC heat exchanger and what sequences it goes in and maybe take a look at the raw value of the heat exchanger plugging, which is essentially the surrogate term there, and try to determine what it is we need to look at in the model to address that.

But in the end, before we formulated our decision and passed that off to be used in a blended, deterministic method for answering that question, we explicitly modeled that, those valves in the PRA, including control systems and generated a new CDF and LRF number associated with that.

So I don't think we've ever just taken a raw or Fussel-Vesely value and used that alone to make a design decision.

CHAIRMAN CORRADINI: Does that answer?

MEMBER STETKAR: Yeah, it does.

CHAIRMAN CORRADINI: Did you have other comments?

MR. WACHOWIAK: Gary has a point there though. The table that Mark was talking about a minute ago, the list of insights in Chapter 19, I guess, was based on important measures like risk achievement work and Fussel-Vesely.

MR. MILLER: Yeah, we basically rolled up -- we accounted for all of the assumptions in the PRA model, which at this point as you've probably said before is a lot of assumptions, but in each system and in our modeling we have certain assumptions that we have to rely on until we have more design detail, things like that.

We roll those up and we prioritize them based on the risk significance, and the things that are truly significant, such that if they changed, we would have to change the model and it would have a significant impact on core damage frequency or large release frequency. Those, we look at the risk significance, and if it meets a certain threshold, then they would go into that table that Mark Caruso had talked about.

So that we make sure that the plant in the design phase understands this aspect needs to either not change it or if we change it, we need to do it in conjunction with the PRA so that we understand the full impact of that.

MR. WACHOWIAK: And the thresholds for that were based on whether we would have an impact to the margin of the safety goal. So we weren't looking at were we changing something in the PRA from ten to the minus eight to two times ten to the minus eight. We were looking at can we increase the LRF by a ten to the minus seven delta. That was the order of magnitude that we were looking at.

So the risk measure that we use there was with respect to the safety goals rather than with respect to the baseline PRA, and that's consistent with the COL ISG that we talked about yesterday.

MEMBER BLEY: Just an aside on that, I did find it and looked through that a little bit. It's called assumptions and insights, and it's kind of hard to tell which is which as you go through, but what's not there in that --

MR. WACHOWIAK: If I could, everything is an assumption. We haven't built the plant yet.

MEMBER BLEY: But what isn't there is the things we were talking about before, I think, is the things that you did not include in the model, and that's a separate thing. It would make a nice tape.

MR. MILLER: Well, we have lower tier assumptions that are documented and things that we did not include, but like I said, those would not make that list unless their significance was such that it would have a significant impact on the results.

MEMBER BLEY: Okay. The things that just come to mind that we know you haven't done yet because things aren't there, you don't have procedures yet. So some of your HRA stuff isn't well done, and John talked about this this morning, the planned maintenance. You haven't I don't think looked at how far out in those tech specs we might go to do rolling maintenance. You know, that's the name of the game now, is to keep the refueling, the annual outages very short, whether that would reach your threshold.

So I think there are things like that that if you haven't model, that you haven't been able to test because you just haven't done them. They're the kinds of things that need to be picked up later that aren't tabulated anywhere that I know of.

CHAIRMAN CORRADINI: Did the staff have any comments relative to John's question?

MR. CARUSO: Yes.

CHAIRMAN CORRADINI: Okay.

MR. CARUSO: The risk importance measure at a component level, we never really had those until we got the top goal on the DRAP program, and we're looking at the topical; we're looking at the process for making decisions about the RAP list, how all of the factors are involved which include more than just the importance measures.

We did look at the system's importance measures that were included in the PRA. Only from the perspective, you know, of what's showing up at the top and does it make sense given how they've modeled it and that sort of thing, but we didn't really use them for anything.

Well, let me back up a second. One of the things that we've done, and I think we sent it to you when we talked about it last time, was this program that we have here to try and develop risk insights that our viewers can use to help them focus their reviews, and we base it on the information we can get from the vendor and their PRA.

We have a number, as you may have seen when you looked at the document, we have a number of factors that go into us choosing what's important or whatever, and I think, you know, we do look at the calculations of the risk achievement works and Fussel-Vesely is part of that, too, but again, it's more than that in terms of identifying it.

There are certain uncertainties in those numbers, especially since as you said we don't -- you know, the model isn't complete, and when you start getting into number stuff, you've got to be very careful.

CHAIRMAN CORRADINI: John, does that clarify, help you?

MEMBER STETKAR: It does a bit. I hear things say that PRA is being used but not exclusively to make any decisions. I'm a little more concerned about using numerical importance measures from this level of PRA to, for example, guide the review process because as I think I mentioned yesterday, a lot of the important insights from reviews are not to look at the things that are important but to look at the things that are not important and understand why they're not important.

So you almost want to concentrate on almost the reverse of that.

MEMBER BLEY: I'd add something here I was going to save for the end. Despite all of the different ways you could use PRA, it seems to me there are two classes that I've separated in my mind now to use the PRA in the design process. One is to identify and fix vulnerabilities, things that stick out and say, "Oh, my God, we don't want that."

This PRA is great for that because after you do that, you get rid of things that are important, and after you get rid of them, you look at them again, and you're still applying the rest of your examination process. So it works great for those.

There is another class of things that to some extent you're doing, although we've been told not exclusively, and that's selecting PDAs, I think, setting test criteria. We talked about one yesterday; defining RTNSS components and their treatment to some extent, not exclusively.

But for these kind of things, then the aspects of the PRA that are important to those decisions need to be pretty darn well treated and vetted and need to be very credible, and I think that's two different categories of things.

So it's the second --

MEMBER STETKAR: That's what --

MEMBER BLEY: -- that you'll notice about.

MEMBER STETKAR: That's why, you know, I started that the PRA is satisfactory for our purpose. Clarifying exactly what our purpose is today --

MR. WACHOWIAK: One of the things though, and I think you're exactly right that there are two different classes of things that we would look at with the PRA. In the second one in terms of prioritization, the selection of RTNSS components doesn't exactly fall into that bin. It kind of straddles the bin somewhat in that what we're trying to find are those components, those active components that you would need to still stay below the vulnerability threshold. So it's still more of a type one application rather than --

MEMBER BLEY: That's probably true because you have the other rules that you're really using.

MR. WACHOWIAK: Right.

MEMBER BLEY: And this might just help you find things you might have missed otherwise.

MR. WACHOWIAK: Right, and what we found though when we did that is when we just started off and applied that, we found that some of our incompleteness in the model gave us answers there that we didn't necessarily agree with because we knew that adding more completeness to some of those sequences would give us the set of equipment that we really thought should be there.

So in some of those areas we added to make that work, and once again, that's kind of what you do in all PRAs. You model what you think you need to model. You look at the results, and you model more things where you don't think that the results got captured everything appropriately.

And some of our ground rules that we

started with really limit the way that we can use importance factors, especially risk achievement work, because we started up front by saying we're not going to rely on operator recoveries in this design PRA because we're trying to assess is the design correct, not are they going to operate it in a more safe manner than out of the box.

So some of those things are incomplete. So if you pick a raw value based on something that really is a recoverable sequence that we didn't add that recovery, your raw is off by a lot. So we have to be real careful in using those importance measures.

The other thing, too, is after you've gone through this process of taking the design PRA and getting rid of things that stick out in pushing the risk into a more balanced and then especially a lower range, you can end up getting funny results after your Fussel-Vesely in RAW.

Now, I have a hypothetical on that. There's a hypothetical nuclear plant that has 12 safety systems. Each safety system is independent from the others, and they're all capable of mitigating all accidents. Okay? So you probably could build something expensive that does that, and each one has a reliability or unreliability of ten to the minus three.

So essentially you get a CDF for this plant of ten to the minus what, three? Ten to the minus 36, but every one of them has a Fussel-Vesely of one and every one of them has a RAW of 1,000. So when you go into that hypothetical regime, the importance measures start to break down, and the attributes of that are low risk and balanced risk profile, and while we're nowhere near this hypothetical plant, the low risk and the balanced risk tends to give us things like that where we end up with traditional thresholds or log two. It doubles the CEM.

Well, if we had operator actions in there, probably the loss of the coffee pot in the control room could affect the performance shaping factors of the operator actions enough to give us a RAW of two. So we want to be real careful how we use importance measures with this plant, and use it to guide us rather than to --

MEMBER APOSTOLAKIS: Is it true that in general importance measures begin to lose their usefulness, their more incomplete of the PRAs or their crude parts of the PRA?

MR. WACHOWIAK: If incomplete PRA will --

MEMBER APOSTOLAKIS: They may mislead you now.

MR. WACHOWIAK: It could mislead you as well?

MEMBER STETKAR: There's two parts. I mean, Rick's example is perfect because it's absolutely true. Absolutely, you know, and you see those kind of things a lot. It's just a general caution about thinking that importance measures are too important.

MEMBER BLEY: And the people who develop them would tell you that.

MEMBER STETKAR: That's right, and also though the contrary part to that, it's one of the key reasons why I keep bringing up this planned maintenance, because the plants that I've looked at that have invoked that, that's not a piece of equipment but, indeed it is a critical -- if you did a risk achievement worth or a Fussel-Vesely importance on the maintenance itself, because it's hard to do it when you slice through the systems, you find out it's a relatively important contributor just because it's removing a quarter of the plant, you know, from service.

MR. FOSTER: Its removing a quarter of a plant from service is one thing, and the other thing that makes that difficult to do without actually seeing what the maintenance is going to be is this errors of commission thing that we talked about yesterday. How likely is the maintenance side going to do something that makes things worse rather than just taking equipment out of service?

MEMBER BLEY: Or then take out a second when that happens at three in the morning.

MR. OESTERLE: Eric Oesterle from the staff.

