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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

SUB-COMMITTEE ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT

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THURSDAY,

MARCH 22, 2007

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The meeting was convened in Room T-2B3 of Two White Flint North, 11545 Rockville Pike, Rockville, Maryland, at 8:30 a.m., Dr. George Apostolakis, Chairman, presiding.

MEMBERS PRESENT:

GEORGE E. APOSTOLAKIS	Chairman
OTTO L. MAYNARD	ACRS Member
THOMAS S. KRESS	ACRS Member
MARIO V. BONACA	ACRS Member
WILLIAM J. SHACK	ACRS Member

NRC STAFF PRESENT:

ERASMIA LOIS
JOHN MONNINGER
GARETH PARRY
SUSAN COOPER
KEN CANAVAN

ALSO PRESENT:

JOHN FORESTER
FRANK RAHN (via telephone)
ZOUHAIR ELAWAR
PAT BARONOWSKI
JEFF JULIUS
ALAN KOLOCZKOWSKI (via telephone)
HAROLD BLACKMAN
BRUCE HALLBERT

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

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

8:31 a.m.

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a meeting of the ACRS Subcommittee on Reliability and Probabilistic Risk Assessment. I'm George Apostolakis, Chairman of this meeting. Member in attendance are Mario Bonaca, Tom Kress --

MEMBER KRESS: Bill said he had a meeting with all the commissioners. He'll be here later.

CHAIRMAN APOSTOLAKIS: The purpose of this meeting is to discuss the staff's plans for evaluating the Agency's human reliability analysis models in an effort to propose either a single model or for the Agency to use all guidance on which models should be used in specific circumstances.

The subcommittee will hear presentations by and hold discussions with representatives of the NRC staff and the industry regarding this matter. The subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full committee. Dr. Hossein Nourbaksh is the designated federal official for this meeting. The rules for participation in today's meeting have been announced as part of the notice of this meeting previously published in the Federal Register on March 5, 2007.

A transcript of the meeting is being kept and will be made available as stated in the Federal Register notice. It is requested that speakers first identify themselves, use one of the microphones and speak with sufficient clarity and volume so that they can be readily heard. We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting.

We will now proceed with the meeting and I call upon John Monninger of the Office of Nuclear Regulatory Research to begin. John.

MR. MONNINGER: Thank you. Good morning, Professor Apostolakis, fellow ACRS members. My name is John Monninger. I'm the Deputy Director for Probabilistic Risk and Applications from NRC's Office of Nuclear Regulatory Research. I believe the actual slide presentation is coming but we do have the handouts so we will proceed.

With regard to HRA, this is about the fourth meeting we've had with the ACRS over the past year, so we've had several very good meetings with a lot of good insights and recommendations from the committee on various topics including, you know, the various HRA methods, the Good Practices Project the NRC proceeded with and also the -- our recent efforts on the HRA benchmarking international project.

I believe you summarized very well the direction or the charge provided by the Commission resulting from the recent meeting with the ACRS and Commission this past year. In addition to that, you have provided some comments at the work session last week, the Regulatory Information Conference session last week on PRA methods, models and tools.

In addition to that, last years ACRS report on the NRC's research program highlighted the need to work, you know, through these various methods and models and come to some type of conclusions and a consensus. With that, we'll move onto the third slide, which is the objectives of the meeting. I think one of the things that is important when we start talking about the various HRA methods is to realize that, you know, many of them have been developed over the past, you know, 20, 25, 27, 28 years or so and of course, over time, they've been developed for various purposes. And also with that in mind, you know, the complexity or their uses has potentially changed.

So with that, you know, what we're going to try to do is summarize the various methods used within the industry, used, you know, by the NRC and being developed by EPRI, discuss the method or the motivation for development of the method, what the scope of the method is, some of the assumptions and some of the major elements and key characteristics.

We're going to try to note some of the differences and similarities with the various methods and then also our plans for moving forward and interacting with the ACRS and addressing the SRM. To the extent practical, you know, we'd like the meeting to be a very interactive roundtable-type discussion because the staff finds a lot of benefit in hearing insights and recommendations from the committee.

To the fourth slide, our first presenter will be Dr. John Forester, from Sandia National Lab. He will cover the ASEP and the ATHEANA methods. Following Dr. Forester, we'll have Dr. Harold Blackman from Idaho National Lab who will cover the SPAR-H method. Following that we'll have Dr. Erasmia Lois and Alan Koloszkwoski from SAIC discuss observation regarding the HRA methods and later on this afternoon, we'll Erasmia come back and talk about the HRA benchmarking project. So with that, I'd like to turn it over to Dr. John Forester.

CHAIRMAN APOSTOLAKIS: You will also have the Agency present their own methods.

MR. MONNINGER: Yes, I'm sorry.

CHAIRMAN APOSTOLAKIS: Yes, that's fine, that's fine, that's fine, yeah. And then we'll have a long discussion among ourselves as to where we can go from here and where we are and so on. So, Dr. Forester.

DR. FORESTER: Okay. As we talked about, I'll do some overviews of the methods here, trying to cover some of the aspects those you may be interested but, frankly, I'm not really sure exactly what it is you'd like to know about the methods, so if this seems to be taking too long or is not getting exactly what you'd like, I'd be glad to answer questions.

CHAIRMAN APOSTOLAKIS: Well, the main idea for the whole subcommittee meeting, I think, is for us to understand better why a particular method was developed, what are the basic assumptions behind it and then how it is used and then at the end, having done this for every major method, maybe we can reach some conclusions as to the similarities, the differences, are the differences necessary or are they just artificial, you know, trying to move forward in this, so at some point in the future, we may end up maybe with two models or three models that everybody accepts and everybody is happy with, including the practitioners in the industry, not just us.

MR. RAHN: Mr. Chairman?

CHAIRMAN APOSTOLAKIS: Yes.

MR. RAHN: This is Frank Rahn in Colorado with EPRI. May I just make a couple of statements at this point? I understand that the phone line might be unavailable for some period today and --

CHAIRMAN APOSTOLAKIS: Sure.

MR. RAHN: -- and just by way of kind of a prelude say a few comments. First of all, I'd like to thank the ACRS and the staff for having us at the meeting. We have attending in person two of our best people, Jeff Julius, who is well-known to you all, who author of the industry -- the HRA calculator and the industry methods, as well, as Zouhair Elawar, who is Chairman of the HRA users group. So thank you to you all for the invitation.

I just wanted to point out in prelude that there are certain things that the industry has in mind that are important to us, while they may be a little different in goals than the NRC and its staff might have, most of them are in common, but again, we have slightly different objectives and I just wanted to bring that to your attention.

The first is that we, as an industry, are focused in on using software and methodologies that will serve the industry and its interactions with NRC, particularly on the licensing front. So we are constrained by several things. One is we are looking for relatively simple methods, that is ones that have the attribute of simplicity as opposed to complexity, such that great term that Howie Lewis used to use, scrutabilty, will be one of our primary objectives for the scrutabilty internally in the industry as well as when the applications go into the staff, they will be well-understood and the staff will be able to review them.

And that's really -- the second attribute is one of reviewability, namely that when the applications supported by methodology go in, they will be understood readily by the staff and they will not be so complex that it takes a PhD in HRA methodology to be able to understand it; as well as where the ability of the industry to produce a quality application there has to be a methodology that will be readily understood by the practitioners in the industry, some of which may not be HRA specialists and we have to have the ability to, I would call it, teachability to make sure that we're able to train the people in the industry to produce an outcome that's well-understood, well-based in theory and experiment and will be, as I said, scrutable by the staff and where everybody understands the strengths and the weaknesses of the method.

Now, that's not to say that we are not very interested and, in fact, we are, in improving our methodologies and moving into advanced techniques as appropriate. We -- and I want to essentially applaud the staff at this point, because I think they have been very open and very forthcoming in terms of the interaction with industry. I think we've had a very good relationship with them in terms of discussing things like benchmarking. They have very often come to our meetings as an example of the HRA user's group. They have attended when it was possible to do so.

There's a Memorandum of Understanding between EPRI and the NRC research in terms of doing joint research in fire PRAs as one example and there have been recent meetings where we have shared our methodology as to how to approach fire HRA. So again, thanks to the staff. We support their efforts. We applaud them for working together with us and I think we're moving together very aggressively and I think with progress.

That's all I wanted to say at this point. You will hear, obviously, more from Mr. Elawar and Jeff Julius later in the meeting.

CHAIRMAN APOSTOLAKIS: Thank you, Frank, and we do thank both you and the two gentlemen who are here for agreeing to come and participate in our proceedings because we all have a common goal here and I believe the objectives that you mentioned of the EPRI efforts are actually the objectives of the NRC staff, too. We all want to have a scrutable method that is understood by people and produces reasonable results and this is why we are meeting here today trying to contribute to that.

MR. RAHN: Right. I didn't mean to suggest otherwise, Mr. Chairman.

CHAIRMAN APOSTOLAKIS: I understand.

MR. RAHN: Yeah. And thank you for this time to speak a little bit out of turn.

CHAIRMAN APOSTOLAKIS: Great. John, maybe now you can start.

DR. FORESTER: Okay, thank you. The first method I'll discuss is THERP and we'll talk about first the motivation for the method. And I think initially the need for HRA methods, per se, sort of came out of the weapons work that was, you know, the building of bombs, people concerned about errors being made. So that sort of how the initial effort got started, particular at Sandia probably with Alan Swain. However, I would imagine the people have been concerned about error for a long time and the notion about how to counteract that has probably been an issue for really a long time.

When WASH-1400 came along and there was the beginning of doing PRA for nuclear power plants, there was a need for human reliability analysis, some way to quantify the human behavior in those scenarios. And that's when the beginning of THERP was developed. This is WASH-1400 and then eventually after that was completed, the Handbook was developed NUREG 1278 which is the THERP document and that was published in 1983.

THERP has probably been used more than any other HRA technique. It was the first technique essentially but a little about it later, I think some of the characteristics of the THERP is also limited in its use. And then true to motivation, they've been developed NUREG 1278 as they state in the document. They intended that document to be a living document where it can be updated by new data that are human performance models and so forth. Of course, that hasn't been done but in lieu of that, there's been a lot of HRA methods that, as we all know, a lot of HRA methods that's been developed.

CHAIRMAN APOSTOLAKIS: So for clarification, THERP is NUREG 1278, right?

DR. FORESTER: Correct.

CHAIRMAN APOSTOLAKIS: There is nothing else. That is THERP.

DR. FORESTER: That is THERP.

CHAIRMAN APOSTOLAKIS: Okay.

DR. FORESTER: Yeah, it's called a Handbook for Human Reliability Analysis, the Technique for Human Error Prediction, but everybody calls it THERP for short.

CHAIRMAN APOSTOLAKIS: Okay.

DR. FORESTER: With regards to the scope of the method, THERP was intended to be a relatively full scope method. Guidance is in there for identifying the human failure events to be included in the models, however modeled in, but the focus even in THERP is mainly on quantification and also in terms of identifying even at that point, I think, HRA tended to expect a lot of the human actions already being cleared in the models. But --

CHAIRMAN APOSTOLAKIS: But they don't use the term human failure event, do they?

DR. FORESTER: I -- no, they don't. That's become more of a PRA term now and that's generally.

CHAIRMAN APOSTOLAKIS: More of a --

DR. FORESTER: Yeah, human error.

FEMALE PARTICIPANT: It's a PRA term.

CHAIRMAN APOSTOLAKIS: They use the term human error.

DR. FORESTER: Yeah. There is a very strong emphasis in THERP on how to model human actions. There's a strong emphasis on doing task analysis for the human actions and how to break those actions into sub-tasks so they can be, you know, analyzed in much more detail. That turned out to be one of the more complex aspects of THERP because you have to build the HRA event trees, and there's a very strong emphasis again, on executing the response. So there was less emphasis on the cognitive aspects of actions in the THERP model.

It focused on errors of omission and simple errors of commission and didn't really put a lot of effort into identifying how or why things might go wrong and what the impact of those things might be. Continue with the scope, there's guidance of quantification of the pre and post-initiator human failure events. The diagnosis, there is, as I understand it, the concern of that diagnosis is one of the last aspect of THERP that they addressed. That was tended to be sort of added on at the end and that was treated mainly through time reliability curves. So they quantified the probability of failure to diagnose, for example, in the control room, a post-initiator action that someone in the control room might be doing in response to an accident.

They'll quantify the diagnosis portion of that and then they'll add on the execution given error probability. So they quantify those separately.

CHAIRMAN APOSTOLAKIS: But the primary driver was the time from the initial receipt of the signals, right?

DR. FORESTER: That's correct. From -- yeah, from the initiating event.

CHAIRMAN APOSTOLAKIS: So event if you've got 32 minutes for example, there was a certain probability that they would do the wrong thing.

DR. FORESTER: That's correct. What they would do, they'd factor in the time for when the cues for the action were received and then they'd also look at how long it took to execute the action and then whatever time was left over, that was the diagnosis time and that could be looked up on that time reliability correlation. So obviously, that probability would vary depending on how long it took them to execute the action. If it was a control room reaction, they had to go outside and do things in the plant that would reduce the time for diagnosis.

Another aspect of the scope of THERP is that they had a simple approach for quantifying dependencies among the sub-tasks and that has been broadly used. People us that pretty extensively, continue to use it over the years. But the guidance there did focus on looking at the sub-tasks involved in executing a particular action. There wasn't any really direct guidance for considering dependencies across events in an accident sequence. So if the operators made a mistake early, well, how would that impact what they might do later? So there really wasn't guidance in the method for addressing that, but, in general, it's still being used in that way and the dependency model is considered to generalize those kinds of situations also.

Okay, some of the key assumptions, I don't want to over-emphasize this but for the most part the THERP models sort of treats human failures as basically random or inadvertent events. There's a strong emphasis on slips and lapses. Again, that was what the model mainly focused on in it's initial phases and only later it came back to look at the diagnosis portion of it, but even within the diagnosis, there's this notion that you know, as long as there's enough time, they'll do the right thing. You know, it's not as if there's a lot of things just going to cause them to make errors is the basic assumption. They have the procedures, and if there's enough time they will be successful, as long as there's enough time available.

Again, the focus is then more on whether they actually carry out the actions in the right way or not. There's also an assumption that it's reasonable to decompose the operator tasks in to multiple sub-tasks, quantify each of those separate actions independently and well, we'll look at dependencies but then, you know, essentially come up with the final human error probability. So it's very detailed decomposing of the actions and that's an assumption that's that right way to proceed.

There's also an assumption that the methods should be applied by THERP experts. They were HRA, human factors people involved in the analysis to the pont that I've heard in talking with Alan Swain, he believed if you really hadn't taken his courses and his training for the methods, that you probably shouldn't be applying it.

There's -- one of the more basic assumptions of the models, there's this generic human error probability, so that if you look at these at operators or even in a maintenance task or something like that and in nominal circumstances, there's -- on average, people will make a mistake one time out of 100. That's sort of the basic assumption. That's the basic human error probability in this type of domain and I don't know how far he expected that to generalize, but at least for this area, he did.

And then given that, you can adjust that basic human error probability by considering various performance shaping factors, things that would increase or decrease the likelihood of error on a given human action. And in doing that, within THERP there's a very extensive discussion about all the different kinds of factors that can influence human performance. But what we're actually going to quantify, there's actually a fairly limited set of PSFs that are directly considered by the model.

A lot of the factors are buried and a lot of the tables are sort of hidden because of the nature of the tables you select, but all in all, particularly for diagnosis, for example, there's only four or five actually critical PSFs considered. And the PSFs are treated as having independent effects. There's no consideration that a particular performance shaping factor might behave in one way in the presence of another PSF or at a different level of PSFs. There's no consideration of interactions.

Here are the major characteristics. THERP has a flow chart that panelists are expected to use to step through and to decide which tables should be used to obtain the human error probabilities and one advantage of this, it provides a reproducible process they can document exactly which tables were selected and going through the flow chart and which HEPs were selected. But I would like to note that even though there's a lot of standardization here in terms of how you walk through those tables, there's a lot of really subtle distinctions in how you select those tables and that process can be fairly challenging and I would say it requires significance and training to be able to do that in a reliable way.

Also another, I think characteristic of the THERP is that although Dr. Swain and Guttmann went to extensive efforts really to try and identify data to support the human error probabilities that are included in the model, there really wasn't a lot of you know, clearly applicable data and they used various kinds of, you know, data from industrial and military facilities and some from power plants, but mainly it was expert opinion of the authors as to how the -- what the human error probability should be.

Now, they had some data to work from so they did some extrapolation from existing data but the diagnosis model, for example, that was entirely based on the speculation, as Swain called it, and the expert judgment of the analyst. I think another characteristic of THERP that people recognize and this is what I eluded to before, there are high resource demands associated with applying THERP. There's a lot of information to be understood before you can apply it and actually again, as you go through and try and select the tables using the flow chart, there's some fairly complex decisions to be made.

MEMBER KRESS: Do you get a distribution element of the error probability?

DR. FORESTER: Yes, yeah, they use error factors essentially so that depending on -- it's really tied to -- in general, the lower the failure probability, the greater the error factor, the greater the uncertainty.

CHAIRMAN APOSTOLAKIS: But in the case of dependencies, for example, where they give these formulas for high, medium, low dependence, I mean, that's where a lot of uncertainties are and there's no guidance, really, how to do it. I mean, the uncertainties have been given on the basic human error probabilities.

DR. FORESTER: That's correct, and the analysts have to decide whether -- why they think it should be low or high, but that's the case in most methods really. It comes down to -- there's not a lot of guidance in THERP either and yet, that model has been used extensively.

CHAIRMAN APOSTOLAKIS: And is it true that this is the method that has been used the most?

DR. FORESTER: I don't have any statistics on it. That was my opinion. That was my impression.

MALE PARTICIPANT: It is true.

CHAIRMAN APOSTOLAKIS: It is true?

MALE PARTICIPANT: Mine is --

CHAIRMAN APOSTOLAKIS: Wait, wait, wait, how do we do that, they have to come closer to the microphone? Yeah, if you want to speak --

DR. ELAWAR: Always in our meeting, they reviewed the whole slide, that's all.

DR. FORESTER: And I did see quite a few applications in the IPEs, although I think, ASEP which I'll talk about actually it was a follow-up from THERP was probably used.

CHAIRMAN APOSTOLAKIS: Now, where were some performance shapings that I'm wondering whether anyone has ever used them, like if you decide that your crew consists of novices, you should increase the human error probability. Has there been a single instance where somebody said, "Yeah, my crew is inexperienced, so I will increase my HEPs"?

DR. FORESTER: I'd be surprised and essentially a novice is someone with less than six month experience and you know, any operating crew is going to have more experience than that.

CHAIRMAN APOSTOLAKIS: Okay. By the way, after lunch we will move to the bigger room, so we'll have more space and microphones and everything, okay? We have another committee meeting there right now.

Okay, so we are moving on to ASEP.

MEMBER BONACA: I have another question since this has been the most used method, I mean, has it been benchmarked against the other methods or what kind of -- how has it been assessed performance-wise? I mean it's been around for 30 years.

DR. FORESTER: That's correct. Frankly, I don't know of any explicit benchmarking of THERP. I mean, its results presumably have been -- I mean, there's been some initial benchmarking studies which we'll talk about later, too, that -- but THERP itself has not been benchmarked to validate the predictions as far as I know, no specific -- there's been THERP and other methods compared along with one another to each other and the outcome of that has not been encouraging, since there's a lot of variability in terms of the outcome and the results.

So -- but as far as -- and maybe someone else is aware of some specific validations of THERP and I'm not.

CHAIRMAN APOSTOLAKIS: Is it true, John, that the part of THERP that survives now is the part of the handbook that deals with a pre-initiating event, errors of omission or commission?

DR. FORESTER: Actually, I think ASEP is used much more frequently for pre-initiators. ASEP is a much more detailed model for dealing with analyzing pre-initiating events and I think that's pretty much the standard.

CHAIRMAN APOSTOLAKIS: I see. I thought it was 1278 that was the standard.

DR. FORESTER: That would not be my impression.

CHAIRMAN APOSTOLAKIS: Okay.

DR. FORESTER: As I'll talk about in ASEP, there are very detailed and straightforward model for dealing with pre-initiator and it's for maintenance staffs essentially in calibrations.

The motivation for ASEP, which was also developed by Alan Swain, well, as we've talked about, THERP can be fairly resource intensive, so there was a need to have a less resource intensive version of THERP. They also would like -- there was a drive to have the model that someone -- that you didn't have to be a human reliability analysis expert to apply, so that systems analysis could actually apply to methods.

CHAIRMAN APOSTOLAKIS: So would kind of expert would that person be? I don't know.

DR. FORESTER: Presumably we'd be talking about just, you know a PRA.

CHAIRMAN APOSTOLAKIS: PRA analyst?

DR. FORESTER: Yeah, PRA analyst that could just go ahead and maybe, you know, someone on the staff, a staff engineer or something, would go ahead and apply the method without having to be an expert in human factors and human reliability.

CHAIRMAN APOSTOLAKIS: So presumably that PRA analyst can also run the thermahydraulic codes, can also do the materials analysis, I mean, in the name of simplicity? The PRA analyst should be able to do everything?

DR. FORESTER: Well, I'm not sure that's the assumption. They -- presumably, yeah, usually when using ASEP you want good TH stuff. You're going to want to know what the timing is. You're going to need experts for that.

CHAIRMAN APOSTOLAKIS: No, I mean, why is HRA treated in a special way and other disciplines require specialists?

DR. FORESTER: The emphasis is on being used, not having to hire someone, I suppose. I don't know, it's just conjecture.

CHAIRMAN APOSTOLAKIS: This -- by the way, I'm sorry to interrupt you but this is a major issue, I think, and I think already Frank Rahn mentioned it and I'm sure it will come up later as swell, the tradeoff between doing a very detailed analysis that requires a certain kind of expertise versus developing a simpler matter that you know, an experiences PRA analyst can use and the question is there, what is it that we are losing by going to the simpler, so to speak, method and is that what's losing or are you losing something that's very important and you should try to stick with a detailed method and under what circumstances?

