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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

April 28, 2006

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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JOINT MEETING OF

THE SUBCOMMITTEES ON

RELIABILITY AND PROBABLISTIC RISK ASSESSMENT AND

PLANT OPERATIONS

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FRIDAY,

APRIL 28, 2006

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ROCKVILLE, MARYLAND

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The meeting was convened in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, at 8:30 a.m., GEORGE E. APOSTOLAKIS, Chairman, Reliability and Probablistic Risk Assessment Subcommittee, presiding.

COMMITTEE MEMBERS PRESENT:

GEORGE APOSTOLAKIS Member, ACRS

THOMAS S. KRESS Member

OTTO L. MAYNARD Member

ACRS/ACNW STAFF:

DAVID FISCHER

MIKE JUNGE

HOSSEIN P. NOURBAKHSH, Designated Federal Official

PANELISTS:

BIFF BRADLEY, NEI

GARY CHUNG, Southern California Edison

JOHN GAERTNER, EPRI

RICK GRANTOM, STP

ALAN HACKEROTT, Chairman PWROG RMSC Subcommittee, Omaha Public Power District

STEPHEN HESS, EPRI

NRC STAFF:

R.P. GROVER, NRR/DIRS/ITSB

ANDREW HOWE, NRR/DRA

TIM KOBETZ, NRR/DIRS/ITSB

ROBERT TJADER, NRR/DIRS/ITSB

I-N-D-E-X

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

(8:31 a.m.)

I. OPENING REMARKS

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a joint meeting of the Reliability and Probablistic Risk Assessment and Plant Operation Subcommittees. I am George Apostolakis, Chairman of the Reliability and Probablistic Risk Assessment Subcommittee.

ACRS members in attendance are Tom Kress and Otto Maynard. Hossein Nourbakhsh of the ACRS staff is the designated federal official for this meeting.

The purpose of this meeting is to discuss the status of the development of risk management technical specifications initiative 4b. We will hear presentations from representatives of the Office of Nuclear Reactor Regulation, Nuclear Energy Institute, South Texas Project Nuclear Operating Company, Southern California Edison, Exelon, and Electric Power Research Institute.

Risk management technical specifications initiative 4b proposes to rely on PRA and risk monitors to calculate technical specification completion times for returning structural systems and component to operable status.

The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full Committee.

The rules for participation in today's meeting were announced as part of the notice of this meeting, previously published in the Federal Register on April 2006. We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting.

A transcript of the meeting is being kept and will be made available, as stated in the Federal Register notice. Therefore, we request that participants in this meeting use the microphones located throughout the meeting room when addressing the subcommittee. Participants should first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We will now proceed with the meeting. And I call upon Mr. Bob Tjader of the Office of Nuclear Reactor Regulation to begin.

MR. TJADER: Thank you, Dr. Apostolakis.

II. GENERAL OVERVIEW OF RISK MANAGEMENT

TECHNICAL SPECIFICATIONS INITIATIVE 4B

MR. TJADER: Yes, I'm Bob Tjader with the Technical Specifications Branch of NRR. And I'm responsible for coordinating the risk management tech spec initiatives. I have to my left here Andrew Howe. He's with the PRA Branch of NRR and the primary reviewer of the PRA aspects of the initiatives.

Today we're here to discuss risk management tech spec initiative 4b dealing with risk-informed completion times. It is probably the most aggressive of the initiatives and entails the greatest effect on plant operations of any of the initiatives to date.

The purpose of this meeting today is to familiarize you once again with initiative 4b. This was the third time we have been before you to discuss initiative 4b. And at this point in time, we are here to present the risk management guidance document, which contains the requirements and the guidance for implementing initiative 4b.

Just as matter of point, the risk management guidance document does contain requirements. And this is in section 2 of the document. And it will be part of the technical specifications. So it will definitely contain requirements. Of course, part of the purpose of this meeting is to obtain your feedback on these initiatives.

We have today members of the industry that will also give presentations. We have members of EPRI, John Gaertner, Steve Hess, who have been involved in preparing the document, the writers of it; Biff Bradley of NEI. We have members of the pilot plants, South Texas, Fort Calhoun; and a proposed pilot plant, San Onofre, who in the very near future we expect to be a pilot plant, giving presentations on how they would implement this initiative.

Eventually our intent is to seek a letter from the ACRS to the Commission providing comments and, of course, hopefully supporting the initiative since it is very aggressive and an innovative approach and a new way of operating plants.

CHAIRMAN APOSTOLAKIS: Eventually? Do you mean in June?

MR. TJADER: Well, if I could delay that to the very last slide, where I have a slide on the status of the initiative, I'll discuss that.

CHAIRMAN APOSTOLAKIS: Okay.

MR. TJADER: We were originally thinking June. I'm not so sure now because we are not quite as far along as three months ago, when we requested the meeting, where I expected us to be a little further along than we are right now.

The purpose of risk management -- what I am going to do in my presentation is just give you a big overview of initiative 4b, sort of a refresher of what initiative 4b is. And I intend to do that quickly so that we can get right to the risk management guidance document and the methodology that it entails, exactly what that is.

The risk management tech spec initiative, the purposes are to align tech specs with the Commission policy statement on PRA to implement that policy statement in making further regulatory decisions with respect to tech specs.

As a corollary to that, we are making tech specs consistent with other regulations and, in particular, consistent with the maintenance rule, particularly maintenance rules (a)(4) paragraph, which requires assessing and managing risk prior to maintenance. And we use that as sort of a linchpin for our risk assessment things. We apply that in areas, in addition to maintenance, at other times.

The purpose of the tech specs, risk management tech spec initiatives, is to enhance safety. That is definitely the primary, I would say, purpose of this. What it does, it allows operators and the NRC to focus on safety, to focus on returning equipment and systems to operability, rather than focusing on shutting down or exiting the mode of applicability of tech specs and, thereby, avoiding unnecessary shutdowns and unnecessary transients that could potentially be avoided. It is to focus on safety and do the risk-intelligent thing. And it takes integrated plant risk into consideration.

It is to focus operator safety, operator focus on safety. It makes them aware of risk contributors and the existing profile of the plant's risk status. And it makes the completion times of tech specs and the actions appropriate to the risk that is involved in the configuration of the plant at the time.

Risk-informed completion times, initiative 4b, what they do is they take a real-time calculation, quantitative calculation, of the risk associated with the plant configuration at that time and calculate what would be an appropriate completion time for taking the required actions of tech specs. And that will extend from a front-stop, what we call it, from the existing completion time up to the risk-informed completion time or up to a maximum of 30 days.

Thirty days gives the licensee time to hopefully restore the system to operable status. The risk-informed completion time or the backstop gives them time to do that or to come to the NRC for further discussion about what to do.

The risk management guidance document itself includes an approved decision-making process. It includes the methodology. It includes, as I said, requirements and guidance. It requires guidance for PRA technical adequacy and capability and along with the attributes and requirements for a configuration risk monitor or tools. It includes quantified metrics for the configuration and cumulative risk. And it also includes documentation and training requirements.

And, as I previously said, we have two pilots at the moment; South Texas, a full plant pilot; Fort Calhoun, who is implementing a pilot on the HPSI system, single system, one; and SONGS, which is a prospective pilot. And they are a standard technical specification plant. And they would also be a full plant pilot.

Just as a refresher, original tech specs, they are not risk-informed from a PRA perspective. They're based upon engineering judgment and evaluation and incorporate the risk associated with the knowledge that the engineers had, which is very good.

They do not consider multiple-system or equipment outages. They focus only on the system of that tech spec. Most of them focus on shutting down or getting out of the mode of applicability.

And, just as a matter of point, it should be noted that 50.36, the regulation that requires specs and which requires LCOs, requires remedial action, but it does not at any point specify specifically completion times or an allowed outage time.

It's just a natural extension that if you're going to have a remedial action, it should be performed within a period of time. I'm going to take that as a point in saying that completion times in and of themselves are not specified in regulation.

Original tech specs are very restrictive, very conservative, but they do have a good safety record. And our intent is not only to maintain that safety record but hopefully to improve on it.

The benefits of the risk management, tech spec risk-informed completion time are that it is risk-informed. It considers the integrated configuration plant risk. It can consider multiple system outages. It manages a broader scope of equipment and systems and components than just those in tech specs.

For instance, when you're in a risk-informed completion bind, the PRA will recognize all components that are operable and inoperable, not just those that are tech spec. So it takes it to a broader risk perspective than just the tech specs. It provides real-time insights on the risks associated with the plants and gives operators guidance on the appropriate action to take, focusing on repair or even in some cases perhaps getting out of the mode of applicability.

It does contain a greater degree of licensee control. The control of the risk-informed completion time will be under their control through the methodology, which will be in tech specs. And to some degree, in one sense, it doesn't really change what is occurring.

For instance, in today's world, if a plant gets up to an existing completion time in tech specs and they cannot restore the system; however, they think they can restore it in the near term, they are very likely to come in for an NOED, a notice of enforcement discretion, requesting permission to go beyond the completion time. And they will use risk information and arguments to propose that. And, more likely than not, more often than not, we approve that.

So, in essence, we aren't really changing anything. We're just adding the -- we're giving them the control and the flexibility to do the right thing without the administrative exercise and burden of going through an NOED.

MEMBER KRESS: When you say, "risk," do you mean strictly just CDF?

MR. TJADER: Primarily. However, the risk-informed completion times are based upon ICDPs, the difference that is realized by the configuration of the plant risk versus a baseline no maintenance-type risk.

MR. HOWE: Let me jump in here. Based on the more restrictive ICDP or ICLERP. So it considers both level I and level II.

MEMBER KRESS: You could use LERF, too.

MR. HOWE: It's required that they assess both unless they've demonstrated up front that LERF is not the limiting metric CDF.

MEMBER KRESS: Okay. How would you apply this to one of the new plants, like a gas-cooled reactor?

MR. TJADER: Well, I think that

conceptually I don't think it would be terribly difficult as long as the gas-cooled reactor had a PRA and a means of quantifying risk with regard to the systems and components that are operable or inoperable.

MEMBER KRESS: They would have some other measure of risk. I see.

MR. TJADER: Yes, I guess. Yes, whatever their PRA is based upon if it's not CDF. I'm not familiar with gas-cooled reactors.

MEMBER KRESS: They don't formally have a CDF.

MR. TJADER: Okay. Risk management guidance document, as I have previously alluded to, contains an overview of the risk management technical specifications.

It contains program requirements in chapter 2. It provides guidance in chapter 3. It provides a methodology for utilizing and implementing the risk-informed completion time. It also has got requirements for PRA quality and configuration risk management tool attributes. And it's got document and training requirements contained in it.

CHAIRMAN APOSTOLAKIS: So the PRA quality is assured by the industry peer review process, correct?

MR. TJADER: Right, exactly. It implements reg guide 1.200 --

CHAIRMAN APOSTOLAKIS: Right.

MR. TJADER: -- as a foundation, but it goes beyond that.

CHAIRMAN APOSTOLAKIS: Is there a similar process for the CRM? I mean, who reviews? You say in your bullet in the previous slide "PRA quality and configuration risk management tool attributes." And it's based on those. So is there a review process of the CRM?

MR. TJADER: There's not the formal reg guide 1.200 type review process. What we have in the risk management guidance document are the attributes that the configuration risk management tool must contain.

What we do envision, particularly for the pilots but not only for the pilots but for every plant that eventually comes down and requests to adopt this initiative is that it would require a site visit by the staff to ascertain the PRAs and the configuration risk management tool's acceptance for applying this initiative.

So it will require additional review and not just a reliance on the reg guide 1.200 and their certification as it's set forth.

CHAIRMAN APOSTOLAKIS: Well, 1.200 and also the document that you sent us is a fairly high-level document.

MR. TJADER: Right. And reg guide --

CHAIRMAN APOSTOLAKIS: It says, "You should do this," "You should do that." But it really doesn't tell you how to do it. So I'm wondering.

You know, we had a very long discussion -- I went back to the transcript -- last June in 2005, when we met again with the same gentleman. And we had the discussion of how to handle common cause failures, how to handle, you know, other attributes. And I'm wondering whether anyone is actually looking how these issues are handled in the CRM.

MR. TJADER: We are considering it. We recognize that reg guide 1.200 is something that is intended to be applied solely by the licensee. Now, it does require peer reviews. It does require that they satisfy their F and O's and all that kind of good thing.

We don't have anything formally set up yet for the configuration monitors and the tools.

CHAIRMAN APOSTOLAKIS: Yes.

MR. TJADER: However, when we do make the site visits, which in the next couple of months we intend to do, one of the things that we have on our agenda is to review the PRA and to review the configuration risk management tool.

So we will have to set up a set of criteria for ascertaining its acceptability and getting some confidence that the tools reflect, accurately reflect, the PRA.

CHAIRMAN APOSTOLAKIS: Yes. I'm not concerned so much about the PRA because I know that the NEI process is very good. And I believe all the plants have actually undergone --

MR. TJADER: John Gaertner is going to give a talk on the monitors in a little more detail.

CHAIRMAN APOSTOLAKIS: Maybe I'm wrong, but I think this is the first time that we are considering the risk monitor in the regulations in general.

MR. TJADER: Yes, in applying it from a required action-type point of view. Yes.

CHAIRMAN APOSTOLAKIS: Okay. So if we say it's okay and finally you guys approve it, then it creates a precedent, does it not? I mean, if a licensee two years later wants to come with another request and says, "We're going to be based on our risk monitor," then the risk monitor is something that has been blessed already.

MR. TJADER: Well, it's been blessed to this application and this level of -- it will have to be blessed. And also there are requirements, let me also add, in the guidance document that PRA and the configuration risk management tools be maintained current, they be maintained to the current design of the plant, and that there be a process in a regularly or relatively prompt basis having that reflected in their PRA and tool.

MR. HOWE: The important thing to realize is that the CRM tools are out there today for (a)(4) or one level. This document puts this at a different level.

CHAIRMAN APOSTOLAKIS: Exactly.

MR. HOWE: Fire risks have to be included quantitatively. Significant sources of external events that can be affected by the configuration have to be included.

CHAIRMAN APOSTOLAKIS: I agree. And I think it's very important to say things like that. But what worries me is the actual details. I mean, I understand that you will have to worry about fires and all of that, but, again, that's high-level.

The question in my mind is -- and I'm not sure that the site visit would do that. I don't know how long it will be and all of that. I mean, if I want to --

MR. TJADER: For being a -- just for your information --

CHAIRMAN APOSTOLAKIS: Yes.

MR. TJADER: -- now, you're right. Whether or not that's --

CHAIRMAN APOSTOLAKIS: If I want to know how exactly does a licensee go from the PRA to the CRM, which is now real time, right, how would I do that? I mean, is the staff going to review that?

It's one thing to talk about yes, we worry about common cause failures and quite another to show how you handle it. And that's what I think we should. I don't expect any, you know, Earth-shaking findings, but it seems to me that we ought to do that.

MR. HOWE: One of the key things that the PRA people are going to be looking at when we go to the site visit is that very thing: the translation of the PRA model to the CRM tool.

CHAIRMAN APOSTOLAKIS: So this will be the first time you do it?

MR. HOWE: In this context, yes. I personally actually translated a PRA model to the CRM tool. How successful I was I'm not sure, but --

CHAIRMAN APOSTOLAKIS: That's what I want to know. I want somebody else to tell me. So you are going to which plant?

MR. TJADER: We are going to South Texas first, then to Fort Calhoun, and then probably depending on --

CHAIRMAN APOSTOLAKIS: SONGS.

MR. TJADER: -- when SONGS comes in with their application --

MEMBER KRESS: Should we go with them to one of those?

CHAIRMAN APOSTOLAKIS: Well, I don't know. I mean, to what extent should we get involved in this?

I was looking at the transcript. We had a long discussion last time when John Gaertner was presenting it. And it was a very useful discussion, but still the question is, you know, how is it actually done in real life? And all I want is this warm feeling that we --

MR. TJADER: Well, we, too, were concerned about that and want that, too. And we recognize that prior to the visit, we have to have an approach and a criteria set up for ascertaining that.

CHAIRMAN APOSTOLAKIS: Dr. Kress raised the issue of maybe some of us coming with you. An alternative would be since we used the word "eventually" about the letter to hold another subcommittee meeting focusing on this kind of stuff and go to the detail, down to the detail.

You know, I appreciate that you can't have rigid rules for everything. And I'm sure when John comes there, we will come back to it because the operator is whether there is a failure of one train, they check whether there is a potential for failure with the other train, and so on.

But I would like to see actual examples. I would like to know, you know, the RAsCal, I believe it is, at South Texas, how does it handle that. Give two, three examples. The San Onofre risk monitor, how does it handle it? And go down to the little detail because --

MR. TJADER: I think it's easier --

CHAIRMAN APOSTOLAKIS: -- human error is also an important area.

MEMBER MAYNARD: From what I've seen on other staff evaluations for other programs, you would typically go out and pick a couple of samples and go through great detail on those --

MR. TJADER: Right.

MEMBER MAYNARD: -- to see all the mechanisms, see how it really is applied. So it's kind of a sampling process, but for what you sample, you typically go into the complete detail all the way through on that.

CHAIRMAN APOSTOLAKIS: I would like to see that. I really would love to see that here.

MR. TJADER: A couple of thoughts. We envision that there are a few configurations that we want to focus on. We haven't selected them yet, but there are a few that we want to focus on, both from the PRA and then into the configuration risk monitor tool.

Just let me refresh your memory, too, that there are two basic approaches to this, implementing this initiative, through configuration risk monitors.

What South Texas uses, which is a RAsCal, which is basically a database, which they will go into, of precalculated configurations, which is actually relatively easier.

CHAIRMAN APOSTOLAKIS: Twenty thousand of them, right?

MR. TJADER: Twenty thousand, yes, plus.

MEMBER KRESS: Yes.

CHAIRMAN APOSTOLAKIS: I want to view them in a subcommittee meeting.

MEMBER KRESS: All 20,000 of them.

CHAIRMAN APOSTOLAKIS: All 20,000. I want the 8,452nd one. David will review the rest and provide a full report.

(Laughter.)

MR. TJADER: And then there is the other method that Fort Calhoun and San Onofre utilized, where they actually use a monitor which currently reflects the configuration of --

CHAIRMAN APOSTOLAKIS: Yes. I understand that. And this Committee, the full Committee, has been talking about visiting a plant, San Onofre perhaps, to actually see the monitor.

But, again, that's not the kind of review that I'm talking about. I'm talking about what's behind the screens. But we should certainly do that soon because it's becoming a very important tool.

MR. TJADER: We envision this summer -- in fact, we're discussing dates right now -- visiting South Texas perhaps in June and then a month later visiting South Texas and --

CHAIRMAN APOSTOLAKIS: South Texas in

August.

MEMBER KRESS: Yes.

MR. TJADER: If their air conditioning works or something.

CHAIRMAN APOSTOLAKIS: Anyway, I think the message is clear that we would like to see some examples perhaps, as Mr. Maynard said, or some other way of reviewing the actual transition from the PRA, which is sort of a static tool to the dynamic evaluation that the CRM --

MEMBER KRESS: Before you leave that slide -- are you through, George?

CHAIRMAN APOSTOLAKIS: Yes, I am.

MEMBER KRESS: I wanted to ask him a question about the --

MR. TJADER: I know. Just I haven't started on that one.

MEMBER KRESS: Well, let me go ahead and ask the question about the third sub-bullet under the second bullet.

MR. TJADER: Oh, the risk-informed completion times are used?

MEMBER KRESS: Yes. What I envision here is maybe you are in shutdown and you're doing various maintenance tasks and you've got things out of service. As you go through this, the configuration is continually changing. You know, you get things fixed, and you realign things. And you're doing different parts of the maintenance. So your risk is continually moving around.

MR. TJADER: Well, first of all, originally we had envisioned this to be all modes. And if a PAR --

MEMBER KRESS: Of course.

MR. TJADER: If a plant's PRA addresses all modes, then they can certainly apply this initiative to all areas that their PRA addresses.

MEMBER KRESS: Yes. I'm just using the shutdown.

MR. TJADER: Currently you don't have sort of a standard shutdown PRA and things like that. And, as Steve Hess will get into in his slide of the risk management guidance document, we originally focused in on the operational modes, the modes 1 to 4 with some constraints on 4, basically those modes in which there are PRAs addressed.

MEMBER KRESS: In principle. It's just the question is still the same. And the question is, if I'm dealing, say, with one particular component that I'm doing maintenance on and if I'm wanting completion time to get that thing back in service and if the configuration is changing during that period of completion time, is the completion time a variable that changes throughout all of that?

MR. TJADER: The completion time dependent on the configuration of the plant at the time?

MEMBER KRESS: At the given time.

MR. TJADER: Basically, the risk-informed completion times are utilized to when you intend to extend beyond the existing completion time. You're currently --

MEMBER KRESS: You've got that, though.

MR. TJADER: And now you're in a risk-informed completion time. Okay. The other time when you're not yet in there, actually, is when you enter a second technical specification. Then you have to check the configuration of the plant and the risk associated to determine that both of the front-stop or existing completion times apply and that the risk-informed completion time would not be limiting. If it's limiting, then you've got to apply that risk-informed completion time. Otherwise you're still --

CHAIRMAN APOSTOLAKIS: Yes, they could probably --

MR. TJADER: -- in the current structure of the tech specs. The third bullet is every time that you have a configuration plant change. Now, obviously in a shutdown condition, this may be much more difficult to apply on a very dynamic thing because things are coming in and out all the time.

But basically what we envision is every time that you have component inoperabilities and things restored, that they will be a recalculation of that completion time and it will be adjusted according to the --

MEMBER KRESS: Okay. That's good. So if it looks like I'm not going to be able to finish what I was doing on this component within the given risk-informed completion time at that configuration, I could go realign things and do different to change my risk and extend that?

MR. TJADER: You could, yes.

MEMBER KRESS: Yes. Okay. I just --

MR. TJADER: You could restore other systems to service to provide time for another --

MEMBER KRESS: I just wanted to see. I just wanted to understand how it works.

CHAIRMAN APOSTOLAKIS: The time starts the moment the first component goes out.

MR. TJADER: That's right.

CHAIRMAN APOSTOLAKIS: And you have 30 days.

MEMBER KRESS: And it ends in 30 days or else.

CHAIRMAN APOSTOLAKIS: It ends in 30 days.

MEMBER KRESS: Okay.

CHAIRMAN APOSTOLAKIS: And 30 days I guess is a defense-in-depth measure, right?

MR. TJADER: Yes. Basically, the tech specs currently for the most part, for most tech specs, the max completion time is 30 days. And we felt that since that, there was some precedent in that. And, plus, it is for very many systems a very conservative limit.

We thought that it was an appropriate -- now, keep in mind that the risk-informed completion time will frequently for many plants be less than the 30 days.

I'm sorry?

MEMBER KRESS: Once again, I wasn't sure about what George said. When does the clock start on a given completion?

CHAIRMAN APOSTOLAKIS: The very first moment you have one component out.

MEMBER KRESS: Even though I am not going to make another component out for --

CHAIRMAN APOSTOLAKIS: Whatever you are doing between, the time starts at the beginning. And you have the 30 days.

MEMBER KRESS: That seems a little strange to me.

MR. TJADER: It all starts with --

CHAIRMAN APOSTOLAKIS: Well, I think the industry will show some nice slides.

MEMBER KRESS: Okay.

CHAIRMAN APOSTOLAKIS: You know, we don't want to be too rational.

MR. TJADER: Steve Hess is going to get into a little more detail on the guidance documents.

MR. HESS: Yes.

MR. TJADER: Actually, I think you have a slide there where you talk about --

MR. HESS: We have a conceptual --

CHAIRMAN APOSTOLAKIS: I know. I know. There is a picture of that --

MR. HESS: There is a conceptual example. I think I would also like to note that the industry expects this is going to be more of an exception that the rule that we actually invoke these provisions.

Predominantly we don't expect to be extending completion times on a routine basis. The most likely impact is we're in the middle of a work week and we have an emerging event. And this allows us to respond appropriately to that event. So this won't be a, we don't envision this being an, all-the-time thing where we're extending completion time.

CHAIRMAN APOSTOLAKIS: Can you please identify yourself for the --

MR. HESS: Oh, I'm sorry. Steve Hess with EPRI.