I just wanted to provide a clarification to something that I thought I heard you say, Dennis, in terms of the use of the PRA. I thought I heard you say that the use of the PRA to select design basis accidents. No?

MEMBER BLEY: I probably said that.

MR. OESTERLE: Okay.

CHAIRMAN CORRADINI: He said something like that, but I let it go.

MR. OESTERLE: All right, and I'll look to my staff experts for confirmation on this, but at this point in time I don't believe the agency is that far along to allow use of PRAs to select design basis accidents. We're still in the deterministic arena for DBAs.

MR. WACHOWIAK: The Option 3 report was withdrawn.

CHAIRMAN CORRADINI: So with that, I'd like to take a break and reconvene with talking about the thermal hydraulic information you have. Fifteen minutes, 10:05.

(Whereupon, the foregoing matter went off the record at 9:48 a.m. and went back on the record at 10:08 a.m.)

CHAIRMAN CORRADINI: All right. Are we all set?

MR. WACHOWIAK: I want to give a preamble on this. We submitted this response probably about a month ago, right, Lou?

MR. LANESE: Longer than a month.

MR. WACHOWIAK: Longer than a month ago, and my understanding is somewhere on your end it didn't quite make it to Mark yet. So this is the first he's seeing it even though we expected that they saw this since we submitted it over a month ago.

So now what we're going to cover here is there is this question of thermal hydraulic uncertainty in passive plant PRAs. We covered a year ago our probabilistic study of the passive uncertainty with respect to success criteria, and we showed through that time that we had a lot of margin numerically, that you would have to change the PRA by quite a bit before there were major changes.

We're not going to cover that here.

One of the issues that came up though was that when we tried to benchmark our PRA code that we used for generating success criteria, which is MAAP 4 with TRAC G, which is the licensing basis code that we use for LOCA at GE, the cases that we used to do the comparison were all cases that were associated with design basis accidents, and in design basis accidents, we never uncover the core, and in all of the PRA success criteria cases, we do uncover the core and then -- not all, but in many of the interesting ones, we uncover the core and then reflood the core.

So the question was will the codes behave in a similar enough manner such that when we say we can calculate we need this much flow or this much from MAAP that TRAC G would also confirm the same sort of phenomenon. So this is an attempt to look at that.

We did some severe accident cases with TRAC G, two in particular. We think we've captured the phenomena that are associated with our success criteria for reflooding the core in these.

So with that, Glen is going to present

this latest part.

CHAIRMAN CORRADINI: And just as a preamble to your preamble, neither of these first with the severe -- within the beyond design basis regime code -- I was going to use the word "sanctification" -- but code approval in some sense doesn't exist. We're looking at a code-to-code comparison just to get a feeling on how the two perform because you're not looking nor are you expected to have anything approved for use in this.

Go ahead. I'm sorry.

MR. SEEMAN: Okay. There are five parts to that supplement.

MR. WACHOWIAK: Yes.

MR. SEEMAN: So do we need to go over the first three that we answered or should I just briefly go over them?

MR. WACHOWIAK: I think the main interest is in Parts A and E or A and D.

MR. SEEMAN: Okay.

MR. WACHOWIAK: These parts were more dealing with how we selected certain sequences, and they didn't really get to this fundamental question: is the code accurate enough to predict what it is we're trying to predict?

CHAIRMAN CORRADINI: Okay.

MR. SEEMAN: Okay. So Part A basically as Rick mentioned, that has to look at a couple of cases where we did see more limiting PRA type accidents, and Part D asks us to look at since we are using TRAC G and TRAC G had been reviewed as part for LOCAs which we didn't uncover, then we wanted for an evaluation of TRAC G in those clad heat-up cases.

So we've picked two LOCA cases to look at, and Case A was a small break LOCA which I would say that that is the TRAC G. Chapter 15 would classify this LOCA, however, in the PRA to be a medium break LOCA.

So here's our conditions from the small break LOCA. There was a GDCS line break, and it has one DPV failure. So what we did to show how the two codes behaved in the core uncovery, we used the two GDCS pools. We did not credit ICS system at six PCCS heat exchangers available. We did use Select, and what we did to obtain core uncovery was delay GDCS injection until we saw the 200 degree -- 2,000 degree Fahrenheit clad temperature.

And so basically in that instance we had a lot of injection there via the six of eight injection lines and equalization, four of four equalization.

CHAIRMAN CORRADINI: And so this was stylized to generate a response but not necessarily physically realizable by some sequence.

MR. SEEMAN: No.

MR. WACHOWIAK: That's correct. What you said is correct.

MR. SEEMAN: Okay. In large break LOCA, we picked the RWCU nozzle break. It's 17 meters from the vessel bottom. We only took credit for one GDCS pool, no ICS four PCCS heat exchangers. We didn't credit SLCC, and our injection system, GDCS used 66 percent of one line. Okay?

Now, there was some caveat on that. When we had an analyst that was running the MAAP cases, we had another analyst running the TRAC G cases, and this is their understanding of our goal for one injection valve, 66 percent one injection valve.

Now, it turns out that at the end we found out that, well, MAAP only uses an area for our connection for GDCS, and TRAC G actually has a network set up for the connection from the GDCS pool to the nozzle, and that includes the valves. So in effect what happened, when the TRAC G analysis was set up to 66 percent, they were not really affecting the area because that wasn't -- the restriction is actually at the nozzle. So the MAAP analysis was done with the 66 percent of the nozzle area. When the TRAC G network was set up to reduce the valve area to 66 percent, it still had the restriction in the nozzle, the RPV nozzle. So in effect, it wasn't affecting the flow rate. So that's why we'll see a difference in the GDCS flow rate.

We did an additional analysis with MAAP at the end.

CHAIRMAN CORRADINI: So there's more flow through the TRAC G calculation.

MR. SEEMAN: You see more flow.

MR. WACHOWIAK: Effectively they didn't do 66 percent of the flow area. They did 100 percent of one blind flow area.

MEMBER APOSTOLAKIS: The 66 percent, where did it come from?

MR. SEEMAN: Well, when we did sensitivity analysis, we were able to show, you know, when we're looking to see how much margin we had, we reduced from our success criteria to two of eight to one of eight, and then we said, well, how about 75 percent of one. How about 50 percent?

Well, it was 66 percent of one, was about where we saw failures. So that's how we got to 66.

MEMBER ABDEL-KHALIK: I guess I'm struggling with the big picture.

MR. SEEMAN: Okay.

MEMBER ABDEL-KHALIK: You know, you have two codes. Neither of them is certified for this kind of analysis, and you're running them under these conditions, comparing them. So what if the results are the same? What does that tell us?

MR. WACHOWIAK: Let me back things up just a little bit on this. Using MAAP for success criteria in PRAs is what is typically done across the operating fleet. The MAAP code itself though has never been reviewed by the NRC, and there has always been an issue with this when we say that MAAP gives the success criteria and the staff says, "Well, how do we know?"

Okay? And for whatever reason, and I don't know what these reasons are, but the code isn't being reviewed, and it's not planned on being reviewed. So for our purposes, what we wanted to show was that, one, we did what the standard for PRA says to use. It says that, you know, codes like MAAP are acceptable as long as you have the systems modeled correctly.

And what we're trying to show here is that using a different code, which is licensed for a different regime, not this regime, but for a different regime, that we do have the plant modeled correctly and that MAAP is going to give us reasonable results.

I think the only question that comes out in this TRAC G is the film boiling coefficient model or is that what the issue is that has not been reviewed? I'm not sure.

I'm looking to someone who may know what the specific issue is on what part of that hasn't been reviewed, but --

CHAIRMAN CORRADINI: You mean for a requenching.

MR. WACHOWIAK: For requenching, yeah. But we get into this position where we're not sure what to do. The staff is asking us how do we know that the MAAP results are right, and we're trying to give them every assurance that the MAAP results are right.

MEMBER ABDEL-KHALIK: But at the end of the day you still don't know.

CHAIRMAN CORRADINI: Is that a question to them or the staff?

MEMBER ABDEL-KHALIK: It's a question to

everybody.

MR. CARUSO: This is Mark Caruso.

I think what we wouldn't have is we would have more confidence than we certainly have now because at least we have a -- our comfort has been expressed in the past about its ability to treat certain thermal hydraulic phenomena well at all compared to a code that, you know, is much more robust.

Now, that said, you're correct in that in the regime of core uncovery and approaching 2,200 degrees, the staff hasn't done a detailed review. We did ask some additional questions on this RAI to get at that, to give us some confidence without having us do a design basis thermal hydraulic review, just give us some additional confidence that what's in TRAC G is good enough.

I mean, that's where we are.

MR. WACHOWIAK: I want to add one thing to this because the way that you phrased that we don't know, I don't think that's right. We know; GE knows. MAAP, every model in MAAP has been benchmarked against experiments. There are reports from EPRI and other places that show that the types of things in MAAP are appropriate for doing PRA success criteria. So we know that we're getting the right results.

We don't have an approved method for them to say that they know that we have the right results.

MR. CARUSO: Plus, in addition to that, we have --

MR. WACHOWIAK: It's a subtlety on this because we're not just throwing the code out there saying, "Oh, I can just go set up any code and run it and give us the success criteria." This is a code that's been used for 15 or more years for developing PRA success criteria and has been, when used appropriately, it develops a set of robust results that can be used for these purposes. It just hasn't been reviewed.

CHAIRMAN CORRADINI: Mark, did you want to say something?

MR. CARUSO: Yeah. Rick is exactly right. The problem that I had was that here we have this MAAP code that the staff has reviewed and a number of the staff in the thermal hydraulic area have expressed concerns about, and to then couple that with the fact that the benchmarks have been done nowhere near, what we're concerned about, you know, we basically fundamentally just want to make sure that when they talk about success criteria, you know, minimal success criteria or the fact that there's a lot of margin in the success criteria, which there is; I mean, you're talking about design basis is fail one. I still win when I fail six out of eight.