Because Frank mentioned earlier that one of the objectives of the EPRI approach is to develop software and help people who are not necessarily trained to be HRA experts but they are reasonable on list, so they understand the plans, the understand how the operators think and then they have these tools that help them. On the other side, you have a method like ATHEANA, as we will discuss later, which required a much more detailed approach. So I think this is an important point for us today to evaluate. Yes, Gareth.

MR. PARRY: This is Gareth Parry from NRR. I think before we get too deep into this, we have to make a distinction between the development of the logic models and the quantification of the human failure -- of the probabilities of the human failure. And I think Jeff can correct me if I'm not, but I thin what Frank Rahn was talking about was the quantification aspects of the human error probabilities and trying to make that more simple and reproducible.

CHAIRMAN APOSTOLAKIS: Yes.

MR. PARRY: I think the task of developing the event sequences and identifying the HFEs has to be done by people who are familiar with the way the plant operates and the way that the procedures are structured and the way that the operators respond to that. So that aspect has to be dealt with correctly and to that extent, I think that's common to all these methods that that has to be done correctly. Where the distinction will become between the methods primarily in terms of the end result is in the quantification aspect. So that's where I think --

CHAIRMAN APOSTOLAKIS: Yeah, that's very true. I agree with you and maybe you shouldn't use the word "correctly", in more detail. Anything should be done correctly.

MR. PARRY: You're right.

CHAIRMAN APOSTOLAKIS: No, but I absolutely agree with you and that would be part of the discussion later, I guess. Which parts have to be done in a certain way, which parts are done in different ways in the name of simplicity, in the name of extra detail and I think that's already a major conclusion which I was aware of by comparing, for example the EPRI calculator in ATHEANA, you see that the first part, identification of scenarios and deviations, is really very detailed and involved because that's the most important thing. I mean, so yeah, that's very true what you said.

By the way in THERP, maybe you mentioned it, but is there such a step of a detailed identification of scenarios? I know that there is a requirement for identifying the various tasks.

DR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: But that's not the same as identifying scenarios -- ATHEANA comes to mind again, where they have the deviations from the expected scenario.

DR. FORESTER: Right.

CHAIRMAN APOSTOLAKIS: And there is something similar in the calculator. So in terms of THERP, is there such a thing or is it only that the HRA analyst has to look at the particular human action and then say, "Well, we know that operators have to do A, B, C, which is really operator focused all the time and not so much scenario --

DR. FORESTER: That's right, it's not focused on the plant conditions or scenario --

CHAIRMAN APOSTOLAKIS: So that's a difference then, would you all agree on that, Jeff?

DR. FORESTER: Yes.

(All members, yes.)

CHAIRMAN APOSTOLAKIS: Usually you disagree but this --

(Off the record comments)

CHAIRMAN APOSTOLAKIS: Not that there is anything wrong with that.

DR. FORESTER: I'd just like to make one more comment with respect --

CHAIRMAN APOSTOLAKIS: Okay, well, that's a major conclusion, though. Such a major -- maybe we should adjourn, because this is really important. This is what I want to understand today and see if all of us agree. That certain things are done better with this method and not as well in that method. That doesn't mean that the method is bad and as you pointed out, I mean, this was -- THERP was a pioneer in methodology.

DR. FORESTER: Absolutely.

CHAIRMAN APOSTOLAKIS: So let's not forget that. I mean, Swain and Guttmann deserve all the credit in the world.

DR. FORESTER: Absolutely. They covered

a lot of information an --

CHAIRMAN APOSTOLAKIS: Yeah, okay, great. So yeah.

DR. FORESTER: Okay, let's see, where are we at here? Okay, another thing to note about ASEP, given that it would be less resource intensive and could be applied in general and to the level of an expert, the issue was the value and it would be more conservative, would result in a more conservative human error probabilities. That was sort of a trade-off essentially. I think another important aspect of ASEP that it did have a more detailed and explicit screening approach for both pre and post initiator events.

So compared to, you know, the more standard kind of process of just picking high values for screening, ASEP did encourage some analysis, even for the screening phase which I thought was a good aspect of it. In terms of scope, it was a technique for both pre and post initiator human failure events as we talked about but there's really no guidance in ASEP for how to identify the human events for including in the models. It was assumed that those would already be in the models and ASEP is primarily just a quantification method.

And as I mentioned, it provides both screening and nominal human error probabilities for both pres and posts and I've already mentioned about the screening analysis. It does a very detailed approach for quantifying pre-initiators. It's fairly straightforward and I'll talk about that in a second. And it is a stand-alone process. You don't need to be a THERP expert in general to be able to apply it.

CHAIRMAN APOSTOLAKIS: Probably there is a NUREG that describes ASEP?

DR. FORESTER: Yeah, NUREG 47-72, I'm sorry, it's part of the accident, yeah -- huh?

MALE PARTICIPANT: Accident sequence.

DR. FORESTER: Yeah, accident sequence with the --

CHAIRMAN APOSTOLAKIS: NUREG CR, right?

DR. FORESTER: NUREG CR 47-72. I'm sorry?

MALE PARTICIPANT: Evaluation program?

DR. FORESTER: The sequence evaluation program, yeah, that was part of this. It was developed for that.

MALE PARTICIPANT: Right.

DR. FORESTER: Okay. ASEP, like THERP in terms of key assumptions has a generic HEP for the nominal conditions and the assumption is that can be adjusted by various PSFs to account for the plant scenario specific characteristics. It also has a relatively small number of PSFs that are included in the model and anything else that might need to be considered essentially is left up to the analysts. And once again the PSFs are treated as being independent.

CHAIRMAN APOSTOLAKIS: I don't understand the statement -- Slide 10.

DR. FORESTER: Oh, Slide 10, I'm sorry. Oh, Slide 10, okay.

CHAIRMAN APOSTOLAKIS: "No guidance so far to identify human events to be included in the PRA."

DR. FORESTER: Correct.

CHAIRMAN APOSTOLAKIS: Isn't the job of the human reliability method to do that or is it the PRA?

DR. FORESTER: Well, my personal opinion is it should involve both. I mean, the human reliability analysis should work with the PRA team in developing the models and deciding which kind of human action should be included based on what the scenarios are.

CHAIRMAN APOSTOLAKIS: Because even THERP, I mean, according to ATHEANA and the calculator, it's really the way the plant is operated and the procedures that identifies whether the humans intervene. It's not the method, the HRA method because the HRA method may analyze it and scrutinize it and identify possible actions and some deviations, but I think the fundamental operation of the plant that determined when the operators are expected to do something. So I'm not so sure that this is a --

DR. FORESTER: Susan would like to comment on that.

CHAIRMAN APOSTOLAKIS: Sure.

DR. COOPER: Susan Cooper, NRC. I guess I'd sort of like to clarify a little bit. At least from my perspective on the role of the HRA analyst and the PRA team. The HRA analyst is part of the PRA team. As a matter of fact, most of the PRA jobs I've been on, I wasn't just the PR -- HRA analyst. I had other jobs. Everybody looked at the procedures. Everybody got the information on how the systems work, Everybody went to the plant for a week at the beginning of the job to understand how the plant worked.

And John's right, the task of identifying human failure events should be a job for both the PRA and HRA analyst. You know, the PRA person or the systems analyst will be looking at their specific system and identifying places where equipment has failed and the operators can, because of procedure, you know, either restart or recover or start another system or something like that.

The HRA analyst might be focusing on some different things that have to do with vulnerabilities with the operators. The HRA analyst also should make sure that throughout the model that, you know, by system by system that you know, if PRA Analyst A and PRA Analyst B didn't model things the same way and there are different system models but they're the same, you make them the same. So it a joint effort to my mind and it always should be.

But the other thing is there's this idea of the HRA person being separate or being somehow different I don't think is often the case. I mean, most of the time, the HRA analyst is a PRA person who's been given also the job of doing HRA.

CHAIRMAN APOSTOLAKIS: I agree with you but you were referring to human failure events.

DR. COOPER: Yes.

CHAIRMAN APOSTOLAKIS: The slide says "Human events" and I interpret that that the operator is expected to do something. So it seems to me that's not determined by the methodology. It's determined by the plant and its procedures.

DR. COOPER: The only ones we model are the failures.

CHAIRMAN APOSTOLAKIS: The failure, the failure, I agree, the failure has to be part of --

DR. COOPER: Yeah, those are the ones you want to identify, they may be omissions or commissions but that's what you're trying to identify. Now, certainly in the process of that, you're going to identify actions that the -- you know, that the operators are expected or required to take and the analysis is, you know, is that something that needs to be modeled, you know. You have to worry about the failure of that being something significant that would change the course of the accident sequence in a way that matters.

MR. BARONOWSKI: I'm going to support what you said except that I want to mention that the PRA people, the analysts for instance, has to be very knowledgeable on how the plant is operated so that they can identify all the places where there might be operator or other human actions and then working with an HRA analyst who understand better how to quantify and perform the HRA methods to quantify the likelihood of failure is kind of the way it fits together. But usually it starts out with someone who really understands the plant. If you don't understand the plant and how it operates, your model won't include all of the things you need to have in there and you might think you have a good model and you don't so that's a really important element.

DR. LOIS: Erasmia Lois, Research Services. I believe what Susan and Pat described are good practices and probably most PRAs were performed like that. The typical or the more conventional practice in the past was the PRA analyst understands the concept and they define the human actions that have to be modeled and then would give to the HRA analyst the task to come up with the probabilities. So there was a disconnect of HRA practitioners or Human Factors Practitioners that were coming out with a -- and the actual PRA -- I don't believe it was an integrated team and that thing was emphasized through the Good Practices document.

Now, a lot of what we're identifying here is in terms of characteristics or the limitations do carry over through the practices, how people were actually doing the human reliability and some of the characteristics we're seeing in the results potentially come from the actual process and how do you go about to do your HRA as opposed to what is the good way or the ideal way.

CHAIRMAN APOSTOLAKIS: We obviously touched on a sore point. I took the words of the slide literally, human events not human failure events, human events. I still don't think that it's the HRA's business to identify those. But we all agree, I agree with you. Please come to our mike.

MR. ELAWAR: I am Zouhair Elawar, I represent the HRA users group. Mr. Chairman, I won't say I agree with you that we not rely on the method to tell us which HRAs we need to model. As you said, the system analyst has the lead and the HRA analyst is part of the team but really the initiation of which HRA to be modeled comes from the system analyst. The HRA practitioner will do the work, will understand the scenario comprehensively and document usually states that this is being written to be used in this whole scenario. It will not be allowed for the same HRA to be used somewhere else even though the same actions are there.

That really becomes a big deal if that was ever uncovered. So the HRA would be written for the specific scenario for the name and it really comes from the system analyst.

CHAIRMAN APOSTOLAKIS: Very good. Thank you. So John --

DR. FORESTER: Yes, sir.

CHAIRMAN APOSTOLAKIS: ASEP was developed because THERP was considered to be too elaborate?

DR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: And because it's presumed to be conservative.

DR. FORESTER: That's correct.

CHAIRMAN APOSTOLAKIS: So if go to the NUREGs and look for the same event and the same performance shaping factors, I will find a higher failure probability in ASEP than in THERP, is that correct?

DR. FORESTER: That's the general idea. In practice whether that happens I don't know if it always works out that way because it's a judgement.

CHAIRMAN APOSTOLAKIS: That's a trade-off.

DR. FORESTER: That's a trade-off, right.

CHAIRMAN APOSTOLAKIS: Very good.

DR. FORESTER: The main components and characteristics of ASEP, again, the pre-initiators like the post-initiators is the basic idea that there's a generic human error rate that can be used for all the human actions. And then since -- particularly the pre-initiators, since in some of them there's not a lot of variability in terms of what's done, there's not a lot of ways the scenario can develop in some ways, so it really focuses on given that basic human error probability looking at recovery in the sense is there a second checker, do they do a functional test of the system, is there a written checklist used. So those kinds of things contribute to the likelihood of whether a particular instrument for example, might have been miscalibrated and left that way or a particular system wasn't restored correctly. So the emphasis is on recovery essentially and pre-initiators.

Post-initiators are usually the same diagnosis curves as the THERP model did, but it did add an adjustment to take account for symptom based procedures which were not in use when THERP was being developed.

CHAIRMAN APOSTOLAKIS: So these are still TRCs.

DR. FORESTER: Yes, they're the same TRCs. I think there was some suggestion, I think, I can't remember exactly, maybe somebody else will recall but symptom-based procedures are available and you can use the lower bound instead of the nominal curve. Is that right? Okay.

It is a simplified -- it does have simplified treatment of the factors so it -- in terms of the complexity of the task, in terms of executing the task they look to see whether it's step by step or dynamic stress level for the operator. So the main PSFs is considered. It apparently uses a simpler dependency treatment, probably fewer levels are probably considered, and it does allow for additional recovery by other staff.

The quantitative values is the same basis as THERP. I think most of those values were taken from THERP and they were just adjusted by the method developers.

CHAIRMAN APOSTOLAKIS: So what is the time frame of development of the ASEP?

DR. FORESTER: ASEP is mid to late `80s, yeah.

CHAIRMAN APOSTOLAKIS: So THERP was `70s?

DR. FORESTER: Well, it was published in `83 but the development was going on in the `70s, right.

CHAIRMAN APOSTOLAKIS: So ASEP was late `80s?

MALE PARTICIPANT: 1987.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER BONACA: That was the time when symptom procedures were being developed.

DR. FORESTER: Yes.

MEMBER BONACA: At the same time.

DR. FORESTER: Right, and so there was an emphasis to include something to treat that within the ASEP model.

CHAIRMAN APOSTOLAKIS: But it was still essentially Swain's judgment.

DR. FORESTER: Yes. Okay, so those are two -- well, I would say THERP is not simplistic, that's for sure, but again, the basic notion, I think we take away from those methods is that there's an assumption that there's a finite set of PSFs that are treated, a small set, but I'm sure Swain would say, and this is something, I think, you were bringing up earlier, something we need to consider, that if you do this process, it's a very standardized kind of process, that it would be good enough. That this is enough -- enough of the set of factors are being considered and if you think you have to consider more, then you need to look in the third methodology. Swain encourages you to just go the expert elicitation process to try and take into account for other PSFs. But his assumption was in both these methods, that this is an adequate set of PSFs to give you a good answer most of the time and whether that's the case or not, I guess, is still to be determined.

Okay, so moving on to ATHEANA, which is the more recent NRC method --

CHAIRMAN APOSTOLAKIS: So when did this start?

DR. FORESTER: ATHEANA started in `97, I think. Well, actually, that's when I became involved, `96, `97. I think it was ongoing by --

DR. COOPER: `93. `92 but --

CHAIRMAN APOSTOLAKIS: So it started for the record, in the early `90s. Is that a correct statement, early `90s?

DR. COOPER: Yes.

MR. JULIUS: It was published in 1996.

CHAIRMAN APOSTOLAKIS: The first -- so the first bullet implies that the previous methods did not do this.

DR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: They did --

DR. FORESTER: The emphasis was on the nominal -- I think most people would agree that the emphasis in the earlier methods was on the nominal case. There wasn't an effort to, as we talked about, look at deviation scenarios or examine how plant conditions might evolve that could cause the operators trouble and that was sort of recognized as occurring in the real world events so that, you know, what was noticed essentially from the live of series of events was that operators before they do make mistakes, they tend to be set up that are forced in some way to take inappropriate actions by the context of the situation.

And also it was noticed that often operators and, you know, airplane pilots, different kinds of -- in different domains will take inappropriate action, so they do commit errors of commission. Those are often involved in serious accidents. So essentially ATHEANA was -- I mean, initially -- I should have mentioned actually that sort of initial motivation for ATHEANA was to be able -- as I recall it, was to -- failed because of a low power shutdown where things were a lot more complex or less standard as opposed to what's going on in full power. So it was looked at as being a more complex environment where there was more variability about what would be going on in the plant. So the notion was you might need a more complex method to deal with that. So there's two driving factors, I think, contributing to motivation for the method.

In addition to those basic things, though, I think along with looking at the existing methods at the time, there were some other concerns about some of the limitations of those existing methods that we thought might need to be addressed. One was the use of the generic data as used in THERP and ASEP with limited empirical basis and the basic idea that you could take one or two curves or a few values and generalize that to all scenarios, basically looked like something that should be examined.

CHAIRMAN APOSTOLAKIS: Are you citing to the TRCs now?

DR. FORESTER: Yes. But even without the TRCs, even with the PSF values and other values within THERP table, the notion that, you know, if you have five steps in a procedure, you probably to make an error is this or 10 steps in a procedure the probability is different. Well, that doesn't address what kind of procedure it is at all or how complex the problem you're dealing with is. I mean, this notion that you can take a generic set of values and use those values in a range of conditions, again, it may very well work that way but it's certainly reasonable to question that.

Also there was a concern about the limited range of PSFs that were expressly being considered. It appeared that again, there was a range of conditions that can influence performance and complex environments, so that maybe the issue was whether, are there enough PSFs, are there a broad enough range of PSFs being sampled to come up with accurate predictions. That's certainly a question. And also the occurrence of applicants treating the PSFs as independent, the notion that you sort of need to take all of the factors that could be important, once you identify things that could draw behavior and take those together to see which ones are really going to be important.

Of course, the trade-off from this is that this additional emphasis on, you know, looking at error-forcing context, identifying deviation scenarios, different ways things might happen that could confuse the operators considering a broader range of PSFs and trying to deal with those in some way that they can be considered holistically, can be viewed by some as requiring more effort and maybe it's the case that there's -- that additional effort is not justified by the outcome.

CHAIRMAN APOSTOLAKIS: So these three supplements were replaced by the concept of the error-forcing context; is that correct?

DR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: And part of it is the more detailed evaluation of possible scenarios and deviations.

DR. FORESTER: Correct, and, again, a broader range of factors. Like in the ATHEANA there's now an emphasis more on -- not emphasis I should say but there's also to consider crew characteristics and how that crew dynamics and so forth might influence performance and things like informal rules that the operators use and other factors that might effect how they will act in a given situation rather than simply relying on general evaluation of the procedures.

Here's the scope of the method, ATHEANA intended to be relatively full scope. It includes guidance for identifying, modeling and quantifying human actions in the HRA. It does focus on post-initiator human actions. In general, I think the concepts are applicable to pre-initiators but there's little specific guidance for pre-initiators. I think at least in part, that's the case, again, most of the time there's not a lot of variation. There's less of a concern, I should say about variation of how the scenario will evolve. But nonetheless, I think the concept still could be useful for application of the pre-initiators.

CHAIRMAN APOSTOLAKIS: So if I have a pre-initiator application, I should go back to ASEP?

DR. FORESTER: Probably. I don't know, I'd have to think about that some more. I think even in that context, if I was doing it, I would certainly be examining what other kinds of things might cause problems here rather than simply looking at recovery. But I think for the most part, those models are adequate. This is my opinion but I haven't really investigated it. I'm sorry.

Okay, so this is addressing potential cognitive failures for human actions but also the potential failures in implementing the desired action is also considered and the situation that could cause either failure in diagnosis or problems that might occur during implementation of the actions, particularly X control action -- X control room action is involved. The left is just the errors of omission and errors of commission, so there's an effort to identify situations that might lead the crews to take inappropriate actions in the post-initiator type situation. And their search schemes included in ATHEANA were identifying error forcing context and for identifying errors of commission. It strives to address a wider range performance conditions and failure modes.

So there is an emphasis on looking at the plant conditions, how the plant might evolve in somewhat different ways that could be problematic. There's also an emphasis on you know, how the PSFs could become important, given these variations in how the plant conditions are evolving. And there's also a concern about maybe you simply don't -- you need to also analyze how the responses are going to be executed and maybe there will be some particular kinds of conditions that would lead to one type of unsafe fact that would cause the loss of a critical function, but there may be another set of conditions that lead to a different act. And maybe one case there's a set of conditions that might lead them to turn off the pump and another situation that might lead them to close a valve.

So the issue is there may be multiple ways that critical function could be lost so there may be multiple unsafe acts that contribute to a given human failure and a PRA. There's also concerns about you know, how do you model different events? Is there -- you know, if you feed and bleed, is it a single action considered or are you looking at modeling one set of conditions that might lead them to fail to feed and another one that might lead them to fail to bleed. So again, this basic notion of maybe we need to examine a little further potential different things.

ATHEANA does still emphasize addressing both the nominal case, and that's where the process starts and trying to examine sort of the basic expectations for how the scenario will evolve, sort of the expected case that the crews might see in the training simulator and so forth. ATHEANA also looked for deviation scenarios. And here's some of the key assumptions. This is an assumption that highest trained people, operators that have good familiarity, good procedural guidance, they have good training, again they're not going to make random or inadvertent errors that lead to serious consequences, not usually. And if they do make those kinds of errors, there's a whole control room of people there and the likelihood is someone is going to notice it.

CHAIRMAN APOSTOLAKIS: So what you're saying is that slips are important.

DR. FORESTER: That's -- again, I think

they're less important because there would more likely be a recovery. So again, the emphasis, we thought needed to be more on, you know, not these sort of random or inadvertent errors but more like, you know, in ways that the scenario could evolve that would confuse the operators. And so that's an assumption, that these accident scenarios and conditions could evolve in ways that confuse the operators.

And there's also another assumption that you need to consider a broader range of influencing factors to be able to obtain realistic estimates of HEPs that in fact, at least some of the time the simpler approaches considering a relatively small number of factors may be adequate in all cases. This is true, that there could be some conditions where you need to do a little bit more analysis to find out what might go wrong.

There's also an assumption that this guidance that's provided in ATHEANA that some people can look at as being fairly complex and we are actually in the process of trying to simplify some of that guidance. But there's an assumption that analysts can use that guidance, can identify the important nature of these and the important shaping factors. And you can do this with an acceptable level of effort. But again, that's something still to be shown. In that sense, we do use a formal facilitator expert opinion elicitation process to obtain the HEPs and so there's an assumption here that that type of process can be used consistently and can produce valid HEPs so it's stepping away from the more standardized type of approach where it's simply followed through a set of tables or a set of flow charts or, you know, curves to come up with the values that you can use expert judgment with a form of process that will also -- can produce consistent results and obtain valid HEPs. The notion is that the qualified experts, operators and trainers in particular who are knowledgeable about the actions of the scenario interest, then you can do that.

Then those people using their -- the information they have that they've obtained using the ATHEANA search processes, their own experience and general experience about how people behave, that that can be done.

