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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

December 15, 2006

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This transcript has not been reviewed, corrected and edited and it may contain inaccuracies.

UNITED STATES OF AMERICA

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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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MEETING

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FRIDAY,

DECEMBER 15, 2006

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ROCKVILLE, MARYLAND

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The Advisory Committee met at 8:30 a.m. in Room T-2B1 of the U.S. Nuclear Regulatory Commission, One White Flint North, 11555 Rockville Pike, Rockville, Maryland, Dr. George E. Apostolakis, Chairman, presiding.

MEMBERS PRESENT:

GEORGE E. APOSTOLAKIS Chairman
WILLIAM J. SHACK Vice Chairman
SAID ABDEL-KHALIK Member
MARIO V. BONACA Member
MICHAEL CORRADINI Member
THOMAS KRESS Member

MEMBERS PRESENT (CONTINUED):

OTTO L. MAYNARD Member

JOHN D. SIEBER Member

GRAHAM WALLIS Member

ACRS STAFF PRESENT:

ERIC A. THORNBURRY

AGENDA ITEMS	PAGE

P R O C E E D I N G S

(8:31 a.m.)

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is the second day of the meeting of the Advisory Committee on Reactor Safeguard subcommittee, Probabilistic Risk Assessment. I'm George Apostolakis, Chairman of the subcommittee.

Members in attendance are Said Abdel-Khalik, Mario Bonaca, Michael Corradini, Tom Kress, Otto Maynard, Bill Shack, Jack Sieber, and Graham Wallis. Eric Thornsburry is the Designated Federal Official for this meeting.

The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on December 4th, 2006.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

Today we plan to finish the presentations from General Electric then hear from the staff regarding any particular areas of interest that they have identified in their requests for additional information.

We will now continue with the meeting and I call upon Mr. Rick Wachowiak -- say it?

MR. WACHOWIAK: Wachowiak.

CHAIRMAN APOSTOLAKIS: Get a Greek for heaven's sake.

(Laughter.)

CHAIRMAN APOSTOLAKIS: From GE to begin today's presentations.

MR. WACHOWIAK: All right.

So we are going to continue with the presentation that we had yesterday. I've talked with Tom Kevern of the NRC staff. And we coordinated our time. So I've got about an hour and a half of time to cover the material. Some of it we talked about in other conversations already yesterday so when we get to things that we have already talked about, I'll move it along.

So the first part of this morning's presentation will be about some modeling issues in our PRA that either the staff have questioned or we've heard in previous meetings with the ACRS subcommittee. Three of them that I want to talk about here are common cause failure methods, treatment of data for components with long test intervals, and then discuss our strategy for addressing thermo-hydraulic uncertainties.

In the PRA, Revisions 0 and 1, we used the alpha factor method for doing common cause. We had some difficulty with that on our end also. Number one, that when we had to do the uncertainty analysis, the numerical uncertainty, at least, we had some difficulties getting the computer code to do it properly when we had that method.

Also, some of our sensitivity analyses that we did we had to go into some manual manipulation of the model to make that work. And it proved to be difficult.

What we are doing in Revision 2 is using the multiple Greek letter method as is supported in the CAFTA software package and so we can directly do our other analyses without a lot of manual manipulation of the terms in the model.

We've also decided that for the purposes of the design certification model, we are going to limit the order in the MGL to just beta, gamma, and delta where we have through delta. And every other letter would be considered to be one after that. So it is like a two, three, all-type model.

CHAIRMAN APOSTOLAKIS: Even with delta and gamma, you don't gain much as I recall. I mean the numbers are very close to one.

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: Are you using the generic numbers or distributions?

MR. WACHOWIAK: The URD has some factors for specific types of components. And then there is a generic unknown component. We're going to start with that set of data. And for other things, what we found is that a lot of things fall into the unknown category from the URD.

CHAIRMAN APOSTOLAKIS: Unknown means what in this case?

MR. WACHOWIAK: It means they didn't collect data for those. It was a component that they didn't have factors for at the time that that document was written. And it is a fairly old document.

CHAIRMAN APOSTOLAKIS: Well, there are NRC documents that are much more recent as you know.

MR. WACHOWIAK: And that's correct. We are going to see if we can pick up information from the newer sources like the INEL database and see what is applicable for these.

CHAIRMAN APOSTOLAKIS: I'm wondering how your designers react to the values that are given.

I'm working with some designers up at MIT and they were very frustrated when I tell them, you know, the beta factor is about .1. And then the guy says well, tell me what to do to reduce it. And I say I don't know. I mean it is a generic number.

And they would go down to .05 or something but the problem there is that there is no clear one-to-one correspondence between what you do to the design and the numbers you are supposed to use. They are essentially fudge factors.

So to argue that I increased the separation therefore beta goes down by a factor of six, for example, is very, very hard. So I'm wondering whether you have similar problems.

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: Okay.

MR. WACHOWIAK: The designers tend to, as is probably in your experience, they tend to think that the common cause failures are all eliminated by a robust design.

CHAIRMAN APOSTOLAKIS: Yes.

MR. WACHOWIAK: And they can be but they don't --

CHAIRMAN APOSTOLAKIS: And they are willing to listen --

MR. WACHOWIAK: Right.

CHAIRMAN APOSTOLAKIS: -- but they want also some advice. I mean tell me what to do and I'll do it and reduce the number.

MEMBER WALLIS: You see a design error which would make your number much bigger than .1.

MEMBER CORRADINI: You could.

MEMBER WALLIS: You don't know. So it is a very uncertain process isn't it?

CHAIRMAN APOSTOLAKIS: In the external event area, that is particularly true because these design errors will reveal themselves when you have the event. But still, I mean, that is an issue that is difficult to handle.

MR. WACHOWIAK: Especially at this stage it is difficult to handle.

CHAIRMAN APOSTOLAKIS: Exactly unless you clearly have, you know, separation and physical barriers all that, it is so hard to argue.

MR. WACHOWIAK: And some of the other things that we are taking into consideration is the operating environment. If you have the same component that is operated in a completely different way than another one, then that would tend to reduce the values. So we are looking at that also.

CHAIRMAN APOSTOLAKIS: Especially, you know, in your case where in many instances you deal with seven out of eight or a very large number. A low number for the total common cause failure frequency would be justified but it would be hard to justify.

MR. WACHOWIAK: Yes. And in the case of the squibs, as we saw, each of the eight valves has four on there so seven out -- well, it would be large number out of 32 that would have to fail to get there.

CHAIRMAN APOSTOLAKIS: It seems to me the alpha factor method should be called the single Greek letter method. And then you go to the multiple Greek letters.

(Laughter.)

CHAIRMAN APOSTOLAKIS: The mean time to laughter is about five seconds.

(Laughter.)

MEMBER WALLIS: Do you want any more jokes about this one?

CHAIRMAN APOSTOLAKIS: No.

MEMBER WALLIS: Okay.

MR. WACHOWIAK: The release of CAFTA that we are using includes a common cause tool. We select the method that we want to use. We put the factors in. And then the code does the tedious work of doing all the right expansions and putting them in the right way in the model. That way if we want to change success criteria or something else, we have less chance of human error on the PRA side and getting things right. It enforces the standards, if you will.

I've got a couple of example things here that we will go through quickly but basically what you do is you define your common cause group, you define the parameters in the model, you tell the code to create the logic. You can also tell the code to remove the logic so when you are changing things, you can bring it in or take it out.

Don't necessarily need to talk about all of the specifics but this is part of define. You go into the database and define it. You input the parameters.

CHAIRMAN APOSTOLAKIS: So you are limiting yourself also to similar components in the same system. Do you consider common cause failure of all squib valves? That would be --

MR. WACHOWIAK: That was one of the terms that we considered. Because the different squib valves for the different systems we talked about yesterday, the GDCS, ADS, and the equalizing lines, and deluge lines, they are really different types of valves we are probably going to get from different places so we will have to look at that. But I don't think that we would have a common cause of all the squib valves if they were different types of valves.

But if we had the same valve in two systems that really are in the same application, they are in the same environment, they get the same maintenance, then we would have to consider that for part of the common cause group.

CHAIRMAN APOSTOLAKIS: But in the current PRA, how do you do it?

MR. WACHOWIAK: I think we made the case that the design of the different types of valves are sufficiently different that we wouldn't need to keep them in the same group.

MEMBER WALLIS: In the case of the DPV, we told you about this yesterday, the load drivers for the DPV I think when you analyze that, you have a common cause of .1 for all of them failing together as I understand it because this is one of your large release events. I was a little puzzled by that.

CHAIRMAN APOSTOLAKIS: So it goes across systems you mean?

MEMBER WALLIS: All systems, everything failed.

MR. WACHOWIAK: Right. Now the load drivers are --

MEMBER WALLIS: Are a probability of .1.

CHAIRMAN APOSTOLAKIS: That's pretty high.

MR. WACHOWIAK: The load drivers aren't actually in the individual systems. They would be contained in the I&C system.

MEMBER WALLIS: Right.

MR. WACHOWIAK: And so they are all in cabinets in the reactor building in the same environment, in the same type of operating conditions. So that as the first cut, we considered those all part of the same thing.

MEMBER WALLIS: And so it was either one or all? It is either one with a probability of ten to the minus six or all with a probability of ten to the minus seven.

MR. WACHOWIAK: That's right.

MEMBER WALLIS: That's -- it just seemed to be a little shaky that you have to make some guess.

CHAIRMAN APOSTOLAKIS: Are you disputing the .1?

MEMBER WALLIS: For this particular set, you decided to be conservative apparently. But still the .1 comes from the air. Release .1, that is wonderful.

MR. WACHOWIAK: It comes from --

CHAIRMAN APOSTOLAKIS: No, the .1 doesn't come from the air.

MEMBER WALLIS: Well --

CHAIRMAN APOSTOLAKIS: There is strong evidence that about ten percent --

MEMBER WALLIS: Is about right for everything?

CHAIRMAN APOSTOLAKIS: -- of individual failures is a common cause. If you look at a thousand component failures, then about ten percent of those involved a failure of an additional component.

MEMBER WALLIS: Okay. And this --

CHAIRMAN APOSTOLAKIS: So there is some --

MEMBER WALLIS: So he is being very conservative --

CHAIRMAN APOSTOLAKIS: They are very conservative.

MEMBER WALLIS: -- when he leaps from one failing to all failing.

CHAIRMAN APOSTOLAKIS: That is right.

MEMBER WALLIS: Okay.

MR. WACHOWIAK: And in Revision 2 for the load drivers, we probably will not do that. We will probably do one, two, three, and then all.

MEMBER WALLIS: In which case you have a much lower probability of this.

CHAIRMAN APOSTOLAKIS: It is not much lower. That was my point --

MR. WACHOWIAK: It is not much lower.

CHAIRMAN APOSTOLAKIS: -- earlier. I mean gamma is usually .7 or something. So --

MEMBER WALLIS: It is .1 here.

MR. WACHOWIAK: This is an example of the database or of the method. It is not actual data.

MEMBER WALLIS: I see. Well, I thought this was just your baseline assumption that everything is .1.

MR. WACHOWIAK: No. The baseline assumption will be the generic alpha, beta, or beta, gamma, delta in the URD. That would be the base assumption. And I think --

CHAIRMAN APOSTOLAKIS: But why the URD, Rick? I mean these are more recent than NRC reports? Very detailed? Using data --

VICE CHAIRMAN SHACK: I think it is nice to have everybody use the URD data then it highlights the differences between the designs and, you know, you don't argue over whether the difference between the two is due to the assumptions they make.

So I would like to see one base case where everybody uses the same data even if it might not be the best data. Then, you know, if you want to go to a more realistic case, that is a different question. But I think it is kind of good to highlight the differences that are inherent in the design by using a common data.

CHAIRMAN APOSTOLAKIS: Why? Do the regulations say I have to worry about how this design compares to another?

MR. WACHOWIAK: Well, from the utilities point of view when I was a customer --

CHAIRMAN APOSTOLAKIS: But we are not.

MR. WACHOWIAK: Well --

CHAIRMAN APOSTOLAKIS: It seems to me we have to use the --

MEMBER KRESS: Even as a way we can compare one design to another, it puts them in perspective at least, you know, whether it is a requirement or not.

CHAIRMAN APOSTOLAKIS: This document is so old. When was it published?

MEMBER KRESS: 1992 or something.

CHAIRMAN APOSTOLAKIS: Even before that.

MEMBER KRESS: It was before that.

CHAIRMAN APOSTOLAKIS: Before, yes. I mean there has been a lot of progress and so on.

MEMBER KRESS: Maybe there ought to be an updated set of standards but I like Bill's concept. It would be nice for everybody to use the same ones.

VICE CHAIRMAN SHACK: Yes, I mean you don't use it -- you know you do it and then you go on to what you think is your best estimate and your sensitivity analysis. But just as a case, I think it is an interesting one.

CHAIRMAN APOSTOLAKIS: Well, if you are asking for it in addition, then I can object. I think it is a waste. It really is a waste. I've never heard anybody on this committee compare a design with something else -- with some other --

VICE CHAIRMAN SHACK: Yes, I know, but when I'm looking at designs, I'd like to know how much of the difference is due to, you know, when you look at an IPE, you know, we know that the IPE results were frequently driven by data assumptions of which were very difficult to justify.

I mean we are having this discussion here. I mean whatever number he comes up with --

CHAIRMAN APOSTOLAKIS: Yes, but if it is

an addition, it is an addition.

MEMBER SIEBER: So it is the only true way to compare designs is to use a common data set.

CHAIRMAN APOSTOLAKIS: And I repeat. Our job here is not to compare designs. We are comparing to the Commission's goals. So what if this, for example, what would that tell you if for the ESBWR, the core damage frequency was three times that of the AP1000. So what? They are both very low. They are both below the goal. They both eventually will meet the Commission's regulations.

Anyway, I mean if it is an addition, why should I object?

VICE CHAIRMAN SHACK: Right. Why should you object?

CHAIRMAN APOSTOLAKIS: Rick should be objecting.

(Laughter.)

MR. WACHOWIAK: Yes, and once again, that is why we are going to look into the newer sources because in the URD, the base data set for failure rates of components is a fairly complete set. When you move into the common cause parameters, it is not as complete of a set. So rather than using unknown for all sorts of things, we want to see what we can find that is out there.

This was an example here. The numbers don't mean anything other than to show that we have three different possibilities. The code can't actually calculate alpha factors if we wanted to. But it does do the multiple Greek letter in two different ways. This would be a static. The computer tells it how to do the expansion. And then if we want to do anything with data or anything later, then we would have to manually redo that.

The other method that has been added now --

MEMBER WALLIS: Let's look at that previous slide. The probability of all events is bigger than the probability of three events?

CHAIRMAN APOSTOLAKIS: The previous slide? Where are you, Graham?

MEMBER WALLIS: I'm at the probability of all the events is bigger than the probability of three of events?

MR. WACHOWIAK: It can't happen.

MEMBER WALLIS: It can't happen?

CHAIRMAN APOSTOLAKIS: I don't understand what that means.

MEMBER WALLIS: Well all events,

presumably, is a whole slew of events, bigger than three. A large number of events. What does the probability of all events mean here?

CHAIRMAN APOSTOLAKIS: That doesn't make sense.

MEMBER WALLIS: That doesn't make sense. It has got to be smaller than the probability of three.

MR. WACHOWIAK: The probability of exactly three --

MEMBER WALLIS: Exactly three?

MR. WACHOWIAK: -- and it could be any of this group of three, or this group of three, or this group of three. So you would have to take how many components are actually in there and multiply that by the number of combinations to get the whole.

MEMBER WALLIS: Presumably all events is everything fails.

CHAIRMAN APOSTOLAKIS: Yes, I don't think that is --

MEMBER WALLIS: How many are there in this all event?

MR. WACHOWIAK: In this example, I think there were --

MEMBER WALLIS: Something looks strange.

It looks like two and a half events or something.

MR. WACHOWIAK: I think there are eight components in this.

MEMBER WALLIS: It doesn't make sense. Eight components failing is more probable than three?

CHAIRMAN APOSTOLAKIS: No, it can't be. And if you look at this -- the probability of all events is the total probability times ten to the minus three. Right? The total probability -- which means the total probability of failure of an individual component. That is what the definition is. And then you multiply that by ten to the minus three. And you get the probability of all events failing.

MR. WACHOWIAK: And that is only because this alpha, beta, and gamma are all set to one -- or beta, gamma, and delta are all set to .1.

CHAIRMAN APOSTOLAKIS: Oh. Okay.

MEMBER WALLIS: But the answer doesn't make sense. We should move on. But it just -- whatever your betas and gammas may be --

MR. WACHOWIAK: These -- I would not expect to see that group of beta, gamma, and delta from an actual failure.

CHAIRMAN APOSTOLAKIS: If beta is .1 --

MR. WACHOWIAK: Right.

CHAIRMAN APOSTOLAKIS: -- why is the probability of two events 1.25 ten to the minus six? I don't understand that.

MEMBER WALLIS: Something is really strange.

CHAIRMAN APOSTOLAKIS: What is the system here? The system is one out of three? Or what?

MEMBER WALLIS: Or eight events. It is two out of eight or something.

CHAIRMAN APOSTOLAKIS: Where are the eight events?

MEMBER WALLIS: Well, he just said -- he said there were eight.

MR. WACHOWIAK: There were eight? I don't have the slide that shows the total. Oh, the basic events are down in here. So looking at how much gap there is on that, it looks like there are eight.

MEMBER WALLIS: You have to scroll down. There are eight. So it's two out of eight.

MR. WACHOWIAK: And it looks like --

MEMBER WALLIS: Any two out of eight.

MR. WACHOWIAK: So this would be any two out of eight.

CHAIRMAN APOSTOLAKIS: Exactly two.

MR. WACHOWIAK: Exactly two.

MEMBER WALLIS: Well, the last one would be all of them at the same time? All eight?

MR. WACHOWIAK: All eight.

MEMBER WALLIS: Well, okay. Something isn't right. You're going to fix it. They're going to fix it.

MR. WACHOWIAK: Okay.

CHAIRMAN APOSTOLAKIS: It is an example.

MEMBER WALLIS: Yes, but it is, you know, an example --

MR. WACHOWIAK: These aren't even necessarily real components.

MEMBER WALLIS: It is a good way of checking the method isn't it? Okay, let's move on then.

MR. WACHOWIAK: Okay. The other way is to put it into the type code database. That's a term for the repository of all the different failure rates and information about the components in our database. Basically you would add the alpha, beta, gamma -- or -- I keep starting at the wrong letter -- beta, gamma, delta into the database. And then what this allows is when we do the uncertainty calculations, it allows for uncertainty on beta, gamma, and delta.

And we are looking at how we want to treat this if that is going to be an important thing to do or if it will just add more confusion. So that is a choice we still have to make yet.

This goes -- just demonstrates the expansion so that it is adding all these terms into the model. And then in the results --

MEMBER WALLIS: These are too small for two and three.

MR. WACHOWIAK: -- it looks like it was a two out of a second order failure. So it was an and of two. See the cut sets that do generate are the two order.

What the code then tries -- when it names these, it tries to come up with a name that can be related back to the components. Since our component naming was not understandable by the computer, it just numbered them one through whatever.

Okay, so that is what we are going to do in this next round.

CHAIRMAN APOSTOLAKIS: But you don't really expect significant change in the results.

MR. WACHOWIAK: Not a significant change.

CHAIRMAN APOSTOLAKIS: Because they are fairly consistent I think.

MR. WACHOWIAK: They should be fairly

consistent. That's right. And I think it will make it --

CHAIRMAN APOSTOLAKIS: They are consistent in the INEL report. When you go back to the requirements document, I don't know because these were generic numbers.

MR. WACHOWIAK: Right. So we think that it will also be more -- we can make it so it is easier to explain each individual event, okay?

So the next thing that I want to talk about was a question that came up about failure rates and how we changed some failure rates in our database. And the methods we employed.

The basic assumption was that the demand data that is in the URD was based on equipment that was typically tested on a quarterly basis. We've got things in ESBWR that are not tested on a quarterly basis. In some cases, our plan for testing is much longer than quarterly, especially things that are inside the containment like squib valves.

We have three methods that we used in the document. And it turns out only two of those three were used and the more controversial of the three is the one that wasn't used. So three cases.

The first case, the test interval was six months or less. We just used the value that was in the URD.

The second case was six months to a year where we wanted to have some increase but we were uncertain as to how much of an increase. What we did was we just picked the 95th percentile of the generic failure probability. It turns out though even though we described that, there were no components that we had in the model that fell into this category.

And then the third one is basically what has been done for evaluating longer test intervals in risk-informed testing. Basically we would take the demand failure probability, convert it back to a failure rate assuming a quarterly test, change the duration of the test, and then recalculate the unavailability due to the failure rate and repair.

CHAIRMAN APOSTOLAKIS: Which one did you use? Two of them you said?

MR. WACHOWIAK: We used this one and we used this one.

CHAIRMAN APOSTOLAKIS: What? The numbers were different or significantly different?

MR. WACHOWIAK: Well, this is the one that was called into question before. And it turns out that we didn't have any components that were in there.

I don't know that there are any issues with either of these other methods.

CHAIRMAN APOSTOLAKIS: So that means the numbers were about the same or -- there is no issue means what?

MR. WACHOWIAK: It means that we shouldn't need to change much based on this. Now there is one other thing that I do want to say is that it is possible that the generic data for the squib valves is not really quarterly data and it is more like an 18-month data because in nuclear power plants, the squib valves are usually tested on a cycle basis.

So we may not need to increase that demand failure probability. We are going to look into the data set and we are going to compare that to other data that is available now.

CHAIRMAN APOSTOLAKIS: When you do an uncertainty analysis you have to have some distribution for the failure rate.

MR. WACHOWIAK: That is right.

CHAIRMAN APOSTOLAKIS: Couldn't you include this kind of uncertainty regarding the underlying testing done on its own in that distribution? Make some broad distribution and say, you know, we are uncertain about the underlying testing regarding the generic information. We don't know what is going to happen at the plant.

Because that always is an easy way out. That is why the point estimates are usually more difficult to defend. Because if you say the number is ten to the minus three, then you have all sorts of discussion. But if you say no, it is a distribution and these are the reasons for that, in my mind it is easier to defend that.

Because when you say continue to use methods one and three, I mean ultimately you will have only one number or one distribution you are using. You are not going to --

MR. WACHOWIAK: This is used -- for the components that match the type one model, we used type one. For the components that are appropriate for the type three model, we used type three.

CHAIRMAN APOSTOLAKIS: Okay.

MR. WACHOWIAK: So we wouldn't be switching back and forth between them on a single component. We would just pick the one that is appropriate for that particular component.

CHAIRMAN APOSTOLAKIS: And this is not in the utility requirements document, is it?

MR. WACHOWIAK: No. And that was the

issue was that the utility requirements document didn't talk about where the data came from and what the underlying parameters of that data were based on. So it was -- this was trying to -- we were trying to compensate for unknowns in the URD.

The next topic is thermo-hydraulic uncertainty. And I'm sure everybody would like to say here -- would like me to say here is our answer and we can move on. But that is really not where are. I want to talk about what it is that we have and how we think we are going to resolve this now.

First off, we think that the PRA success criteria that we currently have is bounding. Not necessarily from saying, you know, you have to have this many valves or this many flow paths, that sort of thing. We think that that is correct for the assumptions that we've made that match the design of the plant.

But what we are calling failure is not core damage. Almost all of our cases where we calculate the success criteria, we start out as a first assumption is if the core is not uncovered, then there is no core damage.

Most of the cases, that is all we consider is did we uncover the core or not. If the core was uncovered, then we just look to see in that particular case what happened after the core uncovery.