CHAIRMAN APOSTOLAKIS: Thank you.

Okay. Bob, can you --

MR. TJADER: Yes. I think we covered this one.

CHAIRMAN APOSTOLAKIS: -- accelerate this?

MR. TJADER: Yes. I'll try. PRA quality goes into the ASME standard that --

CHAIRMAN APOSTOLAKIS: We know this.

MR. TJADER: Okay. You know that? Basically just the criteria for acceptance has to be reliable; in other words, consistent conservative results, repeatable, same configurations, give similar results. And that has to be adequate enforcement and oversight.

We are creating. In fact, we have draft inspection guidelines, TIs, which are under review. And hopefully within the next month, we get them out to the regions for --

CHAIRMAN APOSTOLAKIS: What is exportability?

MR. HESS: Exportability basically that this document, this risk management guidance document, is generic. It can apply to all plants in the industry.

In other words, when we are applying it to the pilots, a proof of concept and once it's done, it can then be utilized and exported to --

CHAIRMAN APOSTOLAKIS: And this document is the one you sent us for review?

MR. HESS: That's right.

CHAIRMAN APOSTOLAKIS: The EPRI document?

MR. HESS: Yes, that's right.

MEMBER MAYNARD: I note that all of the pilot or proposed pilot plants are PWRs. Is this also applicable to BWRs?

MR. TJADER: Absolutely. We were hoping to have a BWR. And perhaps we will. I don't know. We had one, but, I mean, the fact is recognize that you have to have a good quality PRA.

We had two other plants that had volunteered to be pilots. And each of them had difficulties: one for a personnel problem, another I think for economic considerations.

They didn't feel they could upgrade their PRA in a timely fashion to be a pilot. So they had actually written us letters volunteering to be pilots, and, unfortunately, they had to withdraw. One of them was a BWR.

CHAIRMAN APOSTOLAKIS: Wait, wait, wait. This is interesting because we keep saying that all of the plants have been subjected to the NEI peer review. Now what you're saying is that some of them did not actually change the PRA as a result of the review.

MR. TJADER: Well, I think what we're saying is --

CHAIRMAN APOSTOLAKIS: That's an important point.

MR. TJADER: Well, I think what we're saying is that the reg guide 1.200 and the peer review process is a starting point for adequacy for that.

CHAIRMAN APOSTOLAKIS: NEI goes beyond that. I mean, those reviewers, they go down to the detail.

MR. TJADER: Yes, right.

CHAIRMAN APOSTOLAKIS: So to say that all the units can be reviewed is one thing, but to say that they have been reviewed but some of them did not respond to the review comments, that's quite another thing.

MR. BRADLEY: George, this Biff Bradley of NEI. I just wanted to clarify that.

All the plants have been through the NEI peer review process. And then primarily as a result of MSPI over the last year, we have closed the facts, major facts and observations.

However, this takes it to a new level. This is invoking the ASME PRA standard. That's what 1.200 does. It takes PRA technical adequacy up to a higher level.

Even if you closed all your peer review findings, you're not there yet. There are a whole number of new requirements in the ASME standard that now have to be met. And that's the level of PRA that you have to have to do this.

MR. TJADER: Yes. I didn't mean to say that the plants hadn't been through peer reviews or things. What I do want to say is just what Biff said, that it goes beyond current --

MEMBER MAYNARD: And it's not always easy to get somebody to volunteer to be a pilot plant. There's cost and risk associated with that. And even if you have a good program, you may want to wait and see what happens with others before you volunteer.

MR. TJADER: Well, we had two volunteer, actually. They sent in letters. And we actually approved them. We sent them letters back. But, unfortunately, they had to withdraw. And one was a BWR.

MEMBER MAYNARD: The guidance looked generic to me. The only thing that may be on the mode transitions, the mode 3, mode 4 tables that they were showing might be a little different as to what you put in which category for them. But overall I think it looked generic.

MR. TJADER: Finally, the status of the pilot process that we talked about a little bit before. The risk management guidance document, as I started out saying, I was hoping that perhaps at this point in time, three months ago I envisioned we would be a little farther along than we currently are.

I was hoping that we have an approved document. You still have a draft. What you have, we have verbally agreed to what the document, the final document, should contain. And basically what you have is that document. There are only minor differences between what you have and the final document.

CHAIRMAN APOSTOLAKIS: What is LAR?

MR. TJADER: A license amendment request. Okay?

CHAIRMAN APOSTOLAKIS: What is a site visit? Is that where you are going to look?

MR. TJADER: That's right. That's where we go and review. I didn't engage fingers to brain.

CHAIRMAN APOSTOLAKIS: Sounds the same.

MR. TJADER: Yes. Sorry.

CHAIRMAN APOSTOLAKIS: That means you are going to look at things, right?

MR. HOWE: Just drive by.

MR. TJADER: This one I added because one of the comments was that we should have a status of where we are going from here. And this one I added as a result of that comment, and I didn't send it around for review.

At any rate, we do envision in the next few weeks to have in hand the final document. And assuming that it is what we verbally agreed to, which I anticipate it will be, you will receive that.

Now, we also need to provide you with a

safety evaluation. And the problem is with a July or the next full committee meeting, which is a month away on the 31st of May, it's 30 days. And we can start writing that, but there's not basically time to fully prepare that safety evaluation and have it go through the concurrence process by that time.

CHAIRMAN APOSTOLAKIS: Right. But I think, you know, I would be very reluctant to write a letter without having the benefit of your visits.

MR. TJADER: Okay. We recognize that. In fact, I think after discussing it yesterday, we have come to the conclusion that probably the next full Committee meeting is not the appropriate time.

CHAIRMAN APOSTOLAKIS: Okay.

MR. TJADER: And since you expressed an interest to have the results but not also participate in a site visit or two, probably the end of the summer, September, might be the appropriate time. And also we could attend perhaps the subcommittee meeting to go into whatever greater depth that you wanted to.

CHAIRMAN APOSTOLAKIS: Yes. Maybe we can have a subcommittee meeting for a day, day and a half late August or September. And then the earliest we can write a letter is the October meeting.

MR. TJADER: Okay.

CHAIRMAN APOSTOLAKIS: I don't see us -- a lot of people are not here in August and --

MR. TJADER: Well, that should not cause any problems as far as schedule. At this point in time, we have to do the site visits. We have to write the safety evaluation for the risk management guidance document.

Plus, in the next few weeks, we're getting the final revised license amendment request from the plant, from the pilots. And then what we have to do is we have to write -- after we have the safety evaluation risk management guidance document, we have to write the safety evaluation for the license amendment request. And we are hoping that we can have that all done perhaps by the end of the year or at least within the next year.

CHAIRMAN APOSTOLAKIS: Is the industry having a problem with this schedule?

MR. TJADER: Industry would certainly like to have it done as quickly and as fast as possible, but basically they recognize that this is very complex. And I think that if we can get it done by the end of the year or, at the most, within the year, which I fully expect we can do, that hopefully that is not too much of a problem.

CHAIRMAN APOSTOLAKIS: Good. That's it?

MR. TJADER: That's it for me. And thank you.

CHAIRMAN APOSTOLAKIS: Questions? Thank you very much.

MR. TJADER: Thank you. And Biff Bradley will give --

CHAIRMAN APOSTOLAKIS: Yes.

MR. TJADER: -- an introduction to the risk management guidance process and document, followed by Steve Hess in some details.

CHAIRMAN APOSTOLAKIS: Very good.

MR. TJADER: Thank you.

CHAIRMAN APOSTOLAKIS: Do you have any slides, Biff?

MR. BRADLEY: No.

CHAIRMAN APOSTOLAKIS: No?

MR. HESS: Okay.

CHAIRMAN APOSTOLAKIS: So JPG must be John?

MR. GAERTNER: That's me.

CHAIRMAN APOSTOLAKIS: SONGS?

MR. HESS: I don't see mine.

CHAIRMAN APOSTOLAKIS: Yes. We don't seem to have hard copies either.

MR. HESS: There are hard copies in the back. And I have my slides on a stick.

CHAIRMAN APOSTOLAKIS: Where is it?

MEMBER MAYNARD: Yes. They're there.

CHAIRMAN APOSTOLAKIS: Where is it?

MEMBER MAYNARD: About the fourth or fifth one down.

CHAIRMAN APOSTOLAKIS: Okay. Fort Calhoun, John Gaertner. Yes.

Well, Biff?

MR. BRADLEY: Shall I proceed?

CHAIRMAN APOSTOLAKIS: Yes.

MR. BRADLEY: I don't want to go too fast because I don't have a lot to say, and I don't want to --

CHAIRMAN APOSTOLAKIS: That's okay. Speak slowly.

MR. BRADLEY: Okay.

III. INDUSTRY OVERVIEW OF RMTS 14B PROCESS

MR. BRADLEY: Good morning. I'm Biff Bradley of NEI.

And I just wanted to, first of all, say I agree with everything Bob Tjader said regarding this initiative. For the industry, for the operating plants, this is one of what I would call our big four risk initiatives.

We have 50.69 special treatment rulemaking, 50.46(a), which is a large break LOCA redefinition in FPA 805, which is a risk-informed fire protection, and then initiative 4b, which, as Bob said, pretty much of our set of seven tech spec initiatives, this is the ultimate one where we try to apply across-the-board risk-informed completion times.

And for the operating plants that we have laid out, these are the four initiatives that we would like to see have widespread implementation. And so this is important for us.

We have been working on it, as we have the rulemakings and the other things I mentioned, for a long time. We would like to see these move on toward completion. The pilots have put a large effort into this. And personally I believe we're ready to implement this at the pilots. To answer your question earlier, we would like to see this done sooner, rather than later. We think we're very close.

Bob mentioned the PRA policy statement. As you're aware, tech specs are there to preserve the deterministic licensing basis. And then in 1999, 50.65(a)(4) was promulgated, which provided the risk assessment and management for configuration risk.

So right now we basically have supplemental requirements for configuration control. We have deterministic controls through tech specs and risk controls through (a)(4).

What we would like to do is move more toward what the PRA policy statement says, which is complementary use of risk insights, sort of merge these two programs together such that we're complementing this and have one set of configuration control requirements.

We have had a lot of experience with (a)(4). It was promulgated, as I said, in 1999. The plants have developed very impressive programs for assessing and managing risk. And we believe we're ready now to move on to this next step of significant tech spec reform.

Also in that time since 1999, PRA standards have been developed. And, as we briefly discussed earlier, we intend to meet those to get this application through. This is the type of application where you really need PRA standards.

Getting your PRA up to the level where it meets the standard will not only support this application. It will support the other applications, 50.69, 50.46, and obviously a fire PRA to support 805.

So by making those PRA improvements, we would like to see a whole suite of applications that are available to plants that go there.

So, Steve, are your slides up? Okay. We have a lot of material to get through. And I don't want to take any more time. So I am going to go ahead and turn it over to Steve to talk about the guidance document.

MR. HESS: Thank you.

As Biff mentioned, I am Steve Hess with the Electric Power Research Institute. I am the project manager for the risk-informed tech spec initiative 4b. It's a privilege to be able to address this subcommittee today on this important initiative.

Actually, I think Bob Tjader did a marvelous job talking about what the objectives are, important things are. I think there are some key principles that are enumerated up on the board. Our intent is to apply our PRA insights and knowledge to the specific plant configurations to ensure we appropriately manage those configurations and control safety risk.

By "configurations," there's some extension beyond just tech spec equipment. Although the initiative is tied to tech spec inoperability, we consider the configuration of all plant equipment, both tech spec and non-tech spec that are contained within the PRA and configuration risk management models.

Similar to the maintenance rule, it does require at specific threshold levels that we take appropriate management compensatory risk management actions to actively control the risk as we go through these configurations. And those action thresholds for --

CHAIRMAN APOSTOLAKIS: Let me --

MR. HESS: I'm sorry?

CHAIRMAN APOSTOLAKIS: Are these compensatory risk management actions reflected in the PRA? No.

MR. HESS: No.

CHAIRMAN APOSTOLAKIS: Are they in the configuration risk management tool or in --

MR. HESS: They may be. However, when there are modeled actions, for example, if we take a compensatory action, we cannot credit that action in the calculation of the completion time. Although we know that that action will reduce risk to some degree, unless we know how much; i.e., it is already within the scope of the PRA model, -- and more than likely, it won't be -- can't credit that reduction we get in risk, although we know we are getting some.

CHAIRMAN APOSTOLAKIS: But if you do it like South Texas and you have evaluated thousands of configurations, then you will know in advance what actions you would take. Then it seems to me it would be reasonable to say, you know, we'll try to quantify it unless it's impossible.

And then you just say, "These are extra defense-in-depth things that we'll do." I don't know to what extent you have done that.

MEMBER MAYNARD: I thought the guidance allowed it as long as it was proceduralized and you did have that type of information.

MR. HESS: Yes. I thought that's what I had said, that if it is already in the PRA and it has to meet all of those PRA requirements in terms of quality, if it is within the PRA, it's modeled and it has been quantified, then, in fact, you can credit it.

Many of the risk management actions, however, won't meet those criteria. And we will still implement them. And we will do those things to control risk, but we will not credit them in the RICT calculation.

CHAIRMAN APOSTOLAKIS: But they can't be

in the PRA because these are activated when you go to this dynamic situation. The PRA looks at the average plant over a period of time.

MR. GAERTNER: That's correct, yes. They would not be in the base PRA tool.

CHAIRMAN APOSTOLAKIS: They would not be in the PRA.

MR. GAERTNER: But they could be in the CRM.

CHAIRMAN APOSTOLAKIS: They could be in the CRM. And that's my question.

Rick?

MR. GRANTOM: This is Rick Grantom with South Texas.

Steve is right. In many cases, because of the specific configurations, a lot of the risk management compensatory actions that we're talking about would be the management-directed actions to return equipment to service, to not remove other equipment from service, to put other types of controls in place, to manage the risk at that point in time? And those would not be in the model itself.

There is a category, I guess, of what you could call compensatory measures. Sometimes we use the vernacular recovery actions, other operator actions that we incorporate into the PRA, but those are done only if they're proceduralized, entrained on, and they meet the requirements for actually being incorporated into the PRA.

So part of that is in the PRA, but the compensatory actions that Steve is alluding to are these other --

CHAIRMAN APOSTOLAKIS: Even in your pre-evaluated --

MR. GRANTOM: Even in our pre-evaluated.

CHAIRMAN APOSTOLAKIS: Okay. Good.

MEMBER KRESS: Let me ask you a question. It's a hypothetical question. I don't know if you're the right one or if the staff is the right people to answer, but suppose you're in RICT and you're dealing with a particular component and RICT at that configuration says you've got 10 days to complete it and you're not bucking up against your 30 days here and you've already been in it 8 days.

All at once, some contingency happens. And your risk configuration changes. It increases. And you recalculate the completion time by the risks that you're currently in. It turns out to be six days, but you're already in day eight.

What do you do then?

MR. HESS: Because you have reached the limit of your risk-informed completion time, it's the exact same position you're in today, where you're in a tech spec. The same two systems, for example, you're in a tech spec where you don't meet the LCO conditions.

You then have to implement the prescribed actions of the technical specifications within those prescribed --

MEMBER KRESS: It's just like you would have exceeded in the --

MR. HESS: Just like it is today, yes.

MEMBER KRESS: Let me ask another hypothetical question about your third sub-bullet under the second bullet there. Some of us think reg guide 1.174 is a very nice guidance, but it's incomplete.

Suppose it changes in the future. Does that affect this or is something you worry about if it happens, that's a bridge you cross when you come to it?

MR. HESS: I think I'll quote Mike Schild. Don't cross the bridge until you come to it.

MEMBER KRESS: Yes.

MR. HESS: That was something we would

then consider when that may happen.

MR. BRADLEY: I don't think this is any different. I mean, all our applications are based on 1.174. That's like the motherhood document for risk-informed regulation.

MEMBER KRESS: Yes, but --

MR. BRADLEY: If you change that, it's going to change everything we're --

MEMBER KRESS: Yes. But normally we're using it for particular guidance on things like power uprates. It's just a piece of information. Particularly it's for changes to the licensing basis.

And when you use it as a guidance for something that's ongoing all the time, like the tech spec completion times, and you suddenly decide that reg guide 1.174 wasn't complete enough to really deal with what I would call real risk, complete risk, and this dawns on the staff that they need to supplement it, you've already got it built into your rule and your regulation guide and --

MR. TJADER: Well, this is Bob Tjader again.

Basically we're going to be changing a licensee's license. The tech spec changes. The license changes. What we approve in this risk management guidance document we're going to approve at a current revision and date. Okay? It's going to be specific. And that will be part of their license.

And if we decide subsequently that that is inadequate, then I guess basically we're in backfit space. And if it's significant enough, then I guess we can go forward.

But that doesn't mean we have more stringent requirements. We have incorporated in the 1.174 that subsequent plants have not yet adopted. It would be subject to that.

MEMBER KRESS: It may not be subject to the new one.

MR. TJADER: To the new one, but, I mean --

MEMBER KRESS: But the old ones that are already into that would be a backfit?

MR. TJADER: That's right.

MR. HESS: And I think it's probably sounding like a broken record, but, to reiterate, our expectation is that we're invoking the provisions of risk-informed tech specs as more of an exception, rather than a rule.

We expect, by and large, under most of our operation, we will be living within the front stop limits that we currently have with the additional enhancements from a safety perspective that implementing the provisions of this guidance provides us. So you actually are getting a lot of safety benefit, even if you don't specifically ever enter a RICT.

MEMBER KRESS: ACRS tends to think about what is allowed, not what is lacking.

Go ahead.

MR. HESS: The only other thing that ties also with 1.174 is the provisions of this are supplementary to the maintenance rule (a)(4) requirements. If you invoke RMTS, you do both programs. You do RMTS and you still do the (a)(4) requirements. Now, again, practically many of the things you do are going to kill two birds with one stone, but both regulatory requirements apply.

Bob I think also did a nice job on the guidance document. The key is --

CHAIRMAN APOSTOLAKIS: Let's move on.

MR. HESS: Okay. The key is section 2, which provides the definitive requirements of what must be done. The applicability -- and I think it was Dr. Maynard who had noticed that yes, there is a slight difference between the applicability to BWR and

PWR.

Because our PRAs are predominantly at-power PRAs, there is direct applicability to modes 1 and 2 for both types of reactors; for PWRs, permit the extension of that into modes 3 and 4 to the point where you remain on cooling via steam generators.

CHAIRMAN APOSTOLAKIS: Well, we don't have a pilot, a BWR pilot.

MR. HESS: We do not have a BWR pilot. My background is BWRs. I've tried to represent the BWR interest to the greatest extent I could.

The criteria for the various actions are commensurate with 1.174 and what we currently do under (a)(4), the maintenance rule. We look at CDF and LERF on an absolute level, which is, in the vernacular, I think, called the speed limits. And I want to note that those two columns apply simultaneously.

So it's whichever is the more limiting provides you the requirement to meet in terms of, you know, a risk-informed completion time or the threshold at which you must implement compensatory actions because this activity will invoke more risk.

CHAIRMAN APOSTOLAKIS: I must say I don't understand what you say there. Consider the required action to not. In other words, I am in a configuration where my calculation shows that the CDF is greater than 10^{-3}, what you call instantaneous, right?

MR. HESS: Yes. What that means --

CHAIRMAN APOSTOLAKIS: It's already way up there, I mean.

MR. TJADER: Yes. In tech specs, if you don't meet the required -- you have an LCO. If you don't meet the LCO, there's a condition, a set of required actions, that have to be completed within the completion time, the risk-informed completion time or whatever the completion time is.

If you do not meet the required actions within the requisite completion time, then you have to --

CHAIRMAN APOSTOLAKIS: Front.

MR. TJADER: Yes, front stop or whatever. Then you have to perform the requisite actions. You have to perform them. In other words, what we're saying here is if you exceed 10^{-3}, basically you have to comply with the actions, whether it's --

CHAIRMAN APOSTOLAKIS: Or what you're saying is forget about the rest?

MR. TJADER: That's right. Forget the --

MR. HESS: Yes, yes.

MR. TJADER: Take the action.

CHAIRMAN APOSTOLAKIS: It's only four words, "Consider the required document" --

MR. BRADLEY: "Consider" is unnecessary. The required action is not met. That's the bottom line.

CHAIRMAN APOSTOLAKIS: You are not going to the rest of it. That's what it is. You are not going to consider the standard completion times, nothing.

MR. HESS: You implement the provisions of whatever tech specs tell you to do in that case.

CHAIRMAN APOSTOLAKIS: Now, how long does it take to calculate the CDF? I read somewhere that it take an hour. And then I hear other people say, you know, it takes us three minutes. How long does --

MR. HESS: It depends on your tool. It's relatively --

CHAIRMAN APOSTOLAKIS: San Onofre takes what? Two minutes he says. And South Texas?

MR. GRANTOM: This is Rick Grantom.

If it's a pre-evaluated item, it's almost instance.

CHAIRMAN APOSTOLAKIS: Yes. If it's not?

MR. GRANTOM: If it's what we call an

unquantified maintenance state, it's about an hour.

CHAIRMAN APOSTOLAKIS: About an hour. Chances are it will be one of your 20,000. No?

MR. GRANTOM: Chances are, yes. That's why we have 20,000.

CHAIRMAN APOSTOLAKIS: That's a 10^{-3} also.

MEMBER KRESS: Well, 10^{-3} --

CHAIRMAN APOSTOLAKIS: Where did it come from?

MEMBER KRESS: Yes. That was going to be my question.

MR. BRADLEY: That number is in the (a)(4) implementation guidance that is approved by NRC.

MEMBER KRESS: Maintenance.

MR. BRADLEY: It is not a number that obviously you're going to trip up on very often, but a plant with a high baseline CDF, you could theoretically get in a maintenance --

CHAIRMAN APOSTOLAKIS: This number, it seems to me, if you are above this number, you are in the region of adequate protection.

MEMBER KRESS: Well, not necessarily because -- is that a number that says if I were in this configuration --

MR. BRADLEY: The entire year.

MEMBER KRESS: -- for an entire year --

MR. BRADLEY: Yes. So you're not really --

MEMBER KRESS: So the amount of time that you're likely to be in there is at least an order of magnitude.

MR. BRADLEY: So you're not really out of adequate protection there unless you were there for a whole year, which would be a problem, obviously.

CHAIRMAN APOSTOLAKIS: Well, you don't have to be for that whole year. This is typical. I mean, the goal is 10^{-4} and 10^{-3}. Now you're getting into something else. Okay.

MEMBER KRESS: Well, it's like the 30-day backstop --

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER KRESS: -- divided by 2, right? Divide this number because the risk is the time times the --

CHAIRMAN APOSTOLAKIS: Oh, yes.

MEMBER KRESS: So it's 30 days divided by 2.

CHAIRMAN APOSTOLAKIS: No. But, I mean, in other applications, the 10^{-3} CDF is in general considered if you exceed that. But you are moving into a different --

MR. FISCHER: But I would add --

MEMBER KRESS: But what I was saying, this is consistent with the 10^{-4}.

CHAIRMAN APOSTOLAKIS: For the short period, yes.

MR. FISCHER: But the 10^{-3} that's in the maintenance rule guidance was not endorsed by the staff in the reg guide.

MEMBER KRESS: Oh, okay.

MR. BRADLEY: Yes, it was. Reg guide 1.182 endorses the entire section 11 of NUMARC 9301, including this table.

CHAIRMAN APOSTOLAKIS: Okay.

MR. FISCHER: I'll show you where it's not, Biff, after the meeting.

MR. HESS: And this is here. We will not go here voluntarily. This is an enhancement above the numbers.

MR. GRANTOM: If I could add just one thing? This is Rick Grantom again.

When you're talking about a CDF level, you are correct, George, that you're talking about a severe level of degradation. I mean, we're talking two or three trains at STP or something that may be a loss of function.

And this is not something that we would obviously voluntarily ever be in. More than likely, this would be a shutdown situation for STP or most any other plant.

MR. HESS: Or just anybody else, really.

MR. GRANTOM: Yes, anybody else at that point.

CHAIRMAN APOSTOLAKIS: I think we all agree.

MR. HESS: Are you gentlemen fine with this slide or do you want more?

MEMBER KRESS: But does that CDF assume you're at full power?