Our real goal is to have some confidence, that confidence that, you know, those success criteria are good, and I just don't think we had a solid, you know, basis for saying that without, you know, looking a little deeper into this question of, you know, the thermal hydraulic calculations, especially with the situation of MAAP not being reviewed and there being concerns about it.

CHAIRMAN CORRADINI: So can I repeat this and then we can go forward?

So what you're saying is you're looking for qualitative comparisons that give you a good feeling that MAAP hasn't gone off the deep end compared to what TRAC might say for behavior for some stylized accidents.

I mean, what you're really saying is you're looking for qualitative comparisons and quantitative to the point that they're within some undefined point. I mean, you're not looking for a percent or a ten percent agreement because there's no way because there's no experiment. These are stylized calculations. Is that fair?

MR. WACHOWIAK: That's fair.

CHAIRMAN CORRADINI: Okay.

MEMBER SHACK: Well, I think the one other point is the one that came up in the AP-1000. As Rick says, I mean, MAAP has been used in every PRA, but these are passive reactors. We're in different flow regimes than MAAP has been used for for 15 years. So, again, when the AP-1000 came in, they asked them the same sort of questions. You know, demonstrate that MAAP works in a different flow regime than we've been accustomed to using it.

So they did the COBRA TRAC calculations --

CHAIRMAN CORRADINI: To compare it.

MEMBER SHACK: -- to compare it, and you know, the same thing here. We're in a different set of flow regimes than you have 15 years of experience doing. So you know, you look at a different code, again, but as Rick said, MAAP has been around. You know, the staff has accepted it for every other PRA, but you know, the reason that you're looking at it a little bit differently here is it's a little different application, and so you're building confidence in its applicability to different flow regimes.

CHAIRMAN CORRADINI: So just to turn the

tables a bit, I assume the staff is doing the same thing with TRACE and MELCOR, which is when they're doing audit calculations, they're going to use MELCOR both for the in-vessel and the ex-vessel response whether it would be containment or whatever, and conversely, they might -- and we have asked and they are trying -- to do a TRACE/MELCOR comparison so that you don't essentially plug in output conditions from something into the MELCOR containment calculation.

So I think what we're asking of you guys -- I just want to make sure -- we put the onus back on staff for the audit calculations.

Proceed.

MR. WACHOWIAK: Okay. So the first scrap or -- excuse me -- we'll discuss the medium LOCA first and first scrap shows the break flow rate. TRAC G has a little bit higher flow rate there, and I believe that was due to they closed the MSIVs at the beginning. I think MAAP closed it on level. So they got a little higher flow rate, and then at the -- I don't know if you had that.

CHAIRMAN CORRADINI: So red is TRAC and blue is MAAP?

MR. SEEMAN: Yes. I don't have the laser. Ah, the friendly hand.

So what's happening here is this is where the level is -- the level in the reactor gets to where the injection is filling out. So that's why it goes to zero and then when the level reaches the break, then we start getting break flow again.

So here's our cladding temperature history.

CHAIRMAN CORRADINI: Can you go back? So sine you have to have a curve, we can't let a curve go by without torturing it a bit. Okay?

So I have a 1,000 second delay in MAAP, and can you say one more time the reason for the delay? I'm sorry. Not that which one is right, but there's a 1,000 second difference between the red and the blue.

MR. WACHOWIAK: It's 1,000.

CHAIRMAN CORRADINI: Three thousand, 4,000. So I have a 1,000 second difference, and you said something. Can you re-say it?

MR. SEEMAN: I think the TRAC G is showing higher break flow rate at the beginning. So it shows the lower level, and that starts GDCS flow sooner.

MR. WACHOWIAK: Right. Remember, in this case GDCS isn't started on any particular level signal or anything like that. It started when the codes predict that the PCT is 2,000 degrees.

CHAIRMAN CORRADINI: Somewhere.

MR. WACHOWIAK: Yes.

CHAIRMAN CORRADINI: And that's actually the next --

MR. WACHOWIAK: So what this says is that the way that the TRAC G is set up, that it reaches 2,000 degrees about 1,000 seconds before MAAP does, and the reasons in this case were initial flow rate out of the break was higher because of the timing on the MSIVs. Some of the initial assumptions that went into things caused the loss of off-site power concurrent with the accident, caused the TRAC G to immediately close the valves, where in MAAP our model has it delay that.

But, once again, for this particular case, how fast it got to 2,000 degrees wasn't the thing that we were looking for. So we didn't go back and try to resolve that particular issue because that particular issue wasn't the phenomena of interest in here.

And I think one of the other things, and this one was the -- or is it in the next case where the two-phase slip model on the --

MR. SEEMAN: I think that's this one.

MR. WACHOWIAK: Is also a little bit

different where TRAC G is optimized to give more flow out the break than the Moody slip model would predict, and the Moody slip model and the Fauske model, which is what's in MAAP, are very close to each other. We think that's the more realistic case, but TRAC G was set up to maximize the flow out of the break using a different correlation.

CHAIRMAN CORRADINI: So you said something about SMIV closure that I --

MR. WACHOWIAK: Keeps the pressure higher.

CHAIRMAN CORRADINI: And somehow the timing to TRAC automatically -- TRAC G automatically defaults to is different than what MAAP defaults to?

So the inventory difference because of the mass flow rate difference early on is caused more by signals than by model, or a combination?

MR. WACHOWIAK: It's the combination of the two.

CHAIRMAN CORRADINI: Okay.

MR. WACHOWIAK: And when we looked into these, we investigated that and found that those were the reasons why.

CHAIRMAN CORRADINI: Those were the two.

MR. WACHOWIAK: Those were the, yeah, major reasons why this was happening,a nd once again, because this test, if you will, call it experiment, whatever we want to call it, the intent was to show that once we started GDCS injection, we would get the same quenching response which is what the next one shows, is that once you get to the 2,000 degrees, if you start the GDCS, we get a similar quenching time, similar response.

CHAIRMAN CORRADINI: Thank you.

MEMBER APOSTOLAKIS: What is the temperature there, the piece? I can't read it.

MR. SEEMAN: It's between 1250 and 1500 Kelvin.

CHAIRMAN CORRADINI: And the initiation over time is 2,000 degrees. Somewhere in the core of what?

MR. SEEMAN: Two thousand degrees --

CHAIRMAN CORRADINI: What Kelvin?

MR. WACHOWIAK: Fahrenheit, 2,000 degrees Fahrenheit.

CHAIRMAN CORRADINI: But somewhere in the core of what? What temperature?

MR. WACHOWIAK: It was the cladding temperature.

MR. SEEMAN: Peak clad temperature.

MR. WACHOWIAK: So we're looking at Kelvin again, and we set it up on --

MEMBER APOSTOLAKIS: How can I read this? Can you explain to me what this means?

MR. SEEMAN: Well, this is just showing how the cladding temperature, the max cladding temperature of each code is varying with time. So as it uncovers, it starts heating up. So TRAC G actually shows a lower level so that it eats up sooner and then it tracks up in I'm not sure where.

CHAIRMAN CORRADINI: Thirteen, sixty-six.

MR. SEEMAN: That's the peak, but I believe that 2,000 -- would that be -- oh, so anyway, before that is where the GDCS has to start injecting, and then it's going to bring the clad temperature down.

MEMBER APOSTOLAKIS: So the dark line, the horizontal line is what?

MR. SEEMAN: That's our success criteria of clad temperature 1477K or 2200 Fahrenheit.

CHAIRMAN CORRADINI: That's essentially the DBA. That's the --

MR. WACHOWIAK: So if we cross that, we assume that we have core damage.

MEMBER APOSTOLAKIS: So the margin is the difference between the peak and the black line?

MR. WACHOWIAK: Right, but remember this experiment was designed to get that peak as close to the black line as possible before we quench the core. The design of this experiment was to see that if we got the peak clad temperature as close to the acceptance criteria as possible, MAAP and TRAC G will both turn it around with the same kind of response because this is one of the keys.

When we're doing the success criteria as it's heating up, as long as we don't cross through that threshold, we have to shop that MAAP is capable of turning that around similar to the way TRAC G does, and that's --

MEMBER APOSTOLAKIS: So this is not a real --

MR. WACHOWIAK: No, no, this is a hypothetical case.

MEMBER STETKAR: Point, six, six flow-through.

MR. SEEMAN: No, this is actually the six of eight flow.

MEMBER STETKAR: Oh, this is six of eight.

MR. SEEMAN: Yeah.

CHAIRMAN CORRADINI: So that's why you get such an incredible turnaround.

MEMBER ABDEL-KHALIK: How long does it take from the time you reach 2000 F., in other words, initiate GDCS and the time the temperature turns around?

I mean, this scale I still can't read.

MR. WACHOWIAK: Yes, it's 1,000 seconds.

MEMBER ABDEL-KHALIK: A thousand seconds in each increment, right?

MR. WACHOWIAK: Yes. It's just a few seconds. We don't have on this computer the --

MEMBER ABDEL-KHALIK: And what is the significance of these up and down peaks in the MAAP?

MR. SEEMAN: That's where the steam generation increased the pressure enough that when we reflooded, the steam generation increased pressure in the vessel which showed down injection, GDCS.

CHAIRMAN CORRADINI: Be real careful. I don't know what the computer calculation is doing, but if it's tracking peak clad temperature, it could be going from one location to a different location. The spiking may be because in one channel in the BWR it's quenching. I don't know.

MR. WACHOWIAK: That's not what it is.

CHAIRMAN CORRADINI: That's not what it is?

MR. WACHOWIAK: No.

CHAIRMAN CORRADINI: So let's go back to that wiggly line again.