MEMBER KRESS: Uncovery means it reaches the top of active fuel?

MR. WACHOWIAK: Top of active fuel. In all of our success criteria cases, and people can argue about what code you used and how you did it and the assumptions you put in, and that is not the purpose here. The purpose of this particular part of the discussion, what we did was we looked at it and said are we challenging the fuel?

So most of the success criteria is based on not uncovering any fuel. In a couple of the cases, so let's say where we looked at GDCS valves, the number of GDCS valves required, nearly all the sequences show no core uncovery with the number of valves that we picked for the success criteria.

I think there is a couple of the cases, maybe one of the medium LOCAs or something like that where the top couple of inches of the fuel is uncovered and then the fuel is recovered quickly and there is no significant heat up of the fuel.

The fuel temperatures that we would be calling --

MEMBER WALLIS: Uncovered in the sense

that there is a collapsed liquid core in the core or are there bubbles in it?

MR. WACHOWIAK: In our case, it would be bubbles by the calculations.

MEMBER WALLIS: So it is actually dry? I'm talking about the top few inches being completely dry and just steam cooled?

MR. WACHOWIAK: For a matter of a couple of --

MEMBER WALLIS: But when you are saying there is no uncovery, you still have -- you could have a two-phased layer?

MEMBER SIEBER: It is still saturated steam.

MEMBER WALLIS: Okay. So this means --

MEMBER SIEBER: There is no liquid.

MEMBER WALLIS: -- that you have got to calculate your two-phase layer right.

MR. WACHOWIAK: Let me make an analogy to -- and you are right. And that is why we get into all these questions is what is the specific temperature of the fuel right there. But if we look back at the existing plants, in a large break LOCA, the whole core is uncovered. And then it is reflooded quickly and you have heat up that doesn't take the core to core damage.

In these cases, the top couple of inches of the core gets uncovered and then it gets reflooded quickly. And we don't see with our code any temperature increase anywhere in the fuel. So if we can have no core damage with a complete, you know, almost nearly complete void in the core and then reflood, a couple inch layer uncovered and then reflooded should not also be core damage.

MEMBER WALLIS: But what is the uncertainty in this couple of inches? Maybe it is a couple of feet. I don't know. I don't know anything about the analysis.

MEMBER SIEBER: It could be.

CHAIRMAN APOSTOLAKIS: Is that part of the report you are preparing for the staff?

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: This will be submitted when?

MR. WACHOWIAK: What we -- let me get to the end of these couple of slides and I'll do that next.

CHAIRMAN APOSTOLAKIS: These are best estimate calculations, right?

MR. WACHOWIAK: Best estimate

calculations. And --

MR. KEVERN: Did you mention what you are using?

MR. WACHOWIAK: And for what we've used so far, we've used MAAP.

MEMBER WALLIS: Okay.

MR. WACHOWIAK: We don't have TRACG cases for anything other than the design basis-type assumptions which would be one single failure at a time.

MEMBER WALLIS: Isn't TRACG a better tool than MAAP for this?

MEMBER CORRADINI: Not necessarily.

MEMBER WALLIS: Well, what would you say?

MEMBER CORRADINI: I wouldn't put my money on it.

MEMBER WALLIS: I was asking him that.

MEMBER CORRADINI: Sorry.

MR. WACHOWIAK: It depends on what you mean by better.

MEMBER WALLIS: Well, if I'm going to make a safety decision, which one should I rely on?

CHAIRMAN APOSTOLAKIS: It depends on what his is.

MR. WACHOWIAK: In order to --

MEMBER WALLIS: Be careful. We'll bring TRACE into the conversation. It is useful to have two of these tools to compare.

MR. WACHOWIAK: It is useful.

MEMBER WALLIS: It gives you some idea of --

MR. WACHOWIAK: We will be talking about that.

MEMBER WALLIS: -- uncertainty.

MEMBER KRESS: We've never reviewed MAAP nor is it an approved code.

MEMBER WALLIS: Oh, so why should we believe anything about MAAP?

MEMBER KRESS: There is the PRA spec.

MR. WACHOWIAK: You don't have to believe it.

CHAIRMAN APOSTOLAKIS: PRA you believe anything you are told.

(Laughter.)

MEMBER WALLIS: Or the opposite, George.

MEMBER CORRADINI: At least he puts it on a common basis. All the PRAs we have looked at use MAAP.

CHAIRMAN APOSTOLAKIS: I still don't understand this common basis business. So we can have a huge common mode failure where we approve of these designs and we are completely wrong.

MEMBER KRESS: All of them fail at the same time.

CHAIRMAN APOSTOLAKIS: It is an absolute judgment. It is not comparative. We are not going to say this is certified because it looks as good as the other one.

MEMBER KRESS: No, you are right.

MEMBER WALLIS: It doesn't seem to me it is very difficult to get TRACG to model. TRACG already models other events in the ESBWR.

MR. WACHOWIAK: Yes.

MEMBER WALLIS: So it doesn't seem to be very difficult to get it to model some of these more severe events.

MEMBER CORRADINI: Can I ask a different question? I'm sure you guys have done your due diligence and there is somewhere that there are benchmark calculations between TRACG and MAAP on some of these. I can't believe there are not. I've seen them at conferences where the FAI people do their darndest to show.

So I would assume that it is out there that you can show comparisons. There are comparisons.

It is pretty good with these mild transients in terms of --

MEMBER WALLIS: Well, I just need to see the evidence.

MEMBER CORRADINI: Okay. I think that would be --

MEMBER KRESS: Chapter 15 would all be done better.

MEMBER WALLIS: Are we going to see evidence some day?

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: Please do tell us when.

MR. WACHOWIAK: We've done some comparisons but not for all the scenarios that we are looking for in the PRA. Well, and that is part of --

MEMBER CORRADINI: You are not going to, right?

MR. WACHOWIAK: That is part of the issue. We can go and we can do a MAAP calculation that is associated with any branch in all of our entries. And we can show that we have success where there is success. It is possible to do those cases in the time frame available using a tool like MAAP.

If we go and we try to do all that same

thing with TRACG, then this might be the NP3010 program. So it is a -- what we need to do is we need to make sure that we can sufficiently trust what the MAAP code is predicting versus what a more detailed code would predict.

And we've done initial cases where we looked at transients, how long it takes to boil in the core, things like that, and matched inventories, matched some steam flow rates. But the question is did we do enough to show in this particular case. And that is what this is trying to address here.

But all of that doesn't necessarily address thermo-hydraulic uncertainty because everyone says there is still uncertainty even within what TRACG is doing.

MEMBER WALLIS: Are you going to have some sort of meeting with the thermo-hydraulic subcommittee where you present some of these cases where you do get uncovery and you sort of explain why your analysis is adequate?

MEMBER SIEBER: Don't volunteer.

MEMBER WALLIS: We could. Maybe we need to have something like that.

MEMBER KRESS: What exactly do you mean by that last sentence anyway?

MR. WACHOWIAK: That that is just what we were talking about the last -- the question that came from the staff was how do we know that if MAAP shows that the core isn't being uncovered that some other code would also show that the core is not being uncovered? And that is what we have to look at. The TRACG cases that we have right now, none of them show that the core is ever uncovered. That is the TRACG cases.

MEMBER CORRADINI: But these are best estimate calculations where you really haven't looked at all the uncertainties.

MR. WACHOWIAK: That is correct.

MEMBER CORRADINI: You have really done a best estimate and that is it.

CHAIRMAN APOSTOLAKIS: And there will be some uncertainty on all this at some point?

VICE CHAIRMAN SHACK: That is on the next couple of slides.

CHAIRMAN APOSTOLAKIS: Okay. Let's move on.

MEMBER ABDEL-KHALIK: What criterion do you currently use to indicate to the operators that there is core uncovery in current generation reactors?

MR. WACHOWIAK: There is water level in

the shroud. Well, there is no direct water level measurement in a BWR inside the core. It is all indirect from the shroud.

MEMBER ABDEL-KHALIK: But there is nothing we can learn from the emergency operating procedures of current reactors to indicate at least the potential for a core uncovery.

MR. WACHOWIAK: What we can learn from the current reactors is that if you do uncover the core for short periods of time, the core will not be damaged as long as it is shown to be reflooded in a fairly short period of time.

And what we are saying for our PRA, the way we did the success criteria is we started with -- we are not going to -- we will call it a core damage event simply because the core is uncovered.

MEMBER SIEBER: You may want to change that as you refine the uncertainties.

MEMBER CORRADINI: Say that again.

MR. WACHOWIAK: Yes, I agree with that. That in the long term, we should try to address that with using like a 2,200 degree or whatever the right measure is for fuel damage. But at this point in time, I don't think we would ever get a consensus that anybody will trust the 2,200 calculated by codes that we can use in the time frame necessary to generate this PRA.

MEMBER SIEBER: Probably true.

MR. WACHOWIAK: And it would be a little bit of an overkill, I think, to try to do that at this point.

MEMBER CORRADINI: So, can I ask --

MEMBER SIEBER: No, you wouldn't do it unless you have to do it.

MR. WACHOWIAK: Right. And we don't have to do it.

MEMBER SIEBER: Okay.

MEMBER CORRADINI: So can I ask a different question just to get a feeling? So you said in a very few cases there is any sort of computed uncovering of the fuel?

MR. WACHOWIAK: Yes.

MEMBER CORRADINI: Okay. And you used MAAP in all calculations where it can quickly survey all the branches and see what is happening?

MR. WACHOWIAK: We can set up the cases so that we can --

MEMBER CORRADINI: I understand.

MR. WACHOWIAK: --check all the branches.

MEMBER CORRADINI: I understand.

MR. WACHOWIAK: Yes.

MEMBER CORRADINI: And then you have used -- I'm just trying to repeat so I got it right -- and then in certain cases of interest, you've run TRACG?

MR. WACHOWIAK: Not yet.

MEMBER CORRADINI: Oh, you haven't at all?

MR. WACHOWIAK: We have the TRACG cases for the design basis events using design basis assumptions.

MEMBER CORRADINI: Okay.

MR. WACHOWIAK: We have made an attempt with four of those cases to reconfigure the MAAP model to take into account the same kind of design basis assumptions that TRACG used and ran those four cases in TRACG and we got general agreement on the parameters. The trends were the same, about the same magnitude of different values that we investigated.

So we think that MAAP is doing a fairly good job of modeling these. But none of these cases came anywhere close to uncovering the core.

MEMBER CORRADINI: That's fine. That's fine. I understand.

MR. WACHOWIAK: And so the question here is how do we know that when you are getting close to uncovering the core that these two are close enough?

And that is part of the question.

MEMBER WALLIS: Can I go back to your statement that if you showed any uncovery at all, you assumed core damage? Is that what you said?

MR. WACHOWIAK: Except in a couple of cases.

MEMBER WALLIS: But that really is very unrealistic. It may well be you could get a CDF of essentially zero if you took account of the real cooling of the core.

MR. WACHOWIAK: Can we just stipulate that now and move on?

(Laughter.)

MEMBER CORRADINI: No, I'm not going to let you do that. That is a trap. Doesn't answer that question.

MEMBER WALLIS: I think it is up to you to show it in a professional manner in order to stipulate. And it may well be you can do so.

MEMBER CORRADINI: So can I finish my question just so I'm clear? So now you've got a few cases -- I don't know, so if you had 10,000 possible branches, 50 get some sort of itty bitty uncovery. So of all those itty bitties, can you not do even a simpler calculation to see how far off MAAP could be?

In other words, instead of running to a computer calculation, can't I do a hand calculation to do the extreme bounding case and look for that subset of the 50 where you might be concerned. And then look at those in a comparison? I mean I'm kind of curious.

I don't necessarily think that using MAAP is necessarily bad. I'm just trying to understand how you do the selective worry where you get to your last sentence that says concern remains and you are going to alleviate concern by running TRACG. I'm not sure if that would alleviate my concern. That is just another calculation.

MEMBER BONACA: You know the impact of these 50 sequences he is talking about? I mean --

MEMBER CORRADINI: I'm just assuming a number.

MEMBER BONACA: Yes, I understand that.

MEMBER CORRADINI: Yes.

MEMBER BONACA: I'm saying do you have a sense of how much you can prove it?

MR. WACHOWIAK: Let me go back. The question that we have isn't necessarily what happens with a few cases where a couple of inches of fuel gets uncovered and then recovered. It is the overall sense of is the success criteria correct for calculating core damage, okay?

So if we say we need five valves to perform the function and we have really only got four valves to perform the function, is that really core damage?

Now in addressing the sensitivity on the MAAP --

MEMBER CORRADINI: Well I'm just trying to understand how you are going to get rid of your own concern.

VICE CHAIRMAN SHACK: Why don't you do the next two slides and then we can beat you up over what you are actually going to do?

MR. WACHOWIAK: Yes, okay.

MEMBER CORRADINI: You can tell us to be quiet.

MR. WACHOWIAK: The original plan was to say we will benchmark a bunch of these different parameters between MAAP and TRACG. And try to get a better understanding of the comparison between the two codes. We wanted to demonstrate that accuracy of our predictions --

MEMBER WALLIS: Let me ask you something. Have you given TRACG for ESBWR to the staff?

MR. WACHOWIAK: Yes.

MEMBER WALLIS: In a form that they can run?

MR. WACHOWIAK: Oh, I'm sorry. I thought you meant did we submit our topical reports on use of ESBWR to the staff. So I don't know if the code itself --

MEMBER WALLIS: I think GE for some cases has actually given the source code to the staff.

MS. CUBBAGE: This is Amy Cubbage from NRO. Yes, Dr. Wallis, they have given us --

MEMBER WALLIS: Oh, you could run TRACG cases?

MEMBER CORRADINI: It runs just as slow on their computers.

MS. CUBBAGE: The staff does run it, yes.

MEMBER WALLIS: The staff does run TRACG. Okay. So if we have a real question, we can ask you guys if GE doesn't want to run it.

MEMBER CORRADINI: Yes but then I would ask them to run MALCOR because I don't trust TRACG.

MEMBER WALLIS: Well, TRACE will sort it all out for us.

MS. CUBBAGE: I'll just say one more thing about TRACG. It is not reviewed and approved for uncovering reflood.

MEMBER WALLIS: I knew it. I knew it. But you can still run it. Okay.

MR. WACHOWIAK: So we can see some of the quandary that we get into with this issue.

The problem that we have had in executing the original plan is that we've had different revisions of the DCD going on and it takes a lot of our TRACG resources to do what is necessary for Chapter 6 and Chapter 15 of the DCD.

MEMBER WALLIS: How do you do Part No. 2 here without doing an experiment? How can you demonstrate accuracy of a computer code prediction without doing an experiment.

VICE CHAIRMAN SHACK: But since you are not going to do this, move on.

CHAIRMAN APOSTOLAKIS: What is known -- wait a minute, wait a minute.

VICE CHAIRMAN SHACK: Let's move on.

MR. WACHOWIAK: The original plan was that we --

MEMBER WALLIS: We will review this anyway so --

CHAIRMAN APOSTOLAKIS: Okay, tell us.

MR. WACHOWIAK: The question was, you know, why haven't we executed this plan.

CHAIRMAN APOSTOLAKIS: Okay.

MR. WACHOWIAK: Okay, current plan is we want a minimized reliance on additional TRACG cases. And to do this, we are going to start out with a version of the model, a sensitivity of the model that just uses the design basis assumption, single failure criteria. So any time in a system we get two failures, we are going to say it is a failed function.

CHAIRMAN APOSTOLAKIS: Wait. And that is for what? I mean I don't understand that. Is that part of the PRA or the --

MR. WACHOWIAK: This is to address the thermo-hydraulic uncertainty.

CHAIRMAN APOSTOLAKIS: How does that -- that sounds like a regulatory analysis.

MEMBER WALLIS: I don't see any redline strikeouts.

MR. WACHOWIAK: We are going to do a sensitivity of the model where we make the assumptions essentially that have been assumed in the design basis, recalculate the sequences that we have, and then look for any major changes in the results.

If we have some sequences where we find a large change, and large is undefined as of yet, but if there are sequences where there is a large change due to different success criteria now, we will go and investigate just those sequences further most likely using --

VICE CHAIRMAN SHACK: But you have a single failure of an active component but you will still have your passive component so it is not quite the --

MR. WACHOWIAK: No, this is associated with the passive system to address the thermo-hydraulic uncertainty of the passive system.

We are going to, for example, in GDCS -- that is a bad one. But, for example, DPS because different scenarios happen different ways in GDCS, the design basis assumption is that DPVs work -- perform their function if seven of the eight valves open.

MEMBER WALLIS: what is the basis of that contention?

CHAIRMAN APOSTOLAKIS: Yes, how did that come about?

MR. WACHOWIAK: That's -- well, first off, it is the requirement that it has to be single failure-proof. And second off, it was calculated using TRACG in the regime that TRACG is approved for with no uncovery and heat up. And that is the basis for that -- that is the design basis of the plant.

So we will redo -- for this sensitivity, we will redo the success criteria for the DPVs to say that if two of eight fail, we will call it a failed function rather than now where we say if four of eight fail, it is a failed function. And we will look at the delta between those.

If there is not that big of a delta, we will say that we don't think that this is going to be a significant impact --

CHAIRMAN APOSTOLAKIS: What delta is that?

MR. WACHOWIAK: The difference between calculating the sequence probability with a five of eight success criteria versus a seven of eight success criteria.

CHAIRMAN APOSTOLAKIS: But that is where again you -- I mean no, the delta will be negligible because of the common cause failure you are assuming.

That is exactly the problem I was referring to earlier. That after a while, you know, beta, gamma, delta, the product is a certain number. And whether you have five components or six components failing, the model is insensitive to that.

So it all comes down to the common cause failure model. You are not going to see any difference.

MR. WACHOWIAK: That would be my expectation.

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER WALLIS: Which is why they are doing this. So it sort of a big veil.

MR. WACHOWIAK: Before you guys --

MEMBER CORRADINI: Wait, I understand what he is doing.

CHAIRMAN APOSTOLAKIS: No, no. This is an important thing because he is going to say -- I mean Rick is saying that they are going to calculate the probability of the sequence again. And I'm saying that the two sequences that rely on the same model, which is insensitive to whether you have six or seven valves failing. So you know in advance the answer.

MEMBER CORRADINI: But I'm sorry. Maybe you guys are faster than I am. I thought you were looking at the thermo-hydraulic performance using this. Am I misunderstanding?

CHAIRMAN APOSTOLAKIS: He is not. That is the problem.

MEMBER WALLIS: He is not. He is trying to get around having to do it.

CHAIRMAN APOSTOLAKIS: Yes. That is the problem.

MEMBER CORRADINI: You can answer this one. I'm still not clear what you are doing. I understand you are changing the performance of the systems. Are you watching how the system performs? Or just looking how the probability number changes?

MEMBER BONACA: No, he is tightening up the success criteria.

MR. WACHOWIAK: What we have in our model right now and what we will have in the next revision is a realistic success criteria based on core uncovery not core damage. But based on core uncovery that we think is a good best estimate success criteria in the model.

There are some uncertainties associated with that. Should it be six valves? Should it be five valves? Should it be three valves? Should it be seven valves? There are questions about that.

And what we are trying to do here is to look in detail to see in which particular sequences that concern actually makes a difference to the outcome of the results -- the outcome of the PRA. If there is no change to the outcome of the PRA, then we shouldn't be too concerned whether we have it exactly right at five valves or it should be six valves.

VICE CHAIRMAN SHACK: But I think the

conclusion that you get from the case you just mentioned was that the uncertainty in the common cause failure is much more important than the thermo-hydraulic uncertainty.

MR. WACHOWIAK: Right. Right.

CHAIRMAN APOSTOLAKIS: And that --

VICE CHAIRMAN SHACK: And that sort of addresses thermo-hydraulic uncertainty in a certain way.

MEMBER CORRADINI: Yes. I was going to say that just basically answers the first --

CHAIRMAN APOSTOLAKIS: Yes. And then you think about the common cause failure uncertainty and you say, you know, this is the utility required document which was the judgment of people. So that is a very easy way of getting out of it.

MR. WACHOWIAK: Well, I don't want to say that we are getting out of anything. What I want to say is that because of two things, one, that we are not really looking at core damage. We are looking at core uncovery as a success criteria.

That we should be less concerned about the exact success criteria due to the thermo-hydraulic uncertainties and because, like you said, I didn't think of it this way before but because of the uncertainties in the common cause model, even if we did have a better success criteria, we probably don't have a good enough resolution to tell what the difference is.

CHAIRMAN APOSTOLAKIS: But let me -- I mean I haven't really used this so I may be off the mark here but in waste repositories, they have detailed methods that -- first of all, their codes are at least comparable to yours in complexity, okay? And they manage to, you know with various scheme Latin hypercubes and so on to do an uncertainty analysis. They also have conservative success criteria given to them by the EPA and others.

Now they do run the codes. They propagate the uncertainty and they are saying something about how uncertain the performance of the system is. Why is that so difficult to do here?

MR. WACHOWIAK: Essentially because -- I don't know of a better way of putting it but nobody believes any of the codes. So if I did --

MEMBER WALLIS: Including the PRA code.

MR. WACHOWIAK: -- if I did sensitivities of success criteria, you know, using all sorts of different parameters within MAAP to come up with a distribution of potential success criteria, the concern would be well you did that all with MAAP. How do we know that any of it is any good?

CHAIRMAN APOSTOLAKIS: Well, that is what the performance guys are facing, too. That is the question they are facing.

MEMBER WALLIS: Well, I would be interested when you say --

MR. WACHOWIAK: We have done those kinds of things. I can show for GDCS with different parameters modeling different types of friction factors or different valves --

CHAIRMAN APOSTOLAKIS: Right, right.

MR. WACHOWIAK: -- we can show all sorts of different ways that we would predict with that code the core responding. And you have to get down to some very, very restrictive numbers which would be on the order of having less than two of the valves available, two of the eight valves available, before we would even start seeing things where a significant heat up in the core.

CHAIRMAN APOSTOLAKIS: And this is not a convincing argument? In my mind, it is very convincing.

MEMBER WALLIS: I think you should run one of your worst cases using TRACG and using statistical inputs of some sort and show that it is insensitive to the uncertainties or something like that. Whether it is an uncovery of two inches or two feet or ten feet, it may be within the uncertainty. And maybe the uncertainty is so small that uncoveries within, you know, two or three or four inches doesn't make any difference. I don't know until you have done it.

CHAIRMAN APOSTOLAKIS: How long does it take to run TRACG?

MR. WACHOWIAK: With the containment model turned on, it takes -- from what I've been told since I don't run it myself is it is around a week to get it done.

CHAIRMAN APOSTOLAKIS: A week?

MR. WACHOWIAK: Now I don't know if that includes the prep time and the review time and whatever. But when I ask for a case --

MEMBER ABDEL-KHALIK: You indicated yesterday that there is a fairly large uncertainty in the wide range level measurement even though you didn't know exactly what that uncertainty was. The question is how does that uncertainty in hardware performance risk taken in the original TRACG calculations that you did to establish the success criteria?

MR. WACHOWIAK: In the TRACG calculations --

MEMBER ABDEL-KHALIK: Right.

MR. WACHOWIAK: -- what they do for their particular calculations is calculate what the analytical limit for the set point is. So they come up with a limit of worst case of where the thing can be.

And then they use the uncertainty calculation to say where -- if I don't want it to be any worse than here, where should I set the set point above so that even in the worse case uncertainty, it won't go below this. So they do it backward from that.

They don't take into account the uncertainty in the TRACG calculation. They use the TRACG calculation and then an uncertainty factor to set the set point.

So in the PRA in the past, PRAs that have been done for existing plants for success criteria, you would tend to use the nominal value for the set point and you would calculate what would happen based on where the set points are set.