MR. HESS: Yes. Our calculations, there is another slide coming up that our baseline in all our calculations are based off of the zero maintenance state as evaluated in the PRA.

CHAIRMAN APOSTOLAKIS: Again, this gets into -- well, in the calculations of the ICDF and ILERP, you are not really taking as baseline the CDF that we normally call CDF. You're assuming there is no maintenance.

MR. HESS: Correct.

CHAIRMAN APOSTOLAKIS: So you have to

change that. You are not actually assuming. I mean, the plant --

MR. HESS: It's the zero maintenance state. That's correct.

CHAIRMAN APOSTOLAKIS: That's correct. So you have to modify the PRA, then, not to include --

MR. HESS: Yes, sir.

CHAIRMAN APOSTOLAKIS: But the CDF up there, is it the same one? No. It's the --

MR. HESS: Yes. This isn't the delta. This is a --

MEMBER KRESS: That's an --

CHAIRMAN APOSTOLAKIS: Now, in other presentations, though, in similar things, I remember some people internationally, as I see it, the difference between the baseline CDF and the degraded state, which maybe what you are doing is better because there is no maintenance.

MR. GRANTOM: Yes. This is Rick Grantom.

And yes, it is because you're going from a condition where you're assuming there is no maintenance at a baseline level and then measuring the change in risk due to maintenance --

CHAIRMAN APOSTOLAKIS: Yes.

MR. GRANTOM: -- for all components within the scope but not assuming average maintenance across all of these components.

CHAIRMAN APOSTOLAKIS: Right. And if there is maintenance, you are writing this table because you have already started looking into it.

MR. HESS: That is correct.

CHAIRMAN APOSTOLAKIS: Right?

MR. GRANTOM: Yes.

CHAIRMAN APOSTOLAKIS: So the 10^{-6}, 10^{-7} at the bottom, normal work controls --

MR. HESS: That's a demarcation line, where this process requires you to do something more. Let's start with the bottom one, E-6. If I'm going to enter a configuration and I calculate the risk is going to be greater than E-6, it requires me to during that configuration implement appropriate management actions to effectively control risk; for example, make sure operations has a good understanding of what equipment is now more important and is important to protect, what priorities are in terms of getting back from service, things like that, and for planned sequences, predominantly entering those from the time we start doing the work, but implementing those actions where obviously they are appropriate.

In many instances, especially for STP,

they will never even bump up on the next level. But if you now look at your configurations and your schedules and you would exceed E-5, now the requirements of the risk-informed completion time apply. And now those requirements go in and out. And, as the configuration changes, as I think Bob mentioned earlier, you will re-evaluate.

So if I have an emergent event and system Y goes out of service and it changes my risk profile, I am required to go reevaluate and determine how that implements, you know, the risk-informed completion times.

MEMBER KRESS: That's the answer to the question I asked earlier.

MR. HESS: Yes. That's the answer to the question.

CHAIRMAN APOSTOLAKIS: This sentence "Consider the required action to not be met" is confusing. Can somebody explain it in plain English?

MR. BRADLEY: "Consider" is superfluous there. We don't need that word. The required action is not met. I mean, if you hit that --

CHAIRMAN APOSTOLAKIS: You don't consider consider?

MR. BRADLEY: No. Normally we use

"consider" in a different context.

CHAIRMAN APOSTOLAKIS: Yes.

MR. BRADLEY: And here it's just if you are at that level, you now go to the required action. You don't really consider anything. You go to the required action.

MR. HESS: It is standard --

CHAIRMAN APOSTOLAKIS: But you still calculate the completion time, right?

MR. HESS: If you're over E-5.

CHAIRMAN APOSTOLAKIS: If you're over --

MR. HESS: The way it works is your risk-informed completion time is based on the 10^{-5} number.

CHAIRMAN APOSTOLAKIS: Right.

MR. HESS: So if your integrated risk, your ICDP, is greater than 10^{-5}, say that corresponds to ten days. At time t equal ten days, once you reach that limit, that's equivalent to, you know, the situation right now where you have a deterministic front-stop that said, "I've had low-pressure coolant injection out for seven days."

Once I hit t equals seven days, I have not met the requirements of the limiting condition for operation. I take whatever action the technical specifications require.

CHAIRMAN APOSTOLAKIS: And the front-stop might have been three days.

MR. HESS: It may have been three days.

CHAIRMAN APOSTOLAKIS: Okay, okay.

MR. HESS: This is, I guess --

CHAIRMAN APOSTOLAKIS: What is this "Assess non-quantifiable factors"? I thought we said we are not going to take credit for those.

MR. HESS: No, but we will assess those. And we'll base our risk management actions based on those insights. So what actions I implement in the plant from a management perspective to control, maybe I decide to put senior management on around the clock to guide the evolution, as an example.

CHAIRMAN APOSTOLAKIS: What happens if the ICDP is 10^{-3}? You're still doing this?

MR. HESS: You probably busted your speed limit and that --

MR. BRADLEY: You wouldn't plan for that.

MR. HESS: Never go there.

MR. BRADLEY: If you had an emergent condition that put you there, then you're shutting down. You're in the action state.

CHAIRMAN APOSTOLAKIS: The CDF would be

greater than 10^{-3}. So you are in the first row?

MR. BRADLEY: Well, either the ICDP or the CDF that's --

MR. HESS: Well, let me be specific. I mean, the ICDP is a combination of risk and time.

CHAIRMAN APOSTOLAKIS: Right.

MR. HESS: We base it on E-5. So to get to E-3, for whatever the --

CHAIRMAN APOSTOLAKIS: 10^{-3}.

MR. HESS: 10^{-3}. To get to that is a period of time. There's a much shorter period of time to get to the 10^{-5} limit. And that may be ten minutes or something ridiculous.

CHAIRMAN APOSTOLAKIS: So from the practical point of view, we'll never be there?

MR. HESS: From a practical point of view, you'll never be there. And that's why I said, you know, that --

MR. GRANTOM: I would like to add something on this.

CHAIRMAN APOSTOLAKIS: Rick?

MR. GRANTOM: Well, when we're talking about reaching the 10^{-5}, that's the same thing as saying that you haven't met the required conditions to return equipment to service.

So now you have to consider the limiting condition of operation not met. And then you have to follow those actions, which would include shutdown or whatever the appropriate tech spec says to do. So that's really what that means.

It's almost the same as a 10^{-3} instantaneous threshold. You consider that the action is not met. You do what the --

CHAIRMAN APOSTOLAKIS: Why don't you guys just say, "Follow the technical specification requirement"? Why do you have to say, "The required action is not met"?

MR. TJADER: They created the slide utilizing actual tech specs.

MR. BRADLEY: There's all this tech spec terminology that we are required to follow. It's the code of tech specs.

(Laughter.)

MR. TJADER: Our fault for --

CHAIRMAN APOSTOLAKIS: I thought we were also trying to show the public --

MR. BRADLEY: We're not lawyers, nor do we play one on TV.

MR. GRANTOM: If I might, I wanted to continue. You also talking about what type of actions that we might perform. I'll give you an example of some compensatory actions. When we enter what we call an extended allowed outage time, there's a certain set of check-offs that operations perform.

And some of these do have an impact into the configuration risk. For example, if we're going to take a diesel generator out for an extended period of time, we ensure that the turbine-driven auxiliary feedwater pump is operable and available. There's no maintenance on it.

And there's a list of these types of things, no work in the switchyard, those kinds of things. And that's the kind of stuff that really demonstrates the safety benefit of what we're doing now is recognizing configurations, recognizing the contributors of risk to those configurations, and then taking what I call management-directed actions, compensatory measures to mitigate or manage that.

CHAIRMAN APOSTOLAKIS: Now, we will come to issues of uncertainty when Mr. Gaertner --

MR. HESS: Yes, yes. John will talk about those issues in some detail.

I just want to note that, and there is a specific flow chart that is within the guidance document that specified what needs to be done. There are specific entry and exit conditions, required actions if you enter simultaneous LCOs, and specified actions for if you do exceed the allowed completion time.

The key action thresholds, I think we've talked about these --

CHAIRMAN APOSTOLAKIS: Yes.

MR. HESS: -- to a good extent.

CHAIRMAN APOSTOLAKIS: Yes.

MR. HESS: So we'll move on. There are basically three instances of application of this. And the bottom two are significant safety enhancements from the current technical specification situation.

The first and the most likely is if we're in a configuration, we have a need to extend the completion time beyond the current front-stop. And we expect that will be the provisions of using that is most likely within the scope of maintenance programs and, again, more the exception than the rule.

However, there's an enhancement in the RMTS so that whenever we have more than one tech spec LCO, we have tech spec systems simultaneously in OPT. And they are within the scope or at least one of them is within the scope of the RMTS program, regardless of whether we have exceeded a front-stop or not.

Then RMTS has applied. Predominantly the intent of this is to ensure that these systematic interactions and configurations are accounted for. To verify the applicability of the current front-stops; i.e., can I really take this system out of service for seven days, as I am allowed, and this other system out simultaneously for seven days, even if their tech specs don't currently communicate or reference each other.

If our calculations from a risk perspective show that no, from a risk perspective, we want to go shorter, then that RICT provision applies. So it's an enhancement over the current situation from a safety perspective.

The second is -- and I think this was Dr. Kress', really, specifically to answer your question -- once I am in this situation where I have employed risk-managed tech specs and I'm beyond the associated front-stop, whenever a system within the scope of my configuration risk management program goes out of service, I must reevaluate the configuration and obtain its impact on the completion time. The key is it's both tech spec and non-tech spec systems. So, again, it's an enhancement over the current situation.

Calculation requirements. We talked about some of these already. And we referenced the CDF and LERF values from the zero maintenance configuration. We mentioned earlier that -- I think it was Dr. Apostolakis -- that this starts, the clock starts, as soon as the first system becomes tech spec-inoperable.

And I can only reset it basically when I'm out of the configuration where I have an SSC beyond its front-stop. So where I'm actually still in a RICT, I can't reset the clock until I get everything out of that situation.

There are provisions for systems that if we don't have good estimates from the PRA, that we can use conservative or bounding analyses, particularly for things like external events.

We talked about the second main bullet. I think we've talked about pretty much all of these bullets. But we do explicitly include fire risks within the RICT calculations. And we do address other external event risks. And for significant ones, we have to evaluate their impact on the RICT.

And an important provision is if we have any situation where the configuration will involve a total loss of function, we cannot apply the provisions of a risk-informed completion time.

Here is a hypothetical example to show the concepts. Actually, we expect the configurations to have to get here would probably be rather extreme. So we wouldn't expect to be here very often.

But these arrows are intended to be arrows to show the points where things happen to show that, for example, if I take a system out of service based on its risk profile, as you can see, at about t equals seven days, if that system would be out of service longer than seven days, we would be required to implement compensatory risk management actions.

And, again, since it's planned evolution, most of those, at least all of those, would be applicable and possible to do, would be implemented at the start of the configuration.

The example then shows that t equals five days, a second, more safety-significant or risk-significant system comes out of service. And you can see how it changes the risk profile and that now, in fact, it would change your calculation from a 30-day permissive to something less than that.

And then again, when that system comes back from service, one can see that now you would reevaluate and, again, you would be able to have a completion time. But you still could not exceed the 30 days from the time that that first system had gone out of service. And you would integrate this risk.

And there are provisions to make sure you do this throughout the processes and look at it over the course and a cumulative effect over the years.

CHAIRMAN APOSTOLAKIS: So that purple line on the right, the solid line on the right, is when you have what? You have both A and B out?

MR. HESS: Both A and B are out of service simultaneously from t equals 5 to 13.

CHAIRMAN APOSTOLAKIS: The 30-day thing?

MR. HESS: No. Oh, this? Oh.

CHAIRMAN APOSTOLAKIS: You can use a cursor. I think the cursor works.

MR. HESS: Oh, that works okay?

CHAIRMAN APOSTOLAKIS: Yes.

MR. HESS: Okay. We'll try that.

CHAIRMAN APOSTOLAKIS: Okay. So this is the 30-day limit, right, for the backstop?

MR. HESS: That's the 30-day backstop.

CHAIRMAN APOSTOLAKIS: Okay. So we start with component A on the left? And we never hit the ^{10}-5 threshold. So you have 30 days to do it.

MR. HESS: So I would have 30 days.

CHAIRMAN APOSTOLAKIS: Now, B fails or B goes out of service.

MR. HESS: B fails. And now I recalculate. And I would reach the 10^{-5} that t equals 27 days. So I have --

CHAIRMAN APOSTOLAKIS: And what happens then?

MR. HESS: Let's say that I don't get system B back.

CHAIRMAN APOSTOLAKIS: Right.

MR. HESS: At t equals 27 days, if I have not restored the systems, --

CHAIRMAN APOSTOLAKIS: Okay.

MR. HESS: -- I now have to implement whatever the most limiting tech specs action statement is for systems A and B. And, as Rick mentioned, it is most likely a shutdown requirement.

CHAIRMAN APOSTOLAKIS: Okay. If I restore B, then I go to 30 days. I gain an extra three days.

MR. HESS: If I restore B, then I recalculate. And, as you can see, the slope of this is general enough that it could go back to 30 days.

CHAIRMAN APOSTOLAKIS: Okay.

MR. HESS: But it's 30 days from the initial time. It's not 30 new days. It's I really have. what, 18 more days or 17, whatever that number is.

MR. FISCHER: If I could, a quick question. If you restored A, instead of restoring B, where would the clock start? Would it be when B initially went inop?

MR. HESS: When A went inop.

MR. FISCHER: Even though A is back in service?

MR. HESS: Even though A is back, it's the configuration.

MR. FISCHER: Thank you.

MR. HOWE: Steve, a couple of quick points to clarify. If you actually reached the 10^{-5} threshold, even if at that point right then you restored things, you have already accumulated 10^{-5} for this iteration. You don't get the extra days because you have already accumulated that much risk. So you would be done.

The other thing is about the clock setting. The risk accumulation continues as things go in and out, but the 30 days would apply to each individual component. So in the last example you gave, if you restored A, your risk would be best on reaching 10^{-5}, but you would get an additional 30 days from the time B originally became inoperable, just to clarify the points.

CHAIRMAN APOSTOLAKIS: From the first time that something went down.

MR. HESS: The risk.

MR. HOWE: The risk for 10^{-5} continues to accumulate until everything is back in service. So once you accumulate risk, it never goes away. The 30 days, though, is for each component.

CHAIRMAN APOSTOLAKIS: Now, this implies that you never really are allowed the ICDP to go above 10^{-5}.

MR. HESS: That's essentially true.

CHAIRMAN APOSTOLAKIS: Now, if I go to slide 5, it says that when the ICDP is greater than 10^{-5}, their RICT requirements apply, which in my mind meant that you would calculate some RICT.

MR. HESS: No, no, no.

CHAIRMAN APOSTOLAKIS: No, you would not.

MR. HESS: Yes. The RICT, the limit, the time limit, for the RICT is whatever time it takes to reach 10^{-5}. At that time, which is equivalent to 10^{-5} ICDP, then you say that, "I have not met the LCO, and I need to take whatever their prescribed tech spec actions are."

CHAIRMAN APOSTOLAKIS: It seems to me that in slide 5, it would be more informative if you deleted that sub-bullet. Let's go to 5. Can we go to 5? Okay. For the role that says, "ICRP greater than 10^{-5}," it seems to me "The RICT requirements apply" should be deleted. You just follow the tech specs, right?

MR. HESS: That's true.

CHAIRMAN APOSTOLAKIS: And in the next row, RMAT requirements apply and RICT requirements apply. That would be really more close to what you are really proposing.

MR. HESS: Actually, I think what the --

CHAIRMAN APOSTOLAKIS: The only dime or where you're allowed to do this RICT is when you are between 10^{-6} and 10^{-5}.

MR. HESS: Yes.

CHAIRMAN APOSTOLAKIS: It doesn't what that.

MR. HESS: 10^{-5} is really limit. it is the time in which the RICT expires.

CHAIRMAN APOSTOLAKIS: The way I see it, Steve, is that I would calculate a risk-informed completion time if I'm above 10^{-5}. But the slide you just showed does that you are not really going to exceed that.

MR. HESS: You're correct. That could

probably just --

CHAIRMAN APOSTOLAKIS: You could rephrase this.

MR. HESS: Right.

CHAIRMAN APOSTOLAKIS: I man, that is what you said.

MR. HESS: We will do that in the version we get over to the staff.

CHAIRMAN APOSTOLAKIS: Very good. Okay. Remember, now, we are trying to understand what you are doing.

MR. HESS: Well, if it's confusing you, I'm sure it will confuse others.

CHAIRMAN APOSTOLAKIS: Okay. Let's go back to the slide that you just had. That was -- yes, very good.

MR. HESS: You know, if look at that slide, I'm getting conclude that B is sufficiently greater than A because basically its slope is much great.

MEMBER KRESS: That's B plus A, isn't it?

CHAIRMAN APOSTOLAKIS: yes, plus A. So they're basically equal, right?

MR. HESS: Yes. B plus A is a magenta. But based on the differences in slope -- remember, this is a --

MEMBER KRESS: Well, the blue line is the slope of --

MR. HESS: Of A.

MEMBER MAYNARD: Of A.

MEMBER KRESS: Of A.

MR. HESS: The magenta is A plus B, which is almost B itself because it's so much greater.

MEMBER KRESS: Oh, that's a --

MR. HESS: That's a log-scale.

MEMBER KRESS: That's where I -- thank you. That's a log scale. Yes. That's what got me.

CHAIRMAN APOSTOLAKIS: The days are --

MR. HESS: Sorry. Sorry, Dr. Kress. It's a log scale. So B is much greater.

MEMBER KRESS: Yes, right.

MR. HESS: There are specific training requirements that are imposed on all personnel at the plant who are reasonable for the program and making appropriate decisions and taking actions, particularly the station management, the licensed operators, who implement the provisions of the technical specifications. The work control personnel, who typically implement a lot of the actions and control the maintenance evolutions and the plant PRA personnel.

What is there at all required of all the programs, significant enough understanding of the PRA and how it is conductive and what the outputs are to allow them to make effective and robust decisions, including potential impacts of common cause failures, the assumptions and limitations of the models and the inherent uncertainties and integration of that knowledge into making applicable decisions.

Quantitative and qualitative insights to help develop appropriate RMAs. And specific operation of the CRM tool and being able to appropriately interpret the results.

CHAIRMAN APOSTOLAKIS: Wow. You are going to make everybody an expert on PRA.

MR. HESS: Is that a draft?

MR. BRADLEY: Is that anybody else?

MR. HESS: Well, I guess we could do HP text.

There are specific PRA and CRM requirements that John is going to speak to in a few moments. So this is essentially a teaser slide.

CHAIRMAN APOSTOLAKIS: Thank you.

MR. HESS: And I will let John do it because he can do a much better job than I. And specific documentation requirements, both programmatic and in individual exercise of these provisions, and to the sufficient level of detail to allow staff and the residents to be able to evaluate the effectiveness of the program.

With that, I appreciate your time. I am finished and -- questions?

CHAIRMAN APOSTOLAKIS: I have a question. I continuously have a problem with English. On page 1-3 of the EPRI document, there is a sentence that I don't understand, "The processes described herein depart from the maintenance requirements by formally requiring high-risk plant configurations to be treated in a required action for the risk management technical specification not being met." What does that mean?

MR. HESS: Let me take a shot at that. The (a)(4) says that you have to assess and manage risk. It doesn't prescribe what those management actions are.

In this case, we're prescribing specific management actions at that level. That's do you take the tech spec action. So it departs from (a)(4) in that for this particular situation, you have a prescriptive risk management action. I think that's all that was intended to mean.

CHAIRMAN APOSTOLAKIS: Does it make sense to other people? I mean, the intent is fine, but I don't know that it actually says that.

MR. HESS: What was the page, Dr. Apostolakis?

CHAIRMAN APOSTOLAKIS: 1-3.

MR. HESS: 1-3? Okay.

CHAIRMAN APOSTOLAKIS: There is a long paragraph there, somewhere in the middle.

MEMBER MAYNARD: It kind of mixes in some tech spec language of how we consider --

MR. GRANTOM: That's exactly -- there's mixed-in tech spec language in there. You know ,the typical language that you consider the limiting condition of operation condition not met, you know, so you have to invoke the requirements for condition not met. That's what that kind of -- it's a mix of a tech spec wording and --

MR. HESS: I think in layman's terms, to paraphrase Biff, you know, the maintenance rule doesn't require you to take an action. RMTS requires you to take the specific tech spec.

MR. BRADLEY: The maintenance rule doesn't require a specific action. It requires you to assess and manage. And this is specific action that is required for that risk level.

CHAIRMAN APOSTOLAKIS: And the other comment which we have made in the past, this business of calling this CDF and so on "instantaneous" -- I don't know -- bothers me. We were looking for a better word, the instantaneous core damage frequency, instantaneous large early release frequency. "Instantaneous," I mean --

MR. GAERTNER: It's been called the risk rate in the past, which is a better --

MR. BRADLEY: We understand that issue. I mean, if you have a better term --

CHAIRMAN APOSTOLAKIS: I don't.

MR. GRANTOM: I've heard the term "incremental" used. I've heard the term "incremental risk" used.

CHAIRMAN APOSTOLAKIS: Because it's not really instantaneous because you are converting it to -- at that time --

MR. GRANTOM: If it's a snapshot, if it's a picture of a snapshot, it's the risk at that time.

CHAIRMAN APOSTOLAKIS: The current core -- no.

MR. BRADLEY: It's the risk that if you stayed there for a year, that's what you would achieve.

CHAIRMAN APOSTOLAKIS: Right, right.

MR. BRADLEY: But I don't know what other word to use.

MR. HESS: It's almost like electromotive force. It's not really the best of terms, but it's become almost ingrained.

CHAIRMAN APOSTOLAKIS: Yes.

MR. HESS: And we probably --

CHAIRMAN APOSTOLAKIS: Unfortunately, I don't have a better --

MR. HESS: -- is more confusing trying to change it at this point.

CHAIRMAN APOSTOLAKIS: Now, on page 4-1 under "PRA Attributes," "At a minimum, the PRA applied in support of an RMTS program shall include a level I PRA with LERF capability." Now, what is a LERF capability?

MR. GRANTOM: George, that goes back to the ASME standard. The ASME standard right now includes all the level I internal events, but it also does have a section in their requirements for calculating LERF.

Meeting the ASME standard and reg guide 1.200 endorses the ASME standard. That's where the

LERF capability comes form, because that's included in the standard and, thus, included in reg guide 1.200.

CHAIRMAN APOSTOLAKIS: But we are not saying that you should have a CDF capability, right? CDF means you calculate the CDF. Does this mean also you calculate LERF?

MR. HESS: Yes. You must be able to calculate LERF.

CHAIRMAN APOSTOLAKIS: Because the way I interpreted this was, again, you're capable of doing something, but you're not doing --

MR. BRADLEY: No. It's calculated. LERF is calculated.

CHAIRMAN APOSTOLAKIS: So maybe the word "capability" is not the right one.

MR. BRADLEY: I think what we were trying to do --

CHAIRMAN APOSTOLAKIS: That's right. "Capability" gives you a way out of it.

MR. BRADLEY: What we were stating there was it's not a full level I. It's a level I plus LERF.

CHAIRMAN APOSTOLAKIS: Yes. Why don't you guys say that? Can you make a note of that and change it?

MR. HESS: Yes. We'll make a note of that and come up with better wording. But you must do both.

CHAIRMAN APOSTOLAKIS: Right. And that's my understanding, but I don't think that's what it said.

Now, on 4-2, CRM II attributes, number 6, "Each CRM application tool is verified to adequately reflect the as-built, as-operated plant" and so on. How does one do that? Are we going to talk about the --

MR. HESS: John's presentation is going to get into the attributes.

MR. GAERTNER: You might to defer those questions.

CHAIRMAN APOSTOLAKIS: That's fine. That's fine.

And the impact of truncation limits you will cover? Okay. Well, I guess that's it for me.

MEMBER MAYNARD: I have one question. Is this strictly intended for the situation where you find yourself with equipment that is inoperable under this or can the licensee voluntarily enter an action statement that they know they will exceed the front-stop but still be able to --

MR. HESS: The licensee can voluntarily enter the provisions and calculate and, say, it goes out to 20 days or whatever it happens to be. They can do that voluntarily. That is a provision just like it's a provision in the current tech specs to voluntarily remove the systems from service and not exceed, you know, the current LCL limit.