MR. WACHOWIAK: In the MAAP, we have all of the individual node temperatures of the clad, and then we picked which one was the peak, whereas TRAC G tells you peak clad temperature.

CHAIRMAN CORRADINI: I know, but that's what I just said.

MR. WACHOWIAK: We have to derive peak clad temperature in the MAAP case.

CHAIRMAN CORRADINI: You have to find it.

MR. WACHOWIAK: We have to find it, yeah.

CHAIRMAN CORRADINI: But that would partly explain the jaggling because it's one place here and one place there.

MR. WACHOWIAK: Except when we investigated that it was due to the GDCS flow rate. We were getting steam produced enough that the flow rate was starting to --

CHAIRMAN CORRADINI: Get held up?

MR. WACHOWIAK: -- get held up out of the DPVs, increase the pressure a little bit, and the flow in through the GDCS was stopping momentarily and then starting back up again, whereas TRAC G was not showing that sort of a response.

CHAIRMAN CORRADINI: Funny. I would have expected the response that MAAP showed.

MEMBER ABDEL-KHALIK: But isn't the difference significant?

MR. WACHOWIAK: No. It turns out that the total time to quench the core though is approximately the same. What we're saying is that if we turn on GDCS, if we wait until the last minute and turn on GDCS, that we'll turn the core temperature and we'll cross the peak. That's what we're trying to show.

We don't care how long it takes to get all the way down. We're just trying to show that it turns, and it will not cross the peak if we turn that system off or the peak won't cross the acceptance criteria if we turn the system off.

And there are differences in the details of what happens in the core itself, but those differences are happening down in the lower temperatures once again now where we're not challenging the clad anymore.

MEMBER APOSTOLAKIS: So I'm trying to understand this. If there are any uncertainties in the calculation --

MR. SEEMAN: There's a few.

MEMBER APOSTOLAKIS: -- you are arguing that because both the red and the blue line turn around, they really don't matter; is that correct?

MR. SEEMAN: The profiles are similar is what we're looking at.

MEMBER APOSTOLAKIS: No, in this peak, the very peak. if I go and look for uncertainties in the inputs and all that stuff, could it be above the line sometimes?

What is the argument here, that the two codes give similar behavior? I understand that, but in terms of the uncertainties, I thought your main argument when it came to uncertainties was if we change the success criteria, it really doesn't matter. So instead of quantifying the uncertainties, you're saying I'll consider different success criteria and I'm always okay.

Am I missing that or what?

MR. SEEMAN: I think that's what we're saying. This is answering the question that was in the supplement. Give the comparison --

MEMBER APOSTOLAKIS: But you come too close, and I don't understand what that means.

CHAIRMAN CORRADINI: The coming too close though is stylized --

MEMBER APOSTOLAKIS: You designed it that way.

CHAIRMAN CORRADINI: It's a stylized thought experiment, simulation or whatever.

MR. SEEMAN: Our experiment could have said start GDCS when we get to this level, and you know, we just said to maximize the key --

MEMBER APOSTOLAKIS: Yeah, but when you say that in the stylized experiment we don't violate the success criteria -- that's what you said -- I don't see the relation without --

CHAIRMAN CORRADINI: Can I try something else, George, for my understanding? Let's say the red and the blue line was there at six of eight and then they did five of eight and four of eight and three of eight.

MEMBER APOSTOLAKIS: Right.

CHAIRMAN CORRADINI: And then they said, "Ah-ha, the red and the blue, the red goes over at four of eight and the blue goes over at three of eight, and our success criteria was four of eight. Well, that gives us an uncomfortable feeling, and really it should be four of eight as a success criteria, not three of eight."

If they start seeing differences here in how they would derive a success criteria, that would get them nervous. Beyond that, I don't sense this gives them anything other than a qualitative good feeling.

Am I misinterpreting?

MR. WACHOWIAK: You've jumped to the second half of the question, which is the next set of how we look at how many of eight we need to get to. The main intent here was the question that was on the table was can we reasonably predict that the injection of GDCS flow, when it's delayed to when the core is in the heating up range, can we reasonably predict that the GDCS flow will turn the peak and bring the temperature down? Is the code capable of doing that?

CHAIRMAN CORRADINI: Well, the answer to that is yes.

MR. WACHOWIAK: The code is capable of showing that, and we have the other code that's capable of showing it in approximately the same way. So we think -- now, our intent here is that we think now that when we show that with these codes that they are turning this peak, the MAAP shows that the confirmatory code, if you will, TRAC G will also show the same type of response, that we can get the peak temperature down when we turn the system on.

Now, specifically, how much of the system do we need to turn on is the next question that comes up or here where we stylize the experiment to say what is the minimum complement of GDCS flow that we need in order to see that we don't cross the peak.

MEMBER APOSTOLAKIS: Okay. I understand this.

MR. CARUSO: This is Mark Caruso.

I'd like to add that this is important stuff. It's only half a loaf, but it is important in the sense that I think a number of the crux concerns in the thermal hydraulic area were with, you know, the two-phase flow models and the ability -- the way it was treated in MAAP and previous comparisons, and there were concerns about drift-flux models and two-phase flow and that sort of stuff.

So I think, you know, looking at the ability of it to track with TRAC G and do things in this regime is an important piece of information, but we need to get to the next piece, too.

MEMBER ABDEL-KHALIK: But one of the issues that came up during earlier discussion was the possibility of non-condensible gas accumulation in the GDCS lines, and you sort of designed the plant so that the lines are tilted and all that stuff, but you know, tiled by a very few degrees. It's not something that somebody could look at and say, "Yeah, this is built correctly."

So is that possibility included in this?

MR. WACHOWIAK: No, we didn't look at that. That's being handled in the ITAAC phase. Even though it's a small slope there's an ITAAC for that slope.

CHAIRMAN CORRADINI: But I think to answer his question precisely, we're expecting an answer for that in the October 21st meeting.

MR. WACHOWIAK: Okay, and we're not trying --

CHAIRMAN CORRADINI: They owe us a detailed calculation of that, "they" meaning you, GEH, some other "you" in the global GEH.

MEMBER ABDEL-KHALIK: The other question is, well, how close to the limit can you get for this comparison to be as true as you show it to be. In other words, you k now, are there phenomena that when you get to this limit that proceed at a considerably higher right in one code than in the other so that one may show a turnaround and the other may not?

MR. WACHOWIAK: This is what we were trying to do here, was get it as close to the limit as we could without running 4,000 cases to try to optimize that. We think that this is pretty close, and in our actual success criteria that we use, the things that cross that line are crossing it like a rocket. They're going way past it. It's not the things that are coming right up and turning around in our actual PRA success criteria calculations.

We did find some things here, I think, that when you're looking at the success criteria in the PRA, you shouldn't always just look at only one parameter. There's more things to look at. Here we're looking at the one thing, but one of the things that we gained from this and the next one that we looked at is that as long as we can keep the bottom two feet of the core covered, we're probably not going to go into this runaway heat-up range where it's going to even challenge that peak clad temperature.

And so another way of looking at it is in these cases how close are we to fully voiding the core. We fully void the core, thus one of those things where we'd have a hard time getting it to turn around and not meet these peaks.

So there's other things that we gain from looking at other than just right looking at that turnaround.

CHAIRMAN CORRADINI: So it's really back to an inventory question.

MR. WACHOWIAK: Yeah, it's back to an inventory question, and really when we presented before our table of actual success criteria for the PRA because we have a couple hundred map runs that look at different break sizes and different complements of materials, of flow systems, that the ones that we call success aren't the ones that just go up 2,203 degrees and then turn around. If it's going through 2,200, it's going through by quite a bit, and it's a non-success.

And then remember from before when we used MAAP to calculate our success criteria, we calculated the minimum needed. Then we added one, and that's what we used in the PRA.

So it's not in this RAI response, but we did look at that in one of these other cases here in the next case with the .66 of a valve. We can heat up in that one, right? But if we add the one valve, which is the PRA success criteria, there's no heat-up at all.

So let's go on to the next one.

We're not trying to prove that any sequence will actually give you this response. We're not trying to prove that.

CHAIRMAN CORRADINI: This is the same thing though.

MR. SEEMAN: This is the same scenario, and this just shows the TRAC G having a lower --

MEMBER APOSTOLAKIS: Explain the axis before you go into what it does. What are the axes? We can't read it very well.

MR. SEEMAN: Yeah, this is level. It's the two phase level inside the core.

MEMBER SHACK: You get the caption up.

MR. SEEMAN: Oh, so here where we see TRAC G shows the lower level sooner, and then the level recovers and the --

CHAIRMAN CORRADINI: The black line is what? The top of the fuel?

MR. SEEMAN: The top of the fuel, yeah. So the node in TRAC G ends right here. I believe it was the top of the chimney where the node in MAAP actually is like the top of the --

MR. WACHOWIAK: So it's different variable. In MAAP the variable that gives you the water level in the core includes the entire vessel.

MEMBER ABDEL-KHALIK: This is a collapsed level or flood level?

MR. WACHOWIAK: This is the boiled up level.

MEMBER ABDEL-KHALIK: Two phased, yes.

MR. WACHOWIAK: Boiled up level.

MEMBER BLEY: For those of us who don't understand that term, could you explain what the boiled up level means?

MR. WACHOWIAK: Two-phase level. So it --

MR. KRESS: You collapse all of the voids and see where it goes.

MEMBER BLEY: Is that what it is?

MR. WACHOWIAK: Just the opposite.

CHAIRMAN CORRADINI: They define a void fraction above which it's considered above the level and below which is the level, yes.

MEMBER ABDEL-KHALIK: So this is not what the water level indicator in the vessel would actually measure.

MR. WACHOWIAK: No, we've got that on the next slide.

MEMBER BLEY: So it doesn't quite mean anything. It's another --

MR. KRESS: Well, except it's coolable.

MR. WACHOWIAK: It does mean something.