CHAIRMAN APOSTOLAKIS: Now, this is an important point in my view. This is a unique feature of ATHEANA; is that correct?

DR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: Other methods, as

we will hear later, also ASEP and so on, they tend to be more practical here, they give you guidance and numbers and so on certainly the EPRI calculator does that, too.

DR. FORESTER: That's correct.

CHAIRMAN APOSTOLAKIS: This is a unique feature. I can see how it can be very valuable in certain circumstances, but it's probably also what makes people avoid using ATHEANA.

DR. FORESTER: That's probably one element, that's correct.

CHAIRMAN APOSTOLAKIS: And another question is, I mean, yes, it makes sense to do this, but does it make sense to argue to do it all --

DR. FORESTER: No.

CHAIRMAN APOSTOLAKIS: Could there be, for example, a skewing of the SRM also if a screening or a simpler method first for 90 percent of the human errors and then if there are two or three or four that stand out about which there is disagreement or people feel they have to understand them better, for those to apply the more reliable method of ATHEANA? I mean, if we discuss these things and maybe reach some wort of agreement at the end of the day or maybe in the near future, I think we'll be making a lot of progress because we don't want -- I mean, in my view, there are a lot of good things in ATHEANA but this last bullet there is really a killer.

When people see that they have to assemble -- I mean, look at this agency. We did a major exercise of expert opinion elicitation for the frequency of pipe breaks in the context of 50.46 and it was a reviewed and reviewed again the ACRS, et cetera, the subcommittee meetings. It's not a simple thing to do this and to make it part of a routine requirement, it seems to me you're shooting yourselves in the foot.

Now, I see already there are disagreements. Susan.

DR. COOPER: Susan Cooper, NRC. ATHEANA is different than the other methods that we've discussed but certainly it's not the first method that's used expert elicitation. And in fact, SLIM-SLIM mod., which also used expert elicitation, we are approaching the expert elicitation similarly in the experts are operators or operator trainers. Those are the experts. We're not talking about you know, some shadowy group here.

These are the people that, in fact, you know, the PRA team as a whole should be interacting with in any case if they're trying to understand how the operators behave. Now, the way the ATHEANA quantification technique has been designed is to optimize the kind of information that we do have available for US nuclear power plants and the fact that we do have operators and operator trainers who are highly knowledgeable and can help in this expert elicitation process. There may be applications and, in fact, there will be for facilities like Yucca Mountain, where we don't have that kind of expertise -- those kind of experts lying around to be able to use.

So should a different sort of approach be used, I mean, if you don't have the experts? Yes, but do you throw out all the insights that you can get from ATHEANA, I don't think so. So, I mean, there's some other thing that you can do between other than saying, you know, I can't do the quantification approach because I don't have the right kind of experts. Let's just go use ASEP. I mean, that doesn't seem like a total -- a logic process that I would want to follow.

Now, do we have a screening approach developed? No. Have we done screening type analyses with ATHEANA? Yes. Is it documented so that people can have access to it and try to copy it? Not really.

CHAIRMAN APOSTOLAKIS: I wasn't really referring to the availability of experts. I mean, and I agree with you on that point. I read the paper that several of you wrote recently or a couple years ago and you gave a detailed example of the quantification process what the experts gave first as a fifth, 95th and so on and all that. I mean, you must agree that for a person who reads that and things that this is a requirement for every single human error, this is an extraordinary burden to do that. So the question is, whether this approach needs to be applied to every single human failure event that the PNA identifies or there is a way of screening out -- not screening out, quantifying a lot of them using something simpler, yet, accurate or slightly conservative, and focus this on the truly important events where we have to define what important is because I really thing it's killing the method and it's not just my view.

I mean, if you look at the requirement, Frank Rahn started earlier today saying, you know, we need something that the simple -- the gentleman, Mr. Elawar in our meeting months ago or a year ago, emphasized the same thing. You read the EPRI reports, the emphasis is always on developing something that is practical and people can use without losing too much. So we have these two approaches. I'm not saying that using a single method all the time is the wise thing to do either but there has to be a way of bringing those two together. And I think ATHEANA is doing a disservice to itself by insisting on this because there is a lot of good stuff in ATHEANA and you can't just -- I mean, that paper was interesting but my God, it's scary.

DR. COOPER: I don't think the ATHEANA developers would disagree with having other approaches to quantification. As a matter of fact, even though -- I mean, I haven't seen the latest user's guide version, but we've discussed them on the group that we probably do need different approaches, probably for the simple reason that we have very different applications. I mean, we have applications that are going to need first-of-a-kind PRA studies and you start from scratch, never done before, first facility, you need to do it in a different way than you do for something that maybe you'd just be evaluating a certain sequence to make a license amendment. So what we're talking about are different needs.

Now, in a sense you could -- I mean, I agree, ATHEANA has -- you could say has done a disservice to itself in the sense the we started off with a laundry list of all the problems in HRA and we tried to solve all of them.

That doesn't mean that you have to use every aspect of it, you know, but that's what we did. We looked at errors in commission, we looked at, you know, shutdown. We looked at power, we looked at fire at one point in time. We looked at lots of different things and tried to build a method that can address it all. Now, we haven't done that because part of the reason, the quantification and we optimized the quantification as had been described publicly for US nuclear power plants or, you know, modern nuclear power plants.

CHAIRMAN APOSTOLAKIS: Yeah.

DR. COOPER: But I mean, I've used ATHEANA and not used that approach because I didn't have the experts, so I quantified in a different way. But was it still ATHEANA? I think so but you know, I say I'm not using the -- you know, the expert elicitation approach.

CHAIRMAN APOSTOLAKIS: Yeah, I think as a general comment, the purpose of today's meeting is to see how we can move forward and not why certain things have been developed in a certain way. But for example, I can see using this kind of analysis when we build a JET-4 reactor in two years, right? Let's say we decide in a crazy moment to build a gas cooled fast reactor in five years, okay. Now, human error, who knows, you know, I would go into a very detailed evaluation. I'm not sure who the experts will be in that case and so on but for LWRs, for which we have long experience and so on, we've studied them now for 35 years, I would argue without having any strong evidence to support it that the need for this is very limited.

For Yucca Mountain, probably yes, you're right, again, you know, in the preclosure period, who knows what's going to happen.

DR. COOPER: Yeah, I mean, you have to recognize that -- we did recognize that in the sense that for light water reactors we assumed that we would not be doing a full PRA. If you were applying ATHEANA you would probably be addressing a specific issue. For example, there are license amendment requests that involve human actions. And if you were changing your license and for example, you know, shortening the time to respond or something like that, perhaps you should look at that in a little bit more detail than, you know, going to a table in THERP.

So I mean, that doesn't necessarily mean it's a very complicated analysis. You've already identified the event. You already have a basic description of the scenario. You just simply have to explore how it's changed and using a method like ATHEANA, you can do that and that of course, you should be, you know, doing.

CHAIRMAN APOSTOLAKIS: Jeff, please come closer to the microphone.

MR. JULIUS: Jeff Julius, Scientech. From the industry point of view, yes, this is a drawback of the method, that we don't have experts lying around that -- and there's more operating plants but all the operators are busy and the analysts are busy and you know, several people from this room come from the plants and have experienced this. And it is a drawback, the method and it is one of the things that should be factored into looking at how to use in the future.

CHAIRMAN APOSTOLAKIS: Yeah, and I have no doubt that many times, you know, this screening happens and so on but what I would like to see is a document someplace that lays it out in an explicit way and says, you know, "Under these circumstances, this is acceptable, under these circumstances, this is acceptable." So, because de facto, I know, that these things are happening. I mean, we are getting applications for power uprates. People do give us estimates of the change in the human error probability and we tend to accept them. So but it would be nice at some point to write it down and say this is a good thing to do or at this point there are two ways of doing it and so on. Ken.

MR. CANAVAN: Mr. Chairman, Ken Canava, Electric Power Research Institute. Just a quick comment, it may be an unfortunate twist in the phrase that expert opinion elicitation was used. Industry's recent experience with providing the staff with expert elicitations has been not positive and you mentioned one of the three that I'm aware of in the expert elicitation area that have not gone well. And so using this phrase here is probably one of those situations where I don't think industry would --

CHAIRMAN APOSTOLAKIS: No, the one I mentioned actually did go well.

MR. CANAVAN: Well, that one went well but wasn't very resource intensive. The other --

CHAIRMAN APOSTOLAKIS: Would you give us an example of --

MR. CANAVAN: There were two other expert elicitations. One was with the ILRT extension interval and that went poorly. And the other one was a safety -- an analysis done on safety valve lifting following --

CHAIRMAN APOSTOLAKIS: I see.

MR. CANAVAN: -- steam and water relief. And the questions start coming in, well, you know, verify that your experts have enough experience. Verify that you document the process sufficiently. Well, documenting an expert elicitation process, that could be anything from a few sentences to volumes of what was on people's minds. And I would put forth that that becomes an exercise in, "We think you should have wrote three more sentences", or, "You didn't write exactly what was on one of the expert's minds". And then what do you do with very differing opinions? Let's say one operator says, "Yeah, this is no problem, there's nothing distracting, I can do this fine". Another operator turns around and says, "I think I'd have trouble with this and I'm not sure I can do it". How do you rationalize those expert opinions? And so I think this is a little bit more fraught with problems than you might believe, adds a lot of resources to the process.

And I agree with your assertion the

perhaps, it has a role in some of the more actions that contribute more significantly but certainly those that are performing this for everyone is probably not -- every HEP is probably not prudent.

MR. PARRY: I'd just like to comment on the expert elicitation thing.

CHAIRMAN APOSTOLAKIS: So we have Gareth, Zouhair Elawar and then John.

MR. PARRY: Okay, Gareth Parry. I think it's true that the expert elicitation process is a problem from the point of view of reproducibility and certainly for the translator that would be from one plant to another. And that I think is what makes people nervous. But the comment I really wanted to make was that I think your suggestion that what we should be doing is developing the screening method and then a detailed method for the more significant basic events is certainly not inconsistent with the ASME standard and in fact, I think there are requirements in there to do that.

What the standard says, I think is that if I remember correctly, there is -- for capability category 2 which is the -- sort of the goal, perhaps, of the industry, that what you should do, you should use the detailed analysis for the significant basic events and there's a definition of what a significant basic event is. So I think it's right that you wouldn't use -- so we probably do need to have a screening approach that is good enough for a lot of the basic events and a detailed approach that we need for the significant ones. But the catch there has to be, I think, that the detailed approach has to be consistent with the screening approach and based on the same principles.

CHAIRMAN APOSTOLAKIS: Yes, yes, please.

MR. ELAWAR: I am Zouhair Elawar. I am speaking on as HRA petitioners. I have done many of them so far. I would usually follow the procedure, the procedures step-by-step as to that's what their expectation of the accident evolution will go and in most cases, they would have the contingency actions, to me those are the expert elicitations that the expert established that's how the accident may evolve. In the contingency action at the site, I will model the expected behavior or evolution of the accident without modeling the contingencies which usually will take longer time. However, if the HRA turns out to be of the top 20 HRAs in its contribution to the PRA model, then that training will take over. They will practice it as direct expected evolution of the accident as well as potential contingencies. If they want to do it by different methods, we're later able to do it in the time allowed for it.

So indirectly, I would say it's included and I would not be able to really go and elicit experts beyond what is already in the procedure as in terms of its contingencies as to how else it may evolve.

CHAIRMAN APOSTOLAKIS: But I thought Dr. Cooper said that the experts are plant people.

MR. ELAWAR: Yes, and they documented their ideas already in the procedure.

CHAIRMAN APOSTOLAKIS: So you understand that disagreement. Mario.

MEMBER BONACA: But it seems to me, or at least I remember, it was a long time ago when I worked in power plants, on bleed and feed for example, you know, the crew of -- not all the people were thinking the same way about bleed and feed. That was a problem, that you could not rely because you had old-timers that were used to, you know, before bleed and feed became a standard practice the you put in procedure as a way of cooling and some of them clearly were not -- did not buy into the idea.

They really had -- you know, they were

thinking of the damage that that would create to the plant and they were thinking about ways to get out of that. It was apparent if you talked to them.

And you had a new operator, the young ones which were trained, and they were believers in the procedure. So I'm saying that at that stage you would want to interview, in fact, several operators, understand how they think about it and see how the team that you have in the control room would, in fact, do implement the procedure.

MR. ELAWAR: Well, yes, sir, that's consistent with --

MEMBER BONACA: Yeah, so I'm saying, you know, this process of elicitation in some cases seems to me would have to be part of any evaluation of the human performance, I mean, whichever -- if you have the sense that you don't have a cohesive approach by all the team, for example.

MR. ELAWAR: Well, the statement that I wanted to make that I will go by the expected evolution of the accident, not by the contingencies that are already given to me as well. That's the expectation as to how to evolve and you're right, the operators are heavily involved in validating all aspects of the HRA.

MEMBER BONACA: When did we start with bleed and feed as a way of cooling? Some of the old-timers didn't like at all the procedure because they felt that they were going to lose the plant and not recover the plant, et cetera, which was irrelevant. Okay, the point is that they were involved into the process or they were not involved into process and I think we paid a lot of attention to give them credit in the PRA on whether or given the feelings that they had, we were going to be successful. And in fact, the first estimation we made for a C-type plant, which has a very narrow window for bleed and feed, we gave a very low probability of success because of that.

Until then, you know, the crews were trained and trained again, et cetera, and then clearly apparently bought into that. But so I think that there is -- that kind of expert elicitation process was more like testing where the crew was than anything else but was it from the mental step in deciding how credible the action was?

DR. FORESTER: I'd certainly agree with that.

MEMBER BONACA: So in that sense, I mean, I agree with Ms. Cooper.

CHAIRMAN APOSTOLAKIS: I think the result of this is that this is a feature that stands out in ATHEANA and I'm sure in practice there are variations and so on but it would be nice at some point to have a NUREG that explicitly lays out what is going on.

MR. MORAN: Im certainly agreement with having the screening criteria.

CHAIRMAN APOSTOLAKIS: And also, the methods for expert opinion elicitation but, I mean, there are a lot of people who thought about it. I think you guys are using basically the shock approach for the seismic stuff.

DR. FORESTER: That's correct.

CHAIRMAN APOSTOLAKIS: I let Bill Shack step out because of conflict of interest.

(Laughter)

CHAIRMAN APOSTOLAKIS: John, you wanted to say something?

DR. FORESTER: Yeah, just briefly. We've reviewed the expert opinion elicitation for quantification but we want the experts there to bring the information, you know, to help us work with the ATHEANA process, identify all this broad range of information that can be useful so that's the main part of the expert part. And in terms of the elicitation part of it, again, those people can participate and that can be useful. In our experience, we've used it, you know, in several cases in PTS and so forth and in other context and we've actually had -- we feel comfortable with it. It works fairly well. So that's it.

DR. COOPER: Susan Cooper, I just wanted to ask something. The other thing is that we want to build a consensus model for the experts so that idea of having an outlier expert is not one that -- we would want to find out why that is and our experience has been that that person may have a different context in mind, in fact, or have some new information to add. And then they should add to that process so that other people can think about it, too. And often time what happens then is that you end up having two different context or you know, two different ends of the spectrum.

But that informs the process further but the point is that we don't have to worry about averaging because that's just not part of the process. And again, that's just part of getting information.

CHAIRMAN APOSTOLAKIS: I must say, though, when I read the paper, I think both of you were co-authors, when you asked the experts to give you a first person find of distribution, you're really asking for trouble in the -- that's okay, that's all right.

DR. FORESTER: We've simplified that process.

CHAIRMAN APOSTOLAKIS: Huh?

DR. FORESTER: We've simplified that process.

CHAIRMAN APOSTOLAKIS: Oh, you're going to the second person? When I Chair subcommittee meetings, we never meet for longer than an hour and a half, so we'll take a break right now, in spite of what the agenda says.

(A brief recess was taken at 9:57 a.m.)

(On the record at 10:30 a.m.)

CHAIRMAN APOSTOLAKIS: Sorry for this. There was some urgent business that we had to take care of. So we're back in session and Dr. Forester will continue his presentation.

DR. FORESTER: Okay, I think we've covered all of the assumptions, so I'll move onto the next slide which describes some of the major elements. There are a couple of slides on the major elements and characteristics of ATHEANA. We have talked about the fact that it provide guidance for identifying human actions for inclusion in the PRA model. It addresses whether the human failure event should be represented by one or more particular unsafe acts which could include errors of commission. It identifies the nominal scenario as the beginning process for an accident sequence as is usual on PRA and it identifies potential vulnerabilities and important PSFs for the nominal scenario and guidance is provided in the document for that particular -- in the user's guide that will be coming out shortly. And it has a search process for deviation scenarios.

And in that process, it identifies whether any particular aleatory influences including different plant conditions and other contextual deviations that should be considered for the PRA sequence of interest. So there is a focus also in addition to simply focusing on direct PSFs what kind of things might vary that could be important and lead to variation of what the crews do.

CHAIRMAN APOSTOLAKIS: John, are you familiar with an EPRI shop and the way they identify scenarios?

DR. FORESTER: Yes, I've read those documents.

CHAIRMAN APOSTOLAKIS: How different is your approach from theirs?

DR. FORESTER: Well, in terms of the, you know, developing the basic PRA model, I don't think there's going to be any huge differences and I think the process for identifying the nominal scenario would be similar. We may put a little bit more emphasis on a good understanding of the plant conditions that are fed into the human reliability analysis, but I think the basic idea of the nominal context of it would be similar.

CHAIRMAN APOSTOLAKIS: I would expect that the other guys would object to the comment that you would understand the plant better than they would.

DR. FORESTER: Yeah.

(Laughter)

CHAIRMAN APOSTOLAKIS: (Inaudible)

DR. FORESTER: There's more of an emphasis on investigating, you know, the plant conditions in the sense that maybe instrument failures might occur. Again, this goes more into the deviation analysis and the different --

CHAIRMAN APOSTOLAKIS: So you all are doing a more exhaustive deviation analysis from the expected scenario.

DR. FORESTER: Correct.

CHAIRMAN APOSTOLAKIS: I guess we'll wait until you guys take a vote or tell us, but essentially, though, my impression is from reading the various documents, that that part is done in a very similar way and people are very careful to identify some areas and conditions. There may be differences here and there and it depends also who's doing it, I guess, but essentially there is agreement that this is a very important part of the analysis and --

DR. FORESTER: Sure.

CHAIRMAN APOSTOLAKIS: So this is important from --

DR. FORESTER: Sure, there's SHARP, SHARP 1, there's better information and in some ways more broader information about the basic --

CHAIRMAN APOSTOLAKIS: And there are some differences in terminology perhaps. I mean, do they use the words "unsafe acts", and --

DR. FORESTER: No.

CHAIRMAN APOSTOLAKIS: No. And maybe that's something we want to correct in the future. It would be nice to have as much uniformity as --

DR. FORESTER: Certainly, HRP has become a PRA term. I think everybody uses it now.

CHAIRMAN APOSTOLAKIS: Yeah, yeah. No, I'm sure they're not objecting deliberately. It just happened that they did use the terms. Okay.

DR. FORESTER: Okay, a few more characteristics again, there's the use of the formal, facilitator-led expert opinion elicitation process. I think it's worth to note here, just as an aside, that expert judgments is involved in the use of all these methods. Expert opinion is deciding what PSF to use, how to judge the strength of those PSFs, how to adjust -- decide what level they're at, you know which value to use and that's -- you know, even in following the flow charts in THERP and deciding which tables to use, there's some very tricky decisions there which involve expert judgment and probably operation and training staff should be involved in all those judgments. So I don't think it's that dissimilar in that sense.

I think we've talked about most of this. You know, is there guidance for factors and so forth. The final thing is worth noting that there is an intent to address aleatory uncertainties in human failure events. We've changed that process a little bit from the last augmentation we've done. There's more of a striving to include aleatory influences in the specific modeling that we do in developing specific air force in context and account for those.

And then the distribution that's developed is intended to represent the distinguishing service.

CHAIRMAN APOSTOLAKIS: So this is the point, maybe, that we should look for in other methods, how they handle these things and whether they have the --

DR. FORESTER: I think so, yes. And that's the last of my slides, so if there are any questions, I'll --

CHAIRMAN APOSTOLAKIS: Are you staying until the end of the end of the day?

DR. FORESTER: Certainly.

CHAIRMAN APOSTOLAKIS: Okay, thank you very much, John.

DR. FORESTER: You're welcome.

CHAIRMAN APOSTOLAKIS: Any questions from the members? I guess not.

DR. LOIS: I just want to ask about that Alan Koloczkowski is on the phone right now and at 11:15 we have to turn off the phone and both Frank Rahn and Alan will join us for bridge time.

CHAIRMAN APOSTOLAKIS: So right now it's only Alan?

DR. LOIS: Right now --

MR. KOLOCZKOWSKI: Right now, it's me

again.

CHAIRMAN APOSTOLAKIS: Hi, Alan.

MR. KOLOCZKOWSKI: I can't see you but I can hear you anyway.

CHAIRMAN APOSTOLAKIS: Okay.

MR. BLACKMAN: Good morning.

CHAIRMAN APOSTOLAKIS: Good morning.

MR. BLACKMAN: Good morning, I'm Harold Blackman. Let's see, I'm with Idaho National Laboratory where I serve as the Deputy Associate Laboratory Director for Science and Technology. And I'm here to talk a little bit about SPAR-H this morning. This is a quantification technique. And actually this goes back to about 1993 and I can remember sitting in Pat Baronowski's office talking about the development of this particular method. And I think it's important to characterize why this method was developed, what the motivation was to really understand it better.

It was specifically and originally developed to be a quantification technique for the ASP program. We were given certain requirements, if you will, for the method and probably first and foremost was that it would be a method that was applicable by systems analysts who weren't HRA specialists. And because of that, we did tend to -- did tend to take a more conservative approach in terms of the generation of the actual error probabilities and the resulting error probabilities that come about from that particular method. The other thing was that it needed to be quick and easy to apply. You know, back in those days when an event would occur, it would be reviewed on a Monday morning and the NRC staff was interested in being able to perhaps look at the importance of that in terms of other power plants and other events that may have occurred elsewhere. They wanted to be able to have a method which would provide a guide for them to understand what that impact might be. So those were some of the original motivating factors for the development of SPAR-H.