MEMBER MAYNARD: Now, the licensee does have other incentives to minimize the out of --

MR. HESS: Absolutely, absolutely. Again, both the provisions of this and maintenance rule A4 and all the other provisions of --

MEMBER MAYNARD: Not to mention the INPO --

MR. TJADER: The reactor oversight process.

MR. HESS: The ROP, yes. All those provisions still apply. So this is an extra.

MR. TJADER: And they have to justify their actions in the documentation.

CHAIRMAN APOSTOLAKIS: Okay. Unless there are other questions, I propose we take a break now before John takes the floor. We will be back at 10:15.

Thank you, Steve. You finished ten

minutes early.

MR. HESS: Thank you.

(Whereupon, the foregoing matter went off the record at 10:01 a.m. and went back on the record at 10:15 a.m.)

CHAIRMAN APOSTOLAKIS: We're back in session. John?

IV. ATTRIBUTES OF CONFIGURATION RISK MANAGEMENT TOOLS FOR USE IN 14B

MR. GAERTNER: Good morning. I'm John Gaertner with the Electric Power Research Institute.

The subject of this segment of our presentation is "PRA and Configuration Risk Management Tool Requirements for This Application." The term "CRM" has become common in the industry for this application of PRA.

I have a strong technical PRA background. And I have the pleasure of having four individuals in this audience from the industry and NRC who also have a very strong PRA background. So I'm sure that what I can't answer, they can. So we should have an interesting session.

This is a slide that you saw from Steve. The point I want to make is that our intent in this guideline is that all PRA and CRM tool requirements are specified in the risk management guidance. We have intended to be complete. And these are the five areas that generally are considered the necessary considerations for full-scope PRA considerations. And we have attempted to address all five.

The first PRA for internal events and flooding, which is the subject of the ASME standards and the current reg guide 1.200, rev. 0; the second area, PRA for internal fires, which we specifically address; the third area, PRA for seismic and other external events; the fourth area, PRA application to low-power shutdown modes; and then, finally, we address those specific attributes that are necessary to look at for this CRM model application that may not have been completely addressed through the peer review process and the reg guide 1.200 review of the PRA. So in that respect, we have attempted to be complete.

What I will do is discuss each of these items in this talk that follows. But first I would like to review the current status of industry CRM models very quickly since you are familiar with most of this.

As you have heard several times and I'm sure you know, all U.S. plants use quantitative CRM models now for maintenance rule (a)(4) requirements at power. That is quite standard.

Core damage frequency and LERF are the figures of merit. But LERF is sometimes not part of the quantitative CRM model for maintenance rule. However, you did hear that it is a requirement for this application. So there could be a requirement for upgrade at some plants.

Also, internal events are always in the quantitative CRM model for maintenance rule. Flooding is usually there, fire sometimes, seismic less, and other external events only for specific cases.

CRM models, this is a point of definitions so that we don't talk past each other here. When I say, "CRM models," I'm talking about the mathematical model that is an integral part of CRM tools that plants use.

These CRM tools are more than just the PRA. The PRA or the model results are embedded in these CRM tools, but these CRM tools also are the user interface for the operators and the work management personnel and may have other decision criteria and other information besides the PRA.

These tools, you've probably heard the names. Many of the plants use these tools. EOOS, ORAM-SENTINEL, SAFETY MONITOR, these are all commercial tools and RAsCal, which is the tool that is used by Southern California Edison, STP. We call these CRM tools. They contain the CRM models, which are the engines. And those are based or tied to the PRA.

A couple of other interesting points that are important to keep in mind are that the CRM models and their use in (a)(4) are subject to regulatory oversight through the ROP program. There is an inspection vehicle for looking at those applications.

CHAIRMAN APOSTOLAKIS: Does ROP review models? I thought it didn't.

MR. GAERTNER: No, it doesn't. But what it will do is it will review incidents or failings.

MR. BRADLEY: They do review models. It's a reactive inspection. If they identify some issue with risk management or assessment, they can. I don't think it's been invoked, but they do have that capability.

MR. GAERTNER: And, as has been pointed out, these CRM tools are an integral part of regulatory compliance, the maintenance rule. They're very important at every plant in work management and in operations processes at nuclear power plants.

They're in use every day. They're almost like a risk simulator --

CHAIRMAN APOSTOLAKIS: Right.

MR. GAERTNER: -- at the plant. So this is a natural evolution that we're undergoing. This isn't the dramatic change in the thinking of the plant personnel or a dramatic change in plant processes. It's merely a formalization.

Now I'm going to go through each of these five PRA scope areas that we outlined at the beginning: first, internal events and flooding. The PRA model is required to be reviewed to the guidance of reg guide 1.200, rev. 0, which is the current version.

Reg guide 1.200 in its current version assures conformance with the ASME PRA standard, which applies to internal events and flooding. We aim in the guideline for a capability category 2, which is the standard category 2. Any deviations from that are to be justified and documented as part of the preparations for implementation of RITS.

And, again, the PRA model shall include level 1 CDF plus LERF.

MEMBER KRESS: Let me ask you a question at this point. Perhaps the question may be aimed at staff. So feel free to answer it. Is it appropriate to treat all sites the same with respect to these risk metrics? For example, should Indian Point be allowed the same risk changes as South Texas?

MR. BRADLEY: Maybe this was the remark you made earlier about 117.

MEMBER KRESS: It was, yes. It's related to it.

MR. BRADLEY: Yes. We treat all sites the same. It's using 117 for the deltas. Everything, all sites, are treated the same.

MEMBER KRESS: Is that appropriate, do you think, staff?

MR. TJADER: My personal opinion is that it is appropriate. I think plants that have a higher baseline risk should get less flexibility. Basically, the standards I think that are established in reg guide 1.174 are acceptable. And they are equally acceptable for all plants, I think.

MEMBER KRESS: Indian Point would be treated the same as South Texas, though it has a huge population distribution?

MR. GAERTNER: I think CDF and LERF have been shown to be adequate surrogates for the --

MEMBER KRESS: Or individual risk only, though, even though you're dividing the insult by the population.

MR. BRADLEY: We are basing this on the guidance that was written. I guess these discussions were all entertained when we wrote 1.174. And it was finalized. And we're now using it. You know, that's a policy issue for the Commission.

MR. TJADER: I mean, even if it's a higher population area, the LERF statistic is applicable to them, I think. It meets the regulatory requirements, right, of --

CHAIRMAN APOSTOLAKIS: But the risk is not the same.

MEMBER KRESS: The risk is not the same.

CHAIRMAN APOSTOLAKIS: The risk to the population of South Texas and Indian Point is not the same, even if LERF is the same.

MEMBER KRESS: Even if they had the same CDF and LERF.

MR. BRADLEY: That's true, but we're just following the established guidance and the established policies.

MEMBER KRESS: I understand. If I were in your shoes, I would do the same thing. That's why I said I think I may be asking it to staff.

MR. TJADER: I would say I am not aware of any difference in regulations of plants based on once they are sited and accepted, the same set of regulations apply to them. So I don't know why we are going to say PRA is an exception that we have to have different standards for. When we start applying different levels of regulation, it may be more appropriate.

MEMBER KRESS: Good point.

CHAIRMAN APOSTOLAKIS: That's a good point.

MEMBER KRESS: It's a debatable point. It's a good one.

MR. TJADER: Once in a while I come up with a good one.

CHAIRMAN APOSTOLAKIS: So you can leave now.

(Laughter.)

MEMBER KRESS: I would be more inclined to let South Texas do more than Indian Point, you know, just intuitive.

MR. TJADER: That is just your opinion, not a staff position, though.

MEMBER KRESS: Right.

CHAIRMAN APOSTOLAKIS: Okay.

MR. GAERTNER: Second area is PRA for

internal fires. The guidance document for this application says that the effect on the risk-informed completion time must be explicitly considered for internal fires.

That explicit consideration can be done in one of two ways. First, it can be an integral part of the CRM model. The actual fire sequences can be included and the RICT calculated directly from the incremental CRP or the site can opt to use a conservative or bounding methodology to represent fire.

The guidance cites an EPRI methodology or an EPRI study that showed an example of such a conservative or bounding approach. And the reason we included that was not to be prescriptive that one should necessarily use that but to show that it wasn't an arm-waving, it wouldn't be suitable to do something highly qualitative or sloppy, that we're talking about a rigorous consideration of fire.

CHAIRMAN APOSTOLAKIS: I have not seen this EPRI document. This is the first time. Is this something that you guys can give us or --

MR. GAERTNER: We certainly can.

MR. BRADLEY: It's been provided to the staff. I don't know if they can give it to you or we can, either one, whatever.

CHAIRMAN APOSTOLAKIS: David, what --

MR. FISCHER: I'll get it for you.

CHAIRMAN APOSTOLAKIS: Okay.

MR. GAERTNER: What it does is it shows a way in which risk can be --

CHAIRMAN APOSTOLAKIS: Yes.

MR. GAERTNER: -- on an order of magnitude or it's actually a half order of magnitude method. One can actually show how to adjust an RICT from internal events using fire without a full fire PRA. And that's the type of --

CHAIRMAN APOSTOLAKIS: I must say, though, I'm really pleased by the tone of your presentation because in order contexts, people are always trying to find ways out of doing a PRA. And this is really good because you're saying if you want to do this, you have to have these elements. So I'm really very pleased that you're doing this, John.

MR. GAERTNER: The bottom line isn't part of our guideline, but it's just --

CHAIRMAN APOSTOLAKIS: Yes.

MR. GAERTNER: -- to remind you that the ANS fire PRA standard, although under development, is not yet complete. And so we cannot prescribe conformance with an industry standard at this time.

The next issue is PRA for seismic and other external events. External event risk can be addressed in one of several ways. One is one can provide a reasonable technical argument that the external event is not a significant contributor.

The intent here is that without including configuration-specific calculations, one can establish a priori the way in which these will be treated or one can perform an analysis of the contribution of the external events and include this contribution in the RICT either, similar to what we said for fire, by a reasonable bounding analysis or by including the seismic or other external event, specifically in the plant CRM model.

The two full plant pilots that are here both do include seismic sequences in their CRM models, but the guide does not require that. And, again, the ANS standard for seismic and external events, although there is a version of that standard on the street, the revision is currently still being discussed, debated.

CHAIRMAN APOSTOLAKIS: Negotiated.

MR. GAERTNER: Negotiated within the ANS risk committee that approves it. And that's being worked out, but there won't be a near-term ANS seismic or external event standard that has a broad consensus of agreement for a while.

Regarding the application to low-power shutdown modes, we include this because it is an area of consideration in full-scope PRA. However, we do not see a significant need for low-power shutdown PRA in this application.

CHAIRMAN APOSTOLAKIS: I believe Southern California does this, right?

MR. CHUNG: Yes.

CHAIRMAN APOSTOLAKIS: If you want to talk, you have to come to the microphones. If you nod, that's okay.

MR. CHUNG: Gary Chung from Southern California Edison.

We do have shutdown, but we don't have it to the PRA quality level as far as peer review and to those standards yet where we would apply it to this. We have vision to do that but not at this point.

CHAIRMAN APOSTOLAKIS: Okay.

MR. GAERTNER: However, we have addressed. In order to be complete, we have some very specific requirements in the guide. That is, the at-power PRA can be used in modes 1 and 2. If it is used in modes greater than 2, then the at-power PRA model must be verified to be conservative or bounding.

And that applies to the PWR situation, where, as you can see in the table below; that is, the one that Steve Hess presented to you, that this risk-informed tech spec application is applicable in mode 3 and mode 4 under steam generator cooling conditions.

However, you can only use the PRA if it can be verified to be applicable in those higher modes, higher in number, during the --

MEMBER MAYNARD: So this leaves the option for a licensee to really only apply it in modes 1 and 2 if that's what their PRA --

MR. GAERTNER: That's correct. That's correct. If they have a situation where they would find themselves in mode 3, they could say, "I can't use RICT" or they can develop their program in a way to show that they can model those situations.

CHAIRMAN APOSTOLAKIS: What is this cooling here in steam generator?

MR. GAERTNER: Well, mode 4 in a PWR, as you know, is a transition mode. And early in mode 4, you were using the steam generators, but then you transition to shutdown cooling. And we're saying that when you were no longer in steam generators, the at-power PRA is not applicable. And one would have to go to a low-power shutdown PRA, which we're not requiring or addressing in this guide.

CHAIRMAN APOSTOLAKIS: Okay.

MR. GAERTNER: Now we'll go to the final aspects of these PRA and CRM tool requirements, and that is those specific attributes that may not be adequately reviewed and validated in the PRA reviews but which might come up as important in this CRM application.

So the purple down below here -- I hope you can see it -- is the philosophy of this. In order to get a complete confidence that the risk modeling capability is appropriate for this application, one relies on the PRA peer review.

And we rely on the PRA standards assessments, which is represented in reg guide 1.200 plus and includes the utility self-assessment of the PRA. And then one verifies any of these remaining attributes in the CRM model. And that forms a complete review of the risk calculation capability for this application.

CHAIRMAN APOSTOLAKIS: Who is performing this complete review?

MR. GAERTNER: Well, the peer review is

clearly done under the NEI guidelines. And that is the PRA standards assessment will be controlled by reg guide, for right now at least, for the internal events and flood. And then the verification of attributes will be part of this preparation of this program.

CHAIRMAN APOSTOLAKIS: So the NRC staff will satisfy itself at some --

MR. GAERTNER: Yes. That will be up to them how they verify these attributes.

MR. HOWE: I envision that the licensee basically self-assesses these areas, provides the information to us as part of their ALARA. And then, again, we would perform site visits to verify all or appropriate parts of it, just like we do most other types of things we --

CHAIRMAN APOSTOLAKIS: Yes.

MR. GAERTNER: Now, in the interest of time, if -- we could give a talk on each of these nine --

CHAIRMAN APOSTOLAKIS: I understand that, but since we discussed earlier the method issue and most likely will have another subcommittee meeting, maybe we don't spend much time on this now, right?

MR. GAERTNER: Yes. That was what I intended so that --

CHAIRMAN APOSTOLAKIS: But I would like to point out I was reading, just for your information, guys -- I'm not saying you should do this -- I was reading three papers in preparing for this meeting that are relevant to this. And if you don't mind, we'll give you copies so you can have the benefit of what these gentlemen are saying.

One of them, actually, you're citing yourselves, you're citing in the EPRI report. But these are more complete papers. One is from Idaho entitled "Calculating and Addressing Uncertainty for Risk-Based Allowed Times," very interesting. And the other one is from Slovenia and Spain, "Evaluation of Allowed Outage Time Considering a Set of Plant Configurations"; and then the one you cite, "Analysis of Truncation Limiting Probablistic Safety Assessment."

So I will give them to David, you know, just for your information. You don't have to --

MEMBER KRESS: Can David get us copies of that?

CHAIRMAN APOSTOLAKIS: No, I don't think he will give copies to the members. And the NRC staff shouldn't get it.

(Laughter.)

MR. GAERTNER: I'll just say a few words about these but not go over them because, as you said --

CHAIRMAN APOSTOLAKIS: That's fine.

MR. GAERTNER: First of all, the first six are very technical in nature. Well, the first seven are very technical in nature and, you know, are serious considerations that one could if one improperly used a very high-quality PRA for this application, one could get wrong answers. So we have attempted to identify all of those. Then the bottom two are more process-oriented to make sure that you maintain configuration control and quality.

I will point out that the industry is beginning to recognize the importance of this. And an EPRI group called the CRMF, which is our configuration risk management forum, is considering writing a technical guidance document on --

CHAIRMAN APOSTOLAKIS: That would be great.

MR. GAERTNER: -- how to do this, which addresses an earlier question you had, which is yes. This says what you need to do but how you know the details.

CHAIRMAN APOSTOLAKIS: Maybe we can

discuss it here if we have a chance.

MR. GAERTNER: Yes.

CHAIRMAN APOSTOLAKIS: But, you know, in item 7, "Consideration of Uncertainty," when we have pressures on the order of 10^{-6}, you know, there is a question there, how well you know that, and so on.

So I think you should pay particular attention to that when you calculate the delta CDP and delta LERF. Is that a mean value? Can you convince people it is a mean value? Is it appropriate to use a mean value?

So I think these are important issues. And I think a document that addresses these, like the one you mentioned, would be very welcome, actually, very welcome.

Human action, I know that last year, at least, you said that there is an API calculator. But a calculator, really, is not a model. It allows you to use one of four models. So the question is now --

MR. GAERTNER: But this approach for --

CHAIRMAN APOSTOLAKIS: It's a disciplined approach, which I think is great to do that, but, again, you really have to go down to the modeling assumptions and --

MR. GAERTNER: The aspect of human action treatment that is a CRM attribute is to make sure that a human action does not rely on a piece of equipment that you might have out of service, those types of things.

CHAIRMAN APOSTOLAKIS: Right.

MR. GAERTNER: And there are recognized methods now of doing that; for example, the EPRI suite of codes. In a post-processing mode, one can identify those human actions. And then the system will automatically and in a logic sense -- and that human action with that component and find all of the locations in the model where it occurs and insert them.

So these sophisticated tools are making it possible to do this in a very efficient and reliable way.

CHAIRMAN APOSTOLAKIS: I mean, that's great. I mean, I know that when you guys prepare a document, it's not about business that you put it, unless it's used in the regulatory arena. But it would be nice to have an information briefing to the committee because these are important considerations that have wider applicability.

So at some point if you feel you are ready, maybe at the next subcommittee meeting on this subject or some other meeting, I would like to see what you got --

MR. GAERTNER: Go into those in more detail, great.

CHAIRMAN APOSTOLAKIS: Yes.

MR. GAERTNER: Okay. Well, then, I'm done except for your questions. And now I'm excited to hear about the --

CHAIRMAN APOSTOLAKIS: This is great. Everybody is on time today. What is going on? Well, thank you very much, John.

And the next presenter is Mr. Grantom, *et al*. You are the *et al*?

MR. GRANTOM: He is the *et al*.

V. STP IMPLEMENTATION OF INITIATIVE 4B PROCESS

MR. GRANTOM: Okay. Good morning. And thanks for the meeting. I'll go to the first slide. I'm Rick Grantom from South Texas project. I'm the manager in risk management. And with me today is Jay Phelps, the manager of operations in unit 2.

And we're going to give an overview of the agenda. What I'm going to cover is an overview of our PRA and online risk assessment tool. We call it the risk assessment calculator, or RAsCal. We'll talk about the RAsCal attributes and the implementation at

STP.

Just a quick overview of STP's PRA. It is a level I and level II PRA. We use a RISKMAN software. We're a RISKMAN shop. It kind of characterizes that as an event tree linking-type model.

And we have amended this linking model to include what we call a maintenance pre-tree, which is the linking mechanism that we use in order to enable us to calculate a specific configuration or what we call a maintenance state. It includes internal events. We have external events, including the fire PRA, both internal, external floods, high wind. And we have a seismic PRA.

Spatial interactions analysis is incorporated, human reliability analysis. And we have detailed common cause incorporated into the model.

Our update and PRA configuration control program complies with appendix B software quality assurance requirements. And we have procedures for maintaining and updating the PRA on a periodic basis or on an as-needed basis.

We have used the PRA, as many of you know, for many years to incorporate risk-informed applications. We have an industry review. And we are also as part of this pilot efforts for 4b, we're also a reg guide 1.200 pilot for PRA quality.

The RAsCal item here that we talk about, it's a real-time risk assessment tool, but,m really, RAsCal is primarily a graphical user interface for an operator or a work-controlled person.

It doesn't really calculate core damage frequency LERF in and of itself. It makes some adjustments. And one of the features of the RAsCal program or of the configuration risk management program at South Texas is we also have a balance-of-plant model.

And so just like we maintain maintenance states for core damage frequency, we also have maintenance states for balance-of-plant equipment, to include down powers or trips.

And we can adjust the likelihood of a turbine generator-initiating event based on the balance-of-plant maintenance states. And that also feeds into this RAsCal tool. As we mentioned before, we have had over 20,000 of these maintenance states quantified.

We have a very user-friendly interface that we developed in cooperation with STP users. We had work-controlled individuals, operators work with us to try out, you know, exactly how RAsCal looks, feels, and how it goes forward and works with the procedures that we use.

Some of the attributes -- and this is structured to look at the CRM attributes. And since we're kind of a pre-quantified type of approach here, a lot of these roll back to the PRA, like the initiator dependencies.

Basically what you see in RAsCal is a database of maintenance states. And these databases represent full level I, level II quantifications for that specific configuration.

So all of the initiators are represented. Our truncation level is run at even -11 for populating RAsCal's database, which we feel is appropriate for calculating an allowed outage time. RAsCal reflects the PRA results, as I mentioned before. It is not a PRA engine. It doesn't calculate that.

Human action treatment, all of the human action treatments are incorporated in the PRA and comply with the reg guide 1.200 item.

For activities, talking about plant activities, whether it's a planned maintenance activity or surveillance activity, we specifically tailored RAsCal to match the equipment tagout procedure process that we have so that when operations takes out an ox feedwater train A, that's accurately reflected in how RAsCal and how the PRA models that. So there's an appropriate mapping to the basic events that occur there.

As far a as-built, as-operated plant, like I say, we have procedures in which we review modifications, plant procedures, and performance data. That is the minimal requirement for a PRA update to meet this as-built, as-operated station.

On lesser frequencies, the more specific types of PRA, like fire PRA and the seismic, those kinds of things, are done at a different -- HRA updates are done a little bit less frequent than these other items.

The consideration of uncertainty. We do address it in the PRA. And we're going to be performing a detailed uncertainty analysis in the very upcoming new revision to STP's PRA, PRA, rev. 5, which is incorporating all of these other additional considerations that we need for completing this application here. And we'll do the detailed uncertainty calculation, both to address both aleatory and epistemic uncertainty.

We will be using some of the industry guides for that. So we also will be interested in the technical papers that Dr. Apostolakis just alluded to in John's presentation.

CHAIRMAN APOSTOLAKIS: Now, when you say "no calculations in tool," you must calculate the delta CDP. That is done outside the PRA, is it not?

MR. GRANTOM: Yes. That's done outside of the RAsCal CRM tool.

CHAIRMAN APOSTOLAKIS: But it's not part of PRA either. PRA doesn't care about the delta CDP unless you have added some subroutine, right? I mean, PRA itself doesn't care about that. The standard PRAs do not calculate these things.

MR. GRANTOM: Exactly right. Reg guide 1.200 is geared to calculate an average annual CDF.

CHAIRMAN APOSTOLAKIS: Yes.

MR. GRANTOM: What we do now is we create a zero maintenance state, in which we extract the maintenance from that and --

CHAIRMAN APOSTOLAKIS: In that part of the PRA?

MR. GRANTOM: That's actually part of the PRA. That's why we can use this event tree linking. It's kind of interesting because we have a top event that says, "Do you want to calculate the average model or do you want to calculate configurations?" and based on this toggle switch. So, you know, it really is part of the whole model, but it really is two very distinct types of analyses that are done.

The configuration risk management software quality and configuration control RAsCal complies with STP's appendix B software QA program. It's fully tested. And one of the big implementing attributes that we have to do this time is we have a new module to RAsCal to calculate the risk-informed completion times, once again, having to go and address specifically the verification and testing attributes that we have for that.

If there aren't any more questions for me, what I am going to do at this point in time is I am going to turn the presentation over to Jay Phelps here and talk with him. He's going to allow me to be the operator for once in my life and work the PC for him here.

MEMBER MAYNARD: Are you licensed?

MR. GRANTOM: I'm not qualified or certified.

CHAIRMAN APOSTOLAKIS: So, Jay, tell us a little bit about yourself.

MR. PHELPS: I'll do that. I'll really talk a little bit about it. I'm Jay Phelps. I'm the unit 2 operations manager. I am a licensing reactor operator at the South Texas project.

It's always interesting to sit in on these and understand some of the background information, but it really comes down to the rubber hitting the road. Will the operators be able to effectively implement this program and understand what the risk is associated with the plant configuration, understand what appropriate risk management actions they need to take and how do we apply this to comply with what our technical specifications dictate that we do under those certain configurations.