MEMBER BLEY: What does it mean?

MR. WACHOWIAK: It's when the two-phase level is what's actually turning the peak. The one-phase level is telling you the mass of the water in the core. So you get two different things out of those two different ones, but the temperature actually turns around as the two-phase boundary passes the hot node.

CHAIRMAN CORRADINI: Just so we're precise about that, that's almost right. It's what the minimum film boiling time quench temperature or model is, which --

MEMBER BLEY: Thank you. That makes a lot more sense.

CHAIRMAN CORRADINI: But it's essentially tied pretty much to the leading edge of the two-phase mixture, yeah. So this is the level.

MR. WACHOWIAK: Well, this is actually the level outside the shroud, and that is a collapsed mode. So that would be what -- it should be reflective of the mass that's in the core.

And once again, the TRAC G goes down faster because of the initial mass out of the break.

CHAIRMAN CORRADINI: Can I go to the second simulation?

MR. SEEMAN: Okay. This is GDCS flow rate into the core. So --

CHAIRMAN CORRADINI: Keep going. You want to go to the next case, containment response perhaps and then flow rates from different things.

MR. SEEMAN: Okay. So this is our --

CHAIRMAN CORRADINI: Like a rock.

MR. WACHOWIAK: That's what we pressure to do in that case.

CHAIRMAN CORRADINI: Now, this has a difference in the -- which had the 66 percent of the other?

MR. SEEMAN: Well, this is the break flow, right, but TRAC G actually had 66 percent of the valve area, but the restriction at the RPV nozzle was smaller than 66 percent of the valve area. So TRAC G is going to show more GDCS flow, and here again we see some differences because of the two-phase flow model through the break.

So here there was a little bit of a clad heat-up in TRAC G, and I think we'll see that --

CHAIRMAN CORRADINI: can you go back to inventory again? Or maybe we haven't gotten to inventory yet, but if we go back to Rick's explanation, that pink or red blip ought to be somehow reflective in inventory, yes?

MR. WACHOWIAK: Go down to the level case.

CHAIRMAN CORRADINI: Sorry. Excuse me.

MR. WACHOWIAK: There's the two-phase water level, and we see the heat-up in TRAC G as the water level gets down below five --

MR. SEEMAN: Yes, oh, it's really about right there. So when it reaches that -- now, the additional case, we delayed MAAP injection a little bit so that we saw a similar level.

CHAIRMAN CORRADINI: So let's just stay here and repeat the difference. So looking at this, so there's a big difference. This would get you all concerned and worried. However, you had an equalizing line break, the line between the vessel and the RW -- the --

MR. WACHOWIAK: This is a shutdown cooling suction line break, suction.

CHAIRMAN CORRADINI: Oh, shutdown --

MR. WACHOWIAK: So it's a mid-vessel, and it's a big pipe.

CHAIRMAN CORRADINI: Connected to the?

MR. WACHOWIAK: RPV is connected to the shutdown cooling system.

CHAIRMAN CORRADINI: The shutdown cooling system. Excuse me.

MEMBER ABDEL-KHALIK: Artificially these two calculations are different, and you're telling me that the flow rate in the TRAC G calculation is higher than the MAAP calculation. The flow rate from where? Through the GDCS system?

MR. SEEMAN: No, through the break.

MEMBER ABDEL-KHALIK: Through the break? That's why.

MR. SEEMAN: The LOCA flow.

CHAIRMAN CORRADINI: So that's why the inventory is lower.

MR. WACHOWIAK: Yes.

CHAIRMAN CORRADINI: I just want to correlate the difference with the pink and the blue.

MR. WACHOWIAK: And one of the things that we looked at when we investigated that, because we ere comparing the flow rate through the break compared to what the Moody slip flow table should tell you, and the flow rate that we're seeing in TRAC G was higher than that, and when we investigated that particular thing, we were told by our analysts, TRAC G analysts, that they did that on purpose because it's conservative to maximize the flow out the break, whereas the PRA success criteria you wouldn't -- you want to use a realistic flow through the break. So we used the model that matches, more closely matches the experiment.

So once again, every cross-code comparison that anybody ever does is extremely hard to do because of assumptions that were made 25 years ago that don't always get carried forward into these things.

CHAIRMAN CORRADINI: So but just to repeat so that we've got it correctly, for the red line or the pink line, the break flow is larger by the 66 percent or one over 66 percent.

MR. WACHOWIAK: No, that was the GDCS line flow area.

CHAIRMAN CORRADINI: Oh, excuse me. So say it again.

MR. WACHOWIAK: -- bottom line flow area. This is a break flow model.

CHAIRMAN CORRADINI: Okay.

MR. WACHOWIAK: Now, TRAC G and MAAP used the same model, right, for injection flow as break flow. Is that true?

Different regimes. Let's not go there.

CHAIRMAN CORRADINI: If I might repeat this so I get it right, the inventory is lower, but the model is a conservative break flow model rather than a best estimate model in TRAC G.

MR. WACHOWIAK: That's correct.

CHAIRMAN CORRADINI: And that was uncovered when you guys went back and looked and said why is the break flow so different between the two simulations.

MR. WACHOWIAK: Well, it started out why is the break flow different between the two simulations, and then we said, "Well, wait a minute. When we pull out Moody and we calculate with pressure what the break flow should be, we don't get what TRAC G has. TRAC G has more than that, and their response is that's right. There's a conservative model that tends to maximize the break flow rate.

CHAIRMAN CORRADINI: But is that model just for the sake of it's something?

MR. WACHOWIAK: Yeah, it's a name of the model. I don't know what it is though. Don't ask me to explain it because I don't -- other than knowing that it's more conservative than what we have, that's the extent of what I know.

MEMBER ABDEL-KHALIK: I guess I'm a bit confused. I understand that break flow in TRAC G is higher than MAAP because of the difference in models. Can you tell me what the effect of the fact of the choke flow are or the flow area in one case is 66 percent lower than the other, whereas in the case of TRAC G I guess the nozzle is the smallest area rather than the valve.

MR. WACHOWIAK: There is the difference. There is the difference there, is that TRAC G gives higher GDCS flow from that line.

MEMBER ABDEL-KHALIK: So despite the fact that you're getting GDCS flow in TRAC G, you're still predicting higher peak clad temperature.

MR. WACHOWIAK: And that's because you go back up to the level.

MEMBER ABDEL-KHALIK: Because of the higher flow rate out of the hole.

MR. WACHOWIAK: Right.

CHAIRMAN CORRADINI: You don't even uncover. I mean, the key thing is with the break flow that they've -- I mean, let me say it so that we've got the two things. With the break flow chosen in the MAAP calculation, you never uncover the core, whereas you do uncover the core and you get heat-up in the TRAC G calculation. That's why the black line was in between the two.

Can you go up?

That's why the black line was in between the two on the inventory. Show your inventory thing.

Yeah, right?

So you don't even uncover the core. You barely uncover the core with MAAP. You uncover the core by about two or three feet with TRAC G, and then Said's second point which is important is the recovery is much faster with the red line because it's blowing in more water.

MR. WACHOWIAK: Yes, and so now what's difficult here is now to say what does this tell us. Our success criteria that we chose in the PRA was two GDCS values, and what this is showing here is that with one in TRAC G we're successful, and in this particular case with MAAP, we didn't even need one to be successful. We could be successful with less than one.

So it means that our success criteria of two is robust in the PRA, and that's what we were trying to get at with these sets of calculations.

CHAIRMAN CORRADINI: This is back to the success criteria, the second point.

MR. WACHOWIAK: Yeah, the purpose of the calculation isn't to show that two codes do the same thing. The purpose is to show that the success criteria that we use in the PRA is robust, and we think that with this set it demonstrates that our selection of two GDCS valves is robust, and if we went and we repeated this same thing for the DPVs or for the PCCS and all the rest of that, we would end up with the similar sorts of results saying, yes, it's robust.

Now, this RAI didn't ask us to go through all of those separate scenarios, but the process would be similar, and once again, we learn from this that it's something that we probably already knew, but we could get it more to a more precise thing, is about what level in the core that the two-phase level reaches is an adequate predictor of when we're going to start getting heat up.

MEMBER APOSTOLAKIS: So this resolves the issue of uncertainty?

CHAIRMAN CORRADINI: This only answers the RAI.

MEMBER APOSTOLAKIS: Well, can we ask the key question? How do we resolve the issue of uncertainties? Are there any uncertainties?

MR. WACHOWIAK: let me go back through the whole thing.

MEMBER APOSTOLAKIS: I don't understand that. I mean, I can see these studies. I'm sorry.

MR. WACHOWIAK: Let we talk about all of

the pieces that we've done for the thermal hydraulic uncertainty.

MEMBER APOSTOLAKIS: Okay, all right.

MR. WACHOWIAK: The first thing that we did was that we would calculate the minimum complement of equipment needed to reach success.

MEMBER APOSTOLAKIS: And this is done with point estimates essentially.

MR. WACHOWIAK: With point estimates. However, the matrix that we have for looking at all these things does include variations of certain parameters that EPRI in their technical reports have shown to influence the success criteria.

So there is a -- it's not only point estimates, but there are also some parameter variations that EPRI says that when you're using it for success criteria you should investigate ranges of these parameters.

MEMBER APOSTOLAKIS: Which brings me really to the key question here. What in your opinion are the uncertainties here?

If I understand that or if we understand that, then we can look at how you're addressing them and see whether it makes sense. So what are the key uncertainties when you are dealing with a passive system?

One is this business of non-condensible gases, and you said you're going to address that some time in the future, right?

MR. WACHOWIAK: We've addressed it by putting a design requirement for sloping of the lines.

MEMBER APOSTOLAKIS: So that's it.

MEMBER ABDEL-KHALIK: Well, we'll see how the system responds under these conditions.