And then you would do sensitivities to determine what happens if it goes to the different limits. It is more of a best estimate of what will -- what is the expected response versus what is the absolute minimum response.

MEMBER ABDEL-KHALIK: So when you say you are going to designate any core uncovery or any level below the top of the active fuel to signify fuel damage, in that determination, you have taken into account any uncertainty in the water inventory in the plant given that transient?

MR. WACHOWIAK: I agree with that statement, yes. However, we don't say that any amount of core uncovery or just small core uncovery is core damage. What we are saying is that core damage as defined in the ASME standard for PRAs is a significant heat up of the core such that it is going to lose its geometry.

How can we prove what the exact success criteria is for that? And what we get down to is if we know the core doesn't uncover, then we know we are not going to get to that core damage state. So there is a band of margin that is already embedded in the calculation just associated with that particular assumption.

And then to get into questions of okay, now you have stated that you have this much margin and you are going to set your go/no go decision based on this level up here, well how accurate does that level up here have to be?

And what I would say it doesn't have to be very accurate and certainly it doesn't have to be much more accurate than the resolution of the model will allow us to investigate. And this would be the common cause model.

If we can't tell the difference between three valves failing and six valves failing because of the common cause model, why would we care whether it is six versus seven failing if we were to actually calculate core damage? Or maybe six isn't as precise. Maybe it could be five. We still are beyond the resolution of what the probabilistic model can discern.

CHAIRMAN APOSTOLAKIS: And the requirement for seven is based on very conservative assumptions?

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: Is that what you are saying? In other words, I think that what your argument is that if we had an excellent common cause failure model and we were able to run these uncertainties and so on, the result of such a nearly perfect calculation would be that you probably need only five valves, not seven.

MR. WACHOWIAK: yes.

CHAIRMAN APOSTOLAKIS: But you are already way too conservative with the number seven. So why both to do these extra calculations when you already know that seven is very conservative. That's really the basis of your argument.

MR. WACHOWIAK: Right, yes.

CHAIRMAN APOSTOLAKIS: Well, do my thermo-hydraulic expert colleagues agree with that?

MEMBER CORRADINI: The one who was asking the questions is out of the room. So I don't want to answer.

CHAIRMAN APOSTOLAKIS: The number seven comes -- well, that was a mistake on his part -- the number seven comes from regulatory traditional safety requirements --

MR. WACHOWIAK: The requirement is --

CHAIRMAN APOSTOLAKIS: -- which are very conservative.

MR. WACHOWIAK: -- that the function needs to be single failure proof.

CHAIRMAN APOSTOLAKIS: That is the only thing.

MR. WACHOWIAK: Right.

CHAIRMAN APOSTOLAKIS: It is not based on thermo-hydraulic analysis. No, the single failure criterion is single failure criterion.

VICE CHAIRMAN SHACK: Yes. But you have to do the thermo-hydraulics to show that you meet the criterion with that failure.

MEMBER CORRADINI: You have to know that it is based on something.

CHAIRMAN APOSTOLAKIS: Right. And you have done that.

MR. WACHOWIAK: And that has been done. But once again, there, the calculation that shows seven is okay isn't calculating peak clad temperatures less than 2,200 degrees. Well, it is calculating less but the limit isn't 2,200 degrees. The limit is a meter above -- the level a meter above the top of the fuel. There is no clad water reaction. There is nothing going on in that calculation where seven is the design basis success criteria.

In the PRA, we have used a different code to show that we really don't even get to the top of the fuel as long as four of them open rather than seven. But still getting to the top of the fuel doesn't mean that you are going to have core damage. You would have to get much farther down into the core and then not recover the level in a sufficient amount of time. And when we have run some of those, we could get -- with using MAAP as the tool for calculating that, we can get success criteria for the DPVs all the way down to only needing to have two in most scenarios open and three in some scenarios.

So the PRA uses a success criteria of five. We could justify -- like if you went out to a plant today and wanted to look at their success criteria for what they used in their PRA, using that same method that the plants use today, we could probably show two or three depending on the sequence.

And the question comes back to how do you know that it is -- that, you know, five is good enough? Well, because we have margin to actually failing the fuel. We are not using failure of the fuel as the performance measure.

MEMBER CORRADINI: So can I say it back to you a different way since Graham is out of the room?

MR. WACHOWIAK: Yes.

MEMBER CORRADINI: You actually have done some worst case calculations using MAAP, which you say you don't trust --

MR. WACHOWIAK: No, no, I didn't say that.

MEMBER CORRADINI: Okay, I'm sorry. I

said that but you said something quite similar there in a moment of weakness. But using a tool which could not be universally acceptable in all situations and you now know the variation that it takes two to make it work under most cases but you demand five in the PRA and seven in the design basis calculation.

MR. WACHOWIAK: Yes.

MEMBER CORRADINI: And just so that I get a feeling for what that number turns into, what does that turn into in terms of level uncovered and time uncovered just so I have -- I don't know it in terms of two versus seven but I do know it in terms of bare fuel and time that it is bare.

MEMBER BONACA: Yes, that is very important. In addition to that, it seems to me --

MEMBER CORRADINI: That is what Graham is really asking.

MEMBER BONACA: -- is the recover level very fast by means of the addition -- it seems to me that, you know, whether you hang there and you recover slightly and you go above, I mean that point, I would question, you know, how credible is the calculation versus the case where you are adding and your level is coming back up --

MEMBER BONACA: -- with margin.

MR. WACHOWIAK: So let me answer it in a qualitative way since I don't have those cases in front of me.

MEMBER CORRADINI: That's fine.

MR. WACHOWIAK: What we use -- when we use -- let me make sure I'm in the right -- when we use the success criteria that we have in the model know, which is five DPVs, MAAP shows that the core does not uncover in any of our cases and that the fuel temperature decreases during the entire scenario.

If we use four, then the core is shown to uncover -- part of the core is shown to uncover and then be recovered within a time period where there is a -- early on there is some positive slope to temperature but it never increases what the temperature was when the case started.

If we go down to three valves, more of the core uncovers, the temperature starts to go up, does not reach 2,200 degrees before the core is reflooded by the GDCS system. If we use two valves, the temperature in the core exceeds 2,200 degrees before the reflood occurs.

MEMBER CORRADINI: Okay. Thank you.

MR. WACHOWIAK: That is the kind of scenario that we have. So we can -- we have extremely high confidence that the five valves is going to not result in core damage.

CHAIRMAN APOSTOLAKIS: so there will be a report documenting all these things to be submitted soon? I mean you are at the last slide now so you can tell us.

MR. WACHOWIAK: The key here is in order to perform this by, you know, doing these extra cases, we need the version of the model that incorporates those design changes that we talked about yesterday.

CHAIRMAN APOSTOLAKIS: Yes.

MR. WACHOWIAK: So right now what we have said is that that version of the model, the Level 1 at least, which is where the success criteria comes from, that will be ready in April. So we think we can have this report in May.

MEMBER WALLIS: Now to go back -- I'm sorry I wasn't here for a little while but this is a new design. This has got all this gravity-driven flows and things. And so it might be sensitive to thermo-hydraulic uncertainties in a different way from what we are used to.

So I think we need some confidence that the thermo-hydraulic uncertainties aren't going to produce a fairly broad band of behavior around the best estimate prediction.

CHAIRMAN APOSTOLAKIS: What do you mean by different way?

MEMBER WALLIS: Well, it is no longer -- if you have pump and it pumps water in, you know what has happened. If you have something which is going by gravity, it might be more sensitive --

MEMBER CORRADINI: Small driving delta-p.

MEMBER WALLIS: -- in the driving force.

CHAIRMAN APOSTOLAKIS: But, yes. And I agree.

MEMBER WALLIS: So it may be important to get certain things right. And if there is an uncertainty about some of thermo-hydraulic, it may make quite a big difference to the flow rates. I don't know. But it is a different design.

CHAIRMAN APOSTOLAKIS: But the argument they are making -- the heart of the argument, the way I understand it, is the success criteria are so conservative that no matter what you do with these uncertainties, you will not see any change. Is that the essence of the argument? Seven valves out of eight is way out there, Rick is arguing.

MEMBER WALLIS: I understand that. I understand the seven valves. Maybe it is depressurized but are the flows which would happen when the seven valves open, you know, how uncertain are they is the whole thing I'm looking at.

MR. WACHOWIAK: And in particular, we would need to look at that in combination with how we treat the GDCS model. And some of those cases have been done. And I'm still confident that if five valves work and we have even our worst case realistic, if you will, so not just outside the realms of reality --

MEMBER WALLIS: What you need is a thermo-hydraulic code which will --

MR. WACHOWIAK: -- on UDCS.

MEMBER WALLIS: -- run on the PC in five minutes. And then you can run all these cases and there is no problem at all.

MR. WACHOWIAK: I have one of those. It is MAAP.

VICE CHAIRMAN SHACK: When we did the PTS rule, that was sort of the most systematic evaluation of thermo-hydraulic uncertainties I can think of, and what they found there was that the input uncertainties drove -- were, in fact, larger than the thermo-hydraulic code uncertainties.

Now it may be a bad analogy but at least

I would get a warm feeling if you would present parametric input uncertainty calculations, which you can do with MAAP, and tell me what those uncertainties do. And then I would have to make the decision as to whether I want to believe my analogy that those uncertainties really cover the other uncertainties also.

MEMBER CORRADINI: We'd ask the staff to do it with TRACG. They have ways.

CHAIRMAN APOSTOLAKIS: Which other uncertainties?

MR. WACHOWIAK: The uncertainties that are associated with the model itself.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER CORRADINI: His suggestion I think is very valid is you set up a set of sensitivities. You look at it with MAAP. And then make some sort of judgment that those are much larger than what you would expect to see from model uncertainties buried in the models.

MEMBER SIEBER: But the crux of all this is a thermo-hydraulic question as opposed to a PRA question.

VICE CHAIRMAN SHACK: Right.

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER SIEBER: So I would suspect we would finish examining the PRA and reserve the thermo-hydraulic questions to another time where we can do it.

CHAIRMAN APOSTOLAKIS: But the uncertainties are fed into the PRA.

MEMBER SIEBER: Right.

CHAIRMAN APOSTOLAKIS: So it is a PRA question, too.

MEMBER SIEBER: Yes, it is. It drives the PRA.

MEMBER WALLIS: They are inexhorably intertwined.

MR. WACHOWIAK: But even then if we can't -- with the common cause model, if we can't tell the difference between five and four valves success criteria --

VICE CHAIRMAN SHACK: Well, that is only one particular case.

MR. WACHOWIAK: I know but

VICE CHAIRMAN SHACK: And that one, you know, I'm willing to believe there that the common cause model drives me. But just this whole question of your success criteria in general I think could at least be addressed by calculations that you can do.

CHAIRMAN APOSTOLAKIS: If you look at the Gravity Driven Cooling System, GDCS, there the issue of common cause failures is not the driver in the uncertainties, is it?

MR. WACHOWIAK: No.

CHAIRMAN APOSTOLAKIS: Then you will have this thermo-hydraulic uncertainty issue.

MR. WACHOWIAK: In the Gravity Driven Cooling System?

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER SIEBER: Yes.

CHAIRMAN APOSTOLAKIS: I mean it is not an issue of five versus seven valves there.

MR. WACHOWIAK: The only -- there it is different than that. It is too -- it is more complicated that just quite the number of valves. But in the end, the only thing that comes out of the answer is the common cause failure of all the valves.

MEMBER SIEBER: Right.

CHAIRMAN APOSTOLAKIS: All the valves. You have two valves.

MR. WACHOWIAK: Wèll, no, GDCS has two valves per train. And there are four trains.

CHAIRMAN APOSTOLAKIS: Right.

MR. WACHOWIAK: So there are eight valves in GDCS also. And what we see in our results are the only answer that makes it into the cut sets is the common cause failure of all the valves.

MEMBER SIEBER: All the valves, oh.

MR. WACHOWIAK: So if we pick --

CHAIRMAN APOSTOLAKIS: So there is a case here where --

MR. WACHOWIAK: -- two valves, three valves, five valves, it doesn't matter. The answer is the same.

MEMBER WALLIS: One tank alone is enough to do the job?

MR. WACHOWIAK: That would be a case where it would be interesting to look at this because now it is one tank but it is in combination with the equalizing valves. But that particular case would be interesting to look at with this but what I find is that that particular case isn't very risk significant. It is an interesting thermo-hydraulic case but it is not risk significant interesting thermo-hydraulic case.

CHAIRMAN APOSTOLAKIS: Nobody had ever thought of the fact that because the common cause failure models are so insensitive to details they would prevent you from doing uncertainty calculations in other areas. I mean that is an unexpected benefit.

MR. WACHOWIAK: No, no. I mean it just means one uncertainty drives most of the --

MEMBER CORRADINI: Your ignorance is worse than our ignorance.

CHAIRMAN APOSTOLAKIS: But at the same time, one can invoke the defense in depth principle and say, you know, I still want to see this.

MEMBER WALLIS: Maybe we should use Greek letters in thermo-hydraulics. We would be better off.

CHAIRMAN APOSTOLAKIS: You would, you would.

MEMBER WALLIS: Arabic.

CHAIRMAN APOSTOLAKIS: So I guess -- is this -- I mean obviously there is some concern on the part of the subcommittee. Where does that leave us?

VICE CHAIRMAN SHACK: We are chewing up his hour and a half in a big hurry.

CHAIRMAN APOSTOLAKIS: The point is that when GE comes back in May with a report that says exactly what Rick just told us, what are we going to do? It is going to be too late at that time to again express concerns and expect them to do something.

MEMBER WALLIS: Well, I'm not sure what the thermo-hydraulics uncertainties have to do with

ESBWR. Maybe we need a separate meeting which is focused on thermo-hydraulics.

MEMBER CORRADINI: But I don't think --

CHAIRMAN APOSTOLAKIS: It has to be joined it seems to me.

MEMBER CORRADINI: But I don't think it is fair to put the level of scrutiny you might -- I don't know what the thermo-hydraulic committee does in this room but I would be afraid to be in front of them. But I don't think I would exact the level of scrutiny on MAAP that you would on the design base calculations.

That is what I think I take out of this. If he can do the sensitivities to show what Bill had suggested and then look at how the sensitivities of the initial and boundary conditions effect the results. And then make a judgment. You can do check calculations with TRACG.

VICE CHAIRMAN SHACK: With the notion that you also have the other conservatism built in.

CHAIRMAN APOSTOLAKIS: I thought Rick said that they don't want to do that. That was the point from the beginning when I said Latin hypercubes and all that, that is what I meant. That gave the uncertainties.

MEMBER CORRADINI: But I think he is willing to do it. I think they can do it expeditiously with MAAP. They cannot do that sort of massive calculations with TRACG.

CHAIRMAN APOSTOLAKIS: Fine.

MEMBER CORRADINI: That is what I thought I heard him say.

CHAIRMAN APOSTOLAKIS: But I would like to see some evaluation of the uncertainties. And then maybe an argument why this is valid. That would be fine with me.

VICE CHAIRMAN SHACK: And I'm sure you will have further discussions with the staff over what they expect to see.

MEMBER SIEBER: You could do a nonparametric.

MEMBER ABDEL-KHALIK: I have a question for you which may seem a little out of the ordinary. But when the squib valves are initiated, do you generate any gas?

MR. WACHOWIAK: When the -- that would be released into the dry well?

MEMBER ABDEL-KHALIK: No, no, that would be released in the line.

MR. WACHOWIAK: Into the line? No.

MEMBER ABDEL-KHALIK: No?

MR. WACHOWIAK: Not into the line. Maybe a very trace amount into the dry well. But I wouldn't expect anything into the line.

MEMBER ABDEL-KHALIK: Okay.

MEMBER SIEBER: What about a trace?

MR. WACHOWIAK: A trace, okay.

MEMBER SIEBER: Plus you are shearing something off --

MR. WACHOWIAK: You are shearing something, yes. And in that instant --

MEMBER SIEBER: -- in the explosions above that.

MR. WACHOWIAK: -- okay.

MEMBER SIEBER: A trace amount.

MR. WACHOWIAK: A small amount.

CHAIRMAN APOSTOLAKIS: Well, are we don't with this subject for today? At least I think Rick --

MEMBER SIEBER: We think we have really beaten him up enough.

CHAIRMAN APOSTOLAKIS: I mean the task group, were we clear?

MR. WACHOWIAK: Okay?

CHAIRMAN APOSTOLAKIS: Shall we move on because --

MR. WACHOWIAK: We have a decision point that we can make here.

CHAIRMAN APOSTOLAKIS: Okay.

MR. WACHOWIAK: Do we want to talk about fire and flooding real quickly or do we want to have a very fast overview of the --

CHAIRMAN APOSTOLAKIS: I think there is another decision to be made.

MR. WACHOWIAK: Oh.

CHAIRMAN APOSTOLAKIS: I really would hate to wait until June or whatever, that time frame, to look at your report and have the same comments raised by the subcommittee or the full committee.

So the question is should there be a joint thermo-hydraulic PRA subcommittee meeting where we go into more detail on these and we will have had a chance to think about it with your colleagues? Maybe in late January or February? Before you actually do a lot of this work.

MEMBER SIEBER: I think we are all here, right?

MR. WACHOWIAK: If you are going to do all that, you might as well do it when you volunteered them to do Level 2 in January.

CHAIRMAN APOSTOLAKIS: Well, that's a

given.

MEMBER CORRADINI: Oh, I see. It would seem to me if you are going to drag them all here, you might as well drag them all here for just one time.

CHAIRMAN APOSTOLAKIS: Rick, you can tell us what you think. I mean that is a good suggestion. Will you be ready by then? The thing is I really don't want us to be in a position where you have already invested a lot of time and effort doing something and then we come in and say well, gee, we don't like that. I mean it would have been nice for you to have done something else.

So how can we influence the process, if you guys, of course, want to get this input, what is the time frame it may be a good -- the Level 2, we can combine it with the Level 2 subcommittee meeting.

MEMBER CORRADINI: Yes. The question is will we -- we could have some of these parametrics studies using MAAP done at that point in time.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER CORRADINI: Now if we have a joint committee meeting with the two committees, I'm worried that it will just be a several hour discussion about why some people one code versus another. And we won't actually be discussing how does the subject of thermo-hydraulic uncertainty factor into the core damage frequency and large release frequencies.

CHAIRMAN APOSTOLAKIS: Well, the Chairman of the subcommittee is not here but we have some of the members.

MEMBER WALLIS: Well, I think you know some of the questions we are likely to ask.

MEMBER CORRADINI: That's why he is worried. That is why he doesn't want to volunteer.

MR. WACHOWIAK: That is why I am worried about that because we have to remember that this particular subject in the PRA is not addressing the minutia of how you calculate gravity driven systems for design basis accidents.

This is how does the uncertainty of being able to accurately calculate when the core is uncovered and reflood. How does that reflect back on the core damage frequency and the large release frequency?

MEMBER WALLIS: I guess what I'm reflecting is --

MR. WACHOWIAK: And if we can't discern that with our common cause model anyway no matter how accurate we get in our codes, then is it a useful discussion?

CHAIRMAN APOSTOLAKIS: Would it be then better in your mind to have this discussion when we meet on the Level 2 PRA? Because some of the members of the thermo-hydraulic subcommittee will be there anyway. But the focus will not be thermo-hydraulics.

MR. WACHOWIAK: We could do that.

CHAIRMAN APOSTOLAKIS: So when do you --

MEMBER CORRADINI: Can I ask --

CHAIRMAN APOSTOLAKIS: -- think you will have some of these calculations? February? You don't have to have a complete set by the way.

MR. WACHOWIAK: Yes. February should be fine.

CHAIRMAN APOSTOLAKIS: If you say, you know, yes, this is what we plan to do and we agree --

MR. WACHOWIAK: We talked about our schedule yesterday and our rebaselining. We were working on that last night. I'm talking about the engineering schedule that is several pages -- a hundred pages.

CHAIRMAN APOSTOLAKIS: So maybe the February

MR. WACHOWIAK: I think it fits into the February time frame.

MEMBER CORRADINI: Can I ask a point of

information for the two -- oh, I guess Graham is and Said is -- but so I'm not really -- I'm not even sure. So we are now looking at the PRA. Has the thermo-hydraulic subcommittee already looked at design basis questions relative to ESBWR? And if the answer to that is no, we are getting a little bit ahead of ourselves. And that is what, I guess, I'm curious about.

CHAIRMAN APOSTOLAKIS: Have you?

MEMBER WALLIS: Well, I'm not sure we've looked at them --

VICE CHAIRMAN SHACK: You've said the code can be used.

MEMBER KRESS: We said we had the same results.

MEMBER CORRADINI: But in terms of Chapter 15 analysis, has the thermo-hydraulic subcommittee looked into design basis space? That is what I'm curious about.

CHAIRMAN APOSTOLAKIS: We have a comment from the staff. Amy?

MS. CUBBAGE: Right. Amy Cubbage. Yes, the committee has only looked at it in the pre-application review and it was the acceptability of the application of the TRACG code to ESBWR for LOCA and stability. But you have not seen the results or the design.

MEMBER CORRADINI: So I guess we are getting -- unless I misunderstood, we are getting a bit ahead of ourselves because we drag them in about one thing. They are still yet to be dragged in about --

MEMBER WALLIS: Why don't we drag them in in thermo-hydraulics to do the Chapter 15 stuff and also to sort of extend that into this area?

CHAIRMAN APOSTOLAKIS: Because then you would need the PRA guys there.

MEMBER WALLIS: I don't think you need the PRA guy. You just saying show us the thermo-hydraulic uncertainties and beyond design basis accidents.

MEMBER SIEBER: Have we convinced the staff how they can review the PRA and never review MAAP?

CHAIRMAN APOSTOLAKIS: Yes, we will do that after the break. When is the thermo-hydraulic subcommittee going to meet?

MEMBER WALLIS: I have no idea.

CHAIRMAN APOSTOLAKIS: Is it before February when they are going to meet the next time?

MEMBER CORRADINI: Do you want me to look up what we have listed as the time?

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER CORRADINI: The next time --

CHAIRMAN APOSTOLAKIS: The subcommittee to review ESBWR calculations.

MEMBER CORRADINI: Well, I'm just looking for the next thermo-hydraulic subcommittee.

CHAIRMAN APOSTOLAKIS: It has not been set Eric says.

MEMBER CORRADINI: Oh. Well then I don't know.

CHAIRMAN APOSTOLAKIS: So do you think that will be before the February time frame? No?

PARTICIPANT: The meeting is in January.

CHAIRMAN APOSTOLAKIS: Anyway we can still look at these without having the benefit of the other review because really what I think the objective will be will be to agree or come to reasonable agreement that what they are planning to do is reasonable in our minds.

They don't have to have done it. So I see those two as decoupled really to a large extent.

MEMBER CORRADINI: I guess just to -- I guess, Graham, I don't -- if I were them, I wouldn't agree to go into the den of the thermo-hydraulics folks with this. I would rather come back in a -- if they are going to tab a Level 2 discussion, come back and talk about this because a lot of the same folks will be in the room anyway.

CHAIRMAN APOSTOLAKIS: Okay. So --

MEMBER WALLIS: So what kind of animals do you expect to find in this den?

(Laughter.)

MEMBER CORRADINI: I'm just watching his response. I wouldn't want to do it.

CHAIRMAN APOSTOLAKIS: I think we have exhausted the subject. And Eric will work with GE to set up dates for February or thereabouts to address Level 2 plus this issue.

MR. WACHOWIAK: Plus this issue.

CHAIRMAN APOSTOLAKIS: And whatever information GE can bring us by then, that will be fine.