Really, apply our configuration management program that we have utilized to satisfy the maintenance rule (a)(4), assess the risk of the plant configuration, and recognize what we need to do.

We have been using the program in the control room since about 1995 to understand and assess the risk not only of safety-related systems but also those balance-of-plant systems that are integral to the initiators that we see as we go up there. We routinely use it to manage our weekly work.

Next one. Operations uses it. We're all

real time. Rick mentioned tag to our equipment clearance order, tagout procedure. As I remove equipment from service, we update the actual times, update actual return-to-service times. As we do that, our maintenance planning folks, they'll use that to understand is there a better way to do business.

We'll align two or three systems that are going out of service, understand what the risk profile tells us, and then say, "Maybe we can do that better if we move this activity to start on Wednesday and lower the overall station risk." So we develop and minimize our risk through planning and scheduling, utilization of the tools that we do there.

Rick mentioned we've got over 20,000 system configurations prebuilt. The computer program tells my operators if they enter something in or typically it's an emergent condition. We try to align that. It will tell us, "This is an unquantified maintenance state."

And that's when we know to get on the telephone to warn someone in Rick's group. And typically within an hour they can provide that as now one of the maintenance states and give us a valuable number that tells us where we are from a plant configuration aspect.

MEMBER MAYNARD: Who actually puts that in? Is it one of the operators that puts the information in when he takes it out of the service or is it --

MR. PHELPS: When we take something out of service, yes, the operator is entering that data into the program live time.

MEMBER MAYNARD: Okay. And are they the only ones who can enter something in or can somebody else at another location enter anything in? Is it controlled by operations?

MR. PHELPS: Once the planned risk profile, I'll call it, is generated, operations is typically the only person who will go in there. There will be actually a file that is downloaded onto the computer for the planned risk profile for that week. And the operator then will work against that. We'll compare our plan against our actual for that work week's duration.

If there is an emergent item that comes up and it's not going to get worked for a couple of days, our work window coordinators can go in there and adjust the planned risk profile so that it reflects that.

I'm not going to go over all of these. As was mentioned before, our application is pretty much full-scope. This is a list of most of the systems that are included within our technical specifications that will include the allowance for utilization of the risk-informed completion times.

RAsCal --

CHAIRMAN APOSTOLAKIS: Let me -- excuse me, Jay.

MR. PHELPS: Go ahead.

CHAIRMAN APOSTOLAKIS: This 20,000 number, how did you figure out you were going to have 20,000 configurations? I mean, is it automatically done by computer?

MEMBER KRESS: How did they count it?

MR. GRANTOM: Well, the evolution of this, George, is the way it first started out, the initial population in RAsCal's database was that we looked at the 12-week rolling maintenance cycle and we could pretty much ascertain by looking at that the kinds of configurations, when equipment was taken out of service, when it was removed based on that typical generic plant. And we initially populated this thing.

Then what happened, once work planning and maintenance planning got involved with it, well, we probably got double that in terms of them starting to ask questions about functional equipment groups. They decided that they needed to change some of them. And then when they went in their planning process, well, you know, we may take this out here, but what would it look like here?

Well, you get unquantified maintenance data after unquantified maintenance data. So we did have a period of time where we had hundreds of unquantified maintenance states coming from the planning aspects of how they were going to plan work.

And so we grew this database. And, of course, every time we had a new maintenance state, it just became part of the database. And over the years, it's continued to grow over a period of time. And after ten years of doing it, you end up with 20,000 maintenance plus states.

CHAIRMAN APOSTOLAKIS: Now, if you find yourself at 3:00 o'clock in the morning at a particular configuration, how can you identify the pre-evaluative configuration that applies to that? What is the mechanism that allows you to do that?

MR. PHELPS: Just wait until the next slide. I'll give you just a quick screen shot that shows you where you can come up with that information on it.

CHAIRMAN APOSTOLAKIS: Okay.

MR. PHELPS: Okay. Just real quick, we're working on implementation now. I am the sponsoring manager at the South Texas project to be able to implement the risk-informed technical specifications, have a huge team set up with operations, risk management, licensing, work control.

Our training department is integral to that as well as development of procedures to incorporate the industry guidance document, tie those into our configuration risk management program.

We have been working on that for now about four months and continue to look forward to implementation of this. And as soon as we get this pushed through and ready to resolve, we're going to be ready to implement at South Texas project.

We talk about the risk-informed completion time calculator. It can determine that completion time in a very short time. It's just simple drop-down menus. It's a user-friendly wizard format. That's why I have on-shift senior reactor operators participating with this team.

It's basically just like loading a program on your computer. It's going to say, "Enter this information. Go to 'Next' and you can go ahead and enter the remainder of the information," very user-friendly.

It will display that completion time as well as the risk management action time. One of the things we're learning out of this is we want to flag what are those risk management actions that have been identified, whether those are specific steps in a procedure now that take on a much more level of importance so that those items can be briefed ahead of time before that configuration. And the ability to manually start a turbine-driven ox feedwater pump becomes important. We can take those steps up front to increase that human reliability as we move into those.

It will also give us whether the risk-informed completion time is related to our core damage frequency or the large early release factor that's on there.

Rick mentioned here are just a couple of the screen shots that you would see in there. Hopefully you can see that up on the screen. It's going to ask for some information to go through, ask you what time you entered this configuration.

The drop-down menus we talked about on the top are the actual tech spec-related systems. That drop-down menu would give you a sort of all systems that are included within the scope of the configuration risk management tool.

The bottom set of drop-down are those other set of non-safety-related systems that are also credited for those things that contribute to balance-of-plant trips that are in there so that we incorporate the entire overall plant configuration into the determination of the allowed completion time.

As a result of the data that's entered in there, it will give you a delta CDP per hour. And then the next page is going to tell you what is your backstop time and what is the limit out there. Is it limited by 30 days? Is it limited by the core damage probability or the large early release?

For what's on there, it actually literally counts down over underneath the countdown. It will tell you, "You've now got 30-40 hours and 6 minutes, 40 hours and 5 minutes."

So it will give them the countdown and then documentation. We can save those calculations or view the report. It will view the report. It will give you a graphical representation similar to what you saw on the previous screen that John talked about where you saw the train alpha component or bravo and charlie components out of service and see how those change as you go through there.

So all of those tools are available online and easily accessible by the operator in the control room.

This is just really a hierarchy of how we're incorporating obviously our technical specifications and requirements of the maintenance rule.

We're developing our risk management tech spec procedure to incorporate the industry guidance document, all those requirements. And we need to make sure we do run those through our risk management program and risk management actions procedure.

We will do another one there where we'll have some documented actions that we want to take credit for to ensure that the operators take under those specific plant conditions that exist in there.

We talked about training. That is in progress. We've got that actually on our next two requalification cycles that will include all of the licensed operators as well as work control working through the training committees with engineering and management to understand their levels of responsibility as we move through that. All that training schedule will be complete in September with the initial training so that at that point we'll be ready to implement.

Any questions for me?

MEMBER MAYNARD: Just real quickly back on the display there for the risk-informed completion time, now, that could either be based on what comes out of your tool or what is in the tech spec in some cases. So does that have a switch? Can you tell whether this is based on your calculation or whether it's based on the tech spec?

MR. PHELPS: We can tell this one is based on the backstop that I am just going to show in there. That's the flag, if you will, here that is telling us that the actual limiting time was based on the backstop.

MEMBER MAYNARD: Okay.

MR. PHELPS: And if it calculates a different time, this would not be checked. It would be checked over here on either "core damage probability" and reflect the time up here that was related to exceeding E-5 --

MEMBER MAYNARD: Okay.

MR. PHELPS: Now, if you change configurations, as we showed on the graph, that can change. So it behooves the management structure at the plant, as we saw, where it starts from the time you first entered risk-informed completion times out to 30 days.

If you had an event happen at day 29 because you didn't aggressively pursue correction of that condition, you could find yourself in one day to get the other one if you hadn't exited.

MR. GRANTOM: Going back to what George was talking about, if it's 3:00 o'clock in the morning and let's say they go in here and they enter in a configuration over here and it's not in RAsCal's database, they'll get a message that says it's an unquantified maintenance state. And when that happens, the software actually documents the unquantified maintenance states.

There's a file that's written. And then the instructions are to call the person on duty for risk management, one of the people on my team. We have 24-hour coverage with someone on duty. They'll get the call.

Everybody is qualified and certified to go run a maintenance, what we call go run a maintenance, state. And they'll run that maintenance state. They'll add it to the database. And then it's uploaded and fed into the new database there. And then they'll have that within an hour. That's what would happen in that case.

CHAIRMAN APOSTOLAKIS: The person on duty is on site?

MR. GRANTOM: No. They could be at home. They could be at home.

CHAIRMAN APOSTOLAKIS: Okay. Any other questions or comments?

(No response.)

CHAIRMAN APOSTOLAKIS: Thank you very much, gentlemen. Boy, this is going very smoothly today. I don't know what's going on. The Committee is losing its --

MEMBER MAYNARD: It's been my experience that the operators are never hesitant to call somebody at 3:00 o'clock in the --

CHAIRMAN APOSTOLAKIS: Mr. Chung?

MR. CHUNG: Yes, sir. We meet again.

CHAIRMAN APOSTOLAKIS: We meet again. Gary was my student at the UCLA for those of you who --

MEMBER KRESS: Should we hold that against him or what?

CHAIRMAN APOSTOLAKIS: Yes.

(Laughter.)

MEMBER KRESS: UCLA?

CHAIRMAN APOSTOLAKIS: UCLA, yes, a long time ago. He's an old man now.

(Laughter.)

MR. CHUNG: But still a-brewing.

VI. SONGS IMPLEMENTATION OF INITIATIVE 4B PROCESS

MR. CHUNG: As it says, I'm Gary Chung; first and foremost, formerly a student of George. I'm in the PRA Group at Southern California Edison.

It will be brief. We're just entering into being a pilot. We haven't formally sent in a notice of intent to be a pilot, but, for all intents and purposes, we will be. So we're trailing the other two pilots by a year and a half. So my remarks will be brief.

The topics are our plans for initiative 4b. I'll discuss that, a little background in our PRA, some of the history of SONGS with risk-informed tech spec AOTs. I'll go over our CRMP tools and our current and future usage of the safety monitor.

Recently I went before our executive management, which is our chief nuclear officer, all the VPs, all the department heads, all the stakeholders, explained our program of how risk-informed tech specs would work. They're all for it primarily because it allows them to operate the plant in a risk-informed manner in a little more flexibility with a little more logic, risk logic, behind it.

Right now we're currently assessing the logistics and the schedule before we send in our formal intent letter. And those assessments will include what is required for program development, the scope of our license change, and the training and implementation requirements.

The SONGS PRA is a full-scope PRA, "full-scope" meaning it's all the internal and external events that have been modeled, including seismic and fire.

We are currently a reg guide 1.200 pilot plant on another application as an extension of the allowed outage time for DC power. We had entered that out two years ago prior to even thinking about flexible allowed outage times. If we had known at that time what we know now, we probably would have folded it into the flexible allowed outage time for the full plant.

We are peer-reviewed against the ASME standard. And all the facts and observations from that review have been resolved. And we also are reviewed against the ASME seismic standard.

Some of the brief history. We go way back with allowed outage time extensions. Many of our applications and calculations supported the more generic single spec AOT extensions, primarily for the combustion engineering owners' group, including LPSI, safety injection tanks, containment spray system, and containment isolation valves. We're also a risk-informed IST plant, where we've extended in-service testing times.

Our tools that we use, our PRA calculator is WINNUPRA. I think South Texas uses RISKMAN. Ours is WINNUPRA. They use RAsCal for their CRMP tool. We use the SAFETY MONITOR.

The WINNUPRA code is used mainly to develop and maintain the PRA models. That's where the pictures of our fault trees and our fault trees are developed. And then we transfer them. The actual Boolean logic models, we transfer them over to the SAFETY MONITOR. And there is where we toggle switches for actual maintenance and actual system alignments.

Our current SAFETY MONITOR usage is primarily to support the maintenance rule, also support some of our risk-informed tech specs that I alluded to earlier. There is a real-time risk evaluation that's done once per shift in the control room by the shift technical adviser, who apprises the shift supervisor of the results when he runs them.

It's also prior to that point where the control room actually runs it. The work planners in planning their maintenance input their planned maintenance at eight weeks. And then we review it four weeks prior to maintenance and again one week ahead of maintenance before it's turned over to the control room for real-time evaluation.

Our future usage is pretty much the same as now with some enhancements for some of the cumulative risk calculations and the calculation RMAT, the RICT, and some archival documentation provisions.

I want to note that the calculation, the administration, and the control of the CRMP tool and how we calculate it are 95 percent the same as we would do now that we would do later. The only thing that would be different is what you do with the number once you calculate it and the administration of the results.

But as far as actual usage, who would do it is pretty much the same thing as we do now. I think that's the case with you guys as well, right?

Yes.

And, in summary, we will be the third pilot for flexible allowed outage times. Our schedule and program logistics are being evaluated, and our letter of intent to be a pilot is forthcoming.

CHAIRMAN APOSTOLAKIS: Very good. Questions?

(No response.)

CHAIRMAN APOSTOLAKIS: Thank you, Gary. I guess we'll have other chances --

MR. CHUNG: Yes.

CHAIRMAN APOSTOLAKIS: -- to talk to you when you actually do it.

MR. CHUNG: Yes.

MEMBER KRESS: He needs to explain slide 10 to us.

CHAIRMAN APOSTOLAKIS: Yes. Dr. Kress has a question on your slide 10.

(Laughter.)

MR. CHUNG: My 10, the backup slide one?

MEMBER KRESS: Pretty good. Yes.

MR. TJADER: There's a page break after the last slide. It's blank.

MR. CHUNG: I know nothing.

CHAIRMAN APOSTOLAKIS: How much time? Do

you think we're going to be done by 12:00 o'clock.

MR. HACKEROTT: Oh, yes.

CHAIRMAN APOSTOLAKIS: Oh, yes? Everybody says, "Oh, yes"? If I order a taxi, that will be a backstop.

(Laughter.)

CHAIRMAN APOSTOLAKIS: We're flexible. Maybe I should. We have had you here before, right? When was it?

MR. HACKEROTT: A long time ago. It seems a long time ago.

(Whereupon, the foregoing matter went off the record briefly.)

MEMBER KRESS: When you say, "single system pilot," are you talking about just having one system?

MR. HACKEROTT: One system with a flexible allowed outage time in the backstop.

MEMBER KRESS: Since it's related to the total configuration, how do you do that?

MR. HACKEROTT: Well, yes, you can have that system and --

MEMBER KRESS: Oh, but you're just going to deal with it by itself and --

MR. HACKEROTT: Well, no, it and other

systems at the same time. I mean, theoretically you could have it out plus 20 others and --

MEMBER KRESS: Okay. So the single system is just sort of --

MR. HACKEROTT: It's similar, yes. It kind of addresses some of the onerous issues on the encouraging more pilots. And the scope is limited. The scope of the review by the NRC is limited to some extent. The scope of implementation is a little cleaner at the plant. It's a good way to phase your way in.

MEMBER MAYNARD: The tech spec change that put this into action would only be for this system.

MR. HACKEROTT: That's true.

MEMBER MAYNARD: But your capability has to be able to assess that system with other systems being out.

MR. HACKEROTT: It is a little more inherently limited for the next licensing changes.

So with that as my conclusion, are there any questions?

MEMBER KRESS: Yes. That was very good. That was the best talk we've had yet.

MEMBER MAYNARD: That cleared everything up.

CHAIRMAN APOSTOLAKIS: Okay, Alan.

MR. HACKEROTT: Thank you.

VII. FCS IMPLEMENTATION OF INITIATIVE 4B PROCESS

MR. HACKEROTT: I'm Alan Hackerott. I'm going to speak real briefly today about the other pilot. Sometimes it's called the single system pilot. I'm going to talk about why a single system pilot, why it came to be, what the advantages are. And I'll talk certainly about some questions, anything regarding my program at Fort Calhoun station.

I was directly involved, as Gary Chung was, in Southern Cal as the pilot for reg guide 1.77, which is the AOT extensions for single AOTs. And that was done with single systems. That was done back in the old days, before we even had maintenance rule paragraph (a)(4). And single systems were essentially done at that time.

At the time when we were doing that, in discussions with the staff, we said, "Gee, we really ought to" -- it's complicated to look at one particular system because you have to do a worst case to evaluation system. Requirements for under that reg guide were pretty intensive. So efficiency was definitely served on both sides by doing it on a more global basis.

Also, as we recognized, PRA capability would go up. Maintenance capability would go up. It would be very desirable to rely more on the plant-specific evaluation versus the more prescriptive requirements and tier 2 documents.

So one way to address these issues is why single system one. The review theoretically is modest amount of resources is I guess all relative, but a single system does require less review. A single system plus one or two other systems is a more focused review.

And the other thing we talked about, at least Otto mentioned, on the pilot process -- by the way, some of us were fairly reluctant pilots on the first reg guide 1.77. We were just chosen. So it does allow a utility to gain experience, help change the culture, get used to licensing, et cetera, by just doing one. Tech spec changes are certainly smaller. It's a way to phase in.

And the reason that is desirable is it's a great approach. If you don't have or have confidence in your capability of your entire PRA, you can start with one or two or a group of systems.

Also, I believe, as I said, as I looked at some of my old slides last time that I was here, that the important way to improve PRA capability is through applications. That really drives. You start phasing in. It really drives PRA capability at the plant.

Also, with respect to the regulator, the poor residents that have to evaluate this and regions that have to enforce it, it helps phase that in. It helps the learning process.

Why the HPSI system. It's not a low-risk system. And if you use the reg guide 1.77 guidelines, you take the worst failure as an evaluation. And the HPSI system is important. If you take, actually, the pump or the main driver out itself, it is fairly significant. However, the system does have several model subcomponents.

You can have the injection line, have several injection lints, injection valves. There's a mini recirc function. So there are subcomponents of the HPSI system that come out that are relatively not high-risk and you could go into the backstop for.

So that is kind of an interesting exercise in looking at the prime system versus support systems.

MEMBER KRESS: Are you allowed to have that out of service during full-power operation?

MR. HACKEROTT: Yes. All plants have an allowed outage time in HPSI. It varies from --

CHAIRMAN APOSTOLAKIS: The whole system or just one train? How many trains does your system have?

MR. HACKEROTT: Two with a swing pump, the two trains. South Texas, of course, has 3. or 2.98 or something like that. But, as far as I know, everybody else has two trains with different plants have a swing pump.

This was submitted several years ago as a joint application report comparing a variety of plants. It's interesting. You know, some plants have low-pressure pumps that support the high-pressure pumps. It's an interesting system. It makes it a good pilot.

The other thing that is important about the HPSI is it is well-understood. The design basis function is well-understood. It has had PRA attention forever. We have detailed success criteria, thermal hydraulic success criteria, done through the owners' groups for realistic flows.

MEMBER KRESS: Your success criteria is one train has to be in operation?

MR. HACKEROTT: For PRA or design?

MEMBER KRESS: PRA.

MR. HACKEROTT: Yes, yes.

CHAIRMAN APOSTOLAKIS: For design?

MR. HACKEROTT: No. Right. Design is the same. It's the same.

MEMBER KRESS: So okay. I'm all right with that.

MR. HACKEROTT: The MSPI that happened last year, HPSI was one of the systems. And that further enhanced confidence and understanding of the HPSI system.

External events, particularly fire, with respect to HPSI are relatively small and is fairly understood, the role of HPSI in external events.

Once again, the acceptance of the HPSI is single system pilot strong evidence of moving us more toward a more flexible, the famous flexibility of regulation, and would encourage more plants to go in.

A lot of plants are submitting what is called initiative 4a, which is the single system pilot, so that there is still a lot of need and desire out there on the part of a lot of the plants to get just smaller subsets of systems, flexibility, and this would also be a mechanism -- the single system or groups of systems would be another mechanism for those plants to come along.

With that, I'm done with the generic part.

I thought I would start talking about our maintenance of Fort Calhoun station. Any more questions on the single system pilot aspects?

(No response.)

MR. HACKEROTT: Good. Very similar to the other plants that spoke today, we have a robust (a)(4) process. Maintenance is used on the day-to-day evaluation. It's run by ops. It's run from the control room. There are also work week managers who are dedicated to running it and evaluating it for both routine and emergent conditions and keeping the alignments true with the model so that running and standby equipment is kept aligned. It's used to support all planned maintenance starting with the 12-week schedule down to the weekly schedule.

On one PRA, LERF, key seismic things were put in some time ago. Firing sites are evaluated. And model uncertainty and some uncertainty in the external events are addressed by adjusting threshold limits. Similar to the maintenance threshold limits, ours are a little bit lower to account for some of that uncertainty.

An important over-arching philosophy of maintenance is basically it's the tool. Obviously it generates a number. And we talked a lot about the number, but it really is to identify opportunities for an efficient time to add worthwhile risk management actions.

The numbers give you those insights that say at this point the incremental risk is high enough that it warrants the expense and the labor, et cetera, of looking for opportunities for risk management actions. So that's an important concept that was fundamental to our process, which we have been doing for many years.

Obviously the other bullet, "Control and planning and maintenance activities," is often more important than the duration itself. So the control and planning is very important.

Obviously we use quantitative guidelines, thresholds, as I discussed. We also use a qualitative evaluation. Every evaluation we do involves a qualitative at least list of questions that has gone through procedurally to deal with issues that either aren't easily modeled or easily reflected by the model.

My favorite example is floor plugs, various barriers, drains, et cetera, that can affect flooding processes. So an evaluation, you do a quantitative number. Then you look for these other activities going on if there is any digging going on, other work going on on the site. And the process obviously considers planned and well as emerging conditions.

Any time any of those qualitative issues get involved, it usually involves a call to the PRA personnel, where we help sites associated with that configuration.

For a single system, certainly from a tech spec, the change is relatively small, existing procedures and processes. South Texas didn't brag on it, but they have spent a lot of time getting their processes very well-honed.

CHAIRMAN APOSTOLAKIS: Wait a minute now.

MR. HACKEROTT: Yes?

CHAIRMAN APOSTOLAKIS: Are you using the word "backstop" the same way we have been using it all morning? I thought you couldn't change it. The backstop is 30 days.

MR. HACKEROTT: That's correct.

CHAIRMAN APOSTOLAKIS: So what is this "change to backstop AOT"?

MR. HACKEROTT: "Backstop AOT" is the title for 4b.

CHAIRMAN APOSTOLAKIS: So this is RICT?

MR. HACKEROTT: Yes. The change to the 4b initiative --

CHAIRMAN APOSTOLAKIS: So you're not changing the backstop?

MR. HACKEROTT: No, no.

CHAIRMAN APOSTOLAKIS: I mean, that's a --

MR. HACKEROTT: Yes. The maintenance rule process which we use now is robust, will be adjusted, as necessary, to the RMTS guidelines. Also, based on some input from our regulator, they suggest that it's nice to have "Here's the guideline. And here is exactly how we meet it so it's an easily reviewable document so you don't have the procedure spread all over the place." So it's kind of a basis document that's important. Of course, some operator training will have to happen with the new concepts associated with this, continue to happen.

That was it for my plant process. I looked over some old slides presented on flexible AOTs. In some of the old slides, there were lots of issues I had on what the industry is to do and what the NRC would do.

I would just like to comment that in some of the old slides, for success, we said it's important to keep the industry-NRC communications open. The process started actually by an initiative by the NRC in '98 to do flexible AOTs and the other AOT initiatives.

A good example is the NRC-sponsored meeting in '05, 2005, in Kentlands, meetings where a lot of, a very large group of, PRA practitioners addressed capability issues.

I guess I just wanted to say I think the regulator has definitely done a good job of keeping communications open. As we evolve, a lot of discussions and philosophy have to be discussed as we evolve down this process. And there has been a lot of good communication.

The guideline we have been talking about definitely I think meets the needs of both the regulator and the industry. And the great approach does allow more utilities to benefit, more utilities to start improving their PRA capability and process capability and risk cultures by phasing that way.

That's really all I had.

VIII. GENERAL DISCUSSION AND ADJOURN

CHAIRMAN APOSTOLAKIS: Okay. Any comments?