MEMBER APOSTOLAKIS: Yeah, that's what I'm saying.

What else? Is there any other thing that you feel is uncertain here that may be a contributor? You said the EPRI has identified some of those. What are they? Are there any correlations that are not very well understood or applicable?

MR. WACHOWIAK: Talk about the fact of input parameters, the sensitivity suggested --

MEMBER APOSTOLAKIS: Yeah, I want to understand that.

CHAIRMAN CORRADINI: George, I'm still cloudy as to what uncertainty you're asking about. Thermal hydraulic uncertainties or for the PRA?

MEMBER APOSTOLAKIS: For the PRA.

CHAIRMAN CORRADINI: Fine.

MEMBER APOSTOLAKIS: For the PRA, you know, if you read a little bit about passive systems, they will tell you that, you know, unlike active systems they're more sensitive to various uncertainties that exist, and they give you some examples.

So I'm trying to understand what are the uncertainties that we're addressing here and then how we're addressing them.

CHAIRMAN CORRADINI: Got it. One of the things that we would notice with our passive system, this GDCS system, is that it's not as subject to these uncertainties as some other systems might be. We do have -- I'm trying to remember what the number is -- 30 feet ahead on the GDCS line for getting injection started versus I think in some of the earlier reports that we're talking about passive systems, they were talking about two pretty much equal pools with a check valve in between, and there's zero head there.

Now, certainly it's not 250 pounds like a LPIC pump, but still it's not zero, and so we would expect things like in some of these cases, the previous case we saw, is as the core is requenching, the pressure inside the vessel is changing, and that pressure inside the vessel is enough change to have an influence on the flow rate of the water that's coming in from the GDCS pool.

It's not enough to stop it, but it's enough to have an influence on it, and so one of the uncertainties is how much influence do we have on that flow rate, given that we're trying to -- the same questions that we had to the BiMAC. Is there enough head to run water up through the core while it's flashing in the core at the same time?

So that's one of the things, and I think that through these, I think we've shown using two different correlations for film boiling in the core region that we can get an adequate reflood in the range where the fuel is assumed to be as hot as it can get without being fed.

So that was one of the uncertainties that we were trying to address. The main uncertainty, I think, is the flow rate.

Now, this question that comes in is is there some kind of gas binding in those pipes. That's going to be -- we'll have to see what questions you ask and what --

CHAIRMAN CORRADINI: Just to interject, that's outside of the -- that's back in the DB area. We asked them when you were doing --

MR. WACHOWIAK: Okay. So I don't want to --

MEMBER SHACK: -- the water doesn't get in.

MR. WACHOWIAK: And that would be a design issue. In the PRA we've kind of assumed that -- and it's an assumption -- we assumed that the plant is designed properly, and that's an assumption that we have to make in the PRA or we get an NP complete problem that we have to solve.

CHAIRMAN CORRADINI: Okay. I want to do a time check because I'm going to lose some members shortly. So I know John has a couple of questions back on things related to the thing. I wanted to make sure we addressed George's question and other questions relative to this topic and then move back to John's questions.

MR. WACHOWIAK: So let me get back to the one question. The one thing on uncertainty is the total flow area from the GDCS pools into the reactor because in this flow regime, the total number of valves or injection points that would inject is almost a linear relationship kind of sort of almost to the flow.

So what we've looked at here is, one, we calculate what the minimum complement is. We add one to address that we may not know exactly how much flow there's going to be, and then there are some other areas there, and then the third piece that we did was we said now what does it take before the PRA numerical results have been significantly influenced?

So if one is what we calculate, we say we need two, and then three changes the CDF by a factor of 1,000, well, we're in an unstable range here where we're able to calculate what the CDF is, but in fact, when we say our code shows we need one, we use two as the success criteria, but six is where the break point is before you start to radically change the PRA.

We think we're in a pretty stable regime here, that adding the one sufficiently addresses the uncertainties, and even if we weren't exactly right, two to three isn't going to change the numerical results or, you know, still if you want a best estimate, two to one isn't going to change the numerical results either.

MEMBER APOSTOLAKIS: So basically the way you manage it is by adding this extra one, by saying that the code shows that I need to add, I will demand two.

CHAIRMAN CORRADINI: Right.

MEMBER APOSTOLAKIS: And then the assumption there which may be a pretty good assumption is that even if there are uncertainties in the calculation with one, because if I do the second one I have overwhelmed them. Is that the logic?

Without saying whether it's right or wrong, that's the logic.

MR. WACHOWIAK: That's the logic, and that logic works when the change in CDF, by changing that success criteria remains relatively flat in the region that we're looking at. So in the zero to one to two region, that success criteria has very little effect on CDF.

Five to six is a different change, and we would have to do the uncertainty calculations that address uncertainty differently if we were on that other part of the curve. So a combination of all of those things --

MR. SEEMAN: So right here is our base case, and so you can see --

MEMBER APOSTOLAKIS: You're looking at?

MR. SEEMAN: Okay. This is our core damage frequency results.

MEMBER APOSTOLAKIS: Okay.

MR. SEEMAN: Or base case, and this number just has to do with the truncation level that we use to run this. So our existing success criteria is two of eight, GDCS lines, four of eight DPV valves opening and PCCS heat exchangers four of six. So if we change that to five of eight GDCS valve, essentially no difference.

If we changed it to five of eight GDCS valves, eight of eight DPVs and five of six PCCS, the heat exchanger there's still essentially no change. But when we went to six of eight GDCS lines, six of eight DPVs, and five of six, well, okay, now we may be a factor of almost two, and it wasn't until we get to six of eight GDCS lines, six of six PCCS and six of eight, that's when we started.

So here we didn't have any redundancy, and the problem, what was happening here, I think, is we had a test and maintenance firm for the PCCS heat exchangers. So you know, you can see that we're way down here, and until we get to six of eight --

MEMBER APOSTOLAKIS: Excuse me. This blue bar, these are the results of the PRA calculations with different examples, the redundancy.

MR. WACHOWIAK: Yes.

MR. SEEMAN: Well, yeah. Here we've changed our top.

MEMBER APOSTOLAKIS: Instead of two out of eight you say three out of eight, four out of eight, and you do your PRA. That does not involve any thermal hydraulics.

MR. WACHOWIAK: No, that is not thermal.

MEMBER APOSTOLAKIS: So far so good. Then the thermal hydraulics comes when you actually run these codes, right? With one out of eight and you show that it's good enough. So then you're saying if I move to two out of eight, that's even better, and if there were any uncertainties in my one out of eight, the two out of eight takes care of it. That's the logic.

MR. WACHOWIAK: That's what we're saying, and that logic works as long as we're on that part of the curve and it makes little difference whether it's one out of eight, two out of eight --

MEMBER APOSTOLAKIS: Okay. Now I understand. I think it's reasonable.

MEMBER SHACK: But he could even address more if he took three out of eight to really cream the uncertainties. It still wouldn't change his answer.

MEMBER APOSTOLAKIS: They could. They could.

MR. WACHOWIAK: But what we end up doing

though is we start to introduce more and more unrealism, and that causes other problems.

MEMBER APOSTOLAKIS: So the only thing that is left out here is, which is probably extending the unlikely, is there is a sump coupling mechanism that can defeat three or four of these things, you know, and overwhelm and defeat this argument, but I think that's a very --

CHAIRMAN CORRADINI: The staff has a comment.

MR. DUBE: Yes. Don Dube.

Mainly it's a question, but this is a direct result also of the fact that in your common cause failure model, you don't take credit after the fourth valve or so. I mean your conditional probability of the fifth valve is one, and so on and so forth. That's why you're relatively flat.

MR. WACHOWIAK: That is one of the reasons why it's flat.

MEMBER APOSTOLAKIS: Because the common cause failure is not --

MR. WACHOWIAK: And it's probably one of the larger influence on it.

CHAIRMAN CORRADINI: Okay. So can we turn to additional questions that are not thermal hydraulic? John.

MEMBER STETKAR: Yes.

CHAIRMAN CORRADINI: Back up.

MEMBER STETKAR: Thanks.

CHAIRMAN CORRADINI: You get one, maybe two.

MEMBER STETKAR: Okay. I'd like to mention two we're asking. You're going to need probably your model, guys. The three areas that I was kind of looking at, one was modeling logic. Is the and and/or logic correct?

And originally had some questions. I think the Rev. 3 models that we didn't see may have fixed those, at least the ones I found.

The second area was completeness of the models, and that got into are we modeling -- does the PRA model include the equipment in the design? That's the manual valves and all of that kind of stuff, and does it complete the account for all of the causes for failure, given the fact we have all of the equipment. That got into treatment and maintenance and those types of issues.

The third thing that I haven't talked about at all, and that's why I wanted to bring it up while everybody is here, is the treatment of physical and functional dependencies in the model, and I want to address that in two specific examples just because of the time.

The first example is a standby liquid control injection line break. In the Rev. 2 PRA model, it was modeled as a medium LOCA. I understand you have moved it over into the small LOCA model, and I understand why, and I don't have any problem with that.

I want to understand how it's modeled, however. Is it only included as a contributor to the frequency of small LOCAs or is it modeled as a completely separate initiating event?

MR. WACHOWIAK: He's going to check, but I'm pretty sure it's a contributor to small LOCAs.

MEMBER STETKAR: So it's just another small LOCA.

MR. WACHOWIAK: We'll check.

MEMBER STETKAR: And I need to know the answer to that question because it's really important. I mean, I may shut up after that.

CHAIRMAN CORRADINI: You may or will?