The scope of the method, again, it is a quantification technique. It is not a comprehensive HRA method. For those who aren't thoroughly familiar with HRA methods, basically what that means is that this method is used to produce the numbers. We do not make any recommendations in terms of how to go about developing the fault entry structures. We don't make recommendations in terms of what you need to look at. We don't do that. That's not a part of this particular method.

What SPAR does do is it does quantify human errors. It does consider a range of PSS, it does consider dependency and it has gone through a substantial review and modification over the last, let's see, subtraction, is that 14 years, over the last 14 years. So it has a broad user base. We specifically collected information from that user base in an attempt to make the method more usable.

CHAIRMAN APOSTOLAKIS: Let me understand a little better this use in the accident sequence progression. So there is some sequence of events someplace that is declared an ASP. And the objective is to calculate the condition of core damage frequency given that these things have occurred, right? And then based on that, we declare it is important or not important or whatever.

So part of this evaluation may involve actions by the operators. So that's where SPAR-H comes in and says if they operators are supposed to do this, the probability of not doing it is that. It doesn't really get into the commission business, that all of a sudden they intervene and do something wrong, does it?

MR. BLACKMAN: Well, let's talk about that for a second. I mean, the intervening and doing wrong could, in fact, be part of that error. You know, within SPAR, SPAR considers both omission and commission.

CHAIRMAN APOSTOLAKIS: I see.

MR. BLACKMAN: And in fact, if you look at THERP, if you go back to the tables within THERP, which is where some of our methodology comes from, there's about three or four -- I think it's three, three of the tables in Chapter 20, which are the quantification tables, actually deal specifically with errors of commission. What THERP doesn't do and SPAR-H, you know, we've kind of borrowed heavily from THERP, we don't look at the complex errors of commission, which is what ATHEANA does.

ATHEANA looks at complex errors of commission. That's kind of another -- that's something else but we do quantify errors of commission. So it's -- you know, you operate the wrong valve, that is an error of commission.

CHAIRMAN APOSTOLAKIS: Now, the other point, it seems to me that it would be important for you as well to do this deviation analysis. I mean, it's not clear that the operators will go one way, right? I mean, the detailed scenario evaluation and identification that both ATHEANA and SHARP do, why isn't it part of this?

MR. BLACKMAN: It wasn't part of the task.

CHAIRMAN APOSTOLAKIS: It wasn't?

MR. BLACKMAN: No.

CHAIRMAN APOSTOLAKIS: It was just a matter of administrative.

MR. BLACKMAN: Right, we were not asked to develop that part of the technique and we were asked to develop a quantification scheme specifically.

CHAIRMAN APOSTOLAKIS: Okay.

MR. BARONOWSKI: George, can I give a little input to that.

CHAIRMAN APOSTOLAKIS: Of course.

MR. BARONOWSKI: Remember where we're starting from here. We already have a PRA. When you start talking about ATHEANA and SHARP, you're using those tools to construct your PRA model. Okay. We have a PRA. There is some event that occurred so we're overlaying it onto the PRA and we have a few additional questions about human reliability that relate to that specific event or condition.

So yes, if you want to understand a plant's risk and who human reliability plays into it, when you construct your PRA you have to have the right HRA to go along with it but in this case we're presuming that the HRA has pretty much been done except for the specifics that relate to the condition that's identified.

CHAIRMAN APOSTOLAKIS: I understand.

MR. BARONOWSKI: So it's -- as Gareth said, most of the sequential aspects are presumably derived from the PRA development initially and what we're now looking at are some of the quantification elements that change. There is some sequential change, too, but it's primarily just a quantification part.

CHAIRMAN APOSTOLAKIS: You can stay there if you want. I'm sure you --

MR. BARONOWSKI: I'll sit with him. He sat in my office when we started this.

MR. BLACKMAN: Feel free. And I guess I'd like to -- I want to clarify my comment when I'm talking about errors of commission because my colleagues want to make sure that everybody understands. When you actually model these things in fault trees, you're really modeling the fact that a particular action did not occur. Now, the reason that action did not occur, which is an omission, could be, in fact, a contributing error of commission. In other words, you inadvertently effected the wrong valve.

So when you look at -- when you look at resources for errors, those are some of the types of errors that actually lead to not performing an action, which is then a part of a fault or an event tree structure.

MR. PARRY: If you don't muddle the --

CHAIRMAN APOSTOLAKIS: Yeah, you've got to come to the microphone or keep silent.

MR. PARRY: This is Gareth Parry. But you don't model the consequences of turning that wrong valve in the sense that what would happen if that --

CHAIRMAN APOSTOLAKIS: That's correct.

MR. PARRY: So, yes, you use the errors of commission to come up with a number for an error of omission but you don't model the constant.

CHAIRMAN APOSTOLAKIS: I'm wondering -- you know, you interact with a licensee in whose plant something happened and the licensee doesn't use SPAR-H, right? How often do you disagree on the human reliability or error estimates that you come up with and they come up with something else? I mean, is that something that -- I'm not asking for statistics here, but is it something that is frequent?

MR. BARONOWSKI: Most licensees won't go back and do a detailed HRA period. They'll just argue over whether or not the way we've selected the PSS makes sense in the context of their plant's design and training and so forth. So there is disagreement but it's done through like a peer process, if you will, in order to come together. And just to put one more piece of contextual information here, when the ASP program was started, there were four human error values if I recall correctly, 1.0, .5, .3, .1. This was put in place to allow us to have more consideration into factors and a wider range of possibilities. That's all.

CHAIRMAN APOSTOLAKIS: I think it was -- there was a news item the other day that the whole SPAR model may be revised, right, go back -- that was in "Inside NRC".

MR. BARONOWSKI: Oh, I couldn't argue with inside NRC.

CHAIRMAN APOSTOLAKIS: I'm not asking you to argue. I'm just saying that the whole thing is up in the air now apparently.

MR. BARONOWSKI: Not that I know of unless they're talking about the issue of whether to use licensees, PRAs to quantify an SDP finding or not.

CHAIRMAN APOSTOLAKIS: Right, right.

MR. BARONOWSKI: That has nothing to do

with the SPAR models and techniques and methodology.

CHAIRMAN APOSTOLAKIS: Well, if you start using the licensee's PRAs there is not need for SPAR, is there?

MR. BARONOWSKI: Well, it depends on whether you want the NRC to have an audit function or not, much like the thermal-hydraulic computer codes, I think.

CHAIRMAN APOSTOLAKIS: Yeah.

MR. BARONOWSKI: It's an equivalent situation, but we do use our own methods to look at generic issues, the accident sequence precursors and other things, I couldn't give you the list right now but the STP is just one of the application areas.

CHAIRMAN APOSTOLAKIS: It's just one but it's a big one.

MR. BARONOWSKI: It's a big one.

CHAIRMAN APOSTOLAKIS: I mean, this is the real thing now where they're interacting with the licensees, right?

MR. BARONOWSKI: Right.

CHAIRMAN APOSTOLAKIS: I mean, it's the most important thing that the agency has.

MR. BARONOWSKI: Right, and we don't claim that the models have the depth that the licensee's models have. They were really meant to do a quick and dirty look as even Harold started --

CHAIRMAN APOSTOLAKIS: A very wise decision on your part.

MR. BARONOWSKI: Yeah.

CHAIRMAN APOSTOLAKIS: Please, Jeff. You can come here. There is a microphone here.

MR. JULIUS: Jeff Julius, Scientech. Yeah, this -- starting out with ASPARs, I think some of your ASPARs were based on ASPAR. There are differences and I think between the industry and the approach in SPAR and the SBP and this is one, I mean, where this is used as a basis for decisionmaking on the NRC's response to the plant and the significance of events and that is an area of interesting contention, at least with the industry.

CHAIRMAN APOSTOLAKIS: Well, there are most slides of this, so some of the questions will come up a little later. So unless you want to say something more about this, why don't you go on.

MR. BLACKMAN: I will go on.

CHAIRMAN APOSTOLAKIS: Okay.

MR. BLACKMAN: Some of the key assumptions that went into the development of SPAR, first of all, there is a model of human performance and cognition upon which SPAR-H is based. It's not based on specific plant conditions. It takes a general model of human performance which actually is a human information processing model. It takes that model. It then identifies the operational factors which you see present and are important in power plants and those things are things like available information, a quality of training, the experience of the individuals and a number of things like that, which we attempted to basically look at each part of how people take information in, consider that information and then take action.

And so they were broken out across that model. We then looked at all of those operational factors and then produced summary level PSFs that represented those operational factors. The reason why we did that is one of the other, you know, requests from the NRC at the time was to try and be complete, you know, try and be complete in terms of your considerations, in terms of the various factors that will effect performance. So when you look at -- you know, if you go back to the documentation of SPAR-H you can actually see what are the operational factors and which performance shaping factors those are considered in.

We believe that the model that we used was sufficient to describe human performance and it really doesn't matter whether you're talking about a pre-initiator or a post-initiator, whether you're in a shutdown, whether you're -- it doesn't matter because the human performance is not contingent, how we behave, you know, how we process information is not contingent upon the specific situation.

So, essentially what we then had is we had this model which was based on how people work, which them produced the PSFs that we would then use subsequently in the quantification task itself.

CHAIRMAN APOSTOLAKIS: Well, it's not very clear in my mind what exactly you meant. You started out by saying that the model is very strong on a human performance member model, not a specific plant condition, but the last bullet says plant conditions are included.

MR. BLACKMAN: Right.

CHAIRMAN APOSTOLAKIS: So you're starting by having this model of how humans perform and then somehow the plant condition comes into it at some point.

MR. BLACKMAN: The plant condition produces the context or the environment within which the operator is behaving, and because of that, those conditions themselves then change the performance shaping factors that impact that operator's performance, so that's where it comes into play.

CHAIRMAN APOSTOLAKIS: Okay. All right, and these performance shaping factors are specified. I remember there is a table.

MR. BLACKMAN: There is a table. In the new method, there are eight. In the original method, there were six.

CHAIRMAN APOSTOLAKIS: I'm wondering what kind of peer review this model has seen.

MR. BLACKMAN: Well, boy, we've been reviewed, I don't know. How many times have we been reviewed?

MR. BARONOWSKI: I don't know, by the ACRS, you mean?

MR. BLACKMAN: Well, the ACRS --

CHAIRMAN APOSTOLAKIS: No, the ACRS has not reviewed it. We've had a meeting but we haven't really -- but let me tell you why I say this. Last time I looked, there were some issues that in my mind were questionable and I would like to have you and your colleagues address them but maybe today is not the right place.

For example, as I recall, there is a performance shaping factor regarding the culture of a plant. Is it still there, is it still one of the eight?

MR. BLACKMAN: Let me think about culture. I don't think -- no, I don't think we have culture.

CHAIRMAN APOSTOLAKIS: When I saw it, there were red lights going off.

MR. BLACKMAN: Let me read -- this is so I don't miss one. It's available time, it's stress, complexity, experience and training, procedures, ergonomics, fitness for duty and work process.

CHAIRMAN APOSTOLAKIS: Work process.

MR. BLACKMAN: Right.

CHAIRMAN APOSTOLAKIS: What do you mean by that?

MR. BLACKMAN: Work processes are -- you know, they are the way in which work is performed, the controls associated with that work. There would be some culture elements of that, of the work process itself. Actually, we used -- when we originally considered work process, we used a variety of the literature that was out on work process at the time.

CHAIRMAN APOSTOLAKIS: Now, within each performance shaping factor as I recall, you have various levels.

MR. BLACKMAN: Correct.

CHAIRMAN APOSTOLAKIS: Right, and for example, for this particular PSF, how do you decide on the level? I mean, how do you go and say, "Oh, the work processes of this facility were good", or, "They were mediocre"? It's a mystery to me because I don't think anybody really knows. So you make a judgment there and you assign a PSF. So can you elaborate a little bit on that?

MR. BLACKMAN: Sure. It's based on the information which is available about the specific area that you're attempting to quantify, the specific plant, the situation and the context in which it was performed. And that's the information that is used. Now, if there is no information in regard to work process, the method directs the individual to assess it at a nominal level which has no impact on the error itself.

So what we're doing is we're affording the opportunity of the analyst to use that if, in fact, it was a critical element in terms of that particular error that was made. And you know, one of the problems, again, if we go back to 1994 is, one of the questions that was raised, you know, if there was a work process problem, we didn't talk about that specifically because that was added later, but there may have been a fitness for duty problem. And if you don't have a way to account for that in the analysis, then you cannot represent it.

So if you're going to replicate an event that occurred that was due to a fitness for duty problem or was due to a work process problem or was due to whatever the problem may be, you have to have the ability to factor that in, in an appropriate way.

CHAIRMAN APOSTOLAKIS: There are two questions there. What is the basis for assigning a PSF to a particular fitness of duty level? Is it just your judgment and somebody else may have a different judgment?

MR. BLACKMAN: All of these multipliers, you know, that are a part of SPAR-H actually come from other methods. Originally, the rates were derived from THERP, and in fact, if -- I don't know whether you have read the NUREG but 6883 is the NUREG. And in fact, there is a table in 6883 which is --

CHAIRMAN APOSTOLAKIS: The one that's SPAR-H?

MR. BLACKMAN: Yeah, SPAR-H, Table 2.3 actually goes through and shows the comparison of the multipliers to the --

CHAIRMAN APOSTOLAKIS: 68 what?

MR. BLACKMAN: 7883, NUREG CR 6883. And Table 2.3 actually goes through and shows the comparisons of the multipliers from some of the second generation methods to SPAR-H. Now, originally, the original multipliers that came out for the 6 PSF, and by the way, work process was not one of the original -- one of the original performance shaping factors. At that time we had complexity, stress and workload which was integrated into a single factor, experience and training, procedures, ergonomics, fitness for duty and crew dynamics. And that was one of the comments that we were given as we went through the process of field testing this particular method, that that was something that was desired to be added to the method.

And, of course, if you look back in the early -- late 1990s and early 2000s there were individuals who thought that work process was an important part of PRA and were actually developing methodologies in those areas.

MR. BARONOWSKI: I was just going to say that really what he's describing, I think, is to say that this is not a sort of a new stand-alone fundamental method. It's more or less of a agglomeration but a simplification too, of existing techniques. That's the way we pretty much directed it be done because we didn't want to try and go and develop new groundwork in HRA. We just wanted to take what was existing and in some cases difficult to use, if you can remember in the early `90s when they started ATHEANA and everything, and SHARP and all the other techniques, there were a dozen different approaches, and we said, "Hey, look, we can't deal with a dozen approaches. Harold, there's a dozen approaches, give me one simple one back", and that's how it happened.

CHAIRMAN APOSTOLAKIS: Well, yeah, and again, today's purpose is not to go back and see why things were developed. The question is, where do we go from here? So if I go and look at ATHEANA or the EPRI HRA and see something it would be relatively easy for me to find how SPAR-H numbers and approaches relate to those methods? I mean, is there a common underlying theme there or is it different? And if there is a common underlying theme, I would come back to my earlier comment when John Forrester was speaking, why can't I use something like SPAR-H which sounds very straightforward, and maybe a variation of SPAR-H, to screen most of the human errors, screen not in the sense that I will neglect them, assign some reasonable probabilities without going through the expense of expert opinion elicitation and then focus on the few that survive and are more controversial like, you know, the bleed and feed for example in the old days that Mario mentioned, and apply them the more rigorous method of ATHEANA?

Why can't I blend the two? Why do I have to have them separated? Would you object to that? Do you think there is any hope? Maybe not with the existing methods, but is there any hope that this may happen?

MR. BLACKMAN: Well, there is absolutely no reason why one could not use SPAR-H to quantify the resulting human failure events that come about from an ATHEANA analysis. There is no reason why you could not do that. Now, again, but SPAR-H is not going to -- I mean, SPAR-H, you know, then on the other hand, you know, if you look at all of the other work that ATHEANA does in terms of really trying to identify unique failure events, which is what it's about, okay, you know, really getting in there and trying to examine and see where these unique situations and, you know, the complexities of the environment may produce behaviors that aren't originally anticipated, then, you know, but SPAR does not deal with that. SPAR is simply the quantification engine. That's all it is. And if I am sure if you look at -- and I'm not familiar with it, you know, I'll tell you that because I am not a member of EPRI either so I'm not familiar with it, and it -- you know, I'm sure that you could use this as a calculation tool. Once you've identified a human error, a human failure event, you could plug it right in and chunk out a number. Now how that number would compare with the result from the calculator, since the calculator is THERP-based as I understand, is that correct?

Okay, I would imagine they will be pretty close. This might be a bit more conservative but it will be pretty close, that will be my guess.

CHAIRMAN APOSTOLAKIS: So what Pat say earlier about this method assumes that there is a PRA, really what you mean is assumes that is an evaluation of the various scenarios and their deviations and then the quantification can be done using SPAR-H.

MR. BLACKMAN: Yes.

CHAIRMAN APOSTOLAKIS: Okay.

MEMBER BONACA: Although, you do have some overlap, I mean, because you do have performance shaping factors so --

MR. BLACKMAN: Well, the analysis that was done that provided those human failure events or those human errors what SPAR requires is that there is some data regarding PSF that we use. Without that data, then you can't apply it.

CHAIRMAN APOSTOLAKIS: No, after you decide what the PSFs are, is it up to the judgment of the analyst how to put everything together and come up with a probability or is it a rule?

MR. BLACKMAN: No, there's a rule.

CHAIRMAN APOSTOLAKIS: There's a rule.

MR. BLACKMAN: Yeah, and we'll talk about that.

CHAIRMAN APOSTOLAKIS: Okay, so let's go on.

MR. BLACKMAN: Okay, so here is the rule. There are two basic task types, there are diagnosis and action. We use those and there are distinct failure rates, base rates, that are associated with each of those and it's .01 and .001, diagnosis being .01 and action being .001. Those are the base error rates. Those base error rates are then manipulated by the multipliers that will either degrade or improve performance and what we have, again, are the weights that are associated with each of those PSFs.

The rates themselves are benchmarked against the other methods, I've already mentioned that, and then the method allows for modification due to dependency. And dependence is based on an assessment of the combination of cues that are present to the operator which cues them to actually taking action, where it's being done, the time and whether or on it's the same or a different crew.

So it's -- all you do, George, is you assess the PSFs. There are specific weights or multipliers that are -- that are then result from that. Those are then multiplied times the base error rates. There are a couple of correction factors that are in there to make sure that we don't exceed -- well, there is a correction factor that is now in there which is something fairly recent that insures that you don't exceed one and then, of course, there are uncertainty that is also associated with those failure rates.

CHAIRMAN APOSTOLAKIS: Well, I mean, that's proceduralized but there is a lot of judgment there, you know. Maybe not the judgment from the analyst, but your judgment.

MR. BLACKMAN: I mean --

CHAIRMAN APOSTOLAKIS: This is the theme

today it seems to me, that the more proceduralized the approach is, the more you give up something, you know, the specifics of the situation, perhaps the freedom that the analyst will have to adjust things and so on. You might argue that the freedom still exists because the analyst may adjust it be assessed, but I think we will hear also maybe later but that's one of the objectives, to proceduralize it as much as possible so people can actually use it and of the other extreme is ATHEANA which requires a more detailed evaluation.

MR. BLACKMAN: Right, you know and one of the concerns right along was whether or not the results of one these analyses are repeatable. And one of the things that we went through with SPAR-H is actually investigating the reliability, inner rater reliability of SPAR-H. And although I don't remember the specific values but they were on the order of a correlation of .8 or so, which actually is quite good.

So that when analysts would go through who had been trained on the method, would go through and do an analysis based on the same information. They would come up with the same answer. That was also you know, something that we wanted to be able to deal with. Yes, we do -- sure, this method is based on you know, the knowledge that's been gained through the last, you know, 20 years of work in human reliability and yes, you know, we do believe that you really do need to think about human actions within context of the way that we behave and think and perform. And so yes, we're going to constrain you.

We're going to constrain you because we believe that that's how -- I mean, that's actually the way things work and that's how you get better predictions is to, you know, cause people to make decisions within the right -- considering the right variables and the right relationships of those variables.

CHAIRMAN APOSTOLAKIS: Now, there are some -- I remember equations, let's call it that, some were there with some very strange numbers, like 400 and all that. These are intended to reflect dependencies or, I don't remember now?

MR. BLACKMAN: Well, for dependency, specifically, we simply use THERPS approach and THERPS formulas for dependency. So those come directly from THERP actually.

CHAIRMAN APOSTOLAKIS: So we have an equation. That's why I asked about peer review because I have a lot of questions on those but today is not, perhaps, the place to do it. One thing about the dependencies, by the way from the early days of THERP, it seems to me the major uncertainties whether the letter of dependence is say strong or weak or something like that, not just taking one of the equations of dependence and then putting the uncertainty on the -- on their failure rate.

In other words, a structural thing is the uncertainty. Is it really a strong dependence of is it some other kind of dependence? But very few people in my experience, to that anyway. So this is a very proceduralized approach that is based on essentially THERP; is that the argument?

MR. BLACKMAN: Well, there isn't an argument. It's just what it is. And the actual quantification, the values are based on THERP. The method itself is based on a human model of performance from which we generated performance shaping factors from which we then used based rates from THERP and multipliers originally to do the quantification.

So it departs from -- because again what we were attempting to do was to assure some level of completeness in terms of what was considered and then use the best available data in order to provide the failure rates themselves.

CHAIRMAN APOSTOLAKIS: Now one of the PSFs refers to the available time?

MR. BLACKMAN: Yes.

CHAIRMAN APOSTOLAKIS: Okay, keep going.

MR. BLACKMAN: Okay.

MR. BARONOWSKI: I was going to say, did you not look at the number of PRAs to see how the values --

MR. BLACKMAN: Yes, we did. Yeah, in terms of the validation, you know, in terms of validation we did look -- we did do -- we quantified specific sequences, looked to PRAs to see how well our numbers actually agreed and again, they agreed quite well.

MEMBER BONACA: But that implies that all PRAs would have consistency of the human factor then. At the IP level it wasn't the case. I mean, in fact, in one of the SPAR-H, SPAR, they used common methods for all plants. What kind of insights to you have now on this variability by plant?

MR. BARONOWSKI: I don't have that insight but I'm sure it's one that would be worth having.