MEMBER MAYNARD: I do have one quick comment. You talked a little bit about some of the language earlier in the guidance document. I think anybody who reads the tech specs for the first time, you want to rewrite it.

However, over the years, the tech specs are such an important document. And over the years, the interpretation of various statements have been worked out to where I believe that the guidance document really needs to reflect as close as it can the same language that is used in the tech specs. Otherwise you're going to introduce a new interpretation of something.

So I know the language is sometimes difficult, but I really believe it should be matched up with the tech specs around five or ten years of reinterpretation of existing statements.

CHAIRMAN APOSTOLAKIS: Thank you very much, gentlemen. This was very informative, both to the staff and the industry. And we'll most likely meet again in sometime early fall to focus on the methodology primarily.

So, with that, we are adjourned.

(Whereupon, the foregoing matter was concluded at 11:27 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 Reliability andProbabilistic Risk Assessment and Plant Operations Joint Subcommittee

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.

Eric Mollen

Eric Mollen
Official Reporter
Neal R. Gross & Co., Inc.

Risk Management Technical Specifications Guidelines for Initiative 4b, Risk-Informed Completion Times

Presentation to ACRS PRA Sub-Committee
April 28, 2006
Technical Specifications & PRA Branches
Bob Tjader Andrew Howe
415-1187 415-3078

ACRS Meeting Goals

- Familiarize ACRS with Initiative 4b, Risk Management Guidance Document: Requirements and Guidance
- Obtain Feedback on Approach
- Seek letter to Commission supporting the Pilot Process

Purpose of Risk Management Technical Specifications Initiatives

- Align Tech Specs with Commission's Policy Statement on use of PRA
- Consistent with Maintenance Rule
- Enhance Safety/Improve Effectiveness
  - Focus on Operability, versus on shutdown, and
  - Avoid unnecessary plant transients/shutdowns
  - Integrated plant risk considered
- Enhance Operator Safety Focus
  - Heightened awareness of risk contributors & profile
  - Actions & times in Tech Specs perceived as appropriate for risk

Initiative 4 – Risk-Informed Completion Times

- Description: Use configuration risk management
  - "Real-Time" calculation of completion time (CT) based upon current plant configuration and associated risk
  - Extend CT from a nominal value up to a predetermined "backstop" maximum of 30 days
- Implementation: Under development. Risk Management Guidance to include:
  - Approved decision-making process
  - Implementation requirements and guidance
  - Requirements for PRA technical adequacy, and configuration risk monitoring
  - Quantitative configuration and cumulative risk metrics
  - Documentation requirements
  - Training requirements
- Status: STP (full plant) & Fort Calhoun (single system: HPSI) pilots submitted in CY 2004, SONGS (STS & full plant) prospective pilot

Original Tech Specs

- Not Risk-Informed
- Based Upon Engineering Judgment
- Do Not Control Multiple SSC Outages
- Most Focus Toward Shutdown
- CT Not Required by Regulation
- Restrictive
- Safety Record is Good

Benefits of RMTS RICT

- Risk Informed
- Integrate Plant Risk
  - Manage Multiple SSC Outages
  - Manage Broader Scope of SSCs (TS & non-TS)
- Flexible Configuration Management
  - Base Decisions on Real-Time Insights
  - Focus on Repair
  - Licensee Control
- Ongoing Risk Awareness

Risk Management Guidance Document Content

- Risk Management Technical Specifications (RMTS) Overview
- RMTS Initiative 4b Program Requirements
- RMTS Guidance Approach & Methodology
- PRA Quality & Configuration Risk Management Tool Attributes
- Documentation & Training Requirements

RMTS Initiative 4b Process Requirements

- PRA Quality (proof of concept)
  - Scope
  - Level of Detail
  - Acceptability
- Risk-Informed CTs are used:
  - To extend beyond current/existing CT
  - When in > 1 Tech Spec, assess CTs vs RICT
  - When in RICT, evaluate configuration/ operability changes to recalculate RICT

PRA QUALITY MUST BE ADEQUATE TO SUPPORT 4b

- Internal events PRA:
  - Use ASME standard & RG 1.200
  - Establish Basis for PRA Technical Adequacy Sufficient to Meet Adequacy Requirements (e.g., generally ASME capability cat 2)
  - Use PRA Peer Review Findings & Observations
  - Use results of Self Assessments to identify where PRA does not meet the prescribed basis (ASME Capability Category 2)
  - Assess the impact of ASME Supporting Requirements that are met on I4b process; upgrade PRA
- External Events, Transients, & Shutdown Risk
  - Staff will need to reviews licensees' PRAs

CURRENT REVIEW ISSUES

Exportability; Pilot Plant General Acceptance Criteria:

- Reliability
- Repeatability
- Enforceable/Oversight

Status of Pilot Process

- The final Risk Management Guidance Document has been (verbally) agreed to:
  - Minor differences with draft subcommittee has
  - Full Committee to received final along with draft SE
- Sight visits to STP (in June) & FCS (in July) for PRA/CRM review
- Revised LARs to be received in near future
- Goal to issue Pilot LAs by end of year

Back-up Slides

Completion Time (CT) Approach

- CT Features
  - Front Stop; current CT
  - CRMP-based CT (RICT)
  - Back Stop (30 Days)
  - Risk Assessment Tools Must Provide Timely Reliable Result
  - Decision Making Process Reliable Scrutable
- Proposed 4b Tech Spec

Initiative 4b Example

- See proposed 4b Tech Spec; discuss concepts
- Initiative 4b concepts
  - Front Stop; current CT
  - CRMP-based CT
  - Back Stop
  - Risk Assessment Tools provide reliable results in a timely manner
  - Use of reliable Decision Making Process

TABLE 3-1
GENERIC RISK-INFORMED CTs WITH A BACK-STOP: EXAMPLE FORMAT

Actions Condition	Required Action	Completion Time
B. One [HPSI] subsystem inoperable.	B.1 Restore SI subsystem to OPERABLE status.	72 hours
	OR	
	B.2.1 Determine that the completion time extension beyond 72 hours is acceptable in accordance with established RMTS thresholds.	72 hours
	AND	
	B.2.2 Verify completion time extension beyond 72 hours remains acceptable.	In accordance with the RMTS Program (i.e., within 24 hours of a subsequent configuration change)
	AND	
	B.2.3 Restore subsystems SI to OPERABLE status.	30 days or acceptable completion time , whichever is less.

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Risk Managed Technical Specifications Industry Guidance

Stephen M. Hess

Electric Power Research Institute

Presented to:

Advisory Committee on Reactor Safeguards

Reliability & PRA Subcommittee

Plant Operations Subcommittee

April 28, 2006

Objective

- Provide a process and technical guidance to identify appropriate risk-informed completion times (RICT) for SSC's that are Technical Specification inoperable.
- Key Principles:
  - Apply results of PRA to specific plant configurations to ensure plant safety risk is appropriately managed.
  - Requires implementation of proactive compensatory risk management actions (RMA's).
  - Action thresholds for RMA and RICT based on accepted regulatory guidance (RG 1.174).
  - Provisions of RMTS supplementary to Maintenance Rule (a)(4) requirements.

Guidance Document Organization

1) Overview and history of RMTS.
2) RMTS Programmatic Requirements
   - Application of CRM Process to Tech Spec Completion Times (CT's)
   - Documentation
   - Training
   - PRA Technical Adequacy
   - CRM Tools
3) Specific implementation guidance and examples.
4) PRA and CRM programmatic attributes required for RMTS.
5) References
6) Appendix – Glossary of Terms

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Applicability of At-Power PRA's to RMTS

Applicability of At-Power PRA to RMTS	PWR	BWR
Direct Application	1, 2, 3, 4*	1, 2
Not Applicable	4*, 5, 6	3, 4, 5

RMTS is applicable to PWR Mode 4 for cooling via steam generators; RMTS is NOT applicable to PWR Mode 4 for cooling via shutdown cooling.

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RMTS Thresholds

Criterion		RMTS Risk Management Guidance
CDF	LERF	
$\geq 10^{-3}$ events/year	$\geq 10^{-4}$ events/year	- Consider the required action to not be met and follow the technical specification requirements
ICDP	ILERP	
$\geq 10^{-5}$	$\geq 10^{-6}$	– RICT requirements apply – Consider the required action to not be met and follow the technical specification requirements
$\geq 10^{-6}$	$\geq 10^{-7}$	– RMAT requirements apply – Assess non-quantifiable factors – Implement compensatory risk management actions
$<10^{-6}$	$<10^{-7}$	– Normal work controls

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RMTS Process

- Formal structured process.
  - Actions specified in process flowchart.
  - Entry and exit conditions.
  - Actions for simultaneous LCOs.
  - Actions for exceeding specified CT.

Key Action Thresholds

- RMAT
  - Specifies the threshold for which compensatory risk management actions are required.
  - Corresponds to 10^{-6} ICDP or 10^{-7} ILERP RMA threshold is reached, whichever is the shorter duration.
  - Risk management actions implemented to effectively control risks.
- RICT
  - Defines the configuration specific time limits for which plant SSC's can be Technical Specification inoperable.
  - Corresponds to 10^{-5} ICDP or 10^{-6} ILERP threshold is reached, whichever is the shorter duration.
  - Provides a back-stop maximum CT of 30 days.

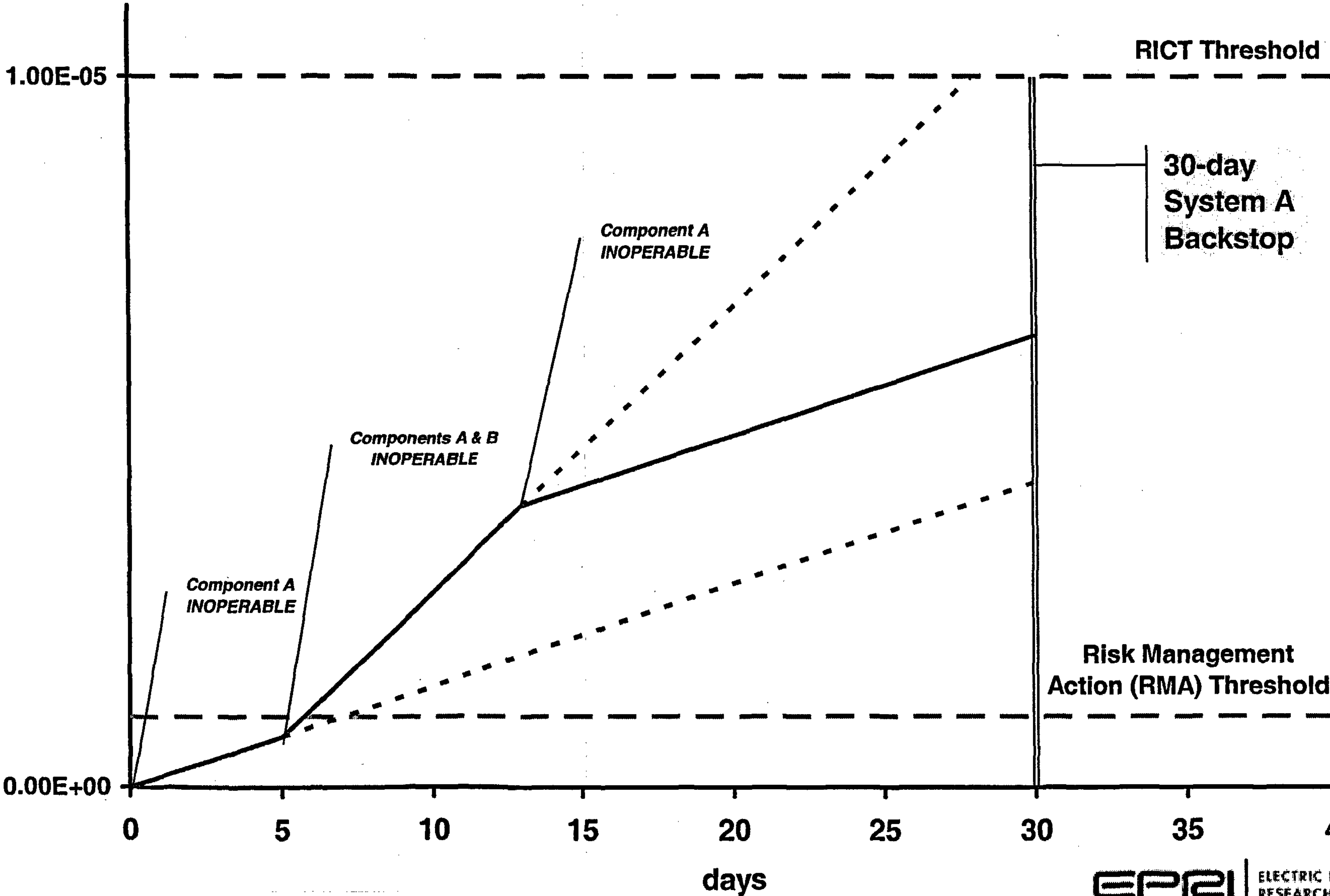
Conditions for RMTS Application

- Extend a CT beyond its front-stop CT.
- Conditions in which more than one Technical Specification LCO is not met and the applicable actions have the provision to utilize a RICT . In this case, the RMTS is applied to confirm acceptability of the affected front-stop CTs.
  - If RICT is shorter than front-stop, RICT applies.
- To evaluate configuration changes once a RICT is being used beyond the associated front-stop CT.
  - Includes both TS and non-TS systems within scope of PRA / CRM models.

Calculation Requirements

- RMAT and RICT:
  - Referenced to CDF and LERF associated with the plant "zero-maintenance" configuration.
  - Referenced from the time of initial entry into the first RMTS.
  - Can only be reset once all RMTS action statements for SSCs beyond their front-stop CTs have been exited.
  - Calculations may use conservative or bounding analyses.
- Compensatory risk management actions may only be credited to the extent they are modeled in the PRA and are proceduralized.
- If an expected repair time is contained in the PRA model, it cannot be credited in the RICT calculation.
- The impact of fire risks shall be included in RICT calculations.
- A RICT exceeding the current front-stop CT may not be applied in cases where a total loss of function has occurred.

RMTS Example



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Training Requirements - Who

- Required for personnel responsible for RMTS actions /decisions.
  - Station management.
  - Licensed operators.
  - Work control personnel.
  - PRA personnel.

Training Requirements - What

- Programmatic requirements of RMTS program.
- Fundamentals of PRA.
  - Analytical methods employed.
  - Interpretation of quantitative results.
  - Potential impact of common cause failures.
  - Model assumptions, limitations and uncertainties.
  - Use of PRA results in decision-making applicable to RMTS.
- Plant specific quantitative and qualitative insights obtained from the PRA.
- Operation of the plant configuration risk management tool and interpretation of results derived from its application.

PRA / CRM Requirements

- **PRA and CRM tool requirements specified.**
  - PRA for Internal Events and Flooding.
  - PRA for Internal Fires.
  - PRA for Seismic and Other External Events.
  - PRA Application to LPSD Modes.
  - Specific CRM Model Attributes.

Documentation Requirements

- Plant program implementation.
- Individual RMTS evaluations.
  - Date / Time for condition entry / exit.
  - Configuration specific risk profile for the duration of extended CTs identifying inoperable equipment and associated plant alignments.
  - Application of bounding assessments or other conservative quantitative approaches were used.
  - Basis for credit taken for PRA functionality.
  - For emergent conditions, the extent of condition assessment for redundant components.
  - Total accumulated ICDP and ILERP accrued during the extended CTs.
- Accumulated annual risk above the zero maintenance baseline due to equipment out of service beyond the front-stop CT.
  - Part of the station periodic PRA updates.
  - Periodicity not to exceed two refueling cycles.

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PRA and Configuration Risk Management (CRM) Tool Requirements for Risk Management Tech Specs

John P. Gaertner
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Presented to:
Advisory Committee on Reactor Safeguards
Reliability & PRA Subcommittee
Plant Operations Subcommittee

April 28, 2006

PRA and CRM Tool Requirements

All PRA and CRM Tool requirements are specified in Risk Management Guidance.

- PRA for Internal Events and Flooding
- PRA for Internal Fires
- PRA for Seismic and Other External Events
- PRA Application to LPSD Modes
- Specific CRM Model Attributes

Current Status of Industry CRM Models

- U.S. plants use quantitative CRM models for Maintenance Rule (a)(4) requirements at power.

- CDF and LERF are the figures of merit, but LERF is sometimes not part of the CRM model.

- Internal events are always in the quantitative CRM model, flooding usually, fire sometimes, seismic less, …

- CRM models are integral to CRM tools such as EOOS, ORAM-SENTINEL, SAFETY MONITOR, and RAsCal:

  Models or ***model results*** are imbedded in CRM tools

Current Status of Industry CRM Models

- CRM models and their use in (a)(4) is subject to ROP oversight and actions.

- CRM Tools are an integral part of regulatory compliance, work management, and operations processes at NPPs. Their use is essential to plant performance.

PRA Requirements

- **PRA for Internal Events and Flooding**
  - PRA model reviewed to the guidance of Regulatory Guide 1.200 Rev 0
  - RG 1.200 assures conformance with ASME PRA Standard
  - Capability Category 2 with deviations justified and documented
  - PRA model shall include Level 1 CDF plus LERF.

PRA Requirements

- **PRA for Internal Fires**
  - Effect on RICT must be explicitly considered
  - Can be integral part of CRM model

    OR

    can be "conservative or bounding" methodology
  - EPRI "*Methodology for Fire Configuration Risk Management*" referenced as an example method.
  - ANS Fire PRA Standard not yet complete

PRA Requirements

- **PRA for Seismic and Other External Events**

External event risks will be addressed by:

- Providing a reasonable technical argument that the external event is not a significant contributor.

OR

- Performing an analysis of the contribution of the external event and including this contribution in the RICT.
  - Perform a reasonable bounding analysis, or
  - Include in the plant CRM model.

PRA Requirements

- **PRA Application to LPSD Modes**
  - If used in Modes >2, at-power PRA model must be verified to be conservative or bounding
  - No LPSD PRA required.

Applicability of At-Power PRA to RMTS	PWR	BWR
Direct Application	1, 2, 3, 4*	1, 2
Not Applicable	4, 5, 6	3, 4, 5

*** Cooling via steam generators**

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CRM Model Attributes

- **Identify all necessary attributes of a CRM model that would not be addressed explicitly by PRA Standards and evaluated by Peer Certification.**
  - Most aspects of the CRM model are identical to the PRA from which it is derived
  - Some attributes are unique to the CRM application

  So, a complete review of CRM technical adequacy requires:

PRA Peer Review + PRA Standards Assessment + Verification of Attributes

Nine CRM Attributes

1. Initiator dependencies
2. Truncation levels
3. Translation from PRA model
4. Human action treatment
5. Activities mapped to basic events
6. Representing the as-built / as-operated plant
7. Consideration of uncertainty
8. CRM software and model quality
9. CRM model maintenance and update

Summary

- All PRA and CRM Tool requirements are clearly specified in the Risk Management Guidance.
- Use of PRA for Risk Managed Tech Specs risk-informs the process and improves safety.
- Residual risk not explicitly included in RICT by these requirements continues to be effectively managed by existing programs and risk management activities.

STP Nuclear Operating Company

STP Implementation of Risk-Informed Technical Specifications

ACRS Subcommittees on Reliability and PRA

April 28, 2006

Introduction

STP Participants

• Rick Grantom	Manager, Risk Management
• Jay Phelps	Manager, Operations Unit 2

Agenda

- Overview of STP's PRA and On-line risk assessment tool, Risk Assessment Calculator (RAsCal)
- RAsCal Attributes and Applications at STP
- RMTS Implementation at STP

STP's PRA Overview

- Full scope Level 1/2 PRA
  - RISKMAN® software
  - Internal events
  - External events including fire, external flood, high wind and seismic
  - Spatial interactions, HRA, detailed common cause
  - Updates per PRA configuration control program
    - Complies with Appendix B Software QA requirements
  - Used for STP applications since 1989
  - Has undergone industry peer review
  - RG 1.200 pilot for PRA quality

RAsCal Overview

- "Real-time" risk assessment tool
- Database of >20,000 maintenance states quantified by the STP PRA
  - Does not calculate CDF or LERF itself
  - Can make some adjustments for specific conditions
    - Trip risk initiator based on plant configuration
- User friendly interface developed in cooperation with STP users

RAsCal Attributes

Initiator dependencies	Same as the PRA
Truncation levels	RAsCal database populated by PRA run at E^{-11} truncation limit.
Translation from PRA model	RAsCal reflects PRA results & does not perform the CDF/LERF calculation
Human action treatment	HRA is included in the PRA
Activities mapped to basic events	Specifically tailored to be the same as PRA based on tag-out procedures

RAsCal Attributes

Representing the as-built, as-operated plant	Updated as the PRA is updated
Consideration of uncertainty	Addressed in PRA. No calculations in tool.
CRM software quality and configuration control	In the STP Appendix B SQA Program
CRM model and software testing	

Current Application of RAsCal

- Applies the STPNOC Configuration Risk Management Program (CRMP) procedure
  - Same program used for 10CFR50.65(a)(4)
- STP has extensive experience in applying the CRMP
  - Routinely used to manage weekly work

Current Application of RAsCal

- RAsCal is used by Operations and Maintenance Planners to quantify configuration risk
- PRA Group may be called to quantify a configuration that is not in RAsCal

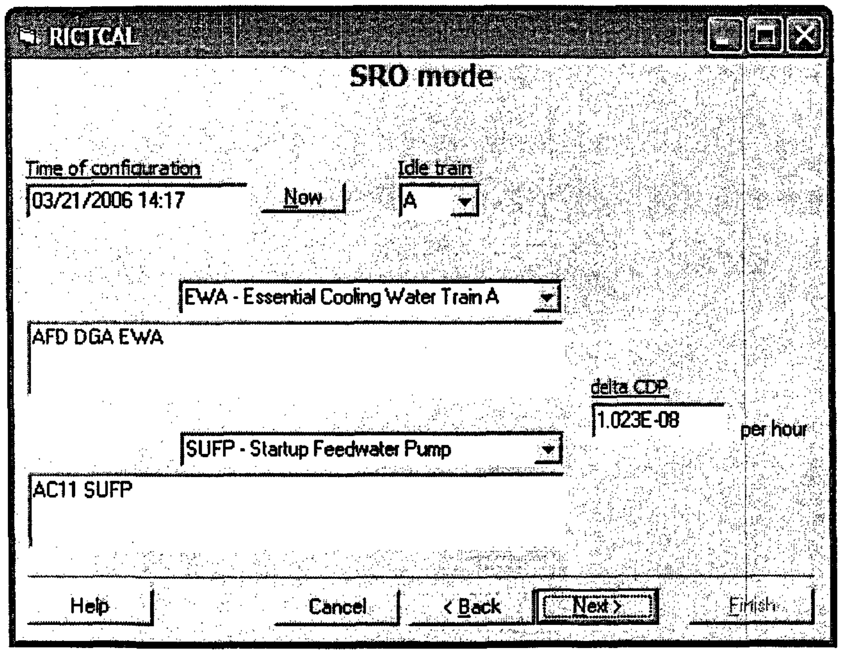
RMTS Implementation – Scope of Applicable TS