MEMBER STETKAR: On this particular issue, I will depending on the answer

MR. WACHOWIAK: Okay. So --

MEMBER STETKAR: Well, the other issue is a little more convoluted. This one theoretically is simple. The other example is a little more convoluted. This one --

MR. WACHOWIAK: So, Walter, they're looking for that. We have it as a contributor, but there are things that are associated with that in that you remember that one case yesterday where we had the initiating event plus the other infraction to address a broken GDCS line down --

MEMBER STETKAR: I want to see how that's modeled, and in particular, while they're looking, I want to look and see how that break is treated in the ATWS model.

MR. WACHOWIAK: And I think how that particular break is treated in the ATWS model. In the standby control system tree is the break. Is there an initiator impact on the break?

MEMBER STETKAR: You can't do a fractional percent because that's a fraction of all small LOCAs. It has got to be that event.

MR. WACHOWIAK: We treated that in the GDCS line. You saw how we treated that in the GCDS line. They're looking --

MEMBER STETKAR: I didn't see how you

treated it because I haven't seen the fault tree that has it in it because every fault tree that I've ever seen has not had that in it. So I couldn't -- I haven't seen any of these house events ever.

MR. LI: Okay. So can I speak now?

CHAIRMAN CORRADINI: Yeah.

MR. LI: This is Jonathan Li from GEH.

You know, we just performed a simple search. When you find those percent something is initiated. We include initial impact, you know. The way we model like the stick (phonetic) is kind of front line system. Below the front line system you have all of the supporting systems. So some of the initial impact is captured in the supporting system. In this case especially it's in the I&C model. So you have a signal. After this select system, you know, which is logical. You know, how do you actuate select?

The actual incinerator has to be coming from the control system. So the impact is captured in the I&C model.

MR. WACHOWIAK: And so what's in the I&C model is the small break. So in a small break LOCA --

MR. LI: Well, that you need to search our basis. Now that --

MR. WACHOWIAK: So small break LOCAL, failure to SCRAM.

CHAIRMAN CORRADINI: Because of time, let me stop there because we're not going to answer my question in real time. My concern is for the staff so that they hear it and so that the other members hear it, is that what happens is the small break loca model, if the control rods do not insert, if I don't shut down the reactor, you require for all ATWS situations, you require standby liquid control injection.

The success criteria is I require injection from both trains. If I have injection through only one train, I lose. I go to melt. If I have a broken standby liquid control injection line, I am guaranteed to not have injection through both trains. I am guaranteed to go to melt for the conditions standby liquid control injection line break and control rods fail to insert, and all conditions come out of the ATWS model and go to melt for that.

I would like to see how that is handled because in anything that I could see in the Rev. 2 and the Rev. 3 fault trees that I could look at did not have that in it, did not have that in it.

CHAIRMAN CORRADINI: Did not have that

particular --

MEMBER STETKAR: Did not have that tradition.

CHAIRMAN CORRADINI: Did not have that conditionality.

MEMBER STETKAR: Did not have that conditionality. It was just not in there. So I had that question about how was that handled.

Second issue comes in through support systems, and it's a similar issue. That's kind of a physical/functional because I can consider it a functional because the functional success criteria requires something that I don't have. Now, you can think of that as physical.

The other part is, for example the -- and there are several examples of this one. I'll use loss of instrument here only because it's something that also moved around between Rev. 2 and Rev. 3. I had a question on it in Rev. 2 as far as what are the impacts from loss of instrument air and how as an initiating event loss of -- and it's called complete loss of compressed air or something like that.

Rev. 2 is treated as a general transient. Now it's treated as a contributor to loss of feedwater because you recognize that loss of air will cause loss of feedwater. That's a functional impact. So it was reallocated to the right initiating event category.

However, again, nowhere in the models for the loss of feedwater initiating event response can I see anything that has a flag or a house event or some condition set that said for the loss of air initiating event I fail the air systems because air is required for a large -- it may not be directly required, but it's a contributor to many of the systems that are in the model.

MR. WACHOWIAK: That one we should have.

MEMBER STETKAR: And it might be in there now, but I'll tell you on Sunday I couldn't see it in anything that I have. So it's really, really difficult for me as a reviewer now to understand how the model works. There's nothing in words that tells me, hey, for this initiating event this is what we did. There is not a story there, nor is there any logic diagram, fault tree logic or anything, that shows me how it was done.

So when I went to go look for this, I couldn't find it. Hence the question.

Now, from what you seem to be popping up now, they seem to be wired in there. When they got wired in there, I have no idea. It must have been in

Rev. 3. I trust that the pictures in Rev. 2 were the Rev. 2 pictures because you spent the money to print them, you know, make PDF files out of all of them.

MR. WACHOWIAK: Yeah, and this was one of the things where in Rev. 2 I think many of these things -- weren't these the things that Eric handled manually in Rev. 2 and then in Rev. 3 he specifically put them into the model so that they didn't need to be --

MEMBER STETKAR: Well, they're really important because I mean I had a whole laundry list of these things. For example, do you lump together electric power failures at the non-safety buses in the general transient model because you argued well it will give us a turbine trip?

However it gives you a turbine trip, but also fails power. You know if it's a single bus, it'll fail power to equipment that you're taking credit for in the feedwater system, condensate sample, for example, and that dependency should be gone through the model. I mean, the things that we've learned from doing many, many other, you know, standard plant PRAs is that the correct treatment of especially support system dependencies is really important, and a lot of times people run those through as -- I don't care what logic model structure you use, whether you use a transient model or something that looks like a feedwater model, but correctly accounting for those dependencies from that particular initiator, whether it's a loss of this bus, whether it's a loss of instrument air, whether it's a loss of DC power, whether it's a loss -- you know, this standby liquid control line break, that those dependencies are, indeed, correctly modeled through the whole thing, Level 1 through Level 2.

CHAIRMAN CORRADINI: So --

MEMBER STETKAR: I'm done.

CHAIRMAN CORRADINI: So you've expressed it. Is this something as a take-away for staff to be aware of or is there more discussion at this point?

MR. LI: I think we can respond.

CHAIRMAN CORRADINI: Briefly. We're going to lose some members, and I need to get some sort of wrap-up comment before they dash out of the room.

MR. WACHOWIAK: And I think it's going to need to be probably a combination of things where you may when you're looking, you may want to look for the specific things, but we can tell you in general what we try to model in this model.

MR. HOWE: Right. This is Justin Howe

from GEH.

And I think in general what you'll see is if you look at the front line systems that depend on air, you won't see the explicit initiating event there because I can say, because all you're see is the support gate that is the top gate for the instrument air system, and under there is where we capture --

MEMBER STETKAR: Yeah, I don't care where the flags are flown. I want to see that the flags are there, the house of answer, whatever it falls, switches.

MR. WACHOWIAK: I think in most of these cases you'll find now that they're there explicitly in the model because that was one of the upgrades that we did for Rev. 3, was to get them out of this nebulous manual thing and into the automatic calculation.

I will have to look at this, but I am a little concerned with the standby liquid control one because of how it got from the old medium LOCA which I think didn't consider ATWS and medium LOCA or was medium LOCA --

MEMBER STETKAR: It did not. Medium ATWS was directly there. You can worry about the small break. I didn't worry about it at that time.

CHAIRMAN CORRADINI: And also because it

was not considered before and when it was moved into the different initiator, there is a potential that we missed that when we created --

MEMBER STETKAR: My question changes when I saw that you moved it, but it was the same kind of one.

MR. LI: Okay. This is Jonathan Li from GEH.

We brought up the Revision 2 also here. So when you see what I'm trying to show here is I find that percent T-RA, which his loss of --

MEMBER STETKAR: But that's a basic event.

MR. LI: It's basic event, yes. What I'm showing is it shows parents (phonetic), The parents which means where this initiator showed up. This initiator showed up in a lot of places. One place this initiator, a group of initiators -- another place is under that P52, which is instrument air assistant tock (phonetic). So that thing can fail instrument air when for other fronting system, you know, it transfer to P52 and it fails that way.

MR. WACHOWIAK: Let me get -- the way we do this, the way our code works is if you have the initiating event in two places. So if the initiating event fails instrument air, when the quantification is done, every initiator that starts or every sequence that starts with a loss of air also includes through the support system the failure of the instrument air system. So anything that we would have counted on that would have required instrument air in that tree, it has already failed.

MEMBER STETKAR: As long as that's done correctly and consistently, you know, and there are a bunch of different -- the mechanics of doing it is the mechanics of doing it. You know, the key is to be able to see and understand that it's done consistently and completely.

MEMBER STETKAR: And I think that one was in Rev. 2.

MR. WACHOWIAK: Was it?

MEMBER STETKAR: Yeah, in instrument air.

MR. LI: The change from Rev. 2 --

MEMBER STETKAR: I didn't recognize it because I'm more used to seeing house events and things like that. Basic events, I always worry about basic events because they are numbers usually.

MR. WACHOWIAK: Yeah, it starts with a percent sign and is an initiator. So initiators that are buried down in fault tree models are meant to address exactly what you're talking about.

MEMBER STETKAR: Keep it as a take-away for the staff because if they're going to do this audit of the Rev. 3 models, which as I understand, just be aware of something to look for.

CHAIRMAN CORRADINI: Good. So at this point I'm going to thank the GEH because I'm going to start losing my Subcommittee and thank the staff, and I'd like to turn and go past all of the Subcommittee that I could get some brief summary, and in Dennis' and in John's case, potentially in George's case, you're going to send me things written.

All right. Let me start with Bill since you are primed.

MEMBER SHACK: It was a very good meeting. I think I learned a lot about the PRA. I think I'm convinced that the PRA meets the expectations it needs for the design certification. So I'm happy.

MR. KRESS: I would have to put ditto marks on exactly what he said, and I can't comment on the BiMAC because I have a conflict of interest. The PRA, I think it meets the needs for certification.

CHAIRMAN CORRADINI: Dennis. And I'm waiting for George to come back. So I'm starting in an odd place.

Dennis, go ahead.