MR. WACHOWIAK: And I will try to make clear in that time that the objective of this thermo-hydraulic uncertainty is to help determine how it is going to effect the PRA analysis.

CHAIRMAN APOSTOLAKIS: Fine. But I mean some calculations showing the uncertainty in the inputs and how they effect the output and then a discussion of the model uncertainty without getting into, you know, major research projects would probably be helpful.

MR. WACHOWIAK: Okay.

CHAIRMAN APOSTOLAKIS: And now your question was whether we should go over the external event analysis?

MEMBER CORRADINI: It's moot.

CHAIRMAN APOSTOLAKIS: Why should we do that?

MEMBER CORRADINI: Let's go to RTNSS.

MEMBER WALLIS: RTNSS. RTNSS.

CHAIRMAN APOSTOLAKIS: Oh, yes, that is important.

MR. WACHOWIAK: Okay.

PARTICIPANT: With about five minutes.

CHAIRMAN APOSTOLAKIS: No, he has more. He has more. But let --

MR. WACHOWIAK: Well, basically what I was --

CHAIRMAN APOSTOLAKIS: Do you have a handout here?

MEMBER WALLIS: Yes.

MR. WACHOWIAK: Yes, it is the one that says Regulatory Treatment of Non-Safety System.

CHAIRMAN APOSTOLAKIS: This one?

MEMBER KRESS: Surprise.

MR. WACHOWIAK: It looks just like this one.

MEMBER WALLIS: Usually they put these in.

CHAIRMAN APOSTOLAKIS: Okay. Thank you.

MR. WACHOWIAK: Oh, yes, you are right. I did change the way the title was.

CHAIRMAN APOSTOLAKIS: Yes, the title -- the big title is Probabilistic Risk Assessment. Here you change it.

MR. WACHOWIAK: I opened the wrong file.

CHAIRMAN APOSTOLAKIS: That is inexcusable, Rick.

(Laughter.)

MEMBER MAYNARD: What is the probability of that?

MEMBER KRESS: Human error.

CHAIRMAN APOSTOLAKIS: .16 we said yesterday.

MR. WACHOWIAK: After having done it, it is one.

Okay, now --

CHAIRMAN APOSTOLAKIS: Do you really need to go over all these slides?

MR. WACHOWIAK: No, we don't need to go over all the slides.

CHAIRMAN APOSTOLAKIS: Oh, okay.

MR. WACHOWIAK: I was trying to give him some reassurance that -- because we covered this topic with the staff in about a day. So --

CHAIRMAN APOSTOLAKIS: So we need at least three days.

MR. WACHOWIAK: We want to talk about -- in the past, revisions of the DCD and in the PRA, there were some questions about how we treated or how we came to our RTNSS set because we had the very minimal set of equipment that was in that program.

We took an extensive look again at all of the different SECYs that are associated with RTNSS and what we have in our design and reassessed that and came up with a different set. And this will be the discussion of that.

Okay. This is basically background, where the information comes from. The one thing I want to point out is that a lot of this is from precedent. It is what happened with AP1000 and AP600 is --

CHAIRMAN APOSTOLAKIS: Speaking of precedents, one thought strikes me here. In -- was it 50.69 where we have this matrix of category one, two, three, four? Are you familiar with that?

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: Is this -- there we have safety-related systems and then the PRA comes in and says no, with the safety related you will have two categories, one and three. Non-risk significant and risk significant. Then you have the non-safety related and you have categories two and four, I think, right?

Four is non-safety related, none risk significant, two, non-safety related but risk significant according to the importance measures. Is this RTNSS business similar our categories? It looks like it is similar to Category Two, non-safety-related. So can we take advantage of the work that was done there and put some order here?

MR. WACHOWIAK: No.

CHAIRMAN APOSTOLAKIS: Why not?

MR. WACHOWIAK: Because the instructions for how to do this is contained here.

CHAIRMAN APOSTOLAKIS: In 94/95, these are the years?

MR. WACHOWIAK: Yes.

CHAIRMAN APOSTOLAKIS: That is way before this 50.69 was approved.

MEMBER WALLIS: Your criterion C is a bit like what he is describing here.

MR. WACHOWIAK: It is a bit like it but when you look at how we have to do it, it is different than what is in 50.69. It is different than what's in -- or not in 50.65 but in the maintenance rule guidance. It is different than what is in the D-RAP guidance.

MEMBER WALLIS: This is --

MR. WACHOWIAK: There are several different risk ranking programs that attempt to do the same thing. They do it in different ways. And you end up with different results if you follow a different path.

CHAIRMAN APOSTOLAKIS: So there is an inconsistency in the regulations then. That is what you are saying? Because in '94, '95, I don't think people were using importance measures to the extent that were used in 50.69.

MR. WACHOWIAK: In this particular case, importance measures don't come into play.

CHAIRMAN APOSTOLAKIS: That's right. So then this question is more appropriate for the staff I suppose.

MR. WACHOWIAK: They are up next.

(Laughter.)

PARTICIPANT: We don't want to miss our shot at them.

(Laughter.)

MR. WACHOWIAK: Okay. The requirements come from -- these are the ABC requirements listed in a slightly different way but we've gone through an evaluation of all those things. What we find is from the deterministic side that we had in Rev 0 of the DCD that ARI was RTNSS and Rev 1 took it out. Well, it needs to go back in. It meets one of these requirements.

Also when looking at this, we found that the feedwater control system or the feedwater controller itself also falls into the RTNSS category because in order for standby liquid control to work, we have to have a feedwater run back. So it falls into here as a support system, if you will, for that.

VICE CHAIRMAN SHACK: Oh, the SLCS requires the successful run back?

MR. WACHOWIAK: Yes.

VICE CHAIRMAN SHACK: I appreciate that.

MR. WACHOWIAK: For the overall success criteria. SLCS can still bring the power down in the reactor but we can't meet all the other containment parameters and things without the run back. So --

CHAIRMAN APOSTOLAKIS: SLCS is a standby control.

MR. WACHOWIAK: Station blackout should not bring in any more RTNSS criteria for the passive science because they are really designed for a 72-hour station blackout. Now we have to look again at other things based on post-72-hour criteria.

Seismic, in our seismic margins analysis, we showed -- well, let me start off, seismic responses all provided by safety-related components so on the deterministic side, nothing comes in there.

Our seismic margins analysis only included safety-related components. And we show that we meet the seismic margins so we don't think we have anything new on seismic coming in. But once again, this post-72-hour safety is applicable to seismic and this is where the controversy comes in.

VICE CHAIRMAN SHACK: I have a question. You mentioned yesterday and the seismic margins was the sort of thing that I noticed that, you know, the seismic margins basically ended up with a set of requirements on fragilities for equipment that you said was going to go back in the design control documents.

MR. WACHOWIAK: Yes.

VICE CHAIRMAN SHACK: Is there anything else from the PRA that is going to go back into the design control documents that you have identified?

MR. WACHOWIAK: Yes.

VICE CHAIRMAN SHACK: A quick one paragraph summary?

MR. WACHOWIAK: Well, we need to go back and specifically look at those and make sure that list is complete. I know we're --

VICE CHAIRMAN SHACK: You won't effect the DAC from your instrumentation and control?

MR. WACHOWIAK: It won't effect the DAC for the instrumentation and control. But it may effect the configuration of the instrumentation and control.

So the DAC itself is based on all the different technical requirements that are associated with I&C. But there is nothing in the DAC that says that two of those load driver cabinets need to be separated so that we would prevent spurious actuation during a fire. That would come out of the PRA and we would list that one as a PRA requirement.

We've made an attempt once at going through and identifying all the things that went into design requirements that came out of PRA analysis. That list is incomplete because a lot of it happened in the conceptual design state.

VICE CHAIRMAN SHACK: Well, I'm think more in this formal statement now where, you know, you've submitted document.

MR. WACHOWIAK: We will work on that. I don't have that off the top of my head.

Now long-term safety. What we have to look at for long-term safety -- this is what happens after 72 hours when our batteries would be considered to be dead. We really need to look at all events. You can't just way well, what do you do after a LOCA?

Well, you have to consider LOCAs. You have to consider transients. You have to consider seismic events. You have to consider hurricane events. All those things. It is a comprehensive look.

And then we have to look at all the different functions.

MEMBER WALLIS: In the long-term cooling, you talked about in this section the back up water from the fire protection system.

MR. WACHOWIAK: Yes.

MEMBER WALLIS: And you said that your

conclusion was RTNSS supplies to selected portions of the ESBWR fire protection system. But there was nothing specific. I mean selected portions could be anything. And it wasn't clear to me how you selected the portions that were RTNSS.

MR. WACHOWIAK: And you are looking at the slide now? Or are you looking at something that was in the --

MEMBER WALLIS: I'm looking at the text.

MR. WACHOWIAK: -- DCD?

MEMBER WALLIS: Text. In the text. The long-term safety we were talking about. You were talking about back up water in this context. And we see here a very vague statement that RTNSS is supplied to selected portions of the fire protection system.

MR. WACHOWIAK: And that may be part of what the contention with the staff on the whole RTNSS issue has been because some considered it less than complete and some considered it not explained very well.

MEMBER WALLIS: Okay. So you don't --

MR. WACHOWIAK: So we've said --

MEMBER WALLIS: -- know the reference here, okay.

MR. WACHOWIAK: -- that this is what our

plan is or this is what our strategy is for handling RTNSS and we still owe the staff a write up on that.

MEMBER WALLIS: But that is where it is. It is still work in progress. That is why it is incomplete.

MR. WACHOWIAK: Okay.

CHAIRMAN APOSTOLAKIS: So how is PRA used to determine -- did you talk about it?

MR. WACHOWIAK: We haven't gotten to that part yet. We will get there.

CHAIRMAN APOSTOLAKIS: Oh, good.

MR. WACHOWIAK: Long-term safety though we have to consider core cooling, decay heat removal, post-accident monitoring, and control room habitability. My strategy for all contingencies is it just basically means we have to be able to say this is how we are going to do long-term safety under these conditions.

In earlier versions of the DCD, the idea was that after 72 hours, we would have enough time and personnel onsite that we can figure out something. And that is not consistent with the guidance that is written in the SECY documents and especially in the precedent that is out there.

It is consistent though with existing

plants in severe accident management planning and things like that. But that is okay. We understand that this is a different plant, different process.

So we've relooked at this and said let's go through it in a systematic process. What is our strategy for any of the different scenarios for long-term safety?

MEMBER WALLIS: What is the difference between core cooling and decay heat removal?

MR. WACHOWIAK: In ESBWR it turns out to be no difference. But in general it could be the containment versus --

MEMBER WALLIS: It could be decay removal from the containment.

MR. WACHOWIAK: Yes.

MEMBER WALLIS: Yes, okay.

MR. WACHOWIAK: But in ESBWR, those things are linked --

MEMBER WALLIS: It is transparent. It is the same thing.

MR. WACHOWIAK: -- it is the same thing.

Those first things need to be done deterministically. Then in the end we can use the PRA to determine the risk significance of any of those functions. So the PRA doesn't tell us what we need for long-term safety. It is used to determine what is the significance of those things for long-term safety after we have figured out what they are.

CHAIRMAN APOSTOLAKIS: And the significance would be what? Importance measures? Or what?

MR. WACHOWIAK: that is kind of how we did that was somewhat by importance measures for this. Other parts of the risk significance is done using the focused PRA to say how we meet the goals with safety-related and RTNSS equipment only.

CHAIRMAN APOSTOLAKIS: So you would find then the --

MR. WACHOWIAK: I'll get to that.

CHAIRMAN APOSTOLAKIS: Okay.

MR. WACHOWIAK: Okay? Just for our plant, zero to 72 hours, everything is safety related. We don't need any operators during that time frame. Three to seven days, there is requirement that anything we are going to consider for long-term safety has to be onsite.

And then for seven plus days, we can go get commodities from offsite. Diesel fuel, water, air bottles, food. I don't know how food factors into any of this.

CHAIRMAN APOSTOLAKIS: Food you said?

MEMBER CORRADINI: McDonald's is always nearby somewhere.

MR. WACHOWIAK: So in general if you have more time then when it has to happen you can impose less stringent requirements on things. So time should be considered in this and when in determining the risk significance, time should be considered also.

We are looking at saying that repair of something we are crediting is okay if you don't need it for three days. Okay? Now that statement itself you have to read some more into it. The fire pump that we have, we have the pump, we can use it for long-term cooling to supply water to the ICPCC pools. But it is one pump though.

If we turn it on, we can refill the pool fairly quickly. And then if the pump fails, you have approximately three more days before you have to get it started again if you have already refilled or mostly refilled the pump.

MEMBER WALLIS: You only have one pump for the fire protection system?

MR. WACHOWIAK: No. That is the portion of the fire protection system that are RTNSS, selected portions of the fire protection system.

So we want to be able to consider that in the deterministic look at these things. Once again, we have to have all the functions. So the next piece then is after we determine all the things from the deterministic look of what is going to be written, then we look to see if there is anything additional that comes out fo the PRA.

We need to meet the safety goals CDF of less than ten to the minus four and LRF of less than ten to the minus six with some consideration for the containment performance goal considering only the safety-related and RTNSS systems. Then if we don't meet those goals, we would add systems until we did, okay?

What we are saying is that for risk significance here, line in the four box thing for 50.69, risk significance here would be those things that you had to add to get to these goals. So you can't meet the goals with just safety-related equipment alone.

MEMBER WALLIS: Is there any one of them that meets the CDF criterion here?

MR. WACHOWIAK: The CDF criteria isn't difficult to meet with ESBWR.

MEMBER WALLIS: Now you don't need any

RTNSS for that do you?

MR. WACHOWIAK: No, the large release frequency one though is a little more challenging since it is two orders of magnitude lower. And we do have the common cause failure of the digital instrument control system, the safety-related --

MEMBER WALLIS: Well, it is this steam explosion business isn't it? That steam explosion is the problem.

MR. WACHOWIAK: No, it's -- if the digital instrument control system has its catastrophic failure, failure of everything, then we lose ECCS and we lose our containment isolation capability.

MEMBER WALLIS: Is this one which is subject to those 0.1 factors? Is that it? Failure of LOCA system.

MR. WACHOWIAK: So that one is in there. So what we have ended up saying is that selected portions of the diverse protection system would meet this risk-significant RTNSS category that give us two ways of performing the ECCS and containment isolation functions.

And we are still looking at which are the right functions to put that in on. It is probably not all of them. It is most likely going to be the manual portion of the DPS. I know that the other vendors did a similar sort of an analysis and came out with about the same results. That would be risk significant, mostly likely subject to a simple type of a tech spec on that system.

Now we've got other systems where we would address uncertainty in the focused PRA. We have been talking back and forth with the staff on how we should go about doing this.

One suggestion is that we take all of our worst case sensitivities, put those together in the focused PRA, and then add other systems associated or other non-safety-related systems and see how we would come about meeting the goals.

CHAIRMAN APOSTOLAKIS: What does this mean? Systems needed to address uncertainty?

MR. WACHOWIAK: When we do the focused PRA, right, there is still uncertainty in the focused PRA.

CHAIRMAN APOSTOLAKIS: Right.

MR. WACHOWIAK: So we have a point estimate. And in the top portion we would say what do we need to get the point estimate below these goals? In this one we have the uncertainty band on the PRA and what systems do we need to add to make sure that the uncertainty band is below those goals.

CHAIRMAN APOSTOLAKIS: Who says that it has to be? I mean these are goals on the mean value. Nobody says that the 95th percentile has to be less than ten to the minus four.

MEMBER CORRADINI: Unless I misunderstood from your overview, you meet the top thing with the mean estimate, right?

CHAIRMAN APOSTOLAKIS: Yes. And that's the regulation. Oh, no, it's not even a regulation.

MR. WACHOWIAK: That's the focused -- the focused PRA removes all non-safety-related systems from the PRA. So the focused PRA has much higher numbers than what you see there.

MEMBER KRESS: But you still meet --

CHAIRMAN APOSTOLAKIS: This is with active systems.

MR. WACHOWIAK: That's with impassive systems.

MEMBER KRESS: In one of our letters, we made the comment that for new plants like ESBWR that the safety goals ought to be CDF ten to the minus five to respond to the Commission's expectation for a high level safety for new plants. Why did you select ten to the minus four for the RTNSS?

MR. WACHOWIAK: This is what was approved in the SRM was ten to the minus four.

MEMBER KRESS: I know but I would have -- if I had have been them, I would have read the ACRS letter and said well, let's use ten to the minus five.

CHAIRMAN APOSTOLAKIS: But you meet that anyway I can see.

MEMBER KRESS: Yes, they made it.

MR. WACHOWIAK: With the focused PRA or with the -- the focused PRA considering uncertainty on everything --

CHAIRMAN APOSTOLAKIS: Point estimates.

MR. WACHOWIAK: Point estimates? Yes, we meet that.

CHAIRMAN APOSTOLAKIS: So I'm really curious about this uncertainty business. I mean yes, it is okay to address but I don't think you start comparing upper percentiles to the goals. That is a very bad precedent.

MEMBER WALLIS: Why?

CHAIRMAN APOSTOLAKIS: Because the goals were set for mean values.

MEMBER WALLIS: But it does show inherent safety.

CHAIRMAN APOSTOLAKIS: Oh, yes, sure.

There is no end to it. I mean it is something to address it but not to make it formal and demand the whole distribution or 95 percent of it.

MEMBER WALLIS: It is a good design tool.

CHAIRMAN APOSTOLAKIS: I mean existing plants don't meet that.

MR. WACHOWIAK: so let me just ask a different question. So if you were to do all this with this upper bound, could you basically say you don't need to evacuate? Could you change your outer --

CHAIRMAN APOSTOLAKIS: No, you are just changing the requirements without any benefit.

MEMBER WALLIS: Why doesn't that benefit?

CHAIRMAN APOSTOLAKIS: Because the staff will come back and tell you, you know, this is irrelevant to evacuation.

MEMBER WALLIS: But the public is safer. There is a benefit.

CHAIRMAN APOSTOLAKIS: Yes but I mean come on. There is a fundamental philosophy here that the Commission sets regulations. And if you meet them, you are safe enough. You are not going to turn around and say yes, but if I was to do this, and this, and that, I'm safer --

MEMBER WALLIS: Why shouldn't a good designer make a thing that is safer than is required? I don't understand what you are arguing about?

CHAIRMAN APOSTOLAKIS: The designer would but we would not demand it.

MEMBER WALLIS: No, we're not. But they are doing it. I mean why should they be blamed for doing something which makes sense?

CHAIRMAN APOSTOLAKIS: Nobody is blaming them.

MR. WACHOWIAK: I want to make sure -- we have designed a plant that is much safer than required.

CHAIRMAN APOSTOLAKIS: Okay.

MR. WACHOWIAK: That is what we presented yesterday, those numbers. This is determining which components that we have designed in have regulatory control on them versus being designed in. So we shouldn't necessarily have -- well, we shouldn't have to change the design of the plant in order to meet these goals. We should be able to say this is what it is. And if there is some availability requirements, okay.

So for the things that are needed to address uncertainty, I understand your concern about keeping the whole of the uncertainty band below those goals because that is not how the goals were established. I share that view.

But the precedent does not do it that way. So we have to -- you know we're trying to get through the process so we've looked at it with that light.

CHAIRMAN APOSTOLAKIS: This statement, these are not risk-significant systems is your proposal or something you have agreed to with the staff?

MR. WACHOWIAK: It is my proposal. In the context of RTNSS, risk significance really comes down to the difference between needing to have things that are like tech specs versus things that can be controlled by the maintenance rule. And I don't want to have a tech spec on a non-safety-related component because it was included in the RTNSS set because of an uncertainty calculation.

So in order to make the words in the SECYs work out, I have to say that these things that are put in here are not considered risk significant as far as the RTNSS program is concerned.

They may be risk significant in the maintenance rule program. They may be risk significant in the D-RAP program. If you did 50.69, they may even be risk significant if you did 50.69. But in RTNSS, they would not be considered risk significant.

CHAIRMAN APOSTOLAKIS: I understand. Now I get it.

MR. WACHOWIAK: Okay. And --

MEMBER WALLIS: I'm not sure how you are going to explain that to a non-expert on regulations but go ahead.

MR. WACHOWIAK: It is difficult.

MEMBER WALLIS: If I were to explain it to my students, they wouldn't have a clue what I was talking about.

MEMBER CORRADINI: It took him an hour just for us.

CHAIRMAN APOSTOLAKIS: Okay, let's --

MEMBER CORRADINI: Or a half an hour.

CHAIRMAN APOSTOLAKIS: Can we speed it up though because I'm going to start losing members.

MR. WACHOWIAK: Okay. We also have to look at initiating events. There is a process that is described in the SECYs there that is also described a little better in the Westinghouse RTNSS Topical, basically going to do the same thing.

And we have been through that. We don't

see any new components coming in that way.

MEMBER WALLIS: On this slide here, that is where I asked you yesterday.

MR. WACHOWIAK: Yes, this is tough one to do at this stage for RTNSS because adverse system interactions come into play after you have done the design details and you have built the thing and you say oh, well this wasn't supposed to do that. The function of all the equipment is that there is no adverse system interactions. It is things that happen in detail design that lead to potential adverse --

MEMBER WALLIS: Well, it is hard to predict but it can be sometimes a thing which really is the Achilles heel of a design, I mean something unexpected in an interaction led to an undesired consequence.

MR. WACHOWIAK: Right.

MEMBER WALLIS: So it is something you have got to be aware of.

MR. WACHOWIAK: We have to be aware of it and in the RTNSS discussion, what we will have to do is we will have to say that this still needs to be considered throughout the design of the plant.

I expect that as we find these, we can design them out of the plant. But if there is something that later on comes up to be an interaction that we can't design around and we have to use a non-safety-related component to address it, well then that will end up going into RTNSS.

MEMBER WALLIS: What was said yesterday was that in reading the text, it just seemed to be very discursive and when you reached conclusions that things were insignificant, it seemed to be a little fluffy or wooly.

But maybe that is the way it has to be at this stage. Maybe that is the way it has to be. And maybe that is why I was expecting a more hard-nosed analysis when it is impossible to do one yet.

MR. WACHOWIAK: That is the case.

MEMBER WALLIS: Okay.

MR. WACHOWIAK: Okay, in the end, what we end up with is from the deterministic side, we have one of our diesel fire pumps is connected to a pair of tanks that provide enough water for seven days of decay heat removal. We said part of the Diverse Protection System, it is looking like that is going to be the manual actuation of ECCS components from the Diverse Protection System.

And then post-accident monitoring, which specific instruments have to be in the post-accident monitoring set for after 72 hours has not been completely established yet. We are going to use the Reg. Guide 1.97 process to help us determine that.

MEMBER WALLIS: This external connection, is this the fire truck drives up and pumps water in?

MR. WACHOWIAK: Yes.

MEMBER WALLIS: And is there any control on the chemistry of the fire water? Does it make any difference to what happens in the long run to --

MEMBER SIEBER: By the fire truck.

MEMBER WALLIS: I would think it might make a difference. You put in some really crummy water, it might eventually gum up something.

MEMBER MAYNARD: Well I think any time you get to this stage in an accident, yes. That is going to be the least of your worries though. It is going to be -- long-term recovery of the plant from something like this is going to be a major issue. Probably it will never happen.

MR. WACHOWIAK: If the fire truck is ever actually used, that will be a big deal.

MEMBER MAYNARD: Right.

MEMBER WALLIS: You want some control of what is actually put in there in terms of what is in the water presumably.

MR. WACHOWIAK: I think --

MEMBER CORRADINI: You've got seven days to figure it out.

MR. WACHOWIAK: In a scenario where we have had a station blackout that has lasted longer than seven days, we probably would be less concerned about the quality of the water at that point.