MEMBER BONACA: Well, I mean, you know, I think the way I see it, since SPAR-H is available and you're doing work, it would be --

MR. BARONOWSKI: Yeah, I think there's

definitely room to move forward, because we really have stopped working on this for some time now. And there's really nothing more for us to do because, as you were mentioning, George, when the issue is so complicated that it falls outside the realm of what we think this tool is capable of handling, we've got to go to the more sophisticated tools. And that's actually part of our procedures.

Now, I don't know how many people will actually go and do and try and use an ATHEANA mainly because it's got a reputation rightly or wrongly so deserved, about being something that takes a lot of effort and time and you just can't do it in a practical way. I'm not saying that's true. I'm just saying that's the reputation.

CHAIRMAN APOSTOLAKIS: Well, that's why the SRM from the Commission was issued.

MR. BARONOWSKI: Yeah.

CHAIRMAN APOSTOLAKIS: Trying to see whether we can blend these methods and not scare people with one method and not over-simplify it with another method. That's the whole point.

MEMBER BONACA: I still am confused about the statement because you say you find consistency with the industry approach and then the next statement is that there isn't consistency among them.

MR. BLACKMAN: Well, let me clarify that because what we were looking at is individual errors, just one error rate within a PRA and so then the inconsistencies come about for you know, in terms of the total, come about because of a number of different reasons. The actual individual error rates are I think -- well, Erasmia can speak to this since she did a lot of work in looking at the actual error rates and the agreement of those, but there's less -- you know, relatively less variability there.

The other thing that we did do is we -- you know, there has been -- reliability has been verified in other domains as well. I mean, SPAR-H has been applied in aviation and space. We've also done some experimental work to compare those values but that's been done outside the agency, really.

CHAIRMAN APOSTOLAKIS: I think we've covered some of the stuff on the following slides but feel free to point out what we have left out.

MR. BLACKMAN: I think we've covered this.

CHAIRMAN APOSTOLAKIS: Yeah, I think we covered this one.

MR. BLACKMAN: And the next one, this is just a little more on why we selected THERP and

George, you kind of asked that question a little earlier. You know, there are study -- validation studies of THERP. There's not very many. There's a handful. I give you one example there where an experiment was actually run to generate failure rates and then was compared to quantification by THERP. Again, it's familiar. It had values which were readily available that we could work with.

And the reconstruction that we did again was to result in this tractable easy to use sort of a technique. What's happened over the course of the first version which was in 1995, I think that's when we published the internal report that describes it. Since then, it's been in use. There's been a lot of field testing and again, we've made modifications based on that field testing and based on the results that have been obtained.

We also have modified it a little bit to deal with different operational modes because some of the multipliers needed to be changed in order to deal with those unique modes and shutdown for example. I've already really talked about dependency, and again, it's a logical combination of factors to deal with dependency and it allows the analyst to consider the factors that really impact that. Again, it uses the THERP equations for adjusting those conditions.

And that's it.

CHAIRMAN APOSTOLAKIS: Okay, so who's going to talk about all HRA models?

DR. LOIS: Actually, Alan and this is the perfect time because when he's through we'll turn the phone off in the time frame and Alan will call.

MR. KOLOCZKOWSKI: Okay, so I'll come back in just a minute or two.

DR. LOIS: Yes. I think this is not going to take more than -- I guess we can go ahead.

CHAIRMAN APOSTOLAKIS: Are we back? Okay, well, welcome gentlemen, and now Dr. Lois will tell us about everything we want to know about all HRA methods.

DR. LOIS: And I will defer that to Alan Koloczkowski for a minute. I'm going to flip through the slides and Ala will cover the material.

CHAIRMAN APOSTOLAKIS: Okay, Alan.

MR. KOLOCZKOWSKI: Okay, this is Alan Koloczkowski with SAIC. I think we're on Slide 25, I believe in your package.

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLOCZKOWSKI: Okay. Now that you've heard a little bit about at least the most prominent

NRC methods, and of course, you'll hear more about the EPRI methods a little later.

CHAIRMAN APOSTOLAKIS: I'm sorry, we haven't heard about this other method that relies only on time and was developed for fire assessments. Is that still an NRC method?

DR. LOIS: It's not an HRA method.

CHAIRMAN APOSTOLAKIS: No, but it deals with human error.

DR. LOIS: But that --

CHAIRMAN APOSTOLAKIS: If I were a licensee, I would rather that way than have to argue that the probabilities are correct or incorrect.

DR. LOIS: So our position is that this is a method for assisting with the determination of the ability of manual actions for fire events.

CHAIRMAN APOSTOLAKIS: Right.

DR. LOIS: And it terms -- in a deterministic manner, and does not involve probability so we're not considering that method as part of the HRA suite of methods. And we're not prepared to talk about that.

CHAIRMAN APOSTOLAKIS: But --

DR. LOIS: Unless -- I mean, if you would like we would in the afternoon, I believe I had a presentation that I did --

CHAIRMAN APOSTOLAKIS: Yeah, I think it would be useful in the afternoon to simply bring it up and maybe use some of the slides you already have because if I were a licensee and I was given the option of going that way, I would rather do that and argue that I have enough time and I don't need to quantify anything because the moment you start quantifying probabilities, you are inviting criticism in reviews. So it's not an HRA matter but it gives you a way to avoid HRA.

DR. LOIS: Actually, on the basis of the comments we received on NUREG 1852 that describes the method, we don't believe that licensees would follow that path. They object to the use of the 1852 criteria a lot. And we're going to have the opportunity to brief you. We have a briefing on May 4/5 on 1852, the NUREG so we'll cover that area, but I'll be more than happy to discuss a little bit about that.

CHAIRMAN APOSTOLAKIS: Yeah, because, in the afternoon, as you know, we have enough time for discussion and at least some briefing so that it will be part of the discussion I think would be useful without necessarily reviewing that particular method.

DR. LOIS: Okay, it will be some slides that we used before.

CHAIRMAN APOSTOLAKIS: Yeah, sure, sure and it doesn't have to be exhaustive either. So Alan, back to you.

MR. KOLOCZKOWSKI: Okay. Slide 25.

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLOCZKOWSKI: Okay, a couple of positives first, to some extent. I think if you try to stand back and you look at all the methods and I'm including not just the NRC method, but also what you will hear about in terms of the EPRI CBDT method for instance, HLRE, what have you. They all certainly provide a means to investigate what are the potential drivers of human performance and ultimately through the quantification portion of the various techniques, try to come up with an HEP which is necessary if you're actually going to quantify the risk.

You've got to come up with a probability. And they certainly all attempt to do that and they attempt to identify what the important drivers are. And so to that extent at one level, certainly there is strong similarities among the methods. However the next bullet, the specifics vary. And this is really getting at some of the things we were just discussing a moment ago when we were going through the SPAR-H. What are the influencing factors that need to be considered, how many? I know we talked about SPAR-H originally had six and then went to eight.

ATHEANA talks about having 15 or 16 different PSFs. THERP and ASEP actually quantify something more like in the neighborhood of four to five PSFs. So when you get down to more of the details of what the influencing factors really should be, how they should be interpreted, how they're defined, how do you measure the strength of those, that's when you start getting variability among the methods. And then further, how you take that qualitative information such as maybe one method said this is a highly complex situation. Maybe in ASEP terminology the equivalent is, this is a dynamic situation.

So how you actually take that and then turn it into a human error probability again most of them use curves or certain rules or a certain figure you look up or whatever, to somewhat try to constrain the analyst in most cases, and turn that qualitative information into a probability and again, the methods, the rules, the curves vary somewhat from method to method.

So one conclusion that one can draw which is getting to the third bullet here, is that certainly all methods attempt to recognize at some level what conditions, what influencing factors should tend to lead to higher error rates versus those that should lead to lower error rates. And I think one of the questions we have to ask ourselves, all of us, industry, the NRC, et cetera, going forward, to try to address this SRM is, is that good enough for a current and anticipated application?

In other words, if we can agree that no matter what method we use that generally they do correctly identify those cases where we would expect the HEP to be fairly high versus those cases where we would expect the HEP to be low, and let's not care necessarily about the exactness of the number, that is the accuracy of the number, let's not care about how we specifically define the PSF that led to those numbers. If that's a good enough answer, then maybe we don't need to go any -- much further forward in the whole field of HRA for that matter.

If on the other hand, one needs to ask the question, do the specifics matter, in terms of knowing what are the drivers, how do we define them, what does that mean in terms of improvements we ought to make to the plant, and how accurate do the numbers have to be, I think those are questions that we haven't really answered to ourselves yet. And I think those are the questions we have to keep in mind in terms of going forward.

CHAIRMAN APOSTOLAKIS: But in the -- no, let's stay there. I'm not sure that the question how accurate do we need to be is the question we should be asking. What we should be asking, it seems to me, is if I -- do the results that I get depend crucially on the method I have chosen and if I choose another method, I will get very different results?

MR. KOLOCZKOWSKI: I think it depends on what you mean by the word "results".

CHAIRMAN APOSTOLAKIS: Results, I mean, a distribution, not a single number. And again, they don't have to be exactly the same, but you know, I mean, if one method gives me a range of between 10^{-3} and five 10^{-2} and another gives me, you know, the same thing essentially but maybe a factor of two here and there, I wouldn't worry too much about it, but if there is significant different as to where the distribution lies, then I would worry. So it's not a matter of really how accurate I need to be. The question in my mind is if I go with SPAR-H or if I go with a calculator, am I going to get drastically different results and if that's the case, why?

Now, Jeff wants to say something.

MR. JULIUS: Hi, Alan, Jeff Julius, Scientech. I'm going to present in -- our formation of this last question is, do the results or the insights from the results, would they change the decision making? You know, we're doing these for applications. That's what you really rely for.

CHAIRMAN APOSTOLAKIS: And I think that's a great way to look at it because ultimately what matters is the decision, that's very true. What really matters is the decision. It's not just the assessment. Okay, Alan, we can move onto 26.

MR. KOLOCZKOWSKI: Okay. Okay, that leads to some issues that we think that we need to at least keep in mind and we will try to address the SRM. First of all, I think we need to recognize that there's been a lot of momentum to use existing methods, no matter how old they are, whatever. We still talk about people using THERP a lot and so on. And because of that, though, we can't even agree, for instance, among methods as to what the list of performance shaping factors ought to be, how they ought to be defined and interpreted and ultimately how to define the level for each factor such as you know, just answering the simple question, what is high work load. Trying to answer that question and using different methods, terminologies, et cetera, is very often quite difficult.

Now, I will say this; there are strides being made to improve this and I know for instance, I know Jeff Julius personally to the extent that he is able to impact what's going on, on the EPRI side, et cetera, they're making strides to try to get their PSFs lined up more and more towards things that for instance ATHEANA might do or SPAR-H might do, et cetera. So I'm not saying we're not making some progress, but clearly when one method is using the term it's a dynamic situation, that is ASEP, and another method is saying, this situation is highly complex, are those equivalent or are they not equivalent, and if they're not, then do we need to make them equivalent or at least identify how they're different so that people understand the differences when they're using one method versus another.

So that's one issue I think we need to recognize is that there's a whole host of terminologies out there and they are not necessarily consistent. And maybe one of the things we have to do is work on that issue as well.

CHAIRMAN APOSTOLAKIS: Maybe we should hire you as a consultant to the committee. These are the questions that really we are asking. This is why this whole issue has been raised. I mean, do we use the same language, would it mean the same things and so on. So you're doing great, Alan.

MR. KOLOCZKOWSKI: Well, I'm hoping the next few slides are, in fact, the kinds of questions that we all ought to be asking ourselves.

CHAIRMAN APOSTOLAKIS: Okay.

MR. KOLOCZKOWSKI: Okay, number two, we just heard about the fact, repeatability. This gets to the repeatability issue primarily. And again, I think we are making strides among many of the methods and the calculator probably more so than most methods are trying to remove some of the flexibility that would therefore, lessen the analyst-to-analyst variability in using the method. And so to that extent, we're trying to make the methods more cookbookish. We're either forcing the user to use the specific curves or a specific table or a specific value or in the case of ATHEANA, for instance, which is a much more flexible method, we're at least trying to shore up the guidance, et cetera, to try to lessen to some extent the amount of flexibility allowed by using the method.

Yet, in spite of our best attempts to do that, and I think, again, this point was made at least I know during the SPAR-H discussion that I was listening to, I don't know if it was made during some of the other discussions, that even among the most prescriptive methods, analysts still have to use judgments with regard to some of the inputs that go into the method, such as deciding is this procedure good or is it nominal or is it poor?

The analyst has to make that judgment. Now, I'll grant you that the documentation of the method provides some guidance to help analysts make that judgment, but the bottom line is, the analyst has to make the judgment and so no matter how prescriptive we get these or try to make these methods, the point is, there is still some level judgment that goes into deciding whether the workload is high, whether the workload is low, or whether the work process is good, whether the work process is poor, et cetera,

Clearly the less prescriptive methods, like ATHEANA would seem to even be more problematic in this area and I'm not so sure that's necessarily true but clearly there's much more flexibility in methods like ATHEANA than perhaps, one of the prescriptive ones. And I think the bottom bullet is worth highlighting, that in spite of the fact that we try to make these things more prescriptive, have somewhat less flexibility, therefore, trying to improve repeatability, we still continue to see certainly at some times, different answers between analysts even though they're using the same method, which -- and it's because of these issues that I've raised in the earlier bullets.

You still have to put the -- that analyst still has to decide on the goodness of the procedure, the goodness of the HMI, et cetera, and one person's view may be different than another person's view.

CHAIRMAN APOSTOLAKIS: But there is also.

MR. KOLOCZKOWSKI: As an issue we have -- repeatability is an issue we have to keep in mind.

CHAIRMAN APOSTOLAKIS: I mean, there is no question that judgment is important but there is also another issue. I mean, it's not just selecting the PSFs and the level of the PSFs. Another issue that is important is the structure of the model itself, the fundamental approach. There are many similarities, we've agreed, you know. The methods look for scenarios and deviations and so on but there is another issue that has to do with the time. Some methods focus on the time that is available to the operators to act and everything else is a performance shaping or a set of performance shaping factors. Other methods treat that time as one of the performance shaping factors. So the analyst now, in doing the judgments has to include that in his or her evaluations.

And I think that's an important distinction, especially in some regulatory actions as power uprates where the main finding is that the available time is shortened by a little bit. So it seems to me that there is a difference there in methods. If one method uses time as just another PSF, he will handle that in one way. If another method really focuses on time itself, he will handle it in a different way. So in addition to the issues that you mentioned, Alan, I would say that the structure of the model itself in particular how time is handled, is a crucial issue, at least in my mind and I haven't seen an argument against it.

And it's something that we really have to investigate and see what we can do about it.

MR. KOLOCZKOWSKI: Understand.

DR. LOIS: But I do want to get a point up here which management brought awhile ago during this benchmarking exercise for the ASEP and the THERP method. Time is treated fundamentally in a way, the same way in known methods in the sense that the first thing you do is you find out how much time you have to do the action and then how much time has been calculated through thermohydraulic analysis.

So it's not just a PSF. Then you find out how much time you need and how much time you have available and then the difference in the methods here is some methods lead you to a curve to find out what is the failure probability for a diagnostic event, or you use a curve to find out what is the failure probability for the whole human action but it's not a PSF like every other PSF. It's more -- the whole structure of the human failure event has been based on the time available and the time needed.

CHAIRMAN APOSTOLAKIS: Well, but if I look at the -- say the EPRI calculator, I mean, there is much more emphasis on the time than on other matters.

DR. LOIS: But the emphasis comes into the way if I know -- if I have enough time then my error rate is pretty small and therefore, I can use those curves to come up with it. Yes, it's more structured way but what -- and I believe many is true and I don't know if you all agree with that. Time is a very -- it's been treated very, very differently than just one PSF, because you build your whole -- eventually your task analysis on the basis of the time needed.

CHAIRMAN APOSTOLAKIS: I'm not sure, I think --

DR. LOIS: It's not rigorously -- I agree with you, that it's not rigorously calculated -- taken into consideration and each one -- from every method, but it's not a PSF like stress which is a lot of judgment; is it high stress or less stress. There's a lot of judgment there. The time is not a judgment call, actually. You know how much time you have.

CHAIRMAN APOSTOLAKIS: Well, there is more to it because in -- when you go to curves, then you try to justify the curves. You maybe do some experiments or, I don't know what the new program that you have in Idaho are. They're both time, right?

DR. LOIS: Fortunately because time is --

CHAIRMAN APOSTOLAKIS: So you can get mostly -- as you know, we had a presentation from the Halden people some time ago and they really looked at time and they -- in fact, it was also aleatory there, so it does appear that, you know, depending on the approach, you pay more attention to it. I'm not saying that the other methods ignore it but it's one thing to say it's a PSF and important PSF and quite another to focus on it and try to get out curves and various -- and we'll hear from EPRI later unless you want to say something now.

MR. JULIUS: I'll just say, I'll describe it more later.

CHAIRMAN APOSTOLAKIS: Okay, but my point is that it's not just a matter of deciding on the right number of PSFs and the levels that Alan mentioned and I agree with that. Let's not forget that the basic structure of the model may be different, that you may select something and focus more on a method than another method might focus on without necessarily ignoring it. Okay, so then moving onto, what, 28 now?

MR. KOLOCZKOWSKI: Yes, Slide 28. This one gets to really the benchmarking or if you will, to some degree validation issues. And you heard and correctly so, that there has been some amount and some attempts to try to benchmark or validate numbers to some degree. Certainly SPAR-H when it was being put together, looked it its multipliers, versus other methods' multipliers, et cetera, as a means of benchmarking, et cetera.

But, I think the one thing that we have not done enough of and one of the things you'll hear more about this afternoon with the Halden benchmarking project is, the bottom line is we want to know when we come up with an HEP, using a method whatever method it is, and we also try to say and these are those reasons for that HEP, these are the drivers, the procedures are poor or the training is poor or whatever it may be, we want to know are we predicting the right drivers so that way we can put the right fixes in place if we decided the risk is too high and we need to do something about it, otherwise, do we need to train the operators better, do we need to improve the procedure, whatever.

And secondly, is the HEP, if you will, correct whatever that means? Is something about .5 the right number or is something around 10^{-3} the right number? It seems to me those are the two things that we really are asking the methods to produce correctly if you will. Give us the right drivers and give us a pretty good idea of what the right HEP value is. And yet, we are trying to predict human performance in very rare events. We're talking about core damage scenarios and PRAs where we have multiple equipment failures and so on and so forth, and obviously, these don't happen every day. So there's no real data out there and so we don't have a measure of truth, if you will, as we do with equipment failure rates where we can actually go and say, "Well, we know we're predicting the right HEP value because look at these events over here and look it, the failure probability is around .5 or is around 10^{-3} or whatever".

And so that whole HRA field suffers from the fact that we have not yet taken on the issue of really trying to do some amount of validation and how we should do that validation to find out if the methods of producing at least the right drivers and approximately the correct HEP values. And that's something we've got to tackle at some point and we're trying to do that and you'll hear more about that in one of this afternoon's discussions.

And the next slide is the two issues that we think also remain. Again, methods are beginning to take on this issue of error commission. And I'll put my ATHEANA hat on for just a moment. If, indeed, though, the most severe event that has occurred, whether it's TMI or whether it's Chernobyl, whether it's the challenger accident, whether it was the Air Florida accident that happened in Washington, DC, typically the really severe events had errors of commission involved in them. And if we, to some degree, fail to really go out and investigate, try to analyze to the same level that we analyze errors of omission now, try to analyze errors of commission, if we don't include that, at least is raises the question are we missing an important aspect of the human risk? And to what extent moving forward do we have to make attempts to be more explicit about trying to come up with, analyze, and address the whole error of commission issue?

And finally, specific training, if we are going to have multiple methods in the end, and again, kind of getting back to the repeatability issues, can we increase the repeatability issue by perhaps, putting further emphasis and further resources on training of these techniques to try to make sure that people are up to speed with the nuances of the method, et cetera, as a means to try to reduce to some extent this analyst-to-analyst variability but I think it's going to persist because even in the most prescriptive methods, still analysts have to make judgments with regards to the input.

Which leads to the last slide, we believe that the commission direction as outlined in the SRM supports many of these activities. I think these five points that I've tried to make are issues that we're going to have to address in making a decision do we try to come up with one method or if we come up with multiple methods, when should we use them. We think those five issues that I've addressed have to be part of this process and in going forward, we do want to acknowledge that we're trying to make some progress on the benchmark issue and again, you're going to hear more about that in one of this afternoon's presentations. But clearly , we recognize that we need to collaborate with the HRS with regards to ideas on how to address these issues moving forward and I think, speaking on behalf of the agency, I think we're very interested in collaborating with EPRI, with the utilities, et cetera, to try to address these issues and starting right from the very first question that I raised earlier that Jeff Julius put so well, if what we have now is good enough for the decisions that we need to make, then maybe a lot of these issue go away, but if they're not good enough for certain kinds of applications and these issues do come up and do have to be addressed, then we've got to figure out a way that the Agency and industry together on how to move forward to address these issues.

That's all I have.

CHAIRMAN APOSTOLAKIS: Thank you, Alan. Now, before we proceed, maybe we can do some planning here. Are any of you constrained by flights or anything? What time do you have to leave because the schedule is to finish at 5:00 but the way we're going it seems to me we're going to go a little beyond 5:00. So the visitors, do you have to leave?

DR. FORESTER: I don't have to leave.

MR. JULIUS: I was going to leave around 3:30 or 4:00 but I'll have to change it during lunch.

CHAIRMAN APOSTOLAKIS: Yeah, it would be a good idea for you to stay, I think, Jeff. Okay, so then we're free to continue our discussions.

The next one is Jeff. How much time do you want? I mean, shall we do it after lunch or do it now and then go to lunch? How much time do you think you'll need?

MR. JULIUS: Well, I appreciate the opportunity to take the coveted after lunch spot. I think I will go for it. This would be a good time to take a break here.

CHAIRMAN APOSTOLAKIS: You think it's a good idea to stop now and --

MR. JULIUS: I'm going to basically focus on the differences. We've heard --

CHAIRMAN APOSTOLAKIS: Yeah, okay.

MR. JULIUS: So --

MR. ELAWAR: I have a very short presentation.