MEMBER BLEY: Mine is a little longer. I'm going to include three things that came up at the June meeting that we haven't talked about again that are still on the table for me. I'm not quite as convinced that the PRA is adequate because there are -- even if we were to say that a Category 3 PRA is fine for this, it's got to have fidelity to the plan. What I'm hearing is --

CHAIRMAN CORRADINI: Category 1 you meant, right?

MEMBER BLEY: Yeah, whatever I said, I meant Category 1.

CHAIRMAN CORRADINI: Okay.

MEMBER BLEY: I was thinking about the next thing. I'll give you this sheet if you want, Mike.

CHAIRMAN CORRADINI: Writing it up later would be much better, but go ahead.

MEMBER BLEY: Oh, okay. I think to have the kind of confidence that was expressed by the first two members, there's a few things I need to hear back from staff. One of them is that they've reviewed the Rev. 3 PRA models and can assure us that essentially the errors that were apparently in the Rev. 2 models have been fixed.

Now, I didn't hear that staff had identified those errors, but John talked about a lot of them. For example, I went to the isolation condenser tree and right down in the second page of it when you start looking at failure, now, these were identified in the Rev. 3 write-up as we took care of a problem with dependence on nitrogen and something else, but we had a failed open valve treated as a failed closed valve. We had a valve that was stated in the drawing and in the write-up as motor operated being treated as an air valve. So there were just errors, and you need to look down and make sure those aren't around.

I'd like to hear -- and this is from the last time -- that the report in the last time that we had a discussion, that you guys found the initiating events through a combination of looking at old initiating events through the old NUREG and through something like a failure mode and effects analysis of the individual ESBWR systems, which is the kind of structured approach I think you need to look at new passive designs. Is there something here that's unique and could get us in trouble?

I haven't been able to find it, but I hope staff has reviewed that and is confident that it can pick up the unusual events that might be associated with the design.

It also talks about not credible in there and it seems an unusual phrase to be in the midst of this kind of analysis.

The third one is the bases and uncertainty in the success criteria I'd like to hear have been reviewed and seem to be reasonably thorough. We heard one yesterday that kind of came because Theo said this was good enough, but now when you look in detail, you need more than that. I'd like to see some detail on that. That's enough on that one.

Conditional analysis, what John was just talking about and the flags, it wasn't -- at least I didn't see it mentioned even in the PRA document. I know it's all in the model, but it seems to me there should have been an explanation that you looked at these things under conditional situations, and I'd like to hear that the staff has dug into that and think that's, other than the two we brought up here, that that's consistently been handled well.

Finally, there's data, and I know there's lots of possibly inapplicable data at this point in time because there are new systems. The one I brought up last time was the vacuum breaker, and that one still bothers me and that hasn't been changed.

The prior, I think, has no basis, and completely dominates the answer of the so-called Bayesian analysis. It's an odd, it's an unusual new design, and it seems to me requires some thought on the common cause aspects of it. That's a gap to me right now, but that's not enough to say the PRA is not good enough.

On the BiMAC, again, I didn't hear the assurances yet on these things,a nd I was interested in that. The first one is that the so-called significant sequences all had greater than six hours. So the assumptions for the tests are reasonable. I'd like to have that confirmed, that you think that's reasonable.

The ROAMM process down side that George brought up of not looking at the alternative paths, I haven't seen anything that talks about why that's a reasonable thing and can't get us into trouble.

The elicitation process, I'd like to hear that the elicitation process in its review was sound and that the results are supportable. we haven't seen that yet, and --

CHAIRMAN CORRADINI: We'll get a copy of that.

MEMBER BLEY: We'll get a copy, but I want to hear from staff on that one. We haven't heard from staff on that one.

And the other two sets of questions on that I don't think were answered here, and I'd like to hear answers. Tom and Mike talked about the three conditions at the time of deluge and have they been addressed, and Said talked about the scaling issues for the experiments.

And the last thing isn't associated with this, but I want to get it on the table. The ISG that says the ASME Category 1 PRA is good enough for design cert. and COLs I think passed through my hands about a month ago, and our staff asked if we wanted to look at that and I said yeah. And I think we want to look at that.

CHAIRMAN CORRADINI: Again? I'm sorry.

MEMBER BLEY: They mentioned yesterday the interim staff guidance that says the ASME Category 1 PRA is good enough for design certification and COL PRAs. We haven't reviewed that. I believe our staff asked me if we should, and I told them yes, and I think we should.

CHAIRMAN CORRADINI: Okay. George, we're going --

MEMBER APOSTOLAKIS: Everybody else has spoken?

CHAIRMAN CORRADINI: On the left-hand side. We're going to the right.

MEMBER BLEY: Clockwise.

MEMBER APOSTOLAKIS: Okay. On a fairly high level, I think there are two or three things that have been resolved in my mind, and I'm very pleased that this was happening. We had extensive discussions on what it means to use PRA in the design certification phase and especially Don Dube's citation there and the ensuing discussion put my mind at ease because in the future a lot of the detailed stuff that may need correction will be corrected not necessarily by you guys, but of another phase, and that this PRA has been used appropriately.

I was very impressed by how well GEH stood up to John Stetkar.

(Laughter.)

MEMBER APOSTOLAKIS: I think they did a hell of a job, which makes me feel much better about the PRA. That doesn't mean that all of the issues have been resolved, but there were people here who were saying, no, we did this; we didn't do that; and we know that we did this, and so on, which I think is very, very good.

The problem of documentation, we understand that now. That's going to be resolved. So overall I'm very pleased with this handling of uncertainties. I mean, I tend to go along and believe it, but it would be nice to see maybe the single calculation that was done with the thermal hydraulics to actually include some uncertainties.

But maybe it's a detail that -- I don't expect, in other words, the peak to jump up if you do it and all of that, but again, you have to, I have to rely on my judgment if that's the case, but a more complete argument would include the uncertainties in one calculation.

But at the same time, maybe we don't understand all of these uncertainties, and by doing this kind of, you know, adding one extra --

MR. KRESS: The uncertainties would be different, the success criteria for one, than they would be for two because you've told the thing to an entirely different flow regime. With two you don't even uncover the core. With one you uncover the core.

MEMBER APOSTOLAKIS: Right. So it would be nice to see --

MR. KRESS: So you have different

uncertainty levels depending on them. I would say, you know, with these thermal hydraulic calculations, you're talking about percentages, like factors of 50 percent, as opposed to factors of ten.

MEMBER APOSTOLAKIS: Yeah. Anyway, overall I'm very happy with what I heard.

CHAIRMAN CORRADINI: John.

MEMBER STETKAR: Thanks a lot. You guys did good.

I'd echo George's. I feel a lot more comfortable in about PRA and your knowledge of the PRA. I might have a difference of opinion, but at least in many of the areas that I question you had active reasons for doing what you did and were aware of them anyway. So that's really good. That helps.

I do, however, still, because this devil is in the details and the fidelity of the PRA to model the design as we understand it today, think that it is important, echoing Dennis' sentiment, that we as a Committee have better assurance -- and this is directed at the staff -- that the staff has taken away some of these concerns about completeness and what may sound like details but, indeed, are important so that at the end, the next time we hear back on this we have reasonable assurance that the staff has looked at the

PRA as it is today, Rev. 3.

And in my mind, the changes that have been made to the PRA are not as minor as you might believe reading through Chapter 22 because a lot of these little things about where house events are put and small changes, they're characterized as small changes to the event model, to the fault trees, indeed, may have bigger effects than what you're led to believe just reading Chapter 22. I'll just say that. They are changes to the logic model, and that shouldn't be taken lightly.

And I'll be quiet now. Thank you.

CHAIRMAN CORRADINI: Said.

MEMBER ABDEL-KHALIK: I'll just limit my comments to the BiMAC presentation. I think I have two concerns. One relates to the scaling, the applicability of the test results to the full scale, and number two, I'm still not clear as to what the limiting phenomenon is, whether it's CHF or OFI. You have not, you know, shown the data that would justify using CHF as the limiting heat flux. If you have a system of, you know, parallel tubes of unequal length subjected to nonuniform heat flux, depending on where the melt ends up, what is the OFI limit for that case?

The single tube experiment doesn't

demonstrate that. The single tube calculations do not demonstrate that.

That's it.

CHAIRMAN CORRADINI: Oh, those were the two. I'm writing. I'm sorry.

Okay. So let me thank GEH and the staff for their time and efforts. Everybody was going into this indicating what in God's name would we do for a day and a half when it was this open, but I think we investigated details that we wanted to get to.

I guess I sit a bit more on the camp of the left -- I hate to say that, but --

(Laughter.)

CHAIRMAN CORRADINI: -- but Bill and Tom, that I think it's adequate for the certification, but I do think though that I've been trying to craft some conclusion here, and from what I've heard of everybody else because I think that's kind of my role in this, is what I think I'm hearing if we're going for consensus is I think the consensus is although some of us may feel it's adequate, I think we're looking to the staff for a review of the Rev. 3 to judge the advocacy. We want to hear from them that they look at Rev. 3, it's adequate, why it's adequate, what's missing, the errors are corrected, et cetera, et cetera, so that we have confidence the staff has given it the good once-over.

Other than that, I would say that in terms of severe accident management, I tried to capture what Said said. I have a number of other things, and I will send out all of this to the members to make sure we're on the same page.

And I guess I'd look to particularly Dennis and John and George on the Level 1 and the sequences to try to give me some discussion because I feel a bit limited in my ability to reflect on a lot of this stuff. So I'm going to look to you guys to fill in.

Other than that, thank you very much. Have a good weekend.

MR. WACHOWIAK: You're welcome. Thank you for the discussion and our opportunity to help you understand what we have.

CHAIRMAN CORRADINI: Adjourned.

(Whereupon, at 11:43 a.m., the Subcommittee meeting was concluded.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of: ESBWR Subcommittee

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