MEMBER WALLIS: Okay.

MR. WACHOWIAK: And just keeping it going until we can figure out how to really get power back and do what we need to do.

MEMBER WALLIS: All right.

MR. WACHOWIAK: It is a contingency -- it is not the preferred path.

Things to address uncertainty, we have -- our BiMAC is in RTNSS to address the uncertainty with the -- since we don't have --

MEMBER WALLIS: That is the one that works with 99.9 percent probability?

MR. WACHOWIAK: The deluge system is 99.9 percent. That is our target reliability. And we need to design a system that meets that reliability. That is the commitment we have.

And then some of the functions of FAPCS, right now it is looking like suppression pool cooling and a cooled LPSI mode of FAPCS would be added to address uncertainty.

The last part is going into treatment. The only thing that is different from what may have been seen before is that for some of the post-72-hour capability functions, the precedent has been that these would be considered seismic category 2 buildings and components. Where that is a little -- or not a little, that's quite onerous for our design to do that.

So what we are saying is the things that are needed here, we will be using a combination -- depending on the significance but a combination of international building codes and this new ASCE code for seismic to address things like our service water system and electrical building, things to keep the diesel generator running after 72 hours.

That is the end.

CHAIRMAN APOSTOLAKIS: Finished? Good.

Any more comments or questions from the members who want to be -- nothing.

Thank you very much, Rick. This was very informative. We appreciate your coming here for the day and a half. And we will keep in touch to set up the new dates.

We will now break for 15 minutes until 10:40. Okay. Off the record.

(Whereupon, the foregoing matter went off the record at 10:24 a.m. and went back on the record at 10:40 a.m.)

CHAIRMAN APOSTOLAKIS: We are back in session. Would you please sit down or stand up but don't talk.

Okay, now we are going to hear from the staff. Would you please identify yourselves and tell us why you can address this committee. What are your qualifications please?

MR. KEVERN: Good morning. My name is Tom Kevern. I'm the Project Manager coordinating the staff's review of the ESBWR PRA. I'm going to start off and give a brief update for the staff from the project management perspective. And then Lynn will provide the staff's perspective on technical issues.

MS. CUBBAGE: Tom, we can't hear you.

MR. KEVERN: It's not working?

PARTICIPANT: You need to get near it.

MR. KEVERN: Oh, okay. Should I start over again?

CHAIRMAN APOSTOLAKIS: No. Well, the

reporter, did you get all that? Okay. She did.

PARTICIPANT: She will scream if she doesn't.

MR. KEVERN: All right. The primary purpose of this meeting of the subcommittee was to provide GE an opportunity to provide an update on the ESBWR PRA. And Rick has done that over the last day, day and a half.

I'd like to point out that the staff had an opportunity to hear the same presentation and engage in extensive discussion and interactions with GE two weeks ago in two days' worth of public meetings that we hosted on PRA and RTNSS. So we are familiar with the topics and the issues and the overall presentation.

And I'd like to add that from a qualitative point of view, we had many of the same issues and discussion that the subcommittee has been having for this day and a half.

Overall, we are encouraged by GE's revised approach to RTNSS. Some of the subcommittee members mentioned in reading the material that has been provided previously it was not real clear exactly what was or was not RTNSS and how they were approaching that topic.

And so we were quite encouraged to hear what they plan to do as well as we are encouraged what plans they have for Revision 2 of the PRA. Now we have to wait and see what the information looks like when it is presented.

Just an update relative to RAIs. The staff's review, since the last subcommittee meeting back in April, continues. To date we have issued a total of 157 RAIs. And the review continues.

Just a little bit of accounting data there, the responses that we have received so far number 84. And that is what we consider both complete as well as partial submittals. So obviously remaining we've got 73 that are still outstanding.

And as far as supplemental information, we currently are in agreement with GE that there is a minimum of 15 that require additional supplemental information and there is likely to be more to come. That is why the plus sign is there on the 15.

I guess a key point on this slide is that the effect on the forthcoming Revision 2 of the PRA is to be determined. So how many of these outstanding RAIs as well as the responses are applicable and will be resolved by Rev 2 or whether we need to go back and do some type of an accounting activity or comparison or exactly how we are going to treat the existing RAIs considering the scope of change that GE has told us we are going to have in Rev 2.

Two concerns that staff has is big picture, schedule and staff resource allocation. The schedule that Rick went through yesterday, just add on the note about the -- or emphasize the issue of COL applications, we are looking at revision -- well, Revision 2 of Chapter 19 are coming in soon. But then more importantly, Revision 3 of the entire DCD including Chapter 19 which is going to incorporate the insights and results of Revision 2 of the PRA as well as the review of Revision 2 of the PRA, and then, as we know, we've got two potential applicants have indicated that they will be submitting COL applications for ESBWR design early November of 2007.

So from a staff resource allocation, that presents a problem. This is not a new problem. I mean we have known about this for a while but this just highlights it with the discussion we've been having these last two days with GE. The staff ends up being tasked with doing parallel reviews on the PRA itself, on the overall design control document for certification, as well as COL applications.

So we are doing parallel reviews and

tasked with doing development and preparation of SERs in parallel with a couple of different subjects. So that is the challenge the staff has. As I've said, we've known about this but we just want to highlight it in front of the subcommittee.

So moving on then, that is the end of my part of the presentation.

MEMBER MAYNARD: Just a question from an overview. Of these questions and the interactions that are going on, just kind of a perspective, how much of that is relative to required versus -- is some of this potentially driving the license applicant beyond what is required in this PRA? Or just kind of a perspective on that.

MR. KEVERN: Are you referring GE? Or the vendor? Or the COL applicants?

MEMBER MAYNARD: The vendor in this case. I'm sure your position is that all these are part of the requirements and driving it above. But, you know, sometimes the types of questions and where these things lead can drive an applicant above what is really required. I'm just --

MR. KEVERN: I guess the staff's position would be it is all required but in some cases, the way the RAI is worded, it would be asking for clarification so that the applicant and the staff member are understanding that the approach and the details of meeting the requirements are the same. That there is asynchronous -- well, there is a synchronized response or a synchronized content of the PRA or the DCD.

Any questions?

(No response.)

MR. KEVERN: All right. At that point, I'd like to transfer it over to Lynn.

MS. MRONCA: Okay. My name is Lynn Mronca and I'm the Branch Chief in the Division of Risk Assessment. My group is the PRA Licensing Branch. And I would like to introduce some of the key technical reviewers before I go into the key technical review issues.

First is Nick Saltos. He is also in the Division of Risk Assessment in NRR. And he is a primary reviewer for Level 1, at power, internal and external events.

And then we have Marie Pohida who is also in Division of Risk Assessment. And she is reviewing the shutdown issues for the PRA.

And then we have Ed Fuller and actually also Bob Palla but he is not here. And Ed and Bob are working on reviewing the Level 2 PRA.

And also I'd like to introduce Hossein Hamzeehee. As you know, he is going to be the Branch Chief for ESBWR and other boiling water reactors in the new reactor organization. As you know, the transition between NRR and NRO occurs on January 21st.

CHAIRMAN APOSTOLAKIS: So he is getting credit he doesn't deserve.

(Laughter.)

MS. MRONCA: No he just puts me here instead, right, today.

Okay. These last two days have been very beneficial to the staff to hear the status of the ESBWR PRA design and issues and to hear the ACRS questions and comments.

Several of the staff issues have already been discussed in the last two days and all of these issues that we will be talking about have been provided either formally to GE as requests for additional information or in the case of some draft RAIs that we haven't sent yet, we have discussed with GE at public meetings.

And I know that you have some questions so whenever you have any, I'm sure the staff will be happy to oblige, happy to answer.

Okay, the first -- we are looking at the key technical review issues in Level 1 at power, internal and external events -- common cause failure probabilities. We have already discussed that a little bit. The switch that GE is going to be doing from the alpha method to the MGL method.

And I think some of the staff comments were that the values of the alpha parameters were not available for some basic events in the reference databases. And that in some cases, the common cause factor probabilities were significantly lower than those used for similar components like in the AP1000 design.

Okay, the next issue --

CHAIRMAN APOSTOLAKIS: You were here this morning so you heard the discussion among the members regarding the values. What is the staff's position? Do you want the applicant to use the latest -- not latest really. I mean we're talking about late '90s, early 00's, I guess.

The values of either alpha factors or the multiple Greek letters, is it okay to go to the utilities required document, which is kind of old, or use the more recent numbers? Is there a difference? Does the staff have a position on this?

MR. SALTOS: Yes, this is Nick Saltos. If I can answer this question. We are not requiring the applicant to go to the utility requirement document but for certain events, we don't have any other -- for the squib valves or software failures, we don't have any other sources. So we want them to use the best available sources.

CHAIRMAN APOSTOLAKIS: So if there are numbers in both the Idaho reports and the utility requirements document, you would rather see the Idaho numbers be used because they are more recent.

MR. SALTOS: If they are more reliable, yes.

CHAIRMAN APOSTOLAKIS: Well, you can't judge that. I mean they are just more recent.

MR. SALTOS: More recent does not necessarily mean it is more reliable especially as they apply to components used in an advanced -- in a new reactor design necessarily.

CHAIRMAN APOSTOLAKIS: I don't know how you want to make that judgment but anyway. Okay. So that answers it.

MS. MRONCA: And again, we are awaiting Rev 2 of the PRA so we can do a more detailed review.

The next issue, modeling of I&C systems, I think we have talked about that a lot in the last two days. And probably with GE in other public meetings more. Just a couple of the issues that the staff had on that is that we requested simplified block diagrams to help understand the fault tree analysis and the basis of some of the common cause events, including the software failures.

And we feel that resolution of this issue is very important because it impacts the modeling of other PRA areas like fire risk as well as PRA applications like RTNSS. And so, again, we are awaiting Rev 2 of the PRA for that.

CHAIRMAN APOSTOLAKIS: So how do you handle something for which there are no accepted models for calculating failure. I mean these guys are not -- you don't expect GE to close the gaps in the state of the art, do you? It's not their business.

So it is important but as a community we really don't know how to do it. So we will go to good old defense in depth. And use a deterministic way of licensing reactors. So clearly you have to understand I mean those block diagrams will be very useful in going through where the signals come from and go to and what they do and all that. But putting numbers on these, I think is asking too much -- for too much.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: So that is my personal view. And I see one other member agrees.

MS. MRONCA: Do you have any response, Nick?

MR. SALTOS: Well, I'd like to comment to that. Yes, in general I agree. But we will have to certify this design with the state of the art that we have today. And what basically our philosophy is if we err, we err in a conservative way.

And we are looking at the high level attributes like separation, number of divisions, separation, redundancy, this kind of features. And that is what we model in the PRA.

Those are the assumptions that we have to have requirements to make sure that they are going to be met when the plant from this design is built.

And the uncertainties, by the way, before you talk about the uncertainties in the RTNSS, we are not talking about the normal uncertainties here that you quantify. We are talking about uncertainties for common cause failure. Meeting that goal of ten to the minus four with a ten to the minus six probability for common cause failure is not good enough.

We want to capture this in our decision

making. So that is the reason that we go through sensitivity studies and try to consider some more conservative values of the probabilities that we feel more comfortable about.

CHAIRMAN APOSTOLAKIS: Are you going to put numbers on the performance of I&C systems?

MR. SALTOS: We can -- the I&C system is going to have certain hardware that we have -- it is not very difficult to put failure rates on those.

CHAIRMAN APOSTOLAKIS: But the thing that is important there is the software.

MR. SALTOS: The software --

CHAIRMAN APOSTOLAKIS: You can't do that, right?

MR. SALTOS: -- yes, this is the big unknown. This is where the area of uncertainty is.

CHAIRMAN APOSTOLAKIS: And you will not --

MR. SALTOS: But we are not going to take our decision for RTNSS on ten to the minus six but we might feel comfortable about taking our decision with ten to the minus three. And based on currently available software in other industries that they can support a ten to the minus three. And considering a show of defense in depth that we have the diversity system available and has the regulatory requirements.

CHAIRMAN APOSTOLAKIS: I think you should rely on those. And the regulatory requirements. I don't think there is any basis for a ten to the minus three or two or five or six. These numbers are completely out of the blue and they don't mean anything. Defense in depth is the name of the game there.

MS. MRONCA: and I think we are looking forward to seeing what GE provides us with for review.

Okay. Next issue, PRA mission time. I know that GE provided the 72-hour mission time sensitivity analysis for the baseline PRA for internal events. And I guess we feel that the post-24 hour failures can be very important for RTNSS. And some important post-24-hour failures were not included.

And no sensitivity study with 72-hour mission time was performed for external events. And we expect that GE is going to address these issues in Rev 2 of the base model also.

Okay? Fire risk issues, I know we didn't go through Rick's slide on fire risks. But the following issues, again, we think should be addressed in the PRA. The potential for fire-induced spurious valve actuations causing LOCA or incorrect valve line up, smoke damage of multiple digital I&C components, probability of fire barrier failure and fire propagation to adjacent areas, the importance of non-safety systems in mitigating fire-initiated accidents, and impact of the I&C design on fire risk analysis. And, again, we are waiting for GE's response on that.

PRA input to the licensing basis, this is kind of a general issue for everybody. But some of the things that we think should be included are to identify the important safety insights related to specific design features and assumptions made in the PRA and use such insights to identify and/or support requirements for the certified design.

CHAIRMAN APOSTOLAKIS: Why is that a GE issue? Isn't that an agency issue?

MS. MRONCA: To identify the important safety insights?

CHAIRMAN APOSTOLAKIS: No. PRA input to the licensing basis. I mean shouldn't the agency decide what that input should be? I mean GE would just comply with whatever the agency decides. Unless I misunderstand the bullet. What does it mean? How much of the PRA becomes part of the licensing basis? Is that what the meaning is? So what does it mean?

MS. MRONCA: Well, maybe we were incorrect in saying licensing basis. I know that is something that we are thinking about now. And that is being discussed with the Commission, too, in terms of how much of the PRA, plant-specific PRA, and also the design-specific PRA are going to be submitted for review.

CHAIRMAN APOSTOLAKIS: That is what it means. It is a Part 52 issue.

MS. MRONCA: Right. It is a Part 52 issue.

CHAIRMAN APOSTOLAKIS: Okay. So then I'll come aback to my earlier comment. This has nothing to do with ESBWR. I mean this is something the agency has to decide. So it is not an issue to raise with those guys.

MR. SALTOS: If I can answer this question here, an objective of the PRA review for design certification, for the ESBWR in the previous ones, you used to identify what we call certification requirements like ITAC, SSEs, RTNSS requirements, okay? This is the responsibility of both the industry and us. It is a joint effort.

At the end, we are going to look at what assumptions are made in the PRA and we are going to agree that the plant has to be built to meet those kinds of assumptions. So this is an effort that involves assumptions, involves results, involves importance, sensitivity, uncertainty analysis, all considered an integrated fashion.

And to identify these kinds of requirements to make sure that the assumption are going to be met when the plant reference certified design is built.

CHAIRMAN APOSTOLAKIS: Yes. But is there an issue there?

MR. SALTOS: Where it is an issue, we have to do the work. We have to identify the ITACs, we will have to identify what components go into the RAP. We have to see if a certain systems means you have a tech spec, we have to go through the RTNSS process and see what kind of system we have to have, regulatory requirements, and what kind of regulatory requirements.

CHAIRMAN APOSTOLAKIS: So you are asking GE to give you input to that process?

MR. SALTOS: Yes.

CHAIRMAN APOSTOLAKIS: Okay. So I suspect that the bullet is not well stated. Anyway, now --

MS. MRONCA: That is correct.

CHAIRMAN APOSTOLAKIS: -- that you explained it, it makes sense.

MS. MRONCA: It makes sense, okay.

CHAIRMAN APOSTOLAKIS: It has nothing to do with the submission of the PRA itself. It is the results of the PRA that are relevant to future tests and so on which I think is meaningful.

MS. MRONCA: I think one other item we had under there was -- I think Nick talked about was RTNSS. And we know that the documentation for that remains to be submitted and reviewed. So if you had any questions on RTNSS, now would be the time.

CHAIRMAN APOSTOLAKIS: And the thermo-hydraulic uncertainty is something that we discussed.

MS. MRONCA: Okay. It's over. Okay.

CHAIRMAN APOSTOLAKIS: For today.

MS. MRONCA: Yes, thermo-hydraulic uncertainty, we don't need to talk about that.

VICE CHAIRMAN SHACK: No, I want to know what the staff's expectations are to address the thermo-hydraulic uncertainty.

MR. SALTOS: Okay. I can talk about how we address the issue for AP600 and AP1000. And my understanding is that GE has committed to so something similar. Okay --

VICE CHAIRMAN SHACK: That is the original plan.

MR. SALTOS: Yes. The thermo-hydraulic uncertainties basically are unimportant in the passive system because of the -- of course, there are more driving forces. And using best estimate computer codes, there is not good enough because of the variability of the different parameters that are used in the thermo-hydraulic calculations.

You might come up with errors that are of the order of magnitude to the driving forces themselves. Therefore, in some systems you might think that you have enough injection lines to do the job. You might not have enough really. And the sequence might end up in core damage.

And before, in order to do that, Westinghouse did not calculate the uncertainties. What they did, they bound the uncertainties because calculating the uncertainties for so many sequences, it is not an easy task. It requires a lot of -- probably thousands of thermo-hydraulic calculations.

And if they can demonstrate that the system with the success criteria they assume could do the job, it was not necessary to go and calculate a number, especially a small number, you know, that would require lots of thermo-hydraulic calculations.

So what they did, the first step was to

identify what we called the low thermo-hydraulic margin risk significant sequences. In other words, the sequences that they have a frequency above a certain cut off and also they have been shown with a particular thermo-hydraulic code like a fast thermo-hydraulic code like MAAP, to have a low thermo-hydraulic margin.

And, of course, we had a lot of questions about do we believe MAAP. And so they did benchmarked, you know, MAAP with NORTRAN who was their licensing basis code and tried to see what are the predictions. So once they benchmarked MAAP, they used that for sensitivity -- the sensitivity around several cases of thermo-hydraulic calculations and with that, they identified those low thermo-hydraulic margin sequences.

And then they used the NORTRAN, the design basis code, to do the calculation for those low thermo-hydraulic margin high risk significant sequences.

CHAIRMAN APOSTOLAKIS: I have two questions. The first one is factual. Last time the subcommittee met you showed us an RAI that dealt with thermo-hydraulic uncertainties. Have you received a response to that?

MR. SALTOS: Not yet.

CHAIRMAN APOSTOLAKIS: When you heard this earlier today, the strategy that GE is proposing, which really says -- and it is not the same with what you just described -- essentially what they are saying is, you know, again, coming back to the valves, the seven out of eight criterion is very conservative, is extremely conservative. If we go down to five or four valves, it is the common cause failure model that saves us because if there are such large uncertainties, that it is really not worth doing any calculations on the thermo-hydraulic side.

Now from what you are saying, you would still like to see some calculations like what was mentioned earlier.

MEMBER SIEBER: Well, no. It is still the question of how many of these -- do you do the parametric calculations with MAAP? And how much do you have to do with a code like TRACG.

CHAIRMAN APOSTOLAKIS: Yes. If you decide to handle this issue.

MR. SALTOS: If I can address the common cause failure, first of all, we are talking about a variety of systems what they don't have that much diversity like the pressurization series. And then when -- the common cause failure for two valves is much higher than the common cause failure of three valves.

So if they did thermo-hydraulic calculations so that they can show they cannot afford to lose two valves, then that would penalize them in the CDF.

CHAIRMAN APOSTOLAKIS: But they are already saying that they can -- oh, I see.

MR. SALTOS: Well they say seven have to -- they don't say seven have to work. They say that they have to be -- if I'm correct, five have to work out of eight. Okay. But if there is six to work to work out of eight means only two are allowed to fail.

So the common cause failure applies to two. It doesn't apply to --

CHAIRMAN APOSTOLAKIS: To the whole thing?

MR. SALTOS: Yes.

CHAIRMAN APOSTOLAKIS: But your argument is that this insensitivity that we talked about earlier may not be such a big deal because it applies --

MR. SALTOS: Yes. What I'm saying is yes, you cannot whisk this issue away because of that.

CHAIRMAN APOSTOLAKIS: I understand now.

It seems that the opposition and I suspect the subcommittee's position is that we would like to see some of these parametric uncertainties propagated and see what happens if, for nothing else, for defense in depth purposes to educate ourselves and so no.

MR. SALTOS: In other words, even if there is an argument regarding the common cause failures, which is also in dispute now, we would still like to see those. And using a code that is running much faster than TRACG, at least for me, would give tremendous insights. I mean it doesn't have to be the complete Cadillac calculation.

MEMBER ABDEL-KHALIK: One of the thermo-hydraulic concerns that I am concerned about is the possibility of non-condensable gases being trapped between the squib valves and the check valves due to error in start up procedure.

If this line is not completely full with water, the squib valve is designed to expand the reactor pressure. And, therefore, that line up to the squib valve will be full of water. The line between the tanks and the check valves will be full of water.

But I haven't seen any details in design or start up procedures that would somehow assure that this space between these two valves will be full of water. And if that space is full of gas, then I can see all sorts of thermo-hydraulic problems associated with the operation of the gravity driven system.

Has that issue come up?

MS. MRONCA: We have thermo-hydraulic staff here if they would like to come up and address an issue.

CHAIRMAN APOSTOLAKIS: This is the thermo-hydraulic staff?

MS. MRONCA: Yes.

PARTICIPANT: The token staff.

PARTICIPANT: The usual suspects.

PARTICIPANT: You come on out of the woodwork.

MR. LANDRY: Okay. Ralph Landry, Chief of Nuclear Performance and Code Review Branch. The exact problem you are asking about we haven't looked at. But we had the auditing done at Wilmington this week. And they have raised a number of questions and several additional analyses which General Electric will be performing.

And I will have to check with them this afternoon when I talk with them and find out if this is run. But there were a number of questions on non-condensable gas transfer between wetwell and drywell.

And I will have to check and see if they have looked at particular lines.

MEMBER ABDEL-KHALIK: Thank you.

CHAIRMAN APOSTOLAKIS: All right.

MR. LANDRY: But, yes, we have raised a number of concerns about non-condensables already. But I'm not really sure about this exact line.

PARTICIPANT: Did you want to say something, Mike?

MEMBER CORRADINI: Well, I just wanted to get back to what Bill said because I think what Bill suggested when Rick was up seems like a reasonable approach. But it is a slight bit different than what you just said. So I want to make sure I've got the two as a way just to talk it out.

What Bill was suggesting that seemed reasonable to me was to use something that runs faster and screen out what the uncertainties are from models versus initial and boundary conditions. And then you get some sort of subset that could get you down to a point where you would start -- some of active fuel starts uncovering.

And at that point, it is not clear what the vendor might chose to do. But what I hear you saying is that at that point, once you have screened down to that, you would want to see some more mechanistic calculation of how the water level and uncovered core and timing of uncovery would be done with some more mechanistic model. Do I hear that right?

MR. SALTOS: When you say more mechanistic model --

MEMBER CORRADINI: Than MAAP.

MR. SALTOS: Yes, yes, more design basis.

CHAIRMAN APOSTOLAKIS: Yes, I know but I mean that is what they used for design basis.

MR. JENSEN: Hi, I'm Walt Jensen of the Fuel Performance and Code Review Branch. And I have been asked to look at the thermo-hydraulic calculations to support the PRA. We haven't seen those calculations yet but our one concern we have is the MAAP code which we haven't reviewed but we have seen comparisons between the MAAP code and more mechanistic models for the analysis of reactor systems.