CHAIRMAN APOSTOLAKIS: No, you'll have your time.

MR. ELAWAR: After him.

CHAIRMAN APOSTOLAKIS: The most important thing, it seems to me is -- well, we want also to hear from Erasmia on the planning of the benchmark exercise but then I would like to have plenty of time for free discussion, you know, so people can discuss their views and so on. That's the whole point of a subcommittee meeting, we don't have the constraints of the full committee meeting that doesn't have enough time.

So then it seems like maybe you -- an hour and a half be enough between the two of you? Will it be enough?

MR. JULIUS: Yes.

CHAIRMAN APOSTOLAKIS: Erasmia, do you need more than an hour?

DR. LOIS: Should not be more than a half an hour actually.

CHAIRMAN APOSTOLAKIS: Okay, so we need

about two hours. Okay, I think that's great. So your suggestion is to break for lunch now and come back for you in an hour?

MR. JULIUS: That sounds good.

CHAIRMAN APOSTOLAKIS: Okay, so we'll reconvene at -- yeah, we will go to the bigger room after lunch.

MR. KOLOCZKOWSKI: Mr. Chairman?

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLOCZKOWSKI: Will the bridge line be available after lunch also?

MR. NOURBAKHSH: Not after 1:00 o'clock bu you can still dial a new number from that room. I'll provide it to you. Can I e-mail the number to you?

MR. KOLOCZKOWSKI: That would be great. Thank you very much.

CHAIRMAN APOSTOLAKIS: Okay, and Alan, you will be on the line as well?

MR. KOLOCZKOWSKI: Yeah, but I'll need a new bridge number.

CHAIRMAN APOSTOLAKIS: Yeah, you can get it, we can do that. So we'll reconvene at 12:50.

(Whereupon at 11:46 a.m. a luncheon recess was taken.)

AFTERNOON SESSION

12:53 p.m.

CHAIRMAN APOSTOLAKIS: We're back in session. We have a few comments from Mr. Zouhair Elawar, Senior PRA Engineer at the Palo Verde Nuclear Generating Station and he is the Chairman of the HRA Calculator User's Group of EPRI.

MR. ELAWAR: Correct.

CHAIRMAN APOSTOLAKIS: This is the second time you've come to our meetings and welcome again.

MR. ELAWAR: A year ago, thank you. There's a page of information that was passed along. I don't believe I have the slides.

CHAIRMAN APOSTOLAKIS: That's fine, we can look at this.

MR. ELAWAR: The purpose of my short presentation is to inform the members about the considerations I would say afforded to HRAs after they have been written. You know, we discussed this in our confidence scores with user groups and most of us believe that many of those items I put here are not widely known to people outside the PRA world.

I will go bullet-by-bullet briefly. As you know, we have in the industry very thorough training program for HRA practitioners. You know, you have to go through qualification cards and people have to do practical training before they are assigned as being -- they need to know, to be of course, PRA practitioners to begin with.

CHAIRMAN APOSTOLAKIS: Is this a short course or what is it? I mean, when you say --

MR. ELAWAR: They have to take reading material and they -- most of the lately have been going through the -- Jeff Julius' training of three day's training; one day on methods, and then one day on the calculator aspects and morphology of it and how to factor the performance shaping factors and so forth. So it's a three-day formal training course plus seven days, I would say, of reading material such as NUREG 1278, the NRC good practices, NUREG 1792 and 1842 and I have to say those are really very informative. They were very, very much appreciated throughout the industry as to how precisely they put the information about various methods and the good practices to read the ASME standard and NUREG 4200.

We have particular thanks to Dr. Lois and Susan Cooper for putting that document together. They were very helpful throughout the industry. So be sur that you realize it's not just anybody -- of course the training does not include psychology type training. We assume that the methods we use and the numbers we get from them and the directions we get through the items already have factored into themselves the psychology aspect of it.

CHAIRMAN APOSTOLAKIS: Well, the psychology aspect is the easy part, right?

MR. ELAWAR: Well, again, I have to emphasize the training at nuclear power plants for HRA practitioners does not include anything other than the technical part of the training.

And in terms of tools, I believe you'll hear from Jeff in details about the calculator. We believe the EPRI HRA calculator have substantially diminished the analyst factor in the error that is coming from the HRA and the PRA models. We really have to benchmark it better. I think we are still short -- somewhat short of the benchmark and pursuing that to satisfy ourselves as to how far we did go into diminishing or perhaps removing analyst factor.

I need to say that Item Number 3 is quite important there, that I have, myself, done this test and I should and I know that other do it. When the PRA models is nearing completion, a review of the HRAs for consistency is a very, very important aspect of it and usually several changes are made when you compare this scenario with those tasks with this stress level with the procedures available, not available and so on and you compare the results how do those fit together, then we usually catch or make significant changes during that review.

CHAIRMAN APOSTOLAKIS: So who is doing the review again?

MR. ELAWAR: The primary HRA practitioners in the PRA group.

CHAIRMAN APOSTOLAKIS: Of the company.

MR. ELAWAR: Of the company.

CHAIRMAN APOSTOLAKIS: Not outside. You don't get any outsiders.

MR. ELAWAR: Well, in the next item we do get outsiders. And for this review, it's an inside review. The whole HRA contribution to the PRA model is always assessed by peer reviewers and quite often internally in terms of how much reliance there is in this PRA model on HRAs. And that is usually done by setting all the HRAs to the one cause that's to fail and see what happened to the core damage frequency and that usually is a very good indicator as to by comparing various PRA models, how much is your model reliable on your HRAs and how much is my model reliable on the HRAs. That really is also an indicator of the overall quality perhaps, of the HRA used in the PRA model.

CHAIRMAN APOSTOLAKIS: But I don't understand that. You're saying models, plural. So you're using model --

MR. ELAWAR: If I go to my PRA model it probably already have set all the HRAs to an event. My core damage frequency from the 1E $^{-5}$ level a 2 or 2.5. That is considered within --

CHAIRMAN APOSTOLAKIS: 2.5 what?

MR. ELAWAR: I quantify --

CHAIRMAN APOSTOLAKIS: 2.5 per year?

MEMBER KRESS: E^{-5}.

CHAIRMAN APOSTOLAKIS: Oh, it's a 10^{-5}?

MR. ELAWAR: No, no, 2.5.

MEMBER KRESS: No, 2.5.

CHAIRMAN APOSTOLAKIS: It's a light water reactor. Before the operators --

MR. ELAWAR: This is an indication of how much reliance --

CHAIRMAN APOSTOLAKIS: Oh, that will probably stop after the first core damage. You will never see the second.

(Laughter)

MEMBER MAYNARD: If you set all operator

errors to occur, the light water reactors are not designed to operate without operator action.

MR. ELAWAR: Well, the point I'm trying to make here, if we were to get a 1^{-3} then we have to come and raise red alarm that you probably don't have enough HRAs or you have values that are too optimistic. Or if you were to get a very, very high number, then we would say you are relying way too much on operators.

CHAIRMAN APOSTOLAKIS: But if we know that as Mr. Maynard just said, that LWRs really need operators, what do you get from this exercise? I mean, you get the 2.5 per year. That's not a surprise.

MR. ELAWAR: Well, I get a measure of reliance on HRAs and --

CHAIRMAN APOSTOLAKIS: How important is it?

MR. ELAWAR: -- I get a general recommendation to the plant that you need to go and look for more HRAs that you might have missed.

CHAIRMAN APOSTOLAKIS: Now, when you do this, do you also do some sort of importance analysis to identify the key human errors that drive this?

MR. ELAWAR: Yes, we do but not in this

task. That's a routine thing. So in other words, I'm saying here -- that's actually the next item is just that.

CHAIRMAN APOSTOLAKIS: But can you tell us which one it is? I mean, which are the key human errors --

MR. ELAWAR: Well, they are in most cases associated with auxiliary feedwater and occasionally with safety injection. Those are usually the PHRAs. So if you look at my next item there, it says, "As a routine thing, it's always done at each plant. They identify the top 20 to 30 HRAs and they analyze them for activity. In other words, they go through the vessel. They go through the details. They go through the assumptions. They pass them to the trainers and they pass them to the simulator people to practice them.

Right now as we speak IMPO is making that a requirement to identify the 10 HRAs. We sent them to IMPO and when they come to assess the plant, their biannual assessment, one key item that they do is they go to the simulators and they surprise the operators with one or more of those 10 IMPO areas. Our list is 20 or 30 but they surprise operators by practicing those IMPO areas to see the rate of success in them.

So the key based on the -- this, the top 20 or 30 are identified and then the procedures are reviewed like for example, in my case, we caught -- there were several procedures with no checkoff requirement which were forcing us to put higher error probability and then we managed to improve it by adding check-off requirements so we carried that in our value for those HRAs.

CHAIRMAN APOSTOLAKIS: Do we have in the agency such a list of the top 10, 15 human errors?

DR. LOIS: We have identified for probably every plant on the basis of the IB and then the NUREG that we created which is 60 -- what is the inside report from the IB review identified those actions but we don't keep an updated live list for each design.

MR. ELAWAR: Mr. Chairman, we have more recent information, yes, you do and right now the component design basis inspection team they are doing just like that in my plant. They receive the top 28 HRAs and they are now in the process of driving those in the simulators and surprise with the operators. That is --

DR. LOIS: Are you reporting those Regions to the --

MR. ELAWAR: No, I don't believe they were reported. It was reported to the team who is going through all the plants. They asked for the top 20 HRAs with their timing and details. And they were given to them. They reviewed them and they selected a few of them. Right now they're being practiced or sort of being examined on the simulator with operator.

CHAIRMAN APOSTOLAKIS: I'm just curious, Gareth, is there anything like that at the NRR?

MR. PARRY: I don't think so because it changes from plant to plant in any case.

CHAIRMAN APOSTOLAKIS: But I mean, that may be --

MR. PARRY: No, but I mean, there's a general agreement that certain of the actions are significant like in bilers (phonetic) it would be depressurization, it would be initiation of RHR and it would be initiation of SLIC or at least reaction to an ATWS would be the big ones, I think.

CHAIRMAN APOSTOLAKIS: Okay.

MR. PARRY: I can't think of any others.

CHAIRMAN APOSTOLAKIS: Well, that would be useful information.

MR. ELAWAR: I would say that groups of (inaudible), the routinely do comparisons between their top 20 sets as well as HRAs and the examiners to why this is there, why this is not so, and usually outliers in the downside or the upside are usually caught and either justified or changed. That's also a routine way of really capturing some outliers.

I mentioned the other item that we think that the good practices produced by the NRC and the peer reports have greatly enhanced our abilities of HRA practitioners to really do a better job on HRAs. I mention the last item on my case here that's speaking of using HRAs or HRA improvement for the purpose of decisions. That is really the crux of the issue that every time any plant does any application to the NRC for any license change, they have to identify the contributing elements to it and that is usually based on delta CDF and not on the assumptive value of CDF.

So if there are some HRAs sitting there that are quite off without us knowing about it, when you deal with a delta CDF, that large uncertainty is largely cancelled out. And if an HRA happens to be important for the specific application, that it will be shown, it will be analyzed also for uncertainty and the 90^{th} percentile value of it. We always produce in most cases distribution, we report the mean and we know the 90^{th} percentile and we analyzed to the NRC the value of delta CDF or the basis of the 95th percentile as well.

So I hope this list will illustrate some actions that really is checks and balances to HRAs sort of after they have been issued.

CHAIRMAN APOSTOLAKIS: Now, one of your responsibilities is to chair this user's group for EPRI.

MR. ELAWAR: Yes, sir.

CHAIRMAN APOSTOLAKIS: What are the issues that the group is dealing with these days?

MR. ELAWAR: Right now, the top issue for us is the fire HRAs. The benchmarking is another issue. And really continuing improvement on the Calculator. The only thing I can say is I'm not here looking -- at this time nobody is looking for -- I don't have methods to use. I need a new -- even though I'm open-minded for any suggestions, that is not an item on our list. The top issue right now for us is the fire HRAs and --

CHAIRMAN APOSTOLAKIS: What issue is that?

MR. ELAWAR: To have a guideline how to write a fire PRA/HRA reviews in the fire PRA model. And maybe Jeff is intended to cover more of that.

CHAIRMAN APOSTOLAKIS: If you plan to,

that's fine.

MR. JULIUS: No, no, but I'll speak to it now, so that NUREG 6850 has a conservative screening approach. It does not describe a detailed method for doing human reliability. Forty percent of the plants are on a three-year clock to go an LAR submittal for transitioning this NUREG to NFP-805 and so this is to support the fire PRA and support of that license memo request.

CHAIRMAN APOSTOLAKIS: So at some point we will be briefed on what the agency is doing along these lines?

DR. LOIS: There is a desire to collaborate with EPRI on this activity. We haven't actually received from NRR the user need to let us go ahead to do that. The Office of Research is planning for it, but if that goes ahead, then we will be kind of collaborative briefing; otherwise, probably EPRI will do it on its own.

MR. RAHN: Mr. Chairman, this is Frank Rahn on the phone.

CHAIRMAN APOSTOLAKIS: Yes.

MR. RAHN: You may or may not be aware that there is a longstanding memorandum of understanding between EPRI and NRC in terms of doing collaborative work in fire PRA.

CHAIRMAN APOSTOLAKIS: Yes.

MR. RAHN: We've all mostly recently started working with NRC and Erasmia and Susan and others, in terms of coordinating our work under that existing MOU to extend to the HRA area.

CHAIRMAN APOSTOLAKIS: Okay, thank you. So thank you very much.

MR. ELAWAR: Yes, thank you.

CHAIRMAN APOSTOLAKIS: Jeff?

MR. JULIUS: I have handouts here to be circulated. I'm going to do a quick switch here.

CHAIRMAN APOSTOLAKIS: Where is your office, Jeff?

MR. JULIUS: Seattle. So we're pretty close to the airport down in Tukwilla.

CHAIRMAN APOSTOLAKIS: That's important, right?

MR. JULIUS: Yeah, that's important.

DR. LOIS: That's my diskette.

MR. JULIUS: Okay. All right.

(Off the record comments)

MR. JULIUS: Good afternoon, Mr. Chairman and members of the ACRS Reliability and PRA subcommittee. My name is Jeff Julius. I've worked with Scientech for 20 years and I'm the Project Manager for the EPRI HRA Users Group. The presentation today, I've started with the problem statement, probably won't spend a lot of time on this but given that this was our fourth meeting on roughly the same topic, I wanted to see what was -- make sure I understood what was different or what we were missing from -- or doing differently.

Then we'll talk about just a quick slide in terms of some estimate of the progress towards those goals, the summary of the methods that are used in the EPRI HRA calculator, again, focusing on the differences. The previous presenters did a good job in terms of explaining THERP and SPAR. We've incorporated those in the calculator. I have some ideas about activities on a proposed plan that I would like to introduce and then our EPRI HRA user's group position statement and then the conclusions.

This was a picture here talking about the different HRA methods over time. We talked earlier about THERP being in 1983 and you can see they've somewhat proliferated. Early in the `80s here, these were done primarily to support the IPE and then later on we see in the `90s some of these second generation methods, CREAM and NARA and CAHR. And you see that

SPAR and ATHEANA and SPAR-H across the top. So the question is about the focusing back down.

And this was previously indicated that --

CHAIRMAN APOSTOLAKIS: That's a statement from me, not from the ACRS. You have to be careful with this committee. I don't doubt that my colleagues probably --

MR. JULIUS: The first paragraph I believe is almost identical to the SRM. The second one was a statement at the reg info conference.

CHAIRMAN APOSTOLAKIS: Right.

MR. JULIUS: And that goes to your question about time and where it fits as a performance shaping factor. From our perspective, we learned a lot, I think between the NRC and the labs and the industry, with the 1792 and the 1842 that project. 1792 is the good practices in implementing human reliability and 1842 is the evaluation of HRA methods against the good practices. And both these documents looked at methods and general approach and their strengths and weaknesses.

In general, I think all of them found that it was difficult based on the documents that we looked at to trace back to the root data source. For example, going into THERP and finding the -- you know, the specific data regarding where the elemental probabilities came from or in HERRI for example, we've got some summary graphs but you know, we want to see maybe the experiments to see if we can reproduce or verify some of the conclusions.

I think it was interesting that in terms of the outcome, that none of the methods were excluded beyond what the original author had specified and, for example, EPRI had said that the first ACR method was -- should not longer be used and so that's a conclusion that's stated in 1842. And that the THERP cognitive model for the time reliability correlation being speculative, that would -- that one shouldn't be used as well. Taking Halden, this Halden project, we were involved with the benchmarking there. And just even in the setup of the problem statement, it's good there because it causes us to use the same language and translate them and when we're sharing data, we want to, you know, not influence based on the methods, so we've gone to a relatively common set of performance shaping factors and then when you look to say what would you use -- you know, how would you interpret or use that data, but it's -- forced us to focus more on a common approach.

The technical approach in the HR

calculator is to follow the SHARP or ASME process and framework and ASME developed this framework off of SHARP and SHARP1 in terms of the identification, the screening, the qualitative characterization meaning the development of the performance shaping factors, and looking whether an action is feasible or not and then a quantification and dependence.

What is an interesting insight out of 1842 for example, was -- is a report set out to look at different HRA quote "methods", but depending on which document you picked up, we weren't always talking on the same terms. One of the valuations was one SHARP1 for instance and that was actually a general process. And ATHEANA is a process and it has a quantification method. And others are specifically for, what was mentioned earlier, for example, that the SPAR is best characterized as meant to fit in as a quantification method and not necessarily for -- as an identification tool.

So in this process or framework that we have in the HRA calculator, we've integrated and allowed for the selection of methods depending on the particular application and the particular type of model that you want to develop. And it consolidates the reports and tables into a single tool and try to use the same common qualitative characterization. So we build a qualitative story and then from that allow quantification in different ways.

I think this technical approach promotes consistency by standardizing first the definitions of the qualitative performance shaping factors. A good example of that was our time line which doesn't down up very well on the slide but this is a picture of the time having a total available time with a time delay and a time for diagnosis and a time for manipulation. This was an element that widely varied across the plants. For example, I had gone out to give a training -- HRA training session in one of the plants. I said, "We've got this action that's -- you know it's six hours and so we've got a real low HEP for it, but I want you to take a look at it."

Well, it turns out that out of the six hours that was a station blackout scenario and it was the restoration of SI following restoration of offsite power. Well, the offsite power wasn't back till five hours into it and they really were -- so, you know, out of that six-hour window, you were in the last hour restoring all the breakers and all the components and when you threw away the first five hours, it significantly changed the look of that HEP.

We promote consistency by standardizing the guidelines. So in addition to the training that Alan Koloczkowski had mentioned, we provide guidelines to say, "Here's the selections for the performance shaping values. Typical selections and some reasonable limits on them and also some assumptions". And part of that, we've taken some of these approaches out of the guidelines and made them into changes in our modeling approach. For example, instead of Version 1 or the original approach, we said, "Select the stress based on these factors and document what you did. And then later on in the current model, we have -- well, look at it the other way around, what are these factors? If you have an abnormal plant response or you're time-stressed, these are times where you should have a higher stress. So we've tried to make that a more subjective approach.

We also adjust limits effecting the quantification. For example, when we do recovery, limiting it to a single measure that's the most likely to be effective. Some models allow for multiple recoveries. When we apply recovery, when we apply dependencies there, so that we aren't using, you know, ending on a 10^{-3} or 10^{-4} factor to it, value this 10^{-2}, you look at the dependence and you might have a conditional probability for example, of .5 or .15. Also setting a minimum HEP level.

CHAIRMAN APOSTOLAKIS: Now, what is it that made you focus on time so much? I mean, as you know in other models they don't go through this detail. You seem to be focusing on time. What was the reason? Is it a historical reason or was it --

MR. JULIUS: Yeah, it's a historical reason. And Gareth can help fill me in here. I've got a couple slides that speak to that. Unfortunately, these were ones that didn't make it in your handout but I have them as a drill-down here that we can go off and show. It was basically starting with the idea of the THERP time reliability correlation and saying, "Well, what can we get or obtain from simulator experiments to maybe make a better curve for example". And so a model was made, a theoretical model, that had to do with different failure modes affecting cognitive and then that model was validated or checked against experiments.

And this is one case where this HGHRA method I would claim -- I would argue that this is a better validation because it is based -- benchmarked and compared to experimental results. When some of the earlier methods talked about validating their method, it was more of a verification of their value against other HRA methods. So if you're taking SPAR and you have a SPAR that's based on THERP compared to ASEP that's based on THERP and also compared to THERP, that's a different kind of quote "validation" as opposed to against experimental results.

So we've postulated this, went out and collected experiments, developed a curve and then you'll see from the shape of this curve, it really was a limited range of applicability and it quickly dropped off and produced -- you can get estimated error probabilities are just below the believable limit, so this minimum HEP limit. So then we looked at -- looked back at our generalized representations and said there must be some failure mode or some things in reality that even if you had all the time in the world, you would make a mistake. So let's postulate what are those types of failures and let's develop a different way to evaluate those.

And that other approach also has time in it. I would argue that time is a performance shaping factor in both of these methods. In the HERR or E method time is the dominant one and everything is -- all these other ancillary performance shaping factors are rolled up and are implicitly included in the time and the other one, since time wasn't the driver, in fact, you know, we saw when we had time available or even tons of time available, we started to look into these other things but we do have an influence of time in there.

CHAIRMAN APOSTOLAKIS: You said you had a couple of slides of --

MR. JULIUS: Yes.

CHAIRMAN APOSTOLAKIS: Can you show them? Are they on this topic, time?

MR. JULIUS: Yes. Yeah. So they're about two out. So would you like to see them?

CHAIRMAN APOSTOLAKIS: Yeah, I would like to see them.

MR. JULIUS: Okay.

CHAIRMAN APOSTOLAKIS: But there is an initial period where time is the main driver in your case, right?

MR. JULIUS: That's right.

CHAIRMAN APOSTOLAKIS: But do the other performance shaping factors play at all? I mean, do you --

MR. JULIUS: It wasn't implicitly through the time. For example --

CHAIRMAN APOSTOLAKIS: -- plainly through time.