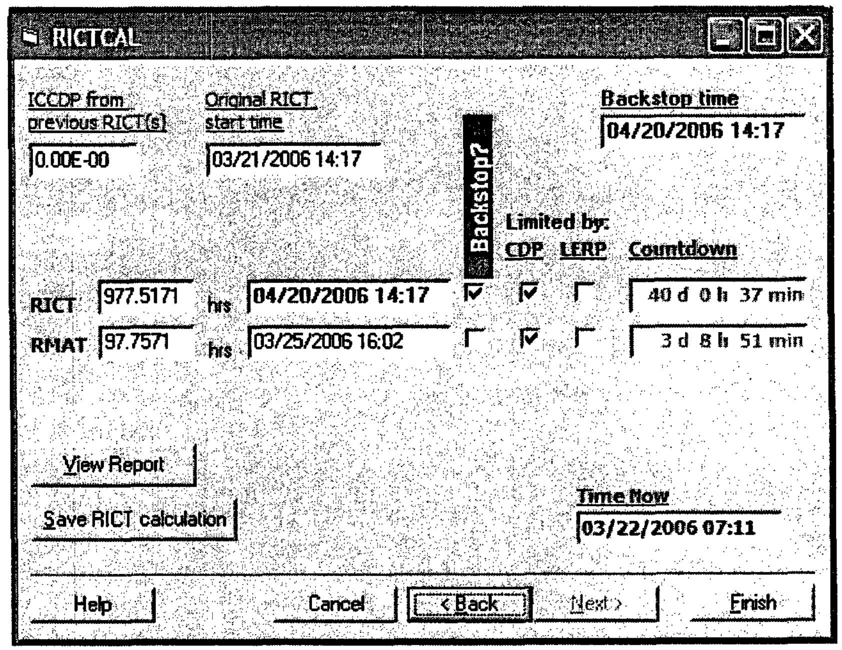
- Selected instrumentation
- Pressurizer PORVs
- Accumulators
- ECCS
- RHR
- RWST
- RCB Purge
- Containment Isolation Valves
- Containment Spray
- Containment Fan Coolers
- AFW
- MSIVs
- Atmospheric Steam Relief
- Control Room Makeup and Cleanup Filtration
- Component Cooling Water
- Essential Cooling Water
- Essential Chilled Water
- SDGs and Off-site circuits
- Batteries
- ESF Buses

RMTS Implementation – Enhancements for RMTS

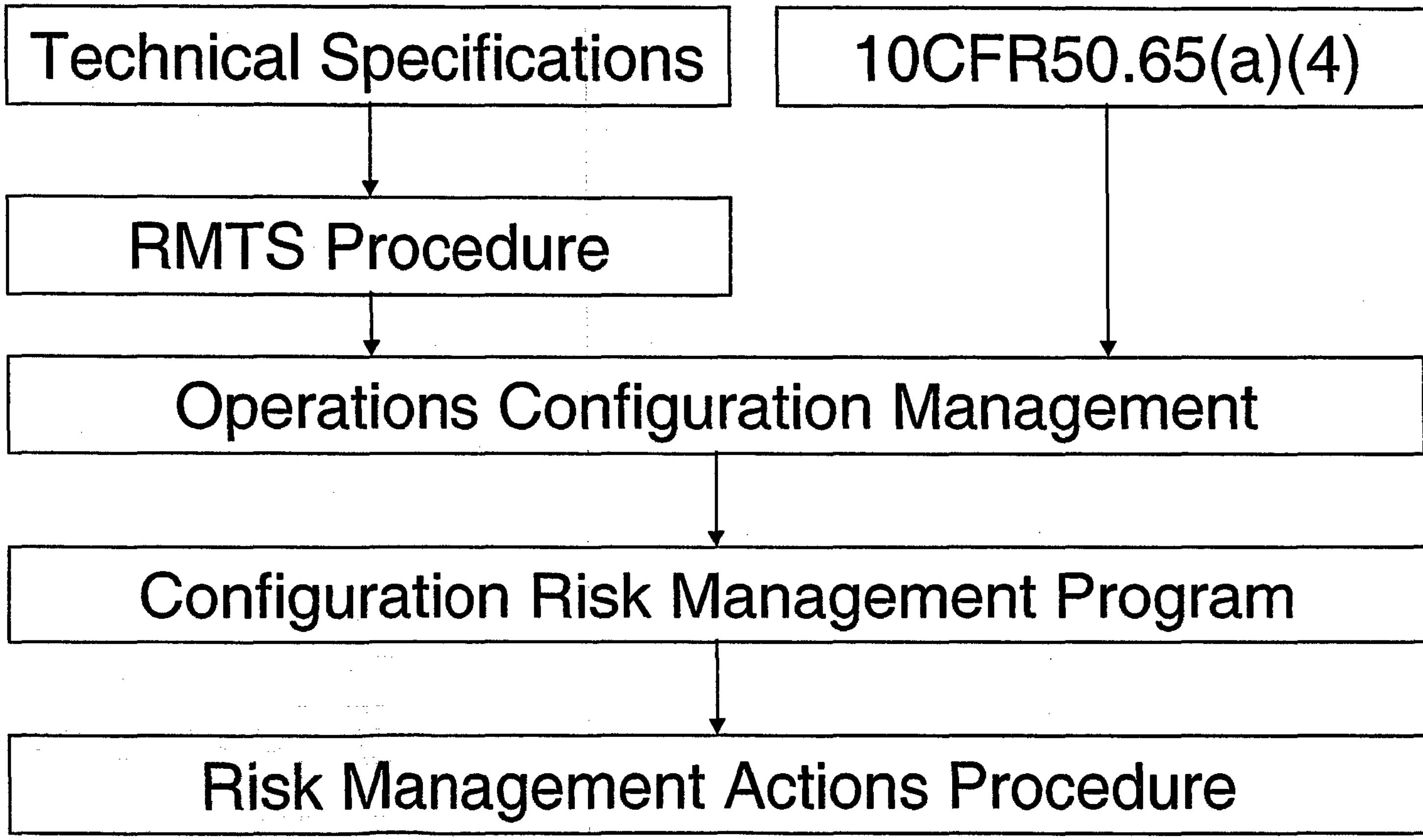
- RAsCal Enhancements (RICTCAL)
  - Capable of determining RICT in a very short time
  - User-friendly “Wizard” format
  - Display RICT and RMAT
  - Flag RMAs
  - CDF and LERF

RICTCAL Sample Screen Shots





RMTS Implementation – Integration into Station Processes



RMTS Implementation - Training

- Training to be conducted on application of new TS for stakeholders
  - Operations
  - Work Control
  - Engineering
  - Management

San Onofre Nuclear Generating Station (SONGS)

ACRS PRA Subcommittee
April 28, 2006

Gary Chung

SOUTHERN CALIFORNIA EDISON

Topics

- SONGS Plans for Initiative 4B
- SONGS PRA
- PRA History with Risk-Informed TS AOTs
- PRA-CRMP Tools
- Current & Future Usage of Safety Monitor

SONGS Plans for Initiative 4B

- SONGS Executive Management recently approved SONGS participation as a pilot
- SONGS currently assessing logistics and schedule before sending formal intent letter
  - Program Development
  - License Change Submittal Scope
  - Training and Implementation

SONGS PRA

- Full Scope PRA (internal & external events)
- R.G. 1.200 Pilot Plant
  - Application: DC Power AOT Extension
  - Peer reviewed against ASME Standard
    - Facts & Observations have been resolved
  - Seismic reviewed against ANS Seismic Standard

SONGS PRA HISTORY

- Technical Specification AOT Extensions (Initiative 4A) for:
  - Low Pressure Safety Injection
  - Safety Injection Tanks
  - Containment Spray System
  - Containment Isolation Valves
- Risk-informed In-service Testing

PRA-CRMP Tools

- PRA Codes: WINNUPRA, Safety Monitor
  - WINNUPRA – used to develop and maintain PRA models. Typically used for development and application. *Solves for <u>average</u> maintenance and <u>average</u> system alignments.*
  - Safety Monitor – utilizes Boolean logic developed by WINNUPRA. Solves actual plant configurations. *Solves for <u>actual</u> maintenance and <u>actual</u> system alignments.*

Current Safety Monitor Usage

- Planned maintenance evaluation under MR a(4)
  - Real time risk evaluation once per shift in the control room by STA
  - Work planners review risk 8, 4, and 1 week ahead of maintenance

Future Safety Monitor Usage For Flexible AOTs

- Same as current MR usage with enhancements for:
  - Cumulative risk calculations
  - Risk Management Action Time (RMAT) calculation
  - Risk Informed Completion Time (RICT) calculation
  - Archival Documentation provisions

SOUTHERN CALIFORNIA EDISON

Summary

- SONGS will be the 3rd pilot for flexible AOTs
- Schedule and program logistics are being evaluated
- Letter of Intent is forthcoming

SOUTHERN CALIFORNIA EDISON

Fort Calhoun Station Approach to Initiative 4B: Single System Pilot

Alan Hackerott
Omaha Public Power District
Chairman PWROG RMSC Subcommittee

Overview

- Why a Single System Pilot?
- RI Maintenance at Fort Calhoun Station

Why a Single System Pilot?

- **Background**
  - Flexible AOT concept emerged following successful single system application in late 1990's
  - Pilots demonstrated that TS can be risk informed
  - Process is straight-forward but individual permanent extensions were manpower intensive and potentially burdensome for both industry and NRC.

Why a Single System Pilot?
(cont'd)

- **Single system Pilot provided a means of tackling these issues in a measured, methodical manner.**
  - NRC can get focused buy-in from branches with a modest amount of resources
  - Utility can institute processes and gain experience prior to a more global implementation

- **Phased and graded aspects of relief provides timely benefit for the entire industry.**

Why HPSI?

- **Useful to understand regulatory issues and address PRA limitations**
  - HPSI risk important system and includes several modeled subcomponents and states
    - Injection/recirculation
    - Mini-recirculation
    - Injection valves, etc.
  - HPSI system dynamics, interaction and role in safety well understood
  - HPSI System well defined overlap with Fire and external events
- **Acceptance of HPSI provides strong evidence of more global applications**

RI Maintenance at FCS

- FCS process integrates PRA with normal day-to-day maintenance
- PRA used to support maintenance week schedule
- Existing process uses Level 1/ LERF PRA model to support MR (a) (4)
  - Key seismic failures considered in model
  - Fire insights considered
  - Model uncertainty and scope issues addressed via threshold limits

Risk Assessment Process at FCS

- Overarching philosophy:

  Identify opportunities for efficient, worthwhile risk management actions

  Control, planning and implementation of Maintenance activities is more important than outage time

- Existing Processes based on blended approach. Includes:
  - Quantitative guidelines and thresholds for RMAs
  - Qualitative guidelines
  - Considers planned and emergent conditions

- Risk assessments performed by Operating staff using EOOS and backed up by PRA personnel

Initiative 4B Projected Evolution

- For Single System Application, change to backstop AOT requires a relatively small change to existing procedures and processes

- Maintenance Rule processes to be adjusted based on RMTS Guidelines

- Operator Training

Comments on Regulatory Process

Process has been effective and goal directed

- Industry-NRC communications open
- Process started in 1998
- NRC sponsored industry-wide meeting at Kentlands
  - Addressed PRA capability, scope and process issues
- EPRI/PWROG RMTS guidance melds needs of both industry and regulator
- Graded implementation allows all utilities to benefit

Closure

- Initiative 4B increases plant safety and reduces potential for unnecessary plant shutdowns and inappropriate violations

- Phased and graded aspects of relief provides timely benefit for the entire industry.

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Analysis of truncation limit in probabilistic safety assessment

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Abstract

A truncation limit defines the boundaries of what is considered in the probabilistic safety assessment and what is neglected. The truncation limit that is the focus here is the truncation limit on the size of the minimal cut set contribution at which to cut off. A new method was developed, which defines truncation limit in probabilistic safety assessment. The method specifies truncation limits with more stringency than presenting existing documents dealing with truncation criteria in probabilistic safety assessment do. The results of this paper indicate that the truncation limits for more complex probabilistic safety assessments, which consist of larger number of basic events, should be more severe than presently recommended in existing documents if more accuracy is desired. The truncation limits defined by the new method reduce the relative errors of importance measures and produce more accurate results for probabilistic safety assessment applications. The reduced relative errors of importance measures can prevent situations, where the acceptability of change of equipment under investigation according to RG 1.174 would be shifted from region, where changes can be accepted, to region, where changes cannot be accepted, if the results would be calculated with smaller truncation limit.

Keywords: Probabilistic safety assessment; Truncation; Risk-informed decision-making; Uncertainty

1. Introduction

Development of powerful computers is changing many methods and analyses in sense that many contributions, phenomena and processes are nowadays considered and evaluated in details, which were not accounted for in the past.

Truncation is a term, which defines cutting off the negligible contribution of the results of the probabilistic safety assessment (PSA), i.e. fault tree/event tree analysis, when evaluating complex facilities [1–7]. Term Probabilistic Risk Analysis (PRA) is sometimes used similarly as term PSA. Sometimes, truncation is also referred to as a term: cut-off.

When analysis of complex facilities faces situation, when billions of minimal cut sets can contribute to the resulting fault tree or event tree evaluation, the contribution of the less significant combinations is usually neglected. Truncation Limit (TL) defines the boundaries of what is considered in the analysis and what is neglected.

TL is not applicable to the Binary Decision Diagram (BDD) approach, which does not need truncation and which produces exact results [2].

1.1. Review of requirements on truncation

Review of requirements on truncation includes the requirements from NUREG/CR-2728 [3], which suggested absolute truncation value of 1×10^{-9}/ry for sequence cut sets, but allowed for relaxation of this, provided that sequences of order 1×10^{-6}/ry are not neglected.

The requirements on truncation, which are defined in the following documents, are emphasized. The documents are selected from the list of the main documents about PSA.

1.1.1. PRA procedures guide (1982)

PRA Procedures Guide (1982) issued by the Nuclear Regulatory Commission (NRC) says that usually it should be adequate to retain the minimal cut sets that contribute 90–99% of the point estimate total, although tighter control could be necessitated if there were reasons for smaller probability cut sets to have substantially larger uncertainty

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factor than those that dominate the point estimate total [5]. By PRA Procedures Guide, the experience indicates that cut sets whose probability is less than 1/1000 of the probability for the largest cut set within a damage bin can usually be safely truncated [5]. But there can be problems, as the examples will show.

1.1.2. PSA application guide (1995)

PSA Application Guide (1995) issued by Electric Power Research Institute says that the recommended TL is 1×10^{-4} below the baseline core damage frequency (CDF) [6]. But there can be problems, as the examples will show.

1.1.3. Standard for PRA for nuclear power plant applications (2002)

Standard for PRA for Nuclear Power Plant Applications (2002) issued by the American Society of Mechanical Engineers requires, that the final TLs are established by an iterative process of demonstrating that the overall model results are not significantly changed and that no important accident sequences are inadvertently eliminated [7]. These descriptive requirements are mostly focused to the overall model results and one may argue that accuracy of specific importance risk measures for specific equipment under consideration is not addressed directly enough. Our method more formally defines the TL and it considers directly also the effects of importance risk measures, as the examples will show.

1.1.4. An approach for using probabilistic risk assessment in risk-informed decisions on plant-specific changes to the licensing basis (2002)

Regulatory Guide RG 1.174 (2002) issued by the NRC requires that the TL has been set low enough so that the truncated set of minimal cut sets contains all the significant contributors and their logical combinations for the application in question and is low enough to capture at least 95% of the CDF. Depending on the PRA level of detail this may translate into a TL from 1×10^{-12}/ry to 1×10^{-8}/ry. In addition, the truncated set of minimal cut sets should be determined to contain the important application-specific contributors and their logical combinations [8]. Lower TL causes that more minimal cut sets are considered for assessment of CDF.

1.2. Purpose of the study

Calculations with PSA models have shown that changing TLs can result in changes in PSA results, i.e. risk measures such as e.g. Risk Increase Factor (RIF) and Fussell–Vesely Importance (FV) that are not necessarily non-negligible [10,11].

Our method more strictly specifies the TLs so that relative errors in the results are more strictly controlled. The basis for the method is presented. It is analyzed and compared with other TLs in terms of the accuracy of results produced for applications in decision-making without the use of developed method.

2. Method

Our method, which more strictly specifies the TLs, considers four general factors:

- PSA methodology,
- quantitative results obtained from a PSA,
- current truncation criteria used in a PSA,
- accuracy of arithmetic operations.

The first three factors are related to a PSA, the fourth factor is more related with mathematics and deals with the effects of absolute and relative errors of arithmetic operations.

2.1. Definition of truncation criteria

Truncation criteria are a set of requirements about TLs that specify which minimal cut sets are important enough to be considered in the results of PSA. If a TL of certain frequency is determined, than the minimal cut sets with frequencies lower than the limit are neglected in the results.

2.2. Background of the method

The four factors are discussed in more details in many documents [1–22]. Only the main references and the key facts about those four factors are emphasized in the following four subsections.

2.2.1. Probabilistic safety assessment methodology

PSA is a standardized way for assessment and improvement of safety of complex facilities with wide application of its results [12,13,15–18,20]. The developed models of PSA can reflect the fact that millions or even billions of minimal cut sets contribute to its results. To handle the calculations, the contribution of the less significant minimal cut sets is neglected [5–7].

2.2.2. Quantitative results from a PSA

Quantitative results of PSA include CDF, large early release frequency (LERF) and changes of those two measures considering equipment j: dCDF_j and dLERF_j, where change of those measures can be defined as:

$$\mathrm{dCDF}_j = \mathrm{CDF}_{1j} - \mathrm{CDF} \tag{1}$$

where: CDF_{1j}=CDF(unavailability of equipment j is set to 1) and

$$\mathrm{dLERF}_j = \mathrm{LERF}_{1j} - \mathrm{LERF} \tag{2}$$

where: LERF_{1j}=LERF(unavailability of equipment j is set to 1), although in certain documents $dCDF_j$ and $dLERF_j$ are defined as [14]:

$$dCDF_j = CDF_{1j} - CDF_{0j} \tag{3}$$

where: CDF_{0j}=CDF(unavailability of equipment j is set to 0) and

$$dLERF_j = LERF_{1j} - LERF_{0j} \tag{4}$$

where: $LERF_{0j}$=LERF(unavailability of equipment j is set to 0).

In addition, the quantitative results obtainable from a PSA include the RIF, which is similar to Risk Achievement Worth (RAW), Risk Decrease Factor (RDF), which is similar to Risk Reduction worth (RRW) and FV [21]:

$$RIF_j = CDF_{1j}/CDF \tag{5}$$

$$RDF_j = CDF/CDF_{0j} \tag{6}$$

$$FV_j = 1 - CDF_{0j}/CDF = 1 - 1/RDF_j \tag{7}$$

where:

RIF_j risk increase factor for equipment j
RDF_j risk decrease factor for equipment j
FV_j Fussell–Vesely importance for equipment j

More detailed descriptions and applications are given in supporting documents [8,9,14,19].

2.2.3. Current truncation criteria in a PSA

Many current PSA were performed some years ago and truncation criteria were defined which reflected the capabilities of the software and hardware of the time. Modern computing capability enables more strict criteria to be used, which would allow one to reconsider the portion, which was truncated in the past. Review of requirements on truncation criteria from selected PSA references is discussed in Section 1.1.

2.2.4. Accuracy of arithmetic operations

Measured or calculated value of specific parameter can be represented by its approximate value and absolute or relative error:

$$x = x_m \pm \Delta x \tag{8}$$

where absolute error is written as:

$$\varepsilon(x) = |\Delta x| = |x - x_m| \tag{9}$$

and relative error is written as:

$$\varepsilon_{rel}(x) = |\Delta x|/|x| = |x - x_m|/|x| \tag{10}$$

where:

x value of specific parameter under investigation,
x_m measured (or calculated) value of specific parameter under investigation.

Absolute error of function: $y=f(x_1,x_2,\ldots x_n)$ can be assessed considering the following expressions [22]:

$$\varepsilon(y) = |\Delta y| = |f(x_1,x_2,\ldots x_n) - f(x_{1m},x_{2m},\ldots x_{nm})| \tag{11}$$

$$|\Delta y| \le \sum_{i=1}^{n} \underbrace{\left(\max x\left|\frac{\partial f(x_1,\ldots x_n)}{\partial xi}\right|\right)}|\Delta xi| \tag{12}$$

Arithmetic operations with values of specific parameters show that multiplication and division cause only small relative errors of resulted value, e.g. relative error of multiplication ($y=x_1*x_2$) can be assessed as:

$$\begin{aligned}\varepsilon_{rel}(y) = \frac{|\Delta y|}{|y|} &\le \frac{|x_2|\cdot|\Delta x_1| + |x_1|\cdot|\Delta x_2|}{|x_1\cdot x_2|}\\ &= \frac{|x_2|\cdot\varepsilon_{rel}(x_1)\cdot|x_1| + |x_1|\cdot\varepsilon_{rel}(x_2)\cdot|x_2|}{|x_1\cdot x_2|}\\ &= \varepsilon_{rel}(x_1) + \varepsilon_{rel}(x_2)\end{aligned} \tag{13}$$

but addition and subtraction can cause large relative error of resulted value, e.g. relative error of subtraction ($y=x_1$-x_2) can be assessed as:

$$\varepsilon_{rel}(y) = \frac{|\Delta y|}{|y|} \le \frac{|\Delta x_1| + |\Delta x_2|}{|x_1 - x_2|} = \frac{\varepsilon_{rel}(x_1)\cdot|x_1| + \varepsilon_{rel}(x_2)\cdot|x_2|}{|x_1 - x_2|} \tag{14}$$

Large relative error of addition or subtraction occurs if the following states [22]:

$$|x_1 \pm x_2| \ll |x_1| + |x_2| \tag{15}$$

The quantitative results from a PSA are subject to the above types of errors, because subtraction is used for obtaining selected risk measures (e.g. Eqs. (1)–(4)). Therefore, considering values of dCDF and dLERF (specially if they are extremely low), one should not forget to consider their errors: the relative error can become extremely large if dCDF or dLERF is very small, and absolute error can be orders of magnitude higher from the value of its parameter.

2.3. Truncation criteria

Specially, it is of concern, if many minimal cut sets, which include basic events connected with equipment j and which may be below the TL, are clustered around some value. Their contribution is neglected when calculating CDF. But, when calculating CDF_{1j} their contribution may become high enough to exceed the TL and they are considered in the value of CDF_{1j}. In this case, dCDF ($dCDF=CDF_{1j}-CDF$) can be overestimated.

On the other hand, there are cases, where dCDF can be underestimated (e.g. if all or the most of the minimal cut sets containing basic events connected with equipment j are truncated when calculating CDF and when calculating CDF_{1j}).

In order that dCDF is not too much overestimated or underestimated, the truncation criteria are developed. The truncation criteria consist of two requirements, which direct selection of the TL in sense that the results of risk measures obtained from PSA can be unambiguously used for decisions. The first requirement considers CDF. The second requirement considers dCDF (or risk measure: FV or RIF instead).

Initially, the PSA results are obtained for several values of TLs and the results are compared. TL is then selected in a way that further decrease of TL does not cause significant difference in the results of PSA: CDF and dCDF. This means that the minimal cut sets, which frequency is below the TL, are neglected. Their portion should be so small that it does not represent significant contribution either to CDF either to other risk measures.

TL	truncation limit on the smallest minimal cut set contribution to include,
TL_{req1}	truncation limit defined due to Criteria 1 in our paper (to be given),
TL_{req2}	truncation limit defined due to Criteria 2 in our paper (to be given),
TL_{i1}, TL_{i2}, TL_{i3}, TL_{i4}	temporary selected truncation limits in carrying out iterations,
$CDF(TL_{i1})$	core damage frequency calculated using truncation limit TL_{i1},
$dCDF_j(TL_{i3})$	change of core damage frequency considering equipment j calculated using truncation limit TL_{i3},
j	equipment under investigation (e.g. component/system modeled in one or more basic events),
ε_{rel_CDF}	acceptable relative error considering CDF,
ε_{rel_dCDF}	acceptable relative error considering $dCDF_j$ (the same acceptable relative error is defined for all $dCDF_j$),
ε_{rel_RIF}	acceptable relative error considering RIF_j (the same acceptable relative error is defined for all RIF_j),
ε_{rel_FV}	acceptable relative error considering FV_j (the same acceptable relative error is defined for all FV_j).

The notation of the method for setting up the TL of PSA consists of two requirements, which are the following:

Requirement 1: $TL_{req1} = \max(\mathrm{round}(TL_{i1}))$, where:

$$|(CDF(TL_{i1}) - CDF(TL_{i2}))/CDF(TL_{i2})| < \varepsilon_{rel\_CDF} \wedge TL_{i1}/TL_{i2} = \alpha \quad (16)$$

Requirement 2: $TL_{req2} = \max(\mathrm{round}\ (TL_{i3}))$, where:

$$\forall j : |(dCDF_j(TL_{i3}) - dCDF_j(TL_{i4}))/dCDF_j(TL_{i4})| < \varepsilon_{rel\_dCDF} \wedge TL_{i3}/TL_{i4} = \alpha \quad (17)$$

Factor α can be defined according to the list of minimal cut sets. Initially, it can be set to 10 and if necessary adjusted. One has to consider that it is possible that there are many minimal cut sets of very small size clustered around some value.