And MAAP doesn't always follow the same trends. So basically just off the shelf, I think one could not support that MAAP is a best estimate computer code for the analysis of reactor systems. And it will have to be benchmarked for a particular case against the more mechanistic code. So that was done for AP1000 and AP600.

MEMBER CORRADINI: Okay. I think -- so what I heard you say and what was just stated is similar. So know let me ask the 64 dollar question. Would the developers of TRACG believe that even TRACG is workable and mechanistic in the regime where I start uncovering for hundreds of seconds and start worrying about other physics that TRACG not necessarily has itself been reviewed for. So I'm getting a second opinion. Good.

CHAIRMAN APOSTOLAKIS: Ralph?

MR. LANDRY: Okay, Mike.

MEMBER CORRADINI: Hi, Ralph.

MR. LANDRY: Hello, Michael. We were very specific when we reviewed TRACG for ESBWR LOCA. We stated very carefully and very specifically that the review did not cover uncovery of the core --

MEMBER CORRADINI: Okay.

MR. LANDRY: -- or core heat up because the analyses that were presented at the time showed that the core never uncovered so we did not review the transition boiling nor the dome boiling heat transfer models in the code. And we stated in the conclusions that should the core ever be shown to uncover, we would have to reopen the review of TRACG because those models were not reviewed for adequacy.

So if you are talking about coming down and uncovering the core and you start to get transition boiling, we cannot make a conclusion as to the adequacy of TRACG at this point.

MEMBER CORRADINI: Okay.

MR. LANDRY: That review may come in the future because General Electric has informed us that their plan is to come in with TRACG for the operating fleet which, of course, will show core uncovery. And we will review those models at that point.

MEMBER CORRADINI: For DBA related?

MR. LANDRY: For DBA related.

MEMBER CORRADINI: Okay. Thank you.

MR. WACHOWIAK: This is Rick Wachowiak. So if they are in a situation now where some don't believe the MAAP results for anything and we have others that say that they don't believe the TRACG results if the core is uncovered, there is no thermo-hydraulic code available for us to calculate core damage.

MEMBER CORRADINI: That is what I was afraid of. So I guess what I'm -- so I'm getting back to what Bill suggested which seemed reasonable at the time. So I just keep on bringing it back up because I want to see if there is a flaw which is if you do a range of initial and boundary condition sensitivity calculations and you find within that you get some subset of core uncovery for some amount of time.

And it is in that window which that Rick suggested is a window, that you know full well it is within a bigger window of potential I'll call margin, is the staff -- does the staff have a plan on what -- forget GE for the moment. Does the staff have a plan of what they are going to do to analyze that to decide if it is good, bad, indifferent? That is what I'm still -- I'm still struggling with.

MR. LANDRY: Are you talking about PRA space?

MEMBER CORRADINI: Yes, let's just stick with the PRA space. Let's not deal with other space.

MR. FULLER: Can I take a crack at this?

MEMBER CORRADINI: Yes. Just PRA space.

MR. FULLER: Yes, I'm stick to PRA space.

CHAIRMAN APOSTOLAKIS: Could you identify yourself for the record?

MR. FULLER: I'm Ed Fuller in Division of Risk Assessment. And I happen to have a little bit of history with MAAP.

It is certainly true that the industry hasn't submitted MAAP for review to the NRC. But on the other hand with respect to its use for success criteria determination, I'm aware -- and the NRC staff are very definitely aware that the MAAP users group has an effort under way to redo the thermo-hydraulic qualification work that was done roughly 15 years ago for both BWRs and PWRs, comparing against various experiments to benchmark some of the models.

And at the same time, it is recognized that these have had to be redone so they are redoing them for MAAP 4. And they are putting together a new MAAP applications document which they will be sharing with the NRC. We are anticipating seeing the very early chapters of this fairly soon because EPRI has told us that they want to send them to us.

It is my understanding that before 2007 is done, they will probably have this qualification -- this benchmark work redone and submitted in a document, probably by the end of 2007. What does this do to our timing for the review of what we are getting for the ESBWR? It doesn't look like the timing meshes very well.

So -- but again, what we are talking about are applications in PRA space where one could expect that applications where the core might or might not uncover in a success criteria determination would be addressed.

CHAIRMAN APOSTOLAKIS: Is there any sense without a detailed statement of how well MAAP has performed? In other words, what are the model uncertainties? The gentleman before Ralph said that he has seen some comparisons and so on.

Oh, you are back.

MR. JENSEN: Yes, I'm here.

CHAIRMAN APOSTOLAKIS: So did MAAP consistently underestimate? Overestimate? By a factor of 1.325? Or by this? By that? In other words, if I see the parametric uncertainty and then I have some idea of the model uncertainty, maybe I will have some insights that are not really very detailed and accurate but at least I'll have some idea that I am not off by significant --

MEMBER SIEBER: Well, I mean you have the AP1000 experience with, you know, the question was, you know, was MAAP applicable to these flows with low driving heads. You know they are not exactly the same sequences here but, you know, they are low driving heads in both cases. It seemed acceptable in that particular situation. And I'm not sure --

CHAIRMAN APOSTOLAKIS: Have you seen any other comparisons that will give us some idea about the model uncertainty there?

MR. JENSEN: The comparisons I'm thinking of --

CHAIRMAN APOSTOLAKIS: You have got to identify yourself again, sorry.

MR. JENSEN: Oh, I'm Walt Jensen of DSS/NRR. And for AP1000 we looked at comparisons between NOTRUMP and RELAP.

And we also ran RELAP calculations and compared MAAP with RELAP and it is hard to say which is the most conservative or which is under predicting or over predicting. Just the trends were different. The pressures, perhaps RELAP would decrease the pressure, slower descent and MAAP perhaps would have a sudden drop and then it would level off. And then by the end of the run, they would have about the same result.

Or they would predict core uncovery at about the same time but getting there, they seemed to go different routes. So when you matched one to the other for a particular plant and a particular sequence, you could say well, yes, MAAP is doing pretty good. We can use it as a scoping tool.

But as far as saying that -- basing their conclusions on what MAAP predicting, other than just looking at a bunch of cases and finding the limiting perhaps -- limiting amount of core uncovery and saying perhaps this is the worst case, I don't think one would want to go any further.

It will be submitted. And there will be more benchmarking done and maybe tomorrow the MAAP will be improved.

CHAIRMAN APOSTOLAKIS: But even when you have different behavior, is it possible to give some sense -- to have some sense as to how far off it is even at the worst point?

MR. JENSEN: Yes.

CHAIRMAN APOSTOLAKIS: By a factor of 100?

MR. JENSEN: No, not a factor of 100. Maybe a factor of two.

CHAIRMAN APOSTOLAKIS: A factor of two. So if I have the parametric uncertainties and then put on top of them a factor of two or three if I want to be more conservative, I still get something useful which I don't necessarily have to use in a specific, you know, compare with criteria.

But I will have a pretty good idea, it seems to me, as to the accuracy of the calculations.

So we are not really talking about a major research project here, are we? We are not. Because the parametric calculations, I mean Guy used to just do this routinely -- yes, Michael, they do in some --

MEMBER CORRADINI: I just --

CHAIRMAN APOSTOLAKIS: -- renowned institutions so --

MEMBER CORRADINI: No, I just -- the only reason I think we want to -- I don't want to bring up any more. I'm just -- sorry.

CHAIRMAN APOSTOLAKIS: No, but I mean --

MEMBER CORRADINI: But I guess what I'm seeing is though -- what has led me to my question is how you answered it relative to what could be done. And it is not necessarily trends or timing as much as it is an interval quantity.

I think the thing that Rick mentioned that I was -- unless I misheard him -- is that seven valves the slope was going down. At five values, the slope went up shortly but it never got close to the original temperature the fuel was at.

Those are the key physical phenomena that if I saw it all the same with MAAP or TRACG, then I would say I don't care about the trending because it is a matter of the stored energy. And if the stored energy is causing a heat up or a cool down.

And that may give me a lot of confidence that given all the wiggling, it is still about the same behavior.

CHAIRMAN APOSTOLAKIS: It is a matter of gaining confidence at the end, that what you are doing is roughly correct.

Okay, I think we -- have we exhausted this? Oh, I'm sorry. Yes, Ralph?

MR. LANDRY: Ralph Landry again. That is an area, it has been the position that we in the DBA side of NOR have taken for years. But MAAP if you want to use MAAP to compare sequence to sequence to sequence, that is fine.

But if you want to use it for quantitative numbers then we have a problem because we haven't reviewed it. And the use of the of the code that we have seen, at places like the Stefan Institute in Czechoslovakia and other institutes that have used the code and compared it with codes like RELAP 5 in Polish papers, we have seen consistently that MAAP over predicts the vessel inventory by a factor of about two to two and a half.

So we know that the code consistently over predicts the quantity of water in the vessel. But that said, if you want to use the code against itself for numbers of sequences, then you can say this sequence relative to this sequence does this, relative to this sequence does this.

And we are not arguing with that. But our argument is what is the quantitative capability because we haven't looked at it and we haven't seen the qualification and assessment of it. Thank you.

MEMBER CORRADINI: Thank you.

CHAIRMAN APOSTOLAKIS: Rick?

MR. WACHOWIAK: This is Rick Wachowiak. I don't know that we resolved anything with all of that. I'm still at a loss of how get to the end here.

We, in the time frame available, we will not be able to have the number of TRACG cases to do what Westinghouse did. What we can do is, if we identify risk significant sequences, we can have some TRACG cases. I don't know that that has been resolved on that.

The other ting about there being discrepancies of things like two and a half times the volume of water, that just sounds like someone didn't know how to use MAAP because you check those sorts of things when you set up your model.

You do a steady state run and you take the mass of water that is in the core and you compare that to your other calculations. Like at GE we have this process called WeVol, weights and volumes. And we compare the mass of water in the vessel to what is in the weeble calculation, which is the official calculation of that. And if there is a discrepancy, you fix it before you do and start doing other calculations.

So I don't understand why GE would be penalized from using a code that has been used throughout the United States and success criteria calculations for PRA because someone in Europe doesn't know how to use the code.

CHAIRMAN APOSTOLAKIS: But is it true, Rick --

MEMBER CORRADINI: We try not to let the professors use the code. That could be even more dangerous.

CHAIRMAN APOSTOLAKIS: Are you saying, Rick, that -- well, would it be wrong on my part to assume that you are still developing a strategy how to deal with this?

MR. WACHOWIAK: Well, I thought I had developed on in that we would do the parametric studies that we were being asked for. And that only in risk significant changes in sequence outcome we would be required to do other code comparisons.

I still get the feeling that the staff is going to want to see every MAAP one show the same results as every TRACG one before we will have this resolved. And I don't know that that is ever going to be achievable.

MEMBER CORRADINI: Can I ask is that what we heard over here?

MR. SALTOS: We would like to -- what Westinghouse did, okay, they used MAAP extensively to do sensitivities, decay heat, friction factors, okay, and then they benchmarked MAAP with NOTRUMP before they did those sensitivities. So they believe in those sensitivities. But they used extensively MAAP and they used NOTRUMP on for those sequences that were shown to have lower margins. Only for those they used NOTRUMP, the licensing code.

Now I hear here that some people don't believe in your TRACG code. That might be a problem.

MEMBER KRESS: It is not that they don't believe it. It just hasn't been reviewed for those things.

MR. WACHOWIAK: But even in going through the process of -- we could benchmark maps and TRACG using the design basis calculations that were done with MAAP -- oh, TRACG, excuse me, but when we have done that, the question comes in well your design basis calculation doesn't come anywhere near uncovering the core so how do we know that when MAAP shows the core uncovery is ripe that you know that. You need to run TRACG to show the core uncovery sequences.

And then there are things that well that was calculated without a LOCA and you need to show that it is going to perform the same way during a LOCA.

And real quickly you can get to the case where Westinghouse was where it looked like in their report they had 34 different sequences that they needed to compare between MAAP and TRACG and that would be a very labor-intensive effort that right now all of our TRACG efforts are going to writing the DCD. And there is none left to go and do that piece of it.

So I'm still not sure where we go other than we complete the strategy that we have and then see where it goes.

CHAIRMAN APOSTOLAKIS: Well, move on then.

MS. MRONCA: Continue? Move on. Okay. Not the end of that issue but for today it is.

Okay. I'll come back to vacuum breakers --

PARTICIPANT: It wasn't much of a detour was it, George?

MS. MRONCA: Okay. For shutdown PRA, one of the issues and these are in the form of draft RAIs and they were discussed last week with GE at a public meeting, the first issue is a large early release frequency risk. It looks like the lower frequency is dominated by pipe breaks in an open containment at shutdown. And one of the concerns of the reviewer was that drain events and vessel diversions weren't assessed.

Another item was the role of the operator --

CHAIRMAN APOSTOLAKIS: Why early release? I thought we were just looking at large releases here.

MS. MRONCA: Marie, do you --

MS. POHIDA: The lower frequency in this plant is dominated by pipe breaks at shutdown. In fact, the lower frequency contribution at shutdown is reported to be greater than full power because basically what is projected to happen is you have a pipe break in vessel penetrations below the L3 level. And you have an open containment because the equipment hatch is open with the operator failing to close it.

I guess you are questioning the large early release frequency as opposed to large release.

CHAIRMAN APOSTOLAKIS: Yes. Why do you worry about early?

MEMBER CORRADINI: It just happens to be early in that case.

CHAIRMAN APOSTOLAKIS: It just happens. We don't have to worry about it.

MEMBER KRESS: They are the same in this case.

MEMBER CORRADINI: They are the same, yes.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: I mean it wouldn't have been wrong to --

MEMBER CORRADINI: It doesn't make it better if it is early.

MS. MRONCA: Okay.

MS. POHIDA: I'm sorry.

CHAIRMAN APOSTOLAKIS: You could have said large release frequency risk then we would have a problem.

MS. POHIDA: Okay.

CHAIRMAN APOSTOLAKIS: You didn't have to emphasize the early part.

MS. MRONCA: Okay. I thought early had to do whether you could evacuate people before they were exposed. And that issue hasn't been -- you know that whole evacuation issue hasn't been evaluated in the shutdown PRA.

CHAIRMAN APOSTOLAKIS: the only reason why I asked the question is because the goal is on the release.

MS. POHIDA: Okay.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: So I was wondering why you had to say early.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: That is only for existing reactors. But move on.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: Here is another model that we have never reviewed. They used the EPRI models. But I guess for human error we use different standards. The model that they are using has not been reviewed by the staff. But give us now what your concern is.

MEMBER CORRADINI: Since he has already jumped ahead.

MS. MRONCA: Go ahead, Marie.

MS. POHIDA: Okay. Well the concern is is that what we have seen in current operating plants that -- what is dominating risk are errors caused by the operator. And it is not pipe breaks but drain down events or vessel diversions caused by the operator.

These type of events were not included in the shutdown PRA assessment. However, there are numerous vessel penetrations at the head and lines leading to rad waste, you know, processing sampling system, you know, how do you protect, you know, somebody from installing a free seal or, you know, mucking around the bottom of the plant that could lead to a potential diversion path?

Also, the auto isolation or the RWCU in the shutdown cooling system function is not included in tech specs. And this jumps back to the role of the operator, you know, what is going to be automated at shutdown and what is going to require the operator to do something at shutdown.

So I'm kind of jumping ahead of my slides here but the tech spec coverage of systems like the isolation condensers, the isolation of RWCU, and shutdown cooling on low level, you know, the CRDs and the SRVs at shutdown the tech spec coverage is sparse right now.

Now I'm waiting for an update on tech specs that is due to arrive December 22nd. But my review has to be based on what I have currently.

CHAIRMAN APOSTOLAKIS: But I would ask Mr. Saltos do you apply to operator models the same scrutiny that you apply to TRACG? You want to see some evidence that TRACG and MAAP and whatever give reasonable results. And here you get results from a model that this staff has never reviewed and yet it is okay.

I mean the EPRI model they are using was never reviewed by the staff. And yet not only in the shutdown case but also at power there is a number .167, the probability that the operator will fail to recognize that something is going on and so on. So I'm wondering about that why we apply different criteria and standards.

MR. SALTOS: Well, we do have some RAIs with respect to the human ability analysis. But overall, I have the impression that the numbers that they are using there are on the conservative side. And this new design they are so automated and the operator actions are not as important as operating plants. And they can afford to use much more conservative probabilities.

CHAIRMAN APOSTOLAKIS: But we will probably see new failure modes actually because of the different times. But no, I agree with you about the numbers. I looked at the numbers. Except for the dependence issue that I raised yesterday, the numbers are reasonable. I mean ten to the minus two is -- common cause failure of non-safety systems.

MS. MRONCA: Yes. That doesn't include -- I guess the RTNSS evaluation does not include common cause factor of non-safety-related systems.

CHAIRMAN APOSTOLAKIS: Let me understand that. You didn't do that? The non-safety-related systems you don't consider common cause? No, you do.

PARTICIPANT: I do.

CHAIRMAN APOSTOLAKIS: Yes for the control override system.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: But this is for shutdown.

MS. MRONCA: This is a shutdown evaluation.

CHAIRMAN APOSTOLAKIS: I'm sorry.

MR. WACHOWIAK: This is on the initiator model of the shutdown --

MS. POHIDA: That is correct.

MR. WACHOWIAK: -- before you get into the fault trees. So it would be the common cause failure of -- I think what you are specifically talking about like all the shutdown cooling pumps while shutdown cooling is in operation.

MS. POHIDA: Yes, the two shutdown cooling pumps, yes.

MR. WACHOWIAK: That is before shutdown.

MS. POHIDA: Because what happens is the cantilever mode of function at shutdown is provided by a non-safety-related system. So according to the RTNSS process you have to look at, either the initiating event frequency contribution for, you know, systems that are providing -- that are non-safety-related.

So in the RTNSS evaluation for shutdown, specifically in the initiating event frequency evaluation, common cause failure of the RWCU shutdown cooling pumps and other common cause failures of RWCU and support systems were not considered in the evaluation.

MS. MRONCA: Okay. Ready? And then risk impact of no containment modes four, five, and six is incomplete.

MS. POHIDA: Yes, we had a bunch of questions. We are trying to understand the risk impact of basically not having a containment in modes four, five, and six. One is that containment integrity is no longer required in modes five and six. Therefore, the containment can be opened up.

And there are certain LOCA sequences that were included in full power during LOCA sequences that were postulated to occur in mode five that were included in the full power contribution. And we had issues with that because during mode five, you could have an open containment.

There is also the issue of that -- in the DCD there are references that the containment isn't noted during power operation. And we also asked questions, you know, if the containment is still closed but, you know, but the containment is deinerted so people can start moving equipment in there, what is the capability of the containment to stay intact given a severe accident with the generation of hydrogen, okay?

So the impact of, you know, how did control at shutdown, the impact of having an open containment in mode five and six, we have a lot of questions in those areas.

MS. MRONCA: Okay. How about key technical review issues in Level 2 PRA in severe accidents? There are really two.

CHAIRMAN APOSTOLAKIS: But it is not the subject of today.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: Anything else you want to add?

MS. MRONCA: Basically we don't have enough information yet to review it. How is that?

MEMBER CORRADINI: We are interested, too.

MS. MRONCA: Okay.

CHAIRMAN APOSTOLAKIS: Any other comments?

(No response.)

CHAIRMAN APOSTOLAKIS: Thank you very much both of you.

Any comments on anything?

(No response.)

CHAIRMAN APOSTOLAKIS: No? Not on anything.

Now we are going to go around the table and you gentlemen will tell me what your first impressions are on what you have heard the last day and a half. Shall we start with Mario or Jack? Who is ready? Jack, are you ready?

MEMBER SIEBER: I struggled through a lot of the review parts assigned to me because of non-sufficient information in the design control document. And, of course, that is under revision right now. The PRA is under revision. And in the I&C section, I expect that I will be able to do a better job when I see what the revisions are.

I think all the other arguments that have been presented pretty clearly lay out the fact that there is a lot of work ahead of everybody in order to come to a conclusion on the PRA acceptability.

That's it.

CHAIRMAN APOSTOLAKIS: Thank you.

Mike?

MEMBER CORRADINI: No other comments at this point.

CHAIRMAN APOSTOLAKIS: Otto?

MEMBER MAYNARD: Well, I believe that both us and the staff have quite a bit to do in pulling together what is going to be required for a success path. As I sit here and listen to all of our questions and suggestions and the staff, there seems to be a lot of uncertainty as to what it is going to take to satisfy us and the staff. And from an applicant's standpoint.

But that can be real challenging trying to shoot at a moving target and just keep trying things until either everybody gets tired or until somebody says that is okay.

So, you know, I think that we have a responsibility to take a look and identify what is it going to take to meet the requirements for us to be satisfied with our review. And not just keep having meetings and taking shots and going off on different paths. So I think it is a challenge.

CHAIRMAN APOSTOLAKIS: Okay, Tom?

MEMBER KRESS: Well, first off, I thought the PRA looked pretty good, very comprehensive and good event trees. But I'm anxious to see the uncertainty analysis. We didn't see much on that.

I think one of the key issues has been this last question we were discussing. I frankly like GE's approach. I think that is about the only way to deal with this question of the uncertainty. A good uncertainty with MAAP is going to tell me a lot, I think.

As far as how many benchmarks you need, I think the staff ought to do some benchmarking with maybe RELAP. I don't think TRACE is ready. But the staff ought to do a little benchmarking on that.

And I think very limited TRACG benchmarking or just maybe a few sequences might be worthwhile. But I can't see requiring the full thing that they required of Westinghouse because GE doesn't have the approved code yet. And, you know, that is just state of the art.

MEMBER SIEBER: Well, I suspect that NOTRUMP wasn't approved for that application either. You just did it with a --

MEMBER KRESS: It might now have been. And I think even a few sequences with unapproved TRACG would be helpful, I think, and probably acceptable.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER KRESS: I don't know what to say about squib valves. I'm still uncertain about them.

CHAIRMAN APOSTOLAKIS: I'm sure another colleague will say something. That's it?

MEMBER KRESS: That's it.

CHAIRMAN APOSTOLAKIS: Thank you.

William?

VICE CHAIRMAN SHACK: No.

CHAIRMAN APOSTOLAKIS: Nothing?

Said?

MEMBER ABDEL-KHALIK: The biggest item I am concerned about is the failure of ability for the squib valves. And the common mode failure probabilities that are included in the analysis are primarily based on environmental issues that result in common mode failures.

But there are other possible scenarios where all the valves can fail simultaneously. For example, you know, in the supplier providing the wrong squib.

And maybe you can get around that by establishing a testing procedure for at least part of the lot that is provided every time some of the valves are replaced. But without that, somehow we need to include that possibility in the estimate of the failure probability.

The other issue, I mean people assume that as soon as you open the valve, water will just flow and there is no problem. And that may very well be the case.

But I need to be sure that either by design or by startup procedures that we don't have sort of large amounts of trapped gas between components like the squib valves and the check valves because that may have an impact on the operability of the systems.

MEMBER SIEBER: It is still driven by a

really high pressure when they open, right?

MEMBER KRESS: You are not worried about the squib valves, you are worried --

MEMBER ABDEL-KHALIK: No, I'm more worried about subsequent -- right -- I am worried about the transient after that.

MEMBER SIEBER: Loops and things like that.

MEMBER ABDEL-KHALIK: Right. You have a big bubble of gas sitting in the line --

MEMBER SIEBER: Okay. I understand that.

MEMBER ABDEL-KHALIK: -- between these two valves.

MEMBER KRESS: That might be particularly important for that isolation --

MEMBER SIEBER: Right. I understand that aspect.

CHAIRMAN APOSTOLAKIS: Mario?