MR. JULIUS: -- if you had a problem with the cues -- let's see, here's the -- where's my mouse? Okay, so in general, this was the empirical method based on time fitted as assessed response time from experiments. This is normalized time and I'll show the equation and what the time variables are. And this was this generalized representation. There's a little decision tree. There's a cognitive processing for procedural mistakes called P_1, a failure to process information in a timely manner. This is a time based aspect of it and then an execution.

So these first two branches are the cognitive detection, diagnosis and decision-making. So this was a theoretical model that was set up. We went in and collected experiments and these were the types of response times as a function of time. This is a normalized non-response -- normalized time, excuse me, and you can see the shape of the curve. So if there's just enough time to do the action, then failure probability is pretty high. If there's 10 times the amount of time available or needed, then it quickly drops off and it continues on a downward slope.

CHAIRMAN APOSTOLAKIS: So the

normalization is with respect to the time needed?

MR. JULIUS: Here, I'll show you. So this normalization is -- start with the time window and the normalized time is the ratio of the -- the logarithmic ratio of the time available for cognitive response divided by the actual time it takes the response. So if there's a problem with the procedure, or if there's distractions, or if there's cues that are coming in late or we don't get the indications, those kinds of things are reflected implicitly in this median response time.

CHAIRMAN APOSTOLAKIS: Who gives you that median?

MR. JULIUS: This is what we typically get in discussions with operators or through the simulator experiments. The trick is in the discussions with the operator, especially if you've got an action that's way down at the end of the sequence, you have to start at the beginning of the sequence and you have to, you know, lay out the initial conditions and walk through the procedures with the successes and failures to really get them in the frame of reference or the context or the scenario because if you call up the operator and say, "Hey, I'm doing feed and bleed. Given that you have low steam generator water level in the steam generators, how long would it take to implement feed and bleed". The answer would be no more than five minutes. I mean, one or two minutes, if it's something out locally, maybe it could take as long as five but then you say, well, "Okay, well let's start from the beginning of this scenario. If it's record trip now and we've lost all feedwater, now we're in FRH1. How long are you spending in FRH1 restoring feedwater", back to the feedwater example that you gave? You spend some time -- "Well, I can dispatch a guy to do that, but I can spend maybe two minutes in the control room, and then I spend another two minutes this", and you start -- "Well, you said you'd be doing this within one minute and now you're already spending, you know, three or four minutes".

"Well, yeah, that's right, I would really be over in here". So it is a iterative, context-based discussion is where we typically get the value for this. And the other one is -- it's a possibility to get the data directly from the simulator, you run the experiment with some different --

CHAIRMAN APOSTOLAKIS: All right, when you say "median", what do you mean? I mean, you have a number of estimates from the operators and you take the median? Why is median? What is the word median doing there?

MR. JULIUS: Probably a better word would be typical or this is the expected crew response time.

MR. PARRY: I think it's really historical, because I think it came out of ORA experiments, where it would have been the median time of the crew responses. See, and the reason the curves look like this is that -- the reason they're normalized like that is so that you can add the data from different responses that have a similar key response structure if you like, to create a larger data set to get a better fit for the curve. But in the original experiments the median was the median of the time that -- of the various crews that repeated the experiment.

CHAIRMAN APOSTOLAKIS: It was a true median.

MR. PARRY: It was a true median of that, yeah.

CHAIRMAN APOSTOLAKIS: So T_w is the time window for cognitive response. So TS_w is what, available time?

MR. JULIUS: This is the available time.

CHAIRMAN APOSTOLAKIS: From thermohydraulics.

MR. JULIUS: Correct.

CHAIRMAN APOSTOLAKIS: T delay is what?

MR. JULIUS: This is, for example, in the feed and bleed example that I gave, if you started with reactor trip, there's two ways to get to feed and bleed. One is the procedural path. We try all these things but the other way, the cue is the steam generator low water level. Well, you may start out with a loss of feedwater, but the water level may come in at five minutes or 10 minutes out of that and your thermohydraulic run was started with reactor trip or loss of feedwater. So that's the time until we actually get the cue to start that -- because that's what's going to prompt him for the action.

CHAIRMAN APOSTOLAKIS: And that also comes from the operators?

MR. JULIUS: It's from the -- it could be from the operators if they're using an alternate cue. We typically go though, to the procedures and that's something you look at the thermohydraulics. I mean, when do we hit low water level; for this initiator, it's this, for this initiator it's that.

CHAIRMAN APOSTOLAKIS: And TM?

MR. JULIUS: That's the manipulation time, so if it's -- and again, this is through a discussion with the operator. If it's something that's a local manual action, we use a job performance measure where they've actually gone through and walked through and they say, "We've got this card that we can do this in 10 minutes". These are just saying out of that total available time, this is what's the effective time that's available then for the cognitive processing? So --

CHAIRMAN APOSTOLAKIS: So you said that the other performance shaping factors like you know, the five or six that Mr. Blackman mentioned earlier are implicitly included here, so I'm trying to understand, if they have, for example, poor work processes, where would that be in $T_{½}$?

MR. PARRY: Yes, correct, that's where it would be.

CHAIRMAN APOSTOLAKIS: But $T_{½}$ is an estimate given by the operators and surely they don't think that they have poor work processes.

MR. JULIUS: No, but an example of that, we have seen this in the last couple of years for example, is that -- is this human factors error reduction technique of going to STAR or three-say communications. So we say, "Not that you're going through easy row, what actions are immediate, what actions do we have to do this stop, touch, act, respond, the STAR process or the three-way communications". You've got to say it. You know, this is an example of where that work process would effect the $T1_f$ and that was part of this interim thing on the discussion. If you ask them, "Oh, yeah, I want you guys at the steam generator level, how long would it take"? "You know, I could do that in a minute". "Well, let's go through the easy row and how long does it really take to talk through and when do you really transfer out and what's the hierarchy", you know, because a lot of times when you transfer out of these areas, you stop and you do a brief. You know, where was that captured or where is that captured in the -- is that captured in the SPAR work processes for example.

This is -- and this method is captured in the pre-meeting response time.

MR. PARRY: Yeah, and Jeff, you might want to mention that F -- the $T_{1/2}$ was obtained from actual simulator trials and it would be implicit in that if --

MEMBER MAYNARD: I would think most of it would have to be from simulator trials. You may be able to talk to the operators and get some adjustments, but just talking to an operator about how long it takes to do an evolution without having some familiar scenarios run, you're not going to get a good number.

CHAIRMAN APOSTOLAKIS: But the simulator does not simulate the work processes. These are the real --

MR. JULIUS: I guess this is just the way -- I guess, I haven't used the work processes very much. I was taking what I would imagine is the work processes as they applied to the, you know, response to reactor trip.

CHAIRMAN APOSTOLAKIS: I mean, you can only simulate so much. You can't simulate the real plant. So this is an area where perhaps, certain things are done in a judgmental way that are done more explicitly in other places.

MEMBER MAYNARD: I don't know what you mean. The simulators can come pretty close. You can interject any type of failure depending on what scenario that you're wanting to run and the -- it pretty well matches most of the thermohydraulics and everything.

MR. JULIUS: Yeah, the only way you can get the approximation is if it's a local manual action, you know, they call out and simulate, we wait a few minutes and they -- or if it's -- you don't get some distractions, extra calls from outside or whatever. But what we do typically, is not only get the crew response time, it's that we usually have a trainer sitting there as well and say, "Okay, you know, the crew is saying this is a response time and we've seen this but based on your experience, what's the fastest and what's the longest", so we get the -- you know, we don't just think it's a --

MR. ELAWAR: In my experience, getting the median response from training is more right than coming from actual operations. In training they have already numerous such incidents. If you go and observe the simulator review alone, you can observe maybe one case and not -- it become too much to impose on them that much, but if you go to the operations training, they have the unbiased opinion based on numerous observations.

CHAIRMAN APOSTOLAKIS: Is that something that -- I'm sorry, you --

MR. JULIUS: No, go ahead.

CHAIRMAN APOSTOLAKIS: Is that something that Halden is spending any time on?

DR. LOIS: Well, Halden is collecting time data, in an actuality, in a way success criteria for the simulator experiments is based on because you cannot have core melt in a simulator. It would take a tremendous amount of time for the crew that has been simulated to go to core melt situation. So the decision is if the human action hasn't been accomplished within 20 minutes or 30 minutes, then it's been perceived as a failure. So this -- yes, time is a very important aspect for these experiments.

CHAIRMAN APOSTOLAKIS: John?

DR. FORESTER: Yeah, I was just going to point out, a couple of things I wanted to mention. One is -- I'm John Forester -- is that in the review of this method, in 1842, we pointed out that to the extent they can run crews to the simulator for each of the HFBs they're trying to quantify or unsafe actions they're trying to quantify, they could run multiple crews through and also may possibly vary the scenario somewhat so you get a little bit more of a range of conditions. That's a very nice approach and you get plant specific data in doing that, but the problem, of course, is that that involves a whole lot of simulator exercises. So then they're limited into how many they can run, obviously.

So then they move to the place where you use expert judgment essentially to obtain information about how long the crews think it will take them to respond. And at that point, it's similar -- it's a process similar to what you use in ATHEANA in terms of eliciting expert judgments about what's going to be happening in a scenario. And I think one of the problems we had with the approach was there wasn't a lot of guidance for how you do that expert elicitation, who you gather that information from --

CHAIRMAN APOSTOLAKIS: If I, you know, I have a plant somewhere and I have to do an HRA, I can use the data that you have already collected or I have to run my own simulator exercises to get a $T_{½}$ that applies to me.

MR. JULIUS: The data we've already collected goes to this sigma or the variation between the crews so this effects the shape of the curve. You have to get this timing data for your specific scenario.

CHAIRMAN APOSTOLAKIS: I have to also run simulated --

MR. JULIUS: Either run it or collect it through the discussion with the trainers or operators or and this might be one of these successive screening types of things because you might go and get the data and you find out that the margin between this ratio is such that time isn't the dominant thing. So, you're working --

CHAIRMAN APOSTOLAKIS: So there is a certain burden here as well. I mean, we keep talking about the ATHEANA burden and the expert judgment. I mean, you do have a burden yourself.

MR. JULIUS: Sure, exactly.

DR. FORESTER: Okay, one other quick item, maybe this is trivial but I think it's a mistake to call time available and timing a PSF in the sense of those things are not effecting the operator. Performance shaping factors refer to what influences the crews in their responses. The time available certainly constrains the likelihood of their success as very small. But that's not really effecting their performance. It just effects whether or not they might get the action done or not. So I think it's a little bit of a misnomer to call it a PSF.

MR. JULIUS: I understand what you're saying. I've had the same thought before in discussion because when the operators are there, for example, and they get to a certain step in the procedure, they're not thinking, "Well, how much time do I have available, you know, is that going to effect this test. You know, I've got to do this, I've got to it now and the general proceduralized and engineering evaluation says I've got time," but then on the other hand if you were to skip that or had a problem with that, it does come into this chance for recovery that, you know, the person sitting next to there, since it does influence the -- and effects the performance.

MR. PARRY: Yeah, I think the other thing that makes you think it's not a performance shaping factor as such is really the performance shaping factor should be in the shape of a curve and what the TW does is tells you where along that curve you want to take your probability. So I agree with John, it's not really a performance shaping factor. It's an independent variable that enables you to evaluate a probability given that you have embedded performance shaping factors into this curve which nobody's mentioned it yet, but the other problem with these types of models is whether that shape of curve is even valid, particularly when you're extrapolating it to large times, which I think is --

CHAIRMAN APOSTOLAKIS: They're doing something else when they go way out there. They don't follow the curve, right?

MR. PARRY: No, well, but people will

generate curves of probabilities as low as 10^{-3} using these curves on the basis of maybe six points which have all been success. So there's a lot of -- there's a large degree of faith that goes into saying that these curves are actually relevant to calculating the probabilities.

MR. JULIUS: And obviously, and a lot of these methods were taken that data they were developed from and the place they were developed from and now we're applying them in different places in different ways. So this is --

CHAIRMAN APOSTOLAKIS: So are you back now to your original presentation or are you --

MR. JULIUS: I will be there in just a second. So this is, for example, the family occurs that as the sigma varies, here's the normalized time and so this is -- as Gareth mentioned you have the performance shaping factors effect which curve you're on and then you're going in at a certain time to pick out the error probability.

CHAIRMAN APOSTOLAKIS: So how would that be done? I mean, you have a set of performance shaping factors such as what?

MR. JULIUS: This cue response structure for example. If there's -- if there is a delay, for example, you have this reactor trip and you know you're going to be doing research switch-over but the cue's not down here but you've several hours of injection. That will effect the sigma or the cue response structure in the shape of the curve and this forewarning would give you a lower error probability for example.

CHAIRMAN APOSTOLAKIS: I mean, again, let's take a practical test. I'm about to do this. You will give me a list of performance shaping factors that will guide me in --

MR. JULIUS: No, this cue response structure for the -- the data that's collected and the curves were generated again, with this normalized time with these three different cue response structures in mind. And this is the -- given this time line, when does the cue come in? Is the cue delayed or initially or is it --

CHAIRMAN APOSTOLAKIS: It's still time oriented. But if -- again, we had a list of eight PSFs this morning from SPAR-H. Are you using any of those?

MR. JULIUS: We did in Version 1. We said this is great from an experimental approach but you know, you can see it has kind of a tight grouping here. There's only two or three selections and they're relatively high. We would postulate that there is -- what factors, performance shaping factors, would effect the crew response, the variations in the crew response such as the procedures and the training. So we made a little decision tree for that and we had this nice range or split but then the experiments didn't really justify the full ranges so we had to scrap that.

CHAIRMAN APOSTOLAKIS: So what you're saying is that in this model what really matters is time. When the cues arrive, how much time thermohydraulics gives you. I guess what matters, too, is the perception of the operators as to how much time they have, not the actual time, right? If they think they have a lot of time and they don't, it doesn't really matter.

MALE PARTICIPANT: That's when it becomes a performance shaping event.

CHAIRMAN APOSTOLAKIS: You can't talk from the back. Next time come to the microphone. Do you want him to repeat it for the record?

THE REPORTER: Sure.

CHAIRMAN APOSTOLAKIS: And tell us who you are.

MR. BLACKMAN: I'll tell you who I am. This is Harold Blackman and in that particular case when it is the perception of time by the operator it then becomes a performance shaping factor.

CHAIRMAN APOSTOLAKIS: And I agree with that but the question is, how is that handled? I mean, it's one thing to talk about --

MR. BLACKMAN: It's not.

CHAIRMAN APOSTOLAKIS: It's not.

MR. BLACKMAN: It's not, time reliability.

MR. PARRY: It's not except that if it goes anywhere it would be implicit in the $T_{1/2}$.

CHAIRMAN APOSTOLAKIS: We don't know that because he just said, they only have a very limited number of --

MR. PARRY: It's true, but that's the only way that you can get it into this type of formalism. And if you do simulated experiments, then to the extent that those simulator experiments are indicative of the real conditions in the accident, you have to believe that their performance shaping factors are going to be implicit in that.

CHAIRMAN APOSTOLAKIS: It seems to me what's going on here is this; if you want to include a lot of these performance shaping factors and you know, you come from the human behavior point of view, then you have to rely on judgment and do, you know certain things like other models do. If you take the point of view that you want to standardize it as much as you can, you know, and develop curves with sigmas and $T_{1/2}$s and so on, then the price you pay is that you are not as flexible as the other methods are to take into account these things. I mean, it's a trade-off. You can't rely on only one method.

MR. JULIUS: And you don't have the insights in terms of what is driving that, so is it the fact that the procedures have a problem so that I can go fix the procedures? I mean, your result is it's time.

CHAIRMAN APOSTOLAKIS: So --

MR. JULIUS: It's a tradeoff.

CHAIRMAN APOSTOLAKIS: -- and I guess a question before us is, you know, is there any way to bring those two approaches together at least to some extent?

MR. PARRY: I guess, George, yeah, you're right in the sense that if you are proposing a plant change that would have an impact on some of these PSFs, then it would be difficult to use this method because you wouldn't know -- the only way you could do it by having an impact on the $T_{1/2}$ and it's not clear how you would generate that change.

CHAIRMAN APOSTOLAKIS: Yeah, and we had an example from Mr. Elawar. You said that something you'd liked in your company, there was no checks or something and you told them to institute them and the probability --

MR. ELAWAR: Yes.

CHAIRMAN APOSTOLAKIS: Would you repeat that?

MR. ELAWAR: Some of the PSFs once they are caught, were identified, they would be corrected.

CHAIRMAN APOSTOLAKIS: Well, how did you catch that? I don't understand using this method would --

MR. ELAWAR: I have my guidance, the authority of -- where somebody is not skipping a step. If he is not checking that completed step, he is not likely to skip a step but if he is initializing this, the is aligned next to each step he initialized, he will easily go to the next one. This is like if you are putting ruler when you are reading fine print and then moving the ruler down, you know, where is your next line.

CHAIRMAN APOSTOLAKIS: So this is not a

case where you would use these curves.

MR. ELAWAR: No, that's not the case, just the error I will assign to each action with checkoff versus without checkoff.

CHAIRMAN APOSTOLAKIS: So these are post-initiating event?

MR. JULIUS: Correct.

CHAIRMAN APOSTOLAKIS: But the example we just heard was pre-initiating.

MR. ELAWAR: Not mine.

CHAIRMAN APOSTOLAKIS: The application.

MR. JULIUS: Or the execution, the execution.

CHAIRMAN APOSTOLAKIS: The execution, so how would that be called here? I mean, you are subtracting the execution time $T_{m.}$ How do you estimate that and how is that consistent with what Zouhair just told us? I mean, is it just an estimate, it's three minutes or is there an elaboration, you know?

MR. JULIUS: There's an elaboration. For many of the actions, there's a job performance measure and there's a -- especially if it's a local manual action that says the crews have to demonstrate that they can complete this in 10 minutes or 15 minutes.

CHAIRMAN APOSTOLAKIS: But Zouhair was

just talking about probabilities and I don't see -- I mean, you're just using T_m. You're not --

MEMBER SHACK: Well, wouldn't you multiply this probability by the probability that you somehow screwed up the manipulation which is his error?

MR. PARRY: You'd have to.

MR. JULIUS: In general what we'd reconcile is, is reacted to this process.

CHAIRMAN APOSTOLAKIS: I'm missing something. What is that?

MR. JULIUS: These are different failure tests. You know, one's effecting the --

MEMBER SHACK: But it's a separate failure.

MR. PARRY: Right, the failure is imagined as being a failure of the cognitive part or the failure of the execution.

CHAIRMAN APOSTOLAKIS: But that comes later.

MR. PARRY: And that comes later. Yeah, Jeff's only talking about the cognizant part now.

CHAIRMAN APOSTOLAKIS: Okay, okay, okay. I'm completely lost now.

MR. JULIUS: But there is this little overlap or link because if the execution, for example, is something that takes hours to go set up, and you've got and some of these STP situations it does, you know, you've got an hour and a half of a time window and it takes an hour to go rig in a crane to go do something, and you know, that will effect the time available for the cognitive.

CHAIRMAN APOSTOLAKIS: But why aren't these slides in the other package? Are they secret or what?

MR. JULIUS: I thought they were the ones that I had previously presented and we weren't going to go into this level of detail. We were going to talk about something a little different. So -- but I checked into the background so --

CHAIRMAN APOSTOLAKIS: Make sure that --

MR. JULIUS: The background, yes.

CHAIRMAN APOSTOLAKIS: So are you going to explain to us this, or what? It's up to you.

MR. JULIUS: Well, I just wanted -- so this was the -- so now we take this curve and this was the one developed from experimental data but here you see this is for the time -- normalized time range with a factor of 10, but as time gets more time available, the curve you extrapolated will continue to drop off and get extremely low human error probabilities. We expect that the actual operator response would tail off and reach some sort of floor minimum out here and so then we developed another method to pick up the, you know, region where the time part went off.

MEMBER SHACK: Is that your minimum HEP level?

MR. JULIUS: That's the minimum HEP level.

CHAIRMAN APOSTOLAKIS: So different factors come into the picture.

MR. JULIUS: That's right, and this goes back to this representation that this curve is the P2 and has the time portion and then -- but given that you have all the time in the world, is there some -- what is the probability of -- something is going to happen and but after doing these experiments, there was a great representation but after watching these simulators, it's hard to tell, okay, were you time limited or you just lost the big picture. So we dropped back in the overall representation and we said there's a cognitive and there's an execution contribution.

CHAIRMAN APOSTOLAKIS: Okay.

MR. JULIUS: So then we invented or came up with -- used those insights to develop this cause-based decision tree method. So this is using the same data and the time lines, because it effects the time available for response, we have for different actions here that are the man-machine interface or four different failure modes, the processing and the cues in information. Is the cue not available, is it a bad indicator, and there's four that have to do with the procedures.

And the little cartoon graphic that's to fix that is down here and we've got four failure mechanisms associated with the man-machine interface indications. This is performance shaping factors where you get, for example, if the cue doesn't work or is bad, is there -- does the procedure tell them to look at something else? Does the training allow for a success path?

And this is in the procedures, however, what's the specific wording, what's the specific actions that are in the procedures and then we look at recovery. So this caused-base decision tree approach then was developed somewhat similar to SPAR, that these decision trees or the points in the decision trees were made from expert judgments and mainly from the data in THERP and so that's how you would get an initial failure probability and then you look at additional people and the time available. If there's many hours available and TSC or ERF is manned, it's possible that they could provide credit for recovery.

You can see from this, if we had initial diagnosis HEP of say with a SPAR basic failure rate of $1E^{-2}$ and you've got three other possible recovery mechanisms that if you had an E^{-2}, and E^{-2} and an E^{-2}, you'd quickly have no contribution from that event. So this is where we limited the recovery credit. You pick the best one, either is the extra crew or the ERF, what's most likely, so that we didn't get into this .1 times a .1 times a .1 and no problem.

So the caused-base decision tree, this was to fill in then for the region where you're not time limited and it's to examine different failure modes.

CHAIRMAN APOSTOLAKIS: I remember there was a paper, which unfortunately, I cannot place any more but I read it years ago from the Cognitive Sciences literature, where they claim that they ran experiments and so on, nothing to do with nuclear power, and they found that if the crew has not figured out what's going on by about 80 minutes into the incident, they will never figure it out. Is that consistent with you?