The most stringent truncation criteria limit, which suits both requirements, is selected as:

$$TL = \min(TL_{req1}, TL_{req2}) \quad (18)$$

The requirement 2 can be substituted with similar requirement on RIF_j for equipment j:

$TL_{req2} = \max(\mathrm{round}(TL_{i3}))$, where:

$$\forall j : |(RIF_j(TL_{i3}) - RIF_j(TL_{i4}))/RIF_j(TL_{i4})| < \varepsilon_{rel\_RIF} \wedge TL_{i3}/TL_{i4} = \alpha \quad (19)$$

or, the requirement 2 can be substituted with similar requirement on FV_j importance for the equipment j:$TL_{req2} = \max(\mathrm{round}(TL_{i3}))$, where:

$$\forall j : |(FV_j(TL_{i3}) - FV_j(TL_{i4}))/FV_j(TL_{i4})| < \varepsilon_{rel\_FV} \wedge TL_{i3}/TL_{i4} = \alpha \quad (20)$$

Example values for the acceptable relative errors for both requirements can be selected as: $\varepsilon_{rel\_CDF} = 1\%$ and $\varepsilon_{rel\_dCDF} = 2\%$ (or $\varepsilon_{rel\_RIF} = 2\%$, or $\varepsilon_{rel\_FV} = 2\%$).

2.4. Evaluation of the method

The method defines two requirements for TL. The first requirement defines accuracy of CDF. The second requirement defines accuracy of $dCDF_j$, which can be substituted by the requirement on accuracy of RIF_j or FV_j.

Similarly, with analogy, the requirements for TL considering: LERF, $dLERF_j$, RIF_j and FV_j, can be determined. TL calculated considering: LERF, $dLERF_j$, RIF_j and FV_j, can be compared to TL considering: CDF, $dCDF_j$, RIF_j and FV_j, and the smaller of both can be selected as the overall TL. Such TL allows application of results of PSA for risk-informed decision-making.

Selected main documents about PSA (PRA Procedures Guide [5], PSA Applications Guide [6]) define only one requirement about TL, i.e. requirement about CDF. The second requirement on $dCDF_j$ (or on RIF_j or on FV_j) is not defined and it is needed according to mathematics of relative errors [22]. Standard for PRA for Nuclear Power Plant Applications [7] and RG 1.174 [8] describe the requirement on truncation descriptively, so it is a matter of interpretation if the second requirement on $dCDF_j$ is covered either by this standard and/or by this regulatory guide.

Development of the second requirement prevents the situation, where RIF_j or FV_j of safety equipment j can vary for more than 80% dependent on definition of TL [10]. If for some applications this may be of sufficient accuracy, for the other applications the presented truncation criteria may be used, specially, if highly accurate results are desired or if they can be obtained cheaply.

Development of the second requirement prevents the situation, where some proposed changes according to RG 1.174 [8] could be acceptable, if certain TL is used, and the same changes cannot be acceptable, if some other TL is used. The following section contains more detailed analysis of TLs.

3. Analysis and results

Two full-scale PSA models for two nuclear power plants (NPP) were used to examine the method and to make specific examples: model NPP_A of nuclear power plant NPP_A and model NPP_S of nuclear power plant NPP_S. Both models are developed in such extent that their results could be used for decision-making.

The commercial and well-known PSA computer code was used, which is capable of fault tree event tree linking approach (i.e. large fault tree small event tree approach). It allows several options on inclusion of success logic for sequences involving success of functional events in the event tree headings [23].

3.1. Models

The main characteristics of the NPP_A are the following: two units (one unit is under investigation, it has two diesel generators), three loops, pressurized water reactor, sub-atmospheric containment and 20 years of successful plant operation.

The main characteristics of PSA model (NPP_A) for internal events as the standpoint for calculation are the following: 21 initiating events, 21 event trees, 112 functional events (event tree headings), 602 sequences, 1484 fault trees, 3510 basic events, 3546 gates, 74 house events.

The main characteristics of the NPP_ S are the following: two units (with three diesel generators: one for each of both units and third, which can be aligned to any of the units, one unit is under investigation), three loops, pressurized water reactor, sub-atmospheric containment and 30 years of successful plant operation.

The main characteristics of PSA model (NPP_S) for internal events as the standpoint for calculation are the following: 12 initiating events, 12 event trees, 41 functional events (event tree headings), 483 sequences, 105 fault trees, 461 basic events, 384 gates, two house events.

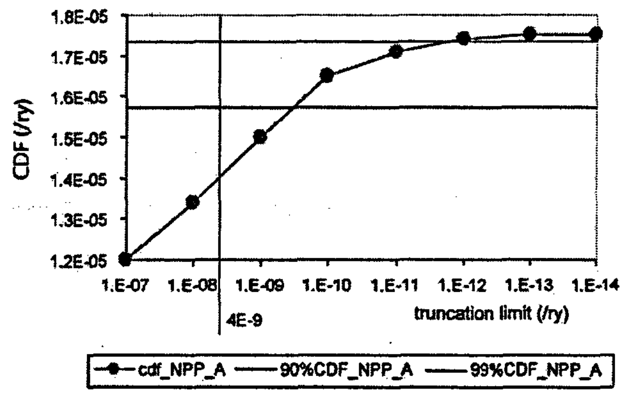

Fig. 1. CDF versus truncation limit for PSA model NPP_A.

PSA model NPP_A (with 3510 basic events) is much more detailed PSA model than PSA model NPP_S (with 461 basic events).

3.2. Results

Fig. 1 shows CDF versus TL for PSA model NPP_A. According to PRA Procedures Guide [5]:

- the defined TL is the one with CDF between 90 and 99% of its point estimate total (region between horizontal lines, $TL=3\times10^{-10}$/ry),
- the defined TL is the one which neglects minimal cut sets of less than 1/1000 of the frequency of the largest minimal cut set (region right from vertical line, $TL=4\times10^{-9}$/ry).

Fig. 2 shows CDF versus TL for PSA model NPP_S. According to PRA Procedures Guide [5]:

- the defined TL is the one with CDF between 90% and 99% of its point estimate total (region between horizontal lines, $TL=3\times10^{-8}$/ry),
- the defined TL is the one which neglects minimal cut sets of less than 1/1000 of the frequency of the largest minimal cut set (region right from vertical line, $TL=8.7\times10^{-9}$/ry).

Table 1 shows the results of the comparison considering the TLs. The first part of the table shows TLs for selected

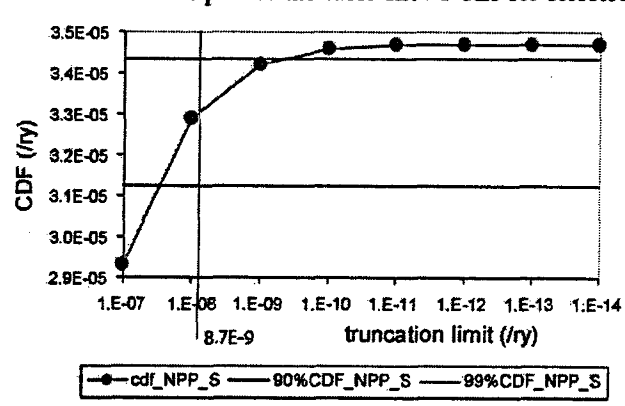

Fig. 2. CDF versus truncation limit for PSA model NPP_S.

Table 1
Truncation Limits (TL) of PSA models: NPP_A and NPP_S

		PRA procedures guide[a]	PSA applications guide
TL for NPP_A	As defined Rounded[b]	3×10^{-10}/ry or 4×10^{-9}/ry 1×10^{-10}/ry or 1×10^{-9}/ry	$1{,}75\times10^{-9}$/ry 1×10^{-9}/ry
TL for NPP_S	As defined Rounded[b]	3×10^{-8}/ry or 8.7×10^{-9}/ry 1×10^{-8}/ry or 1×10^{-9}/ry	$3{,}47\times10^{-9}$/ry 1×10^{-9}/ry
New method[c]			
$\varepsilon_{rel\_CDF}=1\%$ $\varepsilon_{rel\_RIF}=1\%$ $\varepsilon_{rel\_FV}=1\%$	$\varepsilon_{rel\_CDF}=2/\%$ $\varepsilon_{rel\_RIF}=2\%$ $\varepsilon_{rel\_FV}=2\%$	$\varepsilon_{rel\_CDF}=5/\%$ $\varepsilon_{rel\_RIF}=5\%$ $\varepsilon_{rel\_FV}=5\%$	$\varepsilon_{rel\_CDF}=10/\%$ $\varepsilon_{rel\_RIF}=10\%$ $\varepsilon_{rel\_FV}=10\%$
TL for NPP_A			
(1×10^{-12}/ry) 1×10^{-13}/ry (1×10^{-13}/ry)	(1×10^{-11}/ry) 1×10^{-13}/ry (1×10^{-13}/ry)	(1×10^{-10}/ry) 1×10^{-13}/ry (1×10^{-12}/ry)	(1×10^{-9}/ry) 1×10^{-13}/ry (1×10^{-11}/ry)
TL for NPP_S			
1×10^{-10}/ry (1×10^{-10}/ry) (1×10^{-10}/ry)	(1×10^{-9}/ry) 1×10^{-10}/ry (1×10^{-9}/ry)	(1×10^{-8}/ry) (1×10^{-8}/ry) 1×10^{-9}/ry	1×10^{-8}/ry (1×10^{-8}/ry) (1×10^{-8}/ry)

[a] PRA Procedures Guide defines truncation limit in two different ways.
[b] Rounded truncation limit is rounded in a conservative way (portion, which is the same as defined or less than defined, is neglected).
[c] The truncation limits as determined by the new method are written in rows to suit respective requirements: ε_{rel_CDF}, ε_{rel_RIF}, ε_{rel_FV}. Overall truncation limit (determined as minimum of selected two requirements: requirement 1 on CDF and requirement 2 on dCDF or RIF or FV) is written without the brackets. Four combinations of requirements are presented.

two PSA models (NPP_A and NPP_S) as defined by the existing Refs. [5,6]. Column about PRA Procedures Guide in the first part of the table gives two values, because this guide defines TL in two different ways. TLs in the first part of the table are shown as defined by existing Refs. [5,6] and as their rounded values. Rounded TLs are rounded in a conservative way (portion, which is the same as defined or less than defined, is neglected). The reason for rounded values is in easier comparison with the TLs defined by the new method, which are presented in the second part of the table.

The second part of the Table 1 shows TLs as defined by the presented criteria in this paper. Four variations of criteria are presented in four columns, which represent the standpoint for defining the values of acceptable relative errors within the requirements of the method, e.g. $\varepsilon_{rel\_CDF}=1\%$ and $\varepsilon_{rel\_RIF}=2\%$ (or $\varepsilon_{rel\_FV}=2\%$, or $\varepsilon_{rel\_dCDF}=2\%$). Those values were selected based on comparison in the second part of Table 1 keeping in mind the statement, that the results should not be significantly changed by selection of higher values than the selected ones. It is known that, one can always calculate with extreme accuracy to any number of significant figures, but optimal solution is to select the highest relative error, which does not significantly affect the results.

The first requirement about CDF is presented in the first row of the corresponding cells. RIF_j are selected as the second requirement (among: $dCDF_j$, RIF_j and FV_j; according to the method, as defined in Section 2.3), which is presented in the second row of the corresponding cells. The second requirement on RIF_j could be replaced by the requirement on $dCDF_j$ or by the requirement on FV_j. The third row exists in corresponding cells to show informatively the TL in case if FV_j would be the parameters defining the second requirement. Each cell contains two values of TLs in brackets and one value of TL without brackets. TLs, which are written in brackets, correspond only to their corresponding requirement. TL, which is written in particular cell without brackets, represents the final result, which is the most appropriate TL defined by the new method.

Results show that TLs obtained in three different ways in the case of the smaller PSA model, i.e. PSA model NPP_S, which consists of 461 basic events, differ for one to two orders of magnitude between the TL defined by the new method and TL defined by both guides. Results show that TLs obtained in three different ways in the case of the larger PSA model, i.e. PSA model NPP_A, which consists of 3510 basic events, differ for three to four orders of magnitude between the new method and both guides.

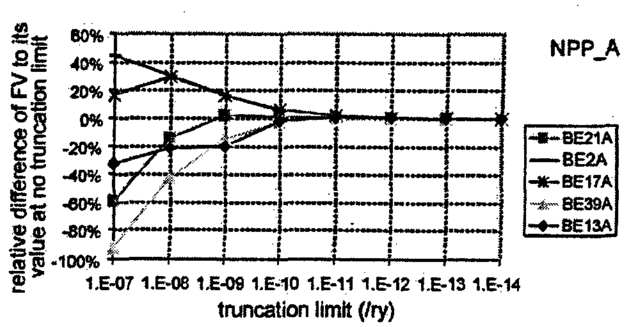

Fig. 3. Sensitivity of FV importance versus truncation limit for PSA model NPP_A.

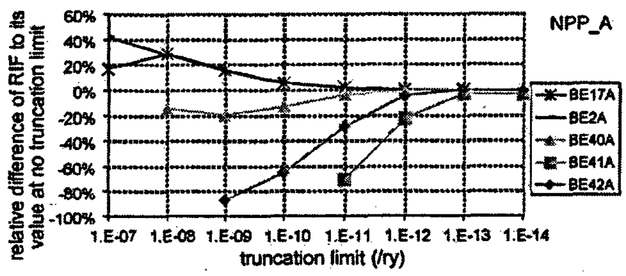

Fig. 4. Sensitivity of RIF versus truncation limit for PSA model NPP_A.

Fig. 3 shows sensitivity of FV_j importance versus TL for selected basic events for PSA model NPP_A in terms of relative difference of FV calculated for each TL versus its respective value calculated without truncation. Fig. 4 shows sensitivity of RIF_j versus TL for selected basic events for PSA model NPP_A in terms of relative difference of RIF calculated for each TL versus its respective value calculated without truncation. Only five basic events for presenting their FV_j importance and their RIF_j on both figures are selected among many basic events, which factors depend significantly on the TL, because the figures with many curves for many basic events would be less clear.

Certain curves, which suit certain basic events on Fig. 4, start at smaller TL than it is selected at the beginning of the scale (1×10^{-7}/ry). The reason for no values at certain larger TLs of those curves on this figure lays in fact that at those higher TLs no minimal cut sets exist, which would contain mentioned basic events.

If only the minimal cut sets that contribute 90–99% of the point estimate total are retained (this suits to TL of 3×10^{-10}/ry), as required in PRA Procedures Guide [5], the results for FV importance show approximately 15% difference compared to the results obtained with no TL. The results for RIF show more than 70% difference compared to the results obtained with no TL. If the TL is defined based on 1/1000 of the frequency of the largest minimal cut set (4×10^{-9}/ry), the situation seems to be even worse, i.e. relative differences are generally higher with larger TL.

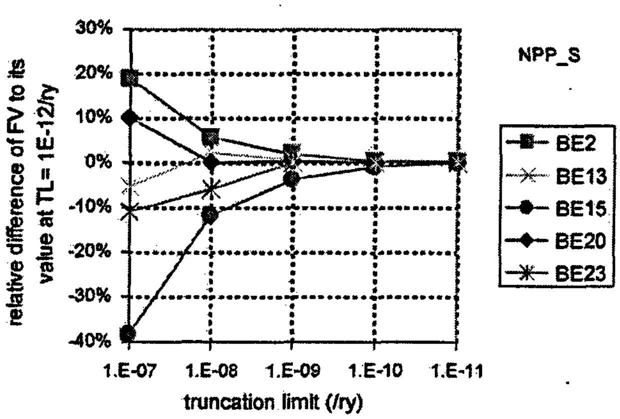

Fig. 5. Sensitivity of FV importance versus truncation limit for PSA model NPP_S.

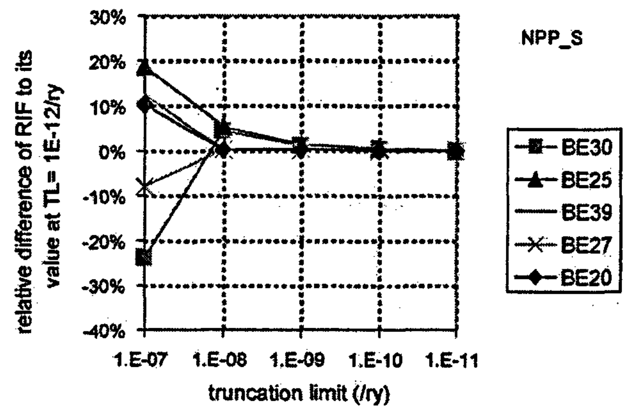

Fig. 6. Sensitivity of RIF versus truncation limit for PSA model NPP_S.

Similarly, Fig. 5 shows sensitivity of FV importance versus TL for selected basic events for PSA model NPP_S in terms of relative difference of FV calculated for each TL versus its respective value calculated with TL of 1×10^{-12}/ry. Fig. 6 shows sensitivity of RIF versus TL for selected basic events for PSA model NPP_S in terms of relative difference of RIF calculated for each TL versus its respective value calculated with TL of 1×10^{-12}/ry.

If only the minimal cut sets that contribute 90–99% of the point estimate total are retained (this suits to TL of 3×10^{-8}/ry), as required in PRA Procedures Guide [5], the results for FV importance show more than 20% difference compared to the results obtained with TL of 1×10^{-12}/ry. The situation is similar for the results for RIF, which shows more than 10% difference compared to the results obtained with TL of 1×10^{-12}/ry.

If the TL based on 1/1000 of the frequency of the largest minimal cut set ($8{,}7\times10^{-9}$/ry) is selected, the results for FV importance and for RIF show couple of % of difference (not more than 15%) compared to the results obtained with TL of 1×10^{-12}/ry. A 15%, 20% or even 80% difference is not necessarily significant for many applications considering the uncertainties in the PSA results from data and assumptions, but in particular applications greater accuracy may be required.

Larger differences in calculations of RIF can consequently result in fact that acceptability of change of component under investigation according to RG 1.174 [8] is shifted from region, where changes can be accepted, to region, where changes cannot be accepted, if more accurate results are considered, i.e. results calculated with smaller TL. Such examples can show the need to define boundaries for decision-making making that account for uncertainties, e.g. by having fuzzy boundaries.

Fig. 7 shows such an example for NPP_A, where change related with component modeled in basic event BE87A can be accepted considering the TL of 1×10^{-9}/ry (defined by Ref. [5]) and can not be accepted considering more accurate calculations, which consider smaller TL, e.g. TL of 1×10^{-13}/ry (defined by the new method).

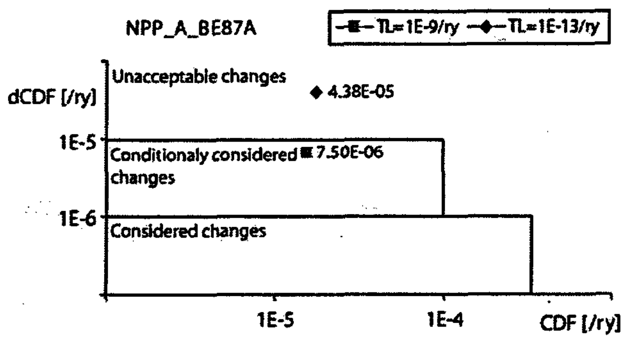

Fig. 7. Comparison of applicability of plant specific change according to RG 1.174 for component BE87A with truncation limit (TL $=1\times10^{-9}$/ry and TL $=1\times10^{-13}$/ry), both used for evaluation of the same PSA model NPP_A.

Similarly, Fig. 8 shows such example for NPP_S, where change related with component modeled in basic event BE37 can be accepted considering the TL of 1×10^{-8}/ry (defined by Ref. [5]) and can not be accepted considering more accurate calculations, which consider smaller TL, e.g. TL of 1×10^{-10}/ry (defined by the new method).

If instead of PSA model for internal events, which was used here, the whole PSA model including external events would be used, some other equipment (e.g. equipment with lower RIF than BE87A for NPP_A, e.g. equipment with lower RIF than BE37 for NPP_S) would show similar situation as it is on Fig. 7 and Fig. 8.

Review of results indicates that the equipment with lower RIF may be more sensitive to changes of TL than equipment with higher RIF.

The results indicate that the requirements about the TLs for more complex PSAs, which consist of larger number of basic events, should be more severe as they are recommended in the main documents about PSA. The TLs as defined by the new method overcome the difficulties with the high increase of relative errors of importance measures and enable the unambiguous use of the results of PSA for the risk-informed decision-making.

Results indicate that numerical accuracy in relative error can be improved significantly if the minimal cut sets are truncated at a lower TL. It is assumed that this is the desired approach and that more accuracy is always better. However, the relative error due to minimal cut set truncation may be much less than the uncertainties due to data and modeling uncertainties. It is recognized that applications, which base more on results of CDF as the primary risk measure, may not need such quite low TL. But for applications, which base more on the results of risk importance measures as primary risk measures, it is recommended to consider the proposed method and its findings.

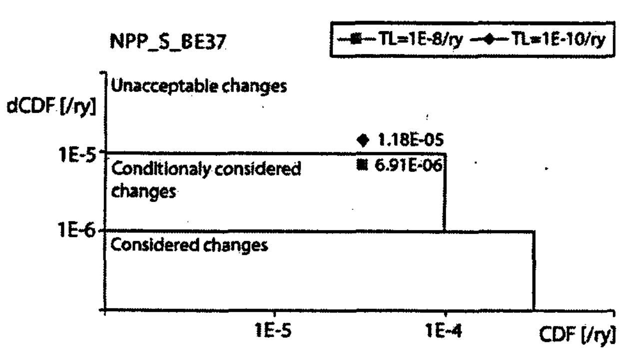

Fig. 8. Comparison of applicability of plant specific change according to RG 1.174 for component BE37 with truncation limit (TL $=1\times10^{-8}$/ry and TL $=1\times10^{-10}$/ry), both used for evaluation of the same PSA model NPP_S.

4. Discussion

Experience with PSA models and analyses showed that in particular applications current requirements on truncation should be more severe in order to prevent inaccuracies in PSA results, which may consequently result in not optimal or even erroneous decisions being made.

A method was presented in this paper for selecting truncation criteria for PSAs. The method defines truncation criteria more strictly than the present criteria in published documents on PSA. The method presented controls the sensitivity of CDF as one of the most common risk measures versus the selected TL and controls the sensitivity of change in CDF versus the selected TL.

The method was tested on two PSA models: one small PSA model and one medium size PSA model. The results of evaluations for both selected PSA models clearly show the effects of using more stringent truncation criteria on increasing the accuracy of the results of PSA for risk-informed decision-making.

The presented method for defining the TL can serve as a support for RG 1.174 and for PRA standard, which both define TL only descriptively. In other words, the method adopts the PRA standard and at the same time it upgrades its descriptive requirements about TL. This is done in a way that the requirements about truncation are defined more strictly and in a way that emphasis is placed also to risk measures, while descriptive requirements in PRA standard emphasize mostly that the overall PSA model results should not be significantly changed and that no important accident sequences should not be inadvertently eliminated due to definition of TL.

Results indicate, that importance of defining the proper TL increases with the size of PSA model. For larger PSA models, the larger relative differences are observed between PSA results with TL defined by the selected main documents about PSA and between PSA results with TL defined by the new method.

Results indicate that the components with smaller RIF in PSA with larger CDF can cause change of region on the figure about the acceptability of proposed changes. The components with larger RIF in PSA with smaller CDF can cause similar change.

As qualitative and quantitative results of PSA are obtained from PSA models, which base on a number of assumptions and limitations, it is a question, if it is reasonable to demand more and more detailed models and perform more accurate results based on those models. But, if PSA results are used for risk-informed decision-making, it is important to evaluate the influence of evaluation options in the PSA and to determine how those options influence the accuracy of PSA results and resulting decisions. In any case, the evaluation options should be selected in a way, that they do not affect the results and their applications for decision-making.

Future work may show the dependence of risk measures versus TL for all options of fault tree and event tree evaluations, which are possible, e.g. regarding:

- event tree success branches considered as true or considered as they are,
- the order of approximation of generating quantitative and qualitative results.

Such and similar information about dependence of risk measures versus TL represents a useful contribution for the future improvement of guidelines for risk-informed decision-making.

Acknowledgements

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