MEMBER BONACA: Yes, the first thing I wanted to point out is regarding the design. I mean I was very impressed by the design. Clearly it is not complete but it seems to me that we understand from current generation of plants where the limitations of these plants were in terms of risk.

And the whole opportunity seems to be

taken, for example double isolation on the penetrations and outside containment and the sources and the diversity of sources of water. I mean somehow this is pointing towards a very robust design. And because of that now the details are not in place. And I had some struggle, as Jack said, too, of identifying some of the future. But I think that, you know, I was very impressed by that.

I also was impressed by the PRA. Clearly it needs some pieces to be put together including observation on the shutdown risk. It is true. There are some questions open there about impact of open containment which has not been addressed in the sequences. But it needs to be.

It seems to me it is more like, you know, a growing pain of the PRA than anything else. So I was quite positively impressed.

CHAIRMAN APOSTOLAKIS: Okay. Well, I may add a couple of comments, too.

Yes, I mean like we shouldn't let even the extensive discussions we have had on some issues cloud the fact this is, in my view, a very good PRA. They have done a very good job. You may disagree with little bits here and there but, you know, this is natural when you have such a massive effort being reviewed by so many people.

The issue of thermo-hydraulic uncertainties, yes, we still have to do some work. But I don't see any showstoppers there. I think the insights that we will gain from the sensitivity analysis that GE plans to do there may be some questions from the staff to expand it a little bit, that would be good enough for me.

So overall, I'm really very impressed by the PRA effort and I might add also by the defense that Rick provided the last day and a half. I was very impressed by that, too.

So it seems like we have a lot of impressed people around here.

MEMBER CORRADINI: Can I ask -- so from a timing standpoint, just -- I want to understand, the timing standpoint is that when we get back together for the Level 2 discussion, there will be some sensitivities relative to how we enter into the thing so that we can discuss this further? Because I guess I am kind of sympathetic to his concern that he is not clear of a path forward for acceptability. And I don't want to leave that somewhat fuzzy.

That has to be clear, otherwise --

CHAIRMAN APOSTOLAKIS: Yes, yes, that is

very true. And that will be a factor in determining the date of the meeting of the subcommittee.

So with that, unless anyone wants to add anything, thank you very much. Thanks to the presenters and the staff. And this subcommittee meeting is adjourned.

(Whereupon, the above-entitled subcommittee meeting was concluded at 11:50 a.m.)

CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards

Docket Number: n/a

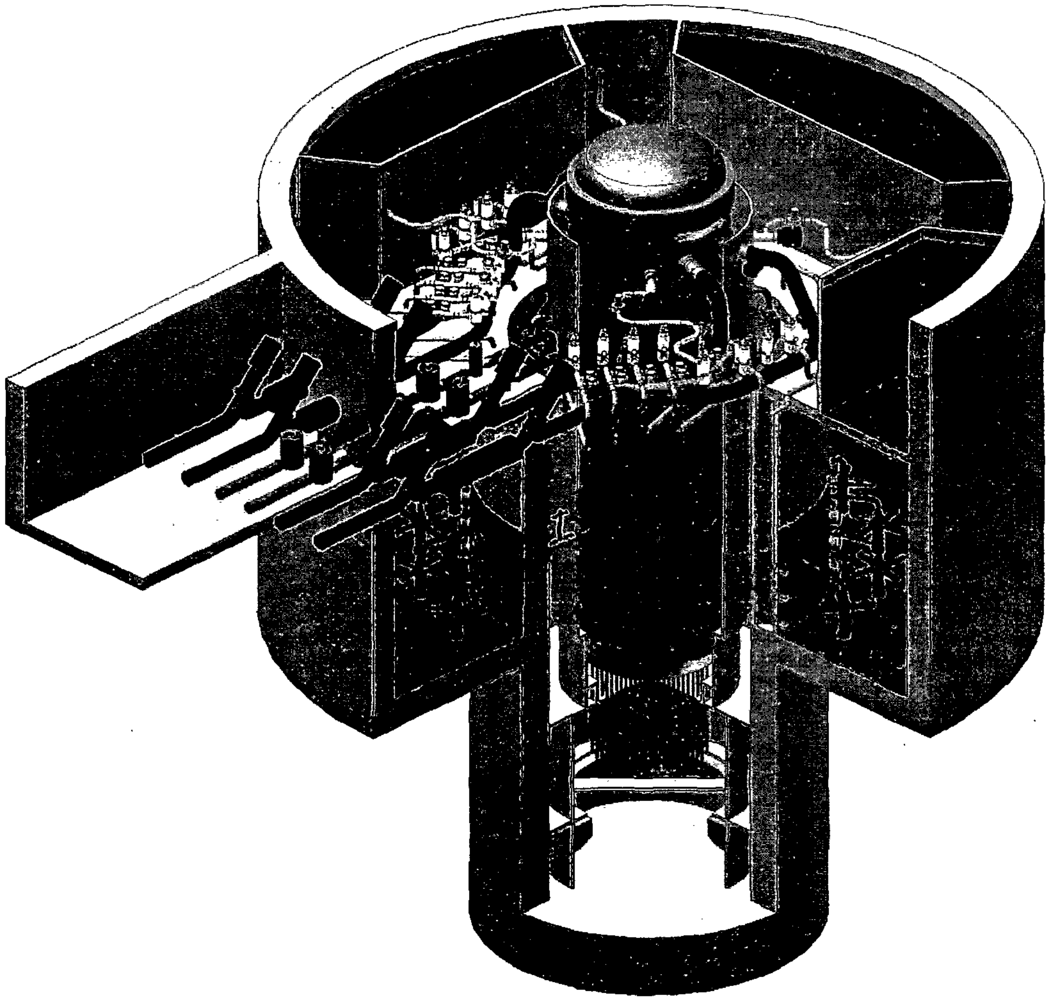
Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Christina Warner
Official Reporter
Neal R. Gross & Co., Inc.

Probabilistic Risk Assessment

Modeling Issues



Presented By:
Rick Wachowiak
General Electric
December 14, 2006

imagination at work

GE Presentation Topics

Common Cause Failure Methods
Data Treatment for Components with Long Test Intervals
Thermal-Hydraulic Uncertainties

Common Cause Model

PRA Rev 1 Used Alpha Factor Method

This Causes Difficulty With:

> Uncertainty Analysis
> Some Sensitivity Analyses

Revision 2 Will Use Multiple Greek Letter Method

> Limit Order of Calculation to β, γ, and δ

Data Sources Under Review

Common Cause Failure Method

The latest release of CAFTA includes a common cause tool.

It enforces a standard method of applying common cause.

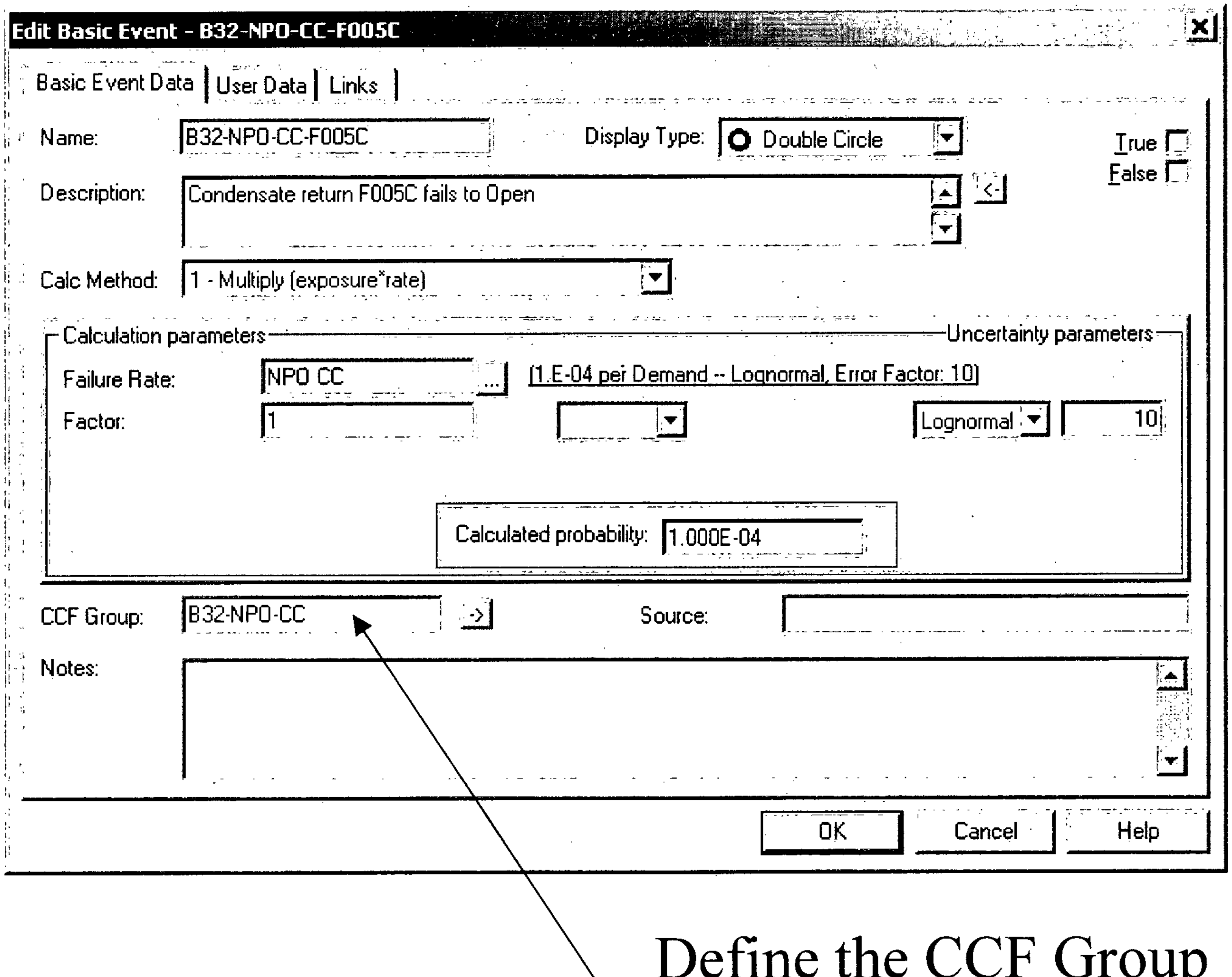
CCF Tool Capabilities

Define CCF Groups

Define CCF Parameters

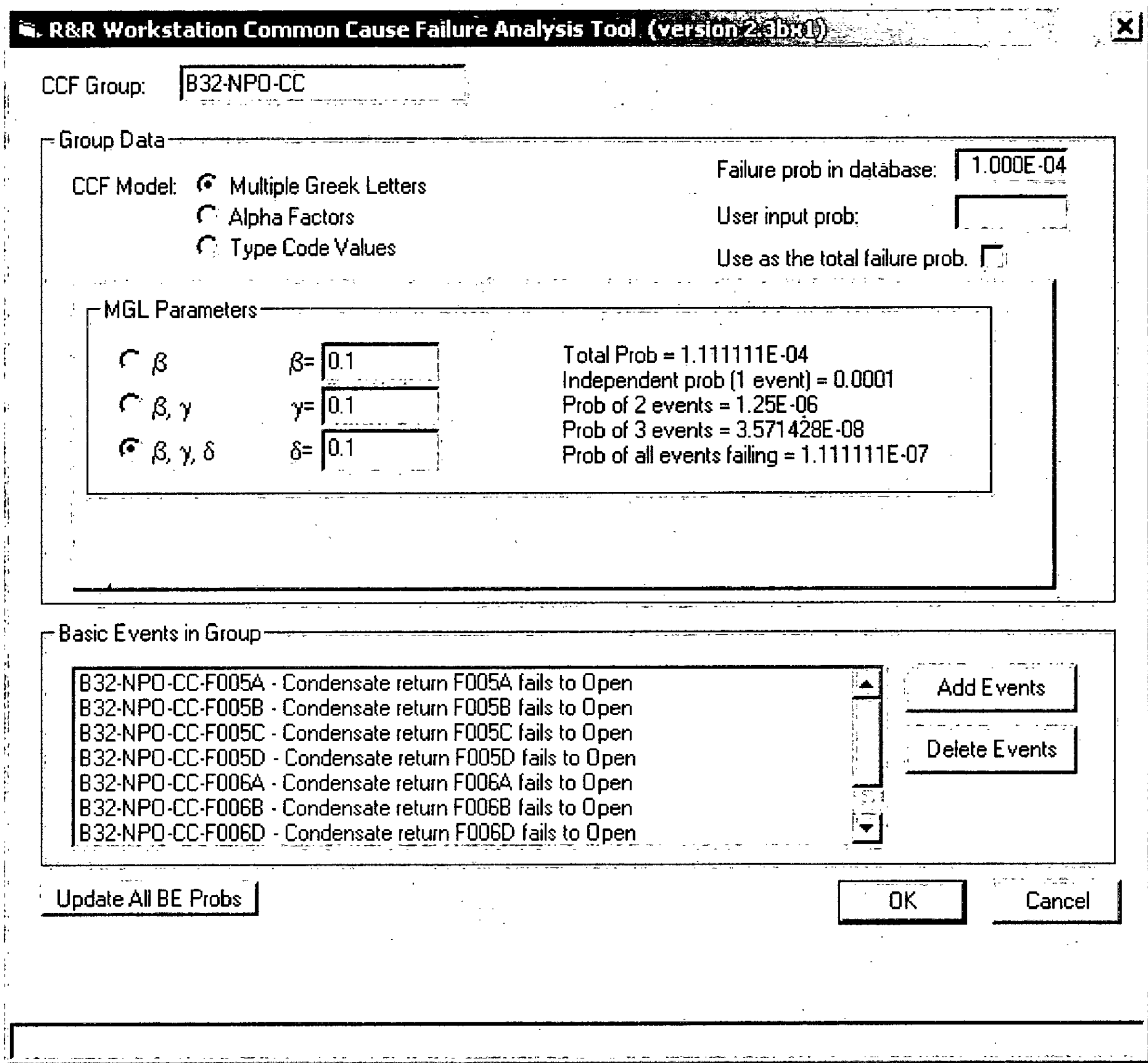
Create CCF Logic

Remove CCF Logic

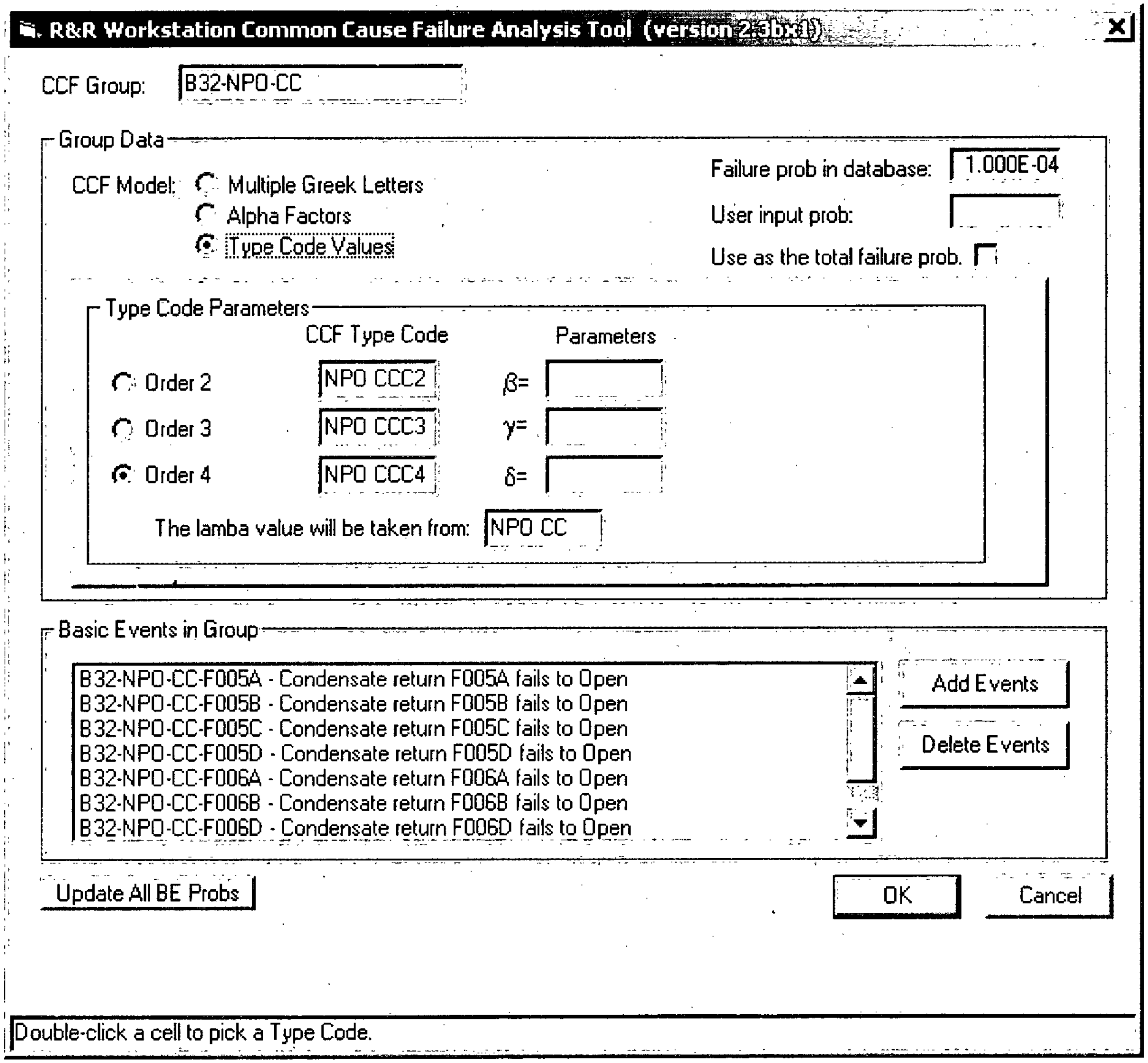


Define the CCF Group

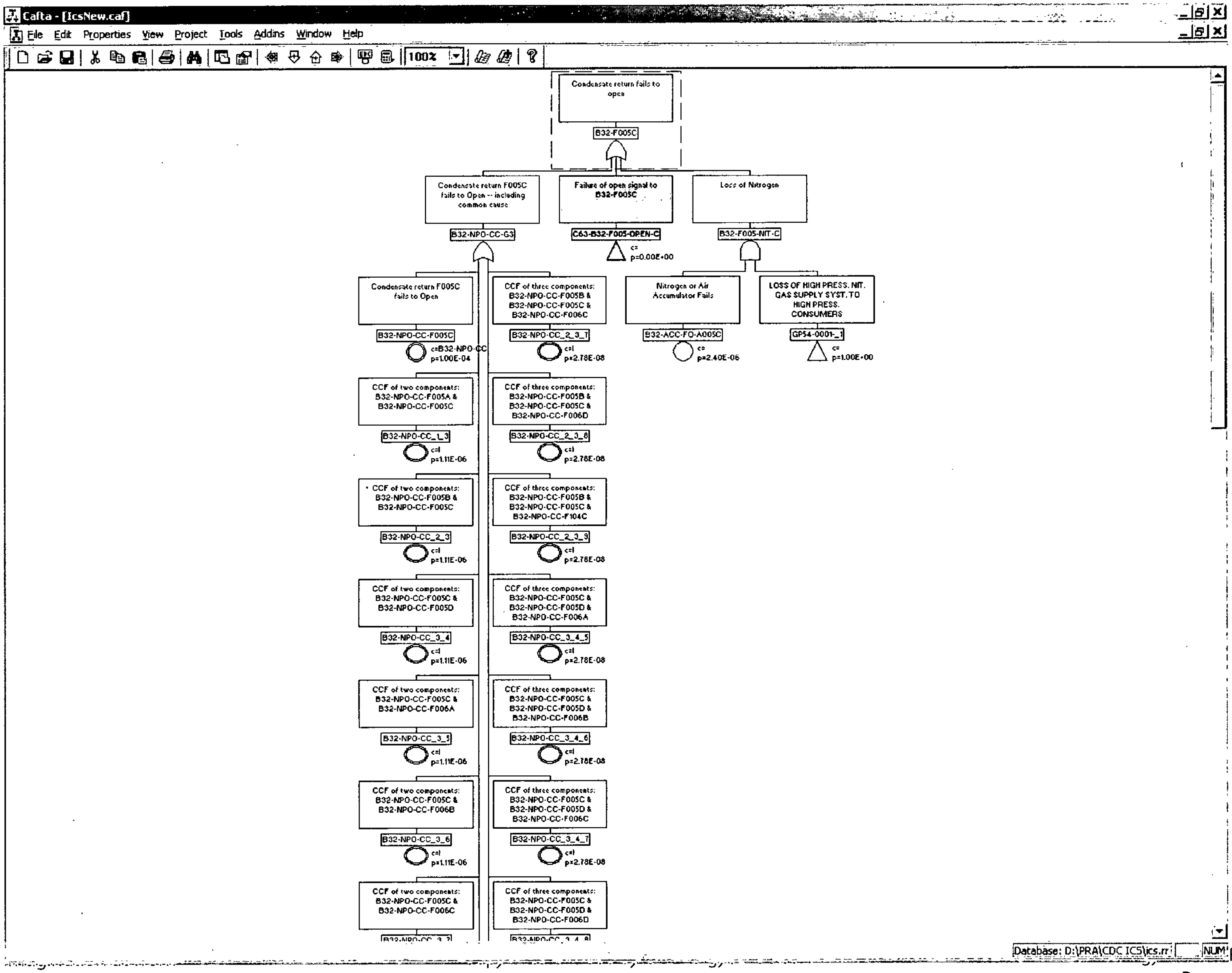
Define the CCF Group Parameters



Type code model



CAFTA does the tedious logic expansion



Cutsets include CCF Terms

Cafta - [Cutset Display]

File Edit Properties View Project Tools Addins Window Help

Disp B32-2LOOPSFAIL 8.3307E-7 Filter: Apply + - Report Compare

1.000E-09	1.000E-05	**B32CNMO_CCNMO-CC_1_2** -
.12%	1.000E-04	**B32-NPO-CC-F104C** - F104C fails to open
1.000E-09	1.000E-05	**B32CNMO_CCNMO-CC_1_2** -
.12%	1.000E-04	**B32-NPO-CC-F104D** - F104D Fails to Open
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_10_18** - CCF of two components: B32-SOV-FE-F009B & B32-SOV-FE-F011B
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_10_22** - CCF of two components: B32-SOV-FE-F009B & B32-SOV-FE-F012B
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_11_19** - CCF of two components: B32-SOV-FE-F009C & B32-SOV-FE-F011C
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_11_23** - CCF of two components: B32-SOV-FE-F009C & B32-SOV-FE-F012C
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_14_18** - CCF of two components: B32-SOV-FE-F010B & B32-SOV-FE-F011B
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_14_22** - CCF of two components: B32-SOV-FE-F010B & B32-SOV-FE-F012B
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting
.05%	1.000E-04	**B32-BV_-MC-F101A** - Manual valve F101A mispositioned closed
	4.348E-06	**B32-SOV-FE_15_19** - CCF of two components: B32-SOV-FE-F010C & B32-SOV-FE-F011C
4.348E-10	1.000E+00	**B32-NONCONDENSE** - Non condensable gasses form in ICS sufficiently to require venting

Cutset#128 Prob: 1.11E-10 Old Prob: 1.11E-10 Generated Database: D:\PRA\CDC ICS\ics.rr NUM

Demand Failure Rates for Equipment with Long Test Intervals

Most Demand Data is Associated with Equipment Tested Quarterly

Some ESBWR Equipment Tested at Much Longer Intervals

Three Methods Proposed, Two Were Used

Demand Failure Rate - continued

Three Cases

1 Test Interval 6 Months or Less

Directly Use Generic Failure Probability

2 Test Interval 6 Months – 1 Year

Use 95th Percentile of Generic Failure Prob

No Components in this Category

3 Test Interval Greater than 1 Year

Convert Demand Failure to Rate (Quarterly Test)

Calculate Unavailability Based on Rate, Test Interval, and No Repair

Demand Failure Rate – Moving Forward

- Continue to Use Methods 1 and 3 Only
- Re-Evaluate Generic Data for Underlying Test Interval

Thermal-Hydraulic Uncertainty

PRA Success Criteria Is Considered Bounding

Very Few Cases Involve Uncovering Any Fuel

In Those Few, No Significant Heatup Calculated

Concern Remains for Calculating Core Uncovery for Various Sequences

T-H Uncertainty – Original Plan

- Intention Was to Perform Comprehensive Benchmark Between MAAP and TRACG for PRA Sequences
- Demonstrate Accuracy of Predictions by MAAP for Beyond Design Basis Sequences
- Other Priorities Continue to Delay this Activity
- No Probabilistic Efforts Involved

T-H Uncertainty – Current Plan

Minimize the Reliance on Additional TRACG Cases

Perform a Quantification of the PRA using Design Basis Success Criteria for Passive Systems

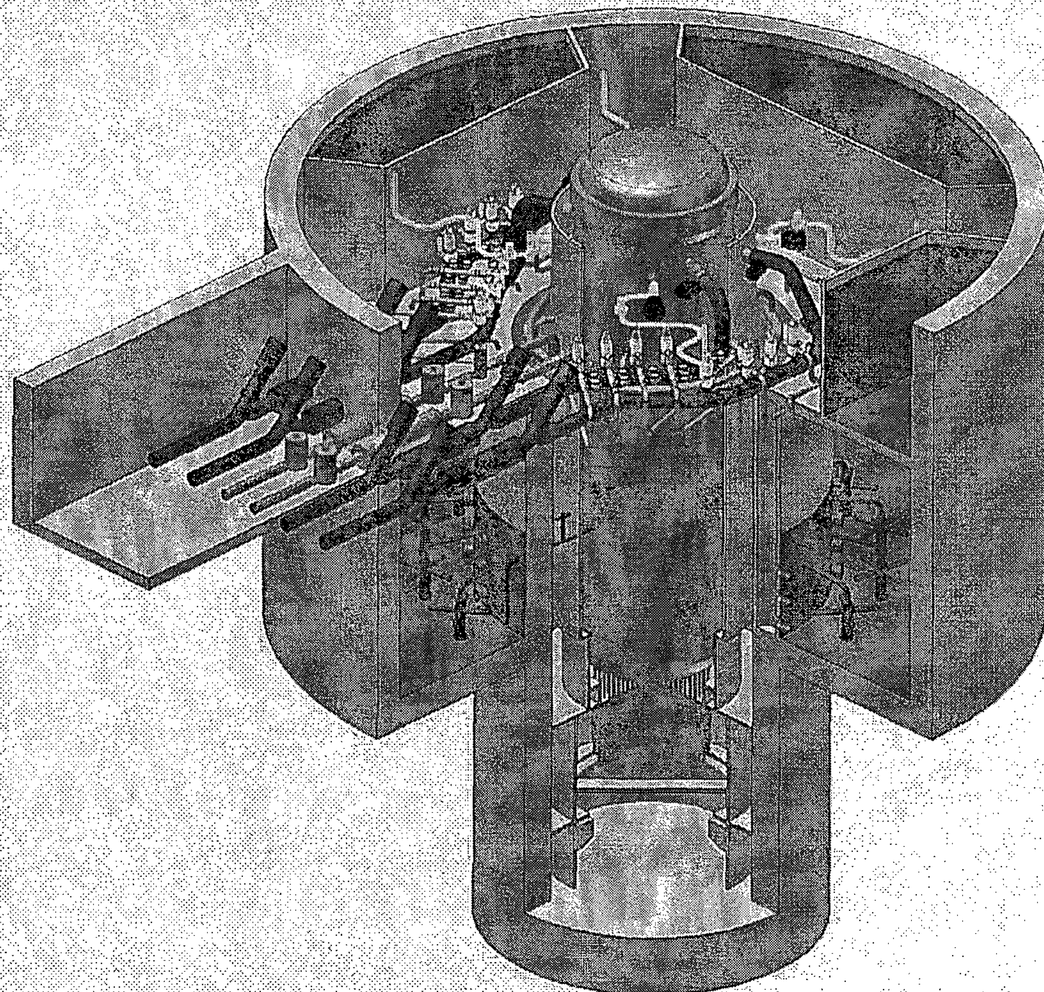
Determine the CDF and LRF Effect

Provide Additional T-H Modeling Only for Sequences that are Outliers

Requires Revision 2 of PRA Model

Probabilistic Risk Assessment

External Events
Summary



Presented By:
Rick Wachowiak
General Electric
December 14, 2006

imagination at work

Flood Assessment - Model

Uses Internal Events PRA Model

Evaluates for Worst Case Flood for Each Building

No Mitigation of Flood Effects

Historical Flood Frequencies Used

> PRA initiated design change for Control Building allows special case
> Eliminates potential vulnerability

Flood Assessment - Results

See Tables 13-5 and 13-6

One Significant Full Power Sequence

> Circulating Water pipe break in Turbine Building
> Building reconfigured to eliminate in revision 2

One Significant Shutdown Sequence

> CRD line break
> Can be considered for design change
> Impact very low

Flood Assessment - Insights

Engineered Protection (e.g. Flood Doors) Not Required

> Will not significantly reduce flood risk if credited

Floor Drain System Can Be Simplified

> Consideration of normally closed system

Floods Are Not Significant Contributors to Risk for ESBWR

Fire Assessment - Model

Uses Internal Events PRA Model

Evaluates for Worst Case Fire for Each Division

No Mitigation of Fire Effects (Bounding Assumption)

> Entire division is affected by any fire in that division

Propagation Considered

Fire Frequencies Based on FIVE Tables

Initiators in Revision 2 Will Be Reduced Due to Elimination of Many 480 V Cabinets

Fire Assessment - Results

See Tables 12-15 and 12-16

Most Significant Full Power Sequence (~50%)

- Fire in Turbine Building
- Design changes for revision 2 significantly reduce this sequence

Reactor Building Fire Sequences Also Contribute

- Conservative assumptions drive these results

Reactor Building Fires Dominate Shutdown Fire Risk

Fire Assessment - Insights

- Assessment Difficult Without Final DCIS and Electrical Configurations
- Risk Will Be Lower When Actual Configuration Is Considered
- Fire Barrier Control Is Likely to Be Required During Shutdown
  - > Needs to be confirmed after final location of equipment is established

Fire And Flood – Overall Impact

Based on the Bounding Assessments Performed Neither Fire nor Flood Should Be Significant Risk Contributors for ESBWR

Table 12-15

Full Power Core Damage Frequency Due to Internal Fires

Fire Area	Scenario[1]	Fire Scenario Frequency (per year)	Core Damage Frequency (per year)
Control Building DCIS Class 1E Electrical Rooms[2]	Division I Fire (FIRE-CONTROL-BUILD-TGEN-DIVI)	2.76E-03	Negligible
	Division II Fire (FIRE-CONTROL-BUILD-TGEN-DIVII)	2.76E-03	1E-13
	Division III Fire (FIRE-CONTROL-BUILD-TGEN-DIVIII)	2.76E-03	Negligible
	Division IV Fire (FIRE-CONTROL-BUILD-TGEN-DIVIV)	2.76E-03	Negligible
Reactor Building Divisional Zones[2]	Division I Fire (FIRE-REACT-BUIL-DIVI)	1.45E-02	7.42E-10
	Division II Fire (FIRE-REACT-BUIL-DIVII)	1.45E-02	7.76E-10
	Division III Fire (FIRE-REACT-BUIL-DIVIII)	1.45E-02	3.61E-10
	Division IV Fire (FIRE-REACT-BUIL-DIVIV)	1.45E-02	3.88E-10
Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building[2]	Division A Fire (FIRE-NON-DIVISIONAL-REDA)	5.57E-02	5.83E-11
	Division B Fire (FIRE-NON-DIVISIONAL-REDB)	5.57E-02	5.83E-11
Turbine Building	Turbine Building Fire (FIRE-TURBINE-BUILD)	6.14E-02	9.69E-09
Fuel Building	Fuel Building Fire (FIRE-FUEL-BUILD)	1.22E-02	Negligible
Control Room	Control Room Fire (FIRE-CONTROL-ROOM-TGEN)	9.42E-03	7.97E-12

Notes:

(1) Parameters shown in parentheses are the fire scenario initiator IDs used in the accident sequence analysis (refer to Tables 12-17 and 12-19).

(2) The CDF results for these scenarios include both single division fire scenarios and multi-divisional fire scenarios (as described in Section 12.5.1 and Table 12-13).

Table 12-16

Shutdown Core Damage Frequencies Due to Internal Fires

Fire Area	Mode[(1)]	Scenario[(2)]	Fire Scenario Frequency (per year)	Core Damage Frequency (per year)
Reactor Building Divisional Zones[(3)]	5	Division I Fire (FIRE-REACT-BUILD-DIVI-M5)	1.12E-03	7.23E-09
		Division II Fire (FIRE-REACT-BUILD-DIVII-M5)	1.12E-03	7.72E-09
		Division III Fire (FIRE-REACT-BUILD-DIVIII-M5)	1.12E-03	3.63E-09
		Division IV Fire (FIRE-REACT-BUILD-DIVIV-M5)	1.12E-03	4.02E-09
	6 Unflooded	Division I Fire (FIRE-REACT-BUILD-DIVI-M6)	2.80E-04	4.53E-11
		Division II Fire (FIRE-REACT-BUILD-DIVII-M6)	2.80E-04	4.53E-11
		Division III Fire (FIRE-REACT-BUILD-DIVIII-M6)	2.80E-04	6.02E-11
		Division IV Fire (FIRE-REACT-BUILD-DIVIV-M6)	2.80E-04	6.02E-11
Non-divisional Areas of Electrical Building; Service Water Building; Control Building non-1E DCIS Rooms; and RCCW and IAS Zones in Turbine Building	5	Division A Fire Propagates to Division B (FIRE-NON-DIVISIONAL-REDA-M5)	2.20E-03	8E-13
		Division B Fire Propagates to Division A (FIRE-NON-DIVISIONAL-REDB-M5)	2.20E-03	8E-13
	6 Unflooded	Division A Fire Propagates to Division B (FIRE-NON-DIVISIONAL-REDA-M6)	5.45E-04	1.92E-10
		Division B Fire Propagates to Division A (FIRE-NON-DIVISIONAL-REDB-M6)	5.54E-04	1.95E-10
Control Room	5	Control Room Fire (FIRE-CONTROL-ROOM-M5)	3.80E-04	2E-13
	6 Unflooded	Control Room Fire (FIRE-CONTROL-ROOM-M6)	9.43E-05	4.56E-11

Notes:

(1) Fire scenarios during Mode 6-Flooded are not explicitly quantified in the accident sequence analysis. Fires cause loss of DHR scenarios, but during Mode 6-Flooded the time to reach RCS boiling is very long. As such, the risk contribution from Mode 6-Flooded fire scenarios is not significant.

(2) Parameters shown in parentheses are the fire scenario initiator IDs used in the accident sequence analysis (refer to Tables 12-18 and 12-20).

(3) The CDF results for these scenarios include both single division fire scenarios and multi-divisional fire scenarios (as described in Section 12.5.2 and Table 12-14).

Table 13-5

CDF Contribution of At-Power Flooding Scenarios

BUILDING	FLOOD SCENARIO	DESCRIPTION(1)	FREQUENCY (per year)	INITIATING EVENT TYPE(2)	DAMAGE	CDF (per year)(3)
Reactor	AP-1	CRDS Pipe Break Outside Containment (FLOOD-RB-CRD-POWER)	3.40E-03	T-GEN	CRDS, FAPCS and RWCU/SDCS	9.74E-14
	AP-2	FPS Pipe Break Outside Containment (FLOOD-RB-FP-POWER)	3.40E-03	T-GEN	FPS, FAPCS and RWCU/SDCS	Truncated(4)
	AP-3	RWCU/SDCS Pipe Break Outside Containment (FLOOD-RB-RWCU-POWER)	3.40E-03	BOC RWCU	FAPCS and RWCU/SDCS	1.19E-12
Fuel	AP-4	FPS Pipe Break in Fuel Building (FLOOD-FB-FP-POWER)	3.40E-03	T-GEN	FPS, FAPCS and RWCU/SDCS	Truncated(4)
Turbine	AP-5	CIRC Pipe Break, Flood below grade elevation (FLOOD-TB-ALL-POWER)	2.80E-02	T-FDW	PCS	3.68E-09
	AP-6	CIRC Pipe Break, Flood above grade elevation (FLOOD-TB-CIRC-POWER)	2.85E-06	T-PSW	PCS, RWCCS	Truncated(4)
Electrical	AP-7	FPS Pipe Break Outside DG Rooms (FLOOD-EB-FP-POWER)	3.40E-03	T-PCS	13.8 kV buses and Batteries A, A1, A2, B, B1, B2, C	Truncated(4)

Table 13-5

CDF Contribution of At-Power Flooding Scenarios

BUILDING	FLOOD SCENARIO	DESCRIPTION(1)	FREQUENCY (per year)	INITIATING EVENT TYPE(2)	DAMAGE	CDF (per year)(3)
	AP-8	Flood in DG Room A (FLOOD-EBGDA-FP-POWER)	3.40E-03	T-GEN	DG(A)	Truncated(4)
	AP-9	Flood in DG Room B (FLOOD-EBGDB-FP-POWER)	3.40E-03	T-GEN	DG(B)	Truncated(4)
TOTAL AT-POWER FLOODING CDF						3.68E-09

Notes:

(1) Parameters shown in parentheses are the at-power flood scenario initiator IDs used in the accident sequence analysis (refer to Tables 13-7 and 13-9).

(2) Identifies the accident sequence structure used in the CDF quantification. Refer to Section 3 for event tree figures.

(3) The quantification is performed at a truncation limit of 1E-14/yr.

(4) No accident sequence cutsets remained above the quantification truncation limit.

Table 13-6

CDF Contribution of Shutdown Flooding Scenarios

BUILDING	FLOOD SCENARIO	DESCRIPTION(1)	MODE	FREQUENCY (per year)	INITIATING EVENT TYPE(2)	DAMAGE	CDF (per year)(3)
Reactor (Outside Containment)	SD-1	CRD pipe break (FLOOD-RB-CRD-PB5)	5	5.80E-04	Loss of RWCU/SDCS	CRDS, FAPCS and RWCU/SDCS	1.32E-13
	SD-2	FPS pipe break (FLOOD-RB-U43-PB5)	5	5.80E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	Truncated(4)
	SD-3	CRD pipe break (FLOOD-RB-CRD-PB6)	6-Unflooded	1.44E-04	Loss of RWCU/SDCS	CRDS, FAPCS and RWCU/SDCS	1.49E-09
	SD-4	FPS pipe break (FLOOD-RB-U43-PB6)	6-Unflooded	1.44E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	8.69E-11
	SD-5	RWCU/SDC pipe break (%BOC-RWCUSD5)	5	5.80E-04	BOC RWCU	FAPCS and RWCU/SDCS	7.37E-14
	SD-6(5)	RWCU/SDC pipe break (%BOC-RWCUSD6)	6	5.87E-04	BOC RWCU	FAPCS and RWCU/SDCS	1.12E-13
Fuel	SD-7	FPS pipe break (FLOOD-FB-U43-PB5)	5	4.36E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	Truncated(4)
	SD-8	FPS pipe break (FLOOD-FB-U43-PB6)	6-Unflooded	1.08E-04	Loss of RWCU/SDCS	FPS, FAPCS and RWCU/SDCS	6.26E-11
TOTAL SHUTDOWN FLOODING CDF							1.64E-09

Notes:

(1) Parameters shown in parentheses are the shutdown flood scenario initiator IDs used in the accident sequence analysis (refer to Tables 13-8 and 13-10).

(2) Identifies the accident sequence structure used in the CDF quantification. Refer to Section 16 for event tree figures.

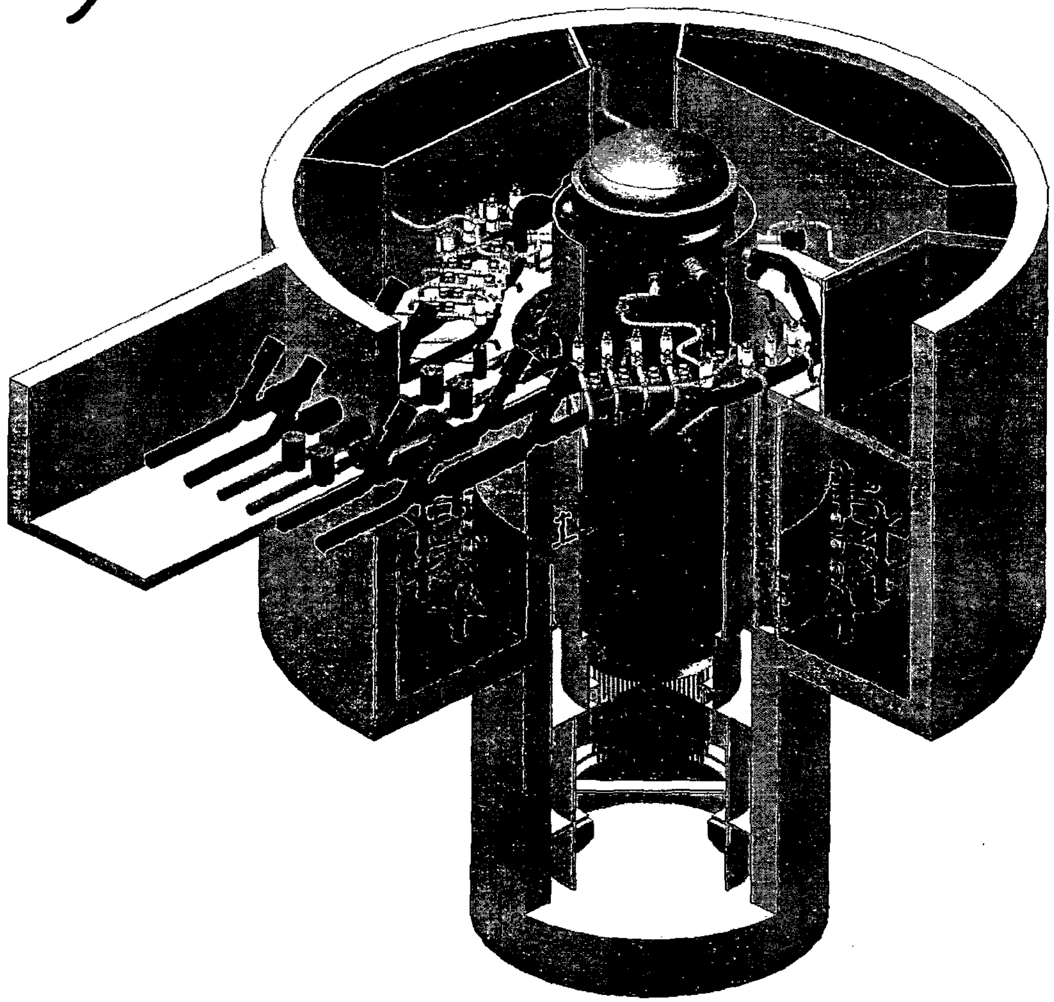
(3) The quantification is performed at a truncation limit of 1E-14/yr.

(4) No accident sequence cutsets remained above the quantification truncation limit.

(5) Both Scenarios 6a (Mode 6-Unflooded) and 6b (Mode 6-Flooded) are included in this line item summary.

Regulatory Treatment Of Non-Safety Systems

Strategy for the ESBWR Standard Design



Presented By:
Rick Wachowiak
General Electric
December 14, 2006

imagination at work

GE Presentation Agenda

Overview of ESBWR RTNSS

- > Our understanding of the issue
- > Methodology for determining equipment set
- > Treatment

Current ESBWR RTNSS Equipment Set

Regulatory Treatment of Non-Safety Systems
- Requirements -

Has Been Required Only for Passive LWR Designs

Regulatory Guidance Contained In:

- > SECY-94-084
- > SECY-95-132
- > Associated SRM's
- > Precedent

Deterministic Equipment Selection

Probabilistic Equipment Selection

Regulatory Treatment of Non-Safety Systems - Equipment Selection Requirements -

Functions Needed to Address ATWS (10 CFR 50.62)

Functions Needed to Address SBO (10 CFR 50.63)

Functions Needed for Post 72 Hour Safety

Functions Needed for Seismic Events

Functions Needed to Prevent Significant Adverse Systems Interactions

Functions Needed to Meet the Probabilistic Safety Goals

ATWS Mitigation - 10 CFR 50.62

Functions Required:

(c)(3) Each boiling water reactor must have an alternate rod injection (ARI) system that is diverse (from the reactor trip system) from sensor output to the final actuation device ....

(c)(4) Each boiling water reactor must have a standby liquid control system (SLCS) with the capability of injecting into the reactor pressure vessel a borated water solution ....

ARI is Non-Safety in ESBWR

SLCS is Safety-Related in ESBWR

Success Using SLCS Requires Successful Feedwater Runback

ARI is RTNSS

Feedwater Controller is RTNSS

Station Blackout – 10 CFR 50.63

ESBWR Has a 72 Hour Coping Period

Nothing More Should Be Required

SECY-94-084

> Diesels or offsite AC power connection can be RTNSS based on other RTNSS criteria

Seismic

Seismic Response Provided By Safety Related Components

> Including seismic margins analysis

Only Issue is Post 72 Hour Safety Following Seismic Event

Long Term Safety

All Initiating Events Are Considered

Required Functions

> Core Cooling
> Decay Heat Removal
> Post Accident Monitoring
> Control Room Habitability

There Must Be A Strategy For All Contingencies

PRA Used to Determine Risk Significance

Long Term Safety - Phases

0 – 72 Hours	Safety Related, No Operators
3 – 7 Days	Resources Must Be On Site
7 + Days	Off Site Commodity Replacement

More Time Until Needed Results In Less Stringent Requirements

Repair Is OK If Backup Is Available (3 + Days)

All Required Functions Must Be Sustained

RTNSS Based On PRA Results

Systems Needed to Meet Safety Goals

- CDF ≤ 10^{-4}
- LRF ≤ 10^{-6} (and containment performance goal)
- These may be risk significant systems
- Simple Technical Specification treatment

Systems Needed to Address Uncertainty

- These are not risk significant systems
- Maintenance Rule treatment

RTNSS Based on Initiating Events

Three Conditions Must Be Satisfied

> Does non-safety system failure cause initiator?

> Is that initiator risk significant?

  - Contributes approximately 10% to CDF

> Can availability controls reduce initiator frequency?

RTNSS Based on Adverse Systems Interactions

Systematic Approach Used

Failure of Non-Safety Systems That Affect Safety Systems

Actuation of Non-Safety Systems That Affect Safety Systems

Detailed Design Expected to Eliminate All Interactions

Proposed RTNSS Functions

ARI and Feedwater Runback for ATWS

IC/PCC Pool Makeup Via Fire Water

> Diesel pump for 3 – 7 days

> External connection for 7 + Days

Parts of Diverse Protection System

Post Accident Monitoring

> Detailed list in development

> Based on RG 1.97

Additional RTNSS Functions to Address Uncertainty

BiMAC Device

Some Functions of FAPCS