MR. JULIUS: That's consistent with both the THERP time and liability correlation, if you look at the way the curves are, as well as basically our shift-over point. It's about the 90-minute point, yeah, yeah.

CHAIRMAN APOSTOLAKIS: So it's consistent. In other words, something is going on but they don't know and probably they will not figure it out. If they haven't figured it out by 80 or 90 minutes, forget it. That's very interesting. It's from your side of the fence. From psychology, very useful stuff from psychology.

MR. ELAWAR: Mr. Chairman, that may no longer be quite applicable because of the requirements now to quickly involve others. We have people on call, on site day and night, people with beepers. Instructions to inform others is very extensive.

CHAIRMAN APOSTOLAKIS: That probably has an impart but I guess the kind of thing they're talking about is it's such an unusual situation that as a community we really don't know what's going on. I don't know how true that is, I mean, but it's interesting though that that number which was from an entirely different community, is more or less consistent with --

MR. JULIUS: With those experiments, with the --

CHAIRMAN APOSTOLAKIS: With the nuclear input, 80 to 90 minutes. I think it was 80 in that paper, but again, it was not a fixed number.

DR. LOIS: Eighty or eight?

CHAIRMAN APOSTOLAKIS: 8-0, 80.

MR. JULIUS: But that does lead to a problem in that for the extremely long time scenarios, for example, the two rupture with successful injection where you're 18 hours out or a loss of spent fuel pool cooling or it's 20 hours to the onset of boiling and a lot of time before the boil-down, I mean, if you limit it to 10^{-4} and you say I've got 24 hours and the second crew comes in. The NRC comes to help and the newspapers are there and everybody else is there trying to help out.

MEMBER SHACK: You're screwed.

MR. JULIUS: It's a bathtub curve, it does back up right now.

(Laughter)

MR. JULIUS: But it would be flat and there wouldn't be some --

MEMBER MAYNARD: Well, something else that's a little, I think, unique about this industry is that the procedures recovery programs don't rely on you really understanding what is happening. They are really set up dealing with the symptoms and you don't have to know what your action is or whether you're going to get there, but if you don't, the recovery procedures are going to take care of things whether you understand whether you've got a tube rupture or whether you've got a small break LOCA or what. It's going to get you there.

CHAIRMAN APOSTOLAKIS: It's like in math, when in doubt, complete the square and see what happens.

(Laughter)

MEMBER MAYNARD: Well, most other things I've been associated with, part of it, you have to figure out what's in order to address it. Your procedures and training is not set up.

CHAIRMAN APOSTOLAKIS: Yeah, that was before TMI actually. That was --

MEMBER SHACK: But that assumes the procedures have thought through everything and you'll recover from those symptoms.

CHAIRMAN APOSTOLAKIS: That's right.

MR. JULIUS: That you have all the functions, yeah.

MEMBER SHACK: Yeah.

CHAIRMAN APOSTOLAKIS: But is that after

the --

MEMBER SHACK: There's a minimum probability there, too.

CHAIRMAN APOSTOLAKIS: Now, if there is a failure, just dump water, right? Just don't think about it. During the Browns Ferry fire they were debating whether it's wise to use water and this and that. I guess now it's fire, water.

MR. JULIUS: Okay, the other piece of this is we have elaborated on our dependency process and this is the dependency between the human failure events that was a hole in the THERP for example. And we have a specific piece set up to support the post-quantification review but in reality the dependency identification evaluation starts when you do the identification of event and find out what's going on and what's the context. And it's also addressed during the operator interviews.

So it was interesting. Out of this whole process when you talk about any of these methods, for example, SPAR when it came up about some of the influence of these performance shaping factors that may or may not be explicit. I mean, and a lot of this, it's driven by ASME and if these are risk significant, you will go and you will get input from the operators. So that presumably, there is some form of mapping or if this wasn't one-to-one mapping well this best fits into this box.

For example, my use of the communications either through a complexity or work processes may be in SPAR for example. And that's kind of independent but it is part of the process, kind of independent of the method. And then so we have a tool then, a piece or a module here in the software to do this post-quantification evaluation and then after that it's up to the analyst, the PRA analyst to decide based on his model. "If I have several events that are of a cognitive piece, so I replace that with a common cognitive piece or do I make these conditional probabilities or if it's a large event tree model, how do I feed that back into the model change?

But using this time line setup it makes it easy to import the cutsets or risk man sequences, depending on your model type, and to say for this cutset for example, here are all the operator actions and here's when they occur, so you can see, are they overlapping in time or are they separate and the one that's circled here, these were overlapping in time and it comes up as red, so it's suggesting that, you know, no credit should be given for this action.

CHAIRMAN APOSTOLAKIS: But again, since we're trying to see how different models approach different things, the dependencies that you are introducing here are consistent with the THERP and SPAR-H dependencies?

MR. JULIUS: The quantification and the approach is consistent with SPAR. We have a decision tree.

CHAIRMAN APOSTOLAKIS: What does that mean? You're using these Swain formulas for strong, medium --

MR. JULIUS: That's right, it's the low, medium and high and complete zero.

CHAIRMAN APOSTOLAKIS: Wow. But again, the uncertainties on the level of dependence is not the distribution of the individual parameters, right? Do you advise people using this, for example, that you know, you may not be sure whether the level of dependency is moderate or weak. And you should do it both ways and then put some distribution on top of it. Wouldn't that be the more reasonable thing to do? I mean, the uncertainty is in the level. You can't really say for sure, "Oh, no, this is weak". I'm not sure how much of the uncertainties --

MR. JULIUS: That was the piece that we

haven't -- that is off in the future. We are focusing on the fire HRN, these benchmarking but there's this activity where we look and it's more to examine, for example these aleatory uncertainties or some of these selection errors so that if -- we've got the software set up so that you can -- we will be able to evaluate that to try to quantify a lower bound or a higher bound based on either a selection of a method -- you know what if it was close to this crossover region at 80 minutes and I wanted to do an HRC or cost-based decision tree, or what if it is -- is it sensitive to the median response time or the time available, so that you could take some of these parameters and to evaluate it.

It's similar with the dependence factor. We have it set in there now and it's easy to go and change it from a low to a moderate or a moderate to a high. We're just saying that here's some generally accepted, similar to SPAR, that these are the things that would influence that. Are you more likely to have a higher dependence if it's the same guys doing it? If they're in the same location or they're from the same procedure. There may be two separate actions but they're both in the same procedure. If he doesn't get that procedure, there is a link there. And then actual quantification. So this goes back to this setup of the model versus the quantification as well.

We're doing the setup but we take the quantification elements from THERP. But this is a important piece and I think we need to start with this whole process and understand where these different models or modules and pieces come in and maybe to make our process complete, I think I stopped in my -- in your handout there at the dependency and then documentation because that's in ASME, but generally this uncertainty piece comes off in this quantification, but that's certainly a part of the overall process.

One of the things we have done in this software release update that we're doing this spring that maybe the ATHEANA guys will be happy to hear is we've allowed the cause based decision trees to have plant specific data instead of this generic data from EPRI TR100-259 and I think -- I don't think Version 4 but I think the next version will also maybe allow for different decision trees. And we're looking ahead to, for example, in the fire HRA, are there different -- one of the questions on ATHEANA is or the pluses of ATHEANA compared to a limitation on our methods was the cost-based decision tree has this fixed set of performance shaping factors. So they rightly asked if you're in a different scenario, like a fire, I mean this method came from evaluation of insights from simulator experiments where we're non-fire scenarios but now you could get communication problems or because they've got breathing apparatuses or some other performance shaping factor, that would be added.

CHAIRMAN APOSTOLAKIS: It just occurred to me, going back to power uprates, because that's a licensing action so we really are about it. I've read in the SERs that the staff issues, the most important thing was a shortening of the available time to the operators. And they give the top three or four, five events. Very often the shortening of the time is insignificant. You know, I remember 32 minutes went down to 29, all right, big deal. But as you go down, though --

MR. JULIUS: It goes from eight minutes to four minutes in --

CHAIRMAN APOSTOLAKIS: Oh, well, you know, so and then it says and we calculated the change in the human error probability and it's three 10^{-3} or something, and the staff says, you know, from the SER now, because I don't know, maybe they've done other things, "This is acceptable". Now, judging from what you're presenting here, somebody, the person or the persons who developed the application for the power uprate, probably went to the curves that you showed us, right? They had the $T_{1/2}$ right? They calculated the TSW, TM and all that. They calculated the performance shaping factors of sigma, select the curve. Is that information submitted to the NRC when NRR reviews this? Is anybody questioning it?

MR. JULIUS: I don't know but you think it should be.

CHAIRMAN APOSTOLAKIS: Well, that's a mystery to me, I mean, because, you know, there is a lot of judgment that goes into this.

MR. JULIUS: Well, you know, the judgment it might be is, it is a possible failure mode that -- I mean, somebody had done all their HEPs with cost based decision tree because they hadn't set up or they didn't see any that were dominated by HER and generally, the influence of time is left. So if you go in and you say, "The time has changed", maybe it's actually one of these that would shift from one method to the other. And if you blindly pick one and --

CHAIRMAN APOSTOLAKIS: Yeah, I don't know. I can't tell from the SER how much these estimates were scrutinized.

MR. PARRY: This is Gareth Parry. Can I make a comment here? Remember George, these are all non-risk informed submittals that you're talking about and so any risk information is --

CHAIRMAN APOSTOLAKIS: Is a gift to us.

MR. PARRY: Sort of, but if it were a risk informed submittal, then no doubt there would be scrutiny of these values. But you've also got to ask ourself whether this time reliability method is, in fact, the appropriate one for dealing with the types of actions that are typically done on a short time scale, which is I think the most critical one is probably initiation of SLIC in the boiler, right? Those actions, I think, are pretty immediate and pretty obvious when the symptoms are there.

CHAIRMAN APOSTOLAKIS: Well, that's why they do typically test them on the simulator.

MR. PARRY: A lot.

CHAIRMAN APOSTOLAKIS: And the assumption is the procedure has not changed. As long as the procedure does not have to change, because of the uprate, then the procedure stays the same and then you see if the response is still the same. I mean, it may be a shorter time but the operator executes the same steps the same way and so that's really what they're checking.

MR. PARRY: Right, I think that's correct.

CHAIRMAN APOSTOLAKIS: Yeah, but I mean, these are official documents. To say that it's not risk informed, therefore, I don't have to worry about it, it doesn't do it --

MR. PARRY: No, and they don't say that.

CHAIRMAN APOSTOLAKIS: So why are we submitting it? Why is this information submitted then? I mean --

MR. PARRY: I think because the ACRS asks for it, typically.

CHAIRMAN APOSTOLAKIS: No.

MR. PARRY: I think it is.

MEMBER BONACA: I think if you had to change the procedures to address the fact that --

MR. PARRY: You would have to do something else.

MEMBER BONACA: -- you would really have to do something else.

MR. PARRY: Right.

MEMBER BONACA: Because then the question is, you have a whole different scenario there. Clearly you're changing the procedure because the existing procedure is not adequate any more and the only constraint is the time constraint, that would be a very significant issue.

MEMBER SHACK: Well, I think it would also change very much if your time window changed. You know, if all your simulator says the guy does the SLIC in a minute, and you've got five minutes, you know, that's one answer. If it was two minutes, you might have a very different --

MR. PARRY: Right, but I think also, you know, it is method dependent because if you use the SPAR-H for this, you wouldn't get a change. Right, because you're already in the -- I'm pretty sure that's the case for -- we're in that low time period.

CHAIRMAN APOSTOLAKIS: But in the deterministic world, I mean, this is a change that is requested within the traditional deterministic regulatory system. How is it handled, the fact that the time was shortened? There must be a way of handling it. So, okay, it's not risk informed. We should neglect or ignore all the risk information that is submitted. Then under what basis do the deterministic guys make a decision that this is okay?

MR. PARRY: It's what Mario said.

MEMBER BONACA: Whether the sequence is ambiguous or not. If it isn't ambiguous --

CHAIRMAN APOSTOLAKIS: Ambiguous meaning?

MEMBER BONACA: Well, for example, that the operator consistently recognizes this is an ATWS event. So there is no confusion regarding that. The material is similar to what you use in PRA so far as the concepts that you're using.

CHAIRMAN APOSTOLAKIS: So the deterministic part is good enough, is that what you're saying?

MEMBER BONACA: No, I was saying that -- well, I think the element that Bill is talking about is important.

CHAIRMAN APOSTOLAKIS: Which is?

MEMBER BONACA: To operate a SLIC system, you may respond within a minute consistently. So now if you go from six minutes to five minutes, you have margin with respect to this action for which consistently you have response for the operators in one minute, if in fact -- I'm sorry.

CHAIRMAN APOSTOLAKIS: Go ahead.

MEMBER BONACA: No, I'm saying if conversely, it would take you four minutes to do the SLIC operation, and you have six minutes available and then you go to five, I think it would be a different issue.

MEMBER MAYNARD: I think on the deterministic side, the short time frames are usually two different types. One, if it's a short time frame there are some of those that are critical, that if they're not does, it does effect the accident there but typically those are handled very quickly up front. You may have eight or nine minutes to do it. Typically, they're the ones that are going to be done in the very first part. So that's one thing they'd have to take a look at, exactly what you guys were talking about.

But a number of these short time frames are really dealing more with how do you classify a given accident? For instance, in the PWR you may have eight or nine minutes to secure safety injection or else you over-fill the pressurizer which would change the -- if you knew that was going to happen, you'd change the category of that type of accident when in reality all that really does is give you then, the equivalent of a small break LOCA which you are really covered for and doesn't result in core damage or the increase in probability is extremely small.

So I think it depends on what are the consequences of missing that step or missing that time frame. Some of them have a critical nature, some don't really effect the core damage frequency just by missing that time frame.

CHAIRMAN APOSTOLAKIS: So basically, the approach then is what I think Dr. Lois is going to present similar to the methodology that was developed in the for fires. Essentially, you're comparing the available time and the time required, and then you make a judgment; this is plenty, the margin is good and we're home free.

MEMBER BONACA: But the delta is in there, too. The value of the time is a very big issue.

CHAIRMAN APOSTOLAKIS: Yeah, so why can't we go ahead --

MEMBER SHACK: Well, I think it's a more integral judgment of whether the action is extremely likely to be completed successfully and you know, is it highly proceduralized, are the symptoms clear and obvious, you know. This is an event that he's trained on, you know, up the wazoo.

CHAIRMAN APOSTOLAKIS: And that's why the time is short.

MEMBER SHACK: And even then, time may not even be the critical issue. You know, changes in time may not be terribly important to that particular kind of event.

CHAIRMAN APOSTOLAKIS: I think the center of it is time because you said earlier --

MEMBER SHACK: Well, no it's --

CHAIRMAN APOSTOLAKIS: -- they always do it in a minute.

MEMBER SHACK: If he had 10 minutes and he gets it down to five minutes but he only needs one minute, the time is not important.

CHAIRMAN APOSTOLAKIS: That's what I'm saying. No, the time that takes one minute is important.

MEMBER SHACK: Okay, it depends on how you look at it.

MEMBER BONACA: The issue of ambiguity comes in. I mean, if this is an unambiguous transient for which he consistently or all the crews consistently take action within a minute, then the six minutes doesn't worry me any more and if it goes to 6.5, it doesn't worry me any more either. Typically what we hear from them is the representation that says that the new times were tried in the simulator and the crews consistently responded with a good margin. So that's one of the reasons why we accepted it.

CHAIRMAN APOSTOLAKIS: So why can't we do the same in the PRA? Why do we need to worry about this? Why don't we follow the same approach and convince ourselves that there is plenty of time for the operators to do it and forget about these models? What is the difference?

MR. JULIUS: I think there's a comparable contribution to some of the other random hardware failures, so you are getting down to the range where if you're throwing that out, you are throwing out one of the insights that there is an operator contribution to this sequence.

MEMBER BONACA: Well, with respect to the PRA, if all these things would converge the way I've described, you would have a pretty high range of operator success. I mean, that's the same thing you're looking at.

MR. JULIUS: That's right, and you're seeing that some of the HEPs, they're low numbers.

CHAIRMAN APOSTOLAKIS: They are very low numbers, right. I mean, they're 10^{-3}, 10^{-4}, right? They have a high probability of success.

DR. ELAWAR: Those are the actions as skill-based, like second nature to the operator. He will never fail to trip the reactor if there is adverse conditions, but when it comes to numerous actions in which he had to follow procedure methodically, then if the time gets short, the REP becomes the issue, but I would classify those as skill-based.

CHAIRMAN APOSTOLAKIS: The question really is, is there any justification for the agency to spend all this money on developing these models when the real decisions are not based on these models?

MR. PARRY: I think you're extrapolating from one case --

MEMBER SHACK: We've gone from 2.5 to 10^5. It's important.

CHAIRMAN APOSTOLAKIS: No, seriously, now why can't I apply the same logic? Surely the operators are trained. So if I have, you know, a los of feedwater or something, you know, two or three times on the simulator. They manage it in three and a half minutes, I have whatever minutes I have. Forget about it, that's it. It's done. Why do this?

MR. PARRY: No, no, you would still need -- I mean, you're basing that on evidence of a certain number of successes. You still have to figure out if there were circumstances under which they would fail? Is there something -- I mean, these are the things that John talks about.

CHAIRMAN APOSTOLAKIS: Why -- I mean --

MR. PARRY: And maybe that base hasn't changed.

CHAIRMAN APOSTOLAKIS: Either in the case that Bill just mentioned, there are circumstances where there were not doing it in one minute, so I had to worry about it, or, I'm convinced they will do it, then I come here and I say, I don't need any PRA models because they will do it.

MEMBER BONACA: Well, I may conclude --

CHAIRMAN APOSTOLAKIS: I mean, in some cases we worry that there may be circumstances that will make them deviate, and in the real decision we don't worry about that. No, no, no, they always did it in a minute. I mean, there is a disconnect there. Is it to keep people busy or what?

MR. PARRY: No, that's a constant.

MEMBER BONACA: By doing the uprate, they have not changed the failure probability for the operator.

MR. PARRY: Right.

MEMBER BONACA: It doesn't mean that there isn't --

MR. JULIUS: A failure probability.

MR. PARRY: That's exactly right.

MEMBER BONACA: And that has to be

accounted for in the PRA because you are looking exactly at that failure probability.

CHAIRMAN APOSTOLAKIS: For why, when the PRA is not used for anything. It's only to pacify the committee. Why spend time on this, why spend money on this? I mean, it doesn't make sense to me.

MEMBER BONACA: No, but in this case, even the committee, even if you use risk issues, if you can conclude that the risk is unaffected by this decision of uprating, then you've made a relative conclusion to justify the uprate. It doesn't mean that you have added the probability of failure, you just haven't changed it.

CHAIRMAN APOSTOLAKIS: I've changed it but supposedly satisfactorily. It's still a mystery to me why we insist on doing this when the real decisions don't take this approach.

MR. JULIUS: That's going to lead into one of my suggestions here on a subsequent slide.

CHAIRMAN APOSTOLAKIS: Okay. Your suggestion would be, forget it?

MR. JULIUS: But before we get there, though, this slide presents kind of the range of applications that we have used the HRA calculator for and some of them are licensing based such as licensing issues or significance determination process or changes to the AOTs and others are internal usage, like for example, the training or prioritization of different activities.

CHAIRMAN APOSTOLAKIS: Configuration risk management, we'll hear about it tomorrow, how HRAs use that? Tomorrow was --

MR. JULIUS: I wasn't planning --

CHAIRMAN APOSTOLAKIS: Not you, I think Mr. Canavan will do that.

MR. JULIUS: Yeah.

CHAIRMAN APOSTOLAKIS: Is he here?

MR. JULIUS: He had to step out.

CHAIRMAN APOSTOLAKIS: Yeah, I think he's scheduled to talk about it.

DR. ELAWAR: They use a little part of the model only. They're not exclusively used by themselves. The model is used for decisions and the model depends on --

MR. JULIUS: Okay, so this is kind of a brainstorming slide. It talks about some different activities that may be considered for an integrated plan. One of the activities was this ATHEANA-like approach in terms of this team. And the comment here is that typically, the team that we've used for 1892 and 1842 was actually researched based and it would be good to have regulation based participation. This would be patterned after the joint EPRI NRC MOU that's used for fire where we have industry and NRC as well as research and regulation and you know, regulation maybe isn't needed in the beginning but will certainly weigh in at the end. You can see the proposed Step 2 here, this something that had been mentioned earlier about establishing common terms and overall integrated approach. What is the overall process and framework? How do the performance-shaping factors of SPAR map to the EPRI HRA calculator. I was at an ASS conference in November and one of the different university methods, IDAC or something, I mean, they had 100 different performance shaping factors. You know, bigger isn't necessarily better.

I mean, there already could be included or grouped in the existing factors that are in the model. And related to that, what is the process for the method selection within this process. But in this number 3, this was something -- the different approach. We've done -- I previous activities, we've looked from the ground up. Let's look at these methods and differ end them and understand the bases for them, but now I want to go around to the other end. Let's look at the applications, let's look at the decisions that were made and take a look, did the HRA come in, weigh in on the decision making and -- or should it have? Maybe it did, maybe it didn't but I think it would be a useful activity to look at the applications that are out there and to identify those areas either where there are differences or maybe where there is holes.

Typically where the biggest differences are, it's the holes in both. This cost based decision tree and a lot of these were meant for procedure based actions in the control room and now we're doing local actions that are diagnosis in the plant that have no procedures and that doesn't fit well with either of these methods. That should be the focus on the activities and this review would help provide that focus. And partly that is also to get off this review of this past two documents have looked internally at the Level 1 internal events but there's a lot of activity to add spatials of fires and floods and also often externals and shutdowns, that's all part of going to the full scope PRA. We should be looking ahead or downstream at not only the applications but what are the models going to look like to get out and ahead to really provide -- should we even be doing HRA but if we should maybe it should be off in this, maybe it's fire HRA.

So this was some -- maybe this was meant to lead into, you know, some ideas to consider in the discussion this afternoon but this was a first --

CHAIRMAN APOSTOLAKIS: No, this is an excellent list and I think we should revisit it during the roundtable discussion to get views from other people, but I think this is a great contribution. Do you plan to continue or this is the end?

MR. JULIUS: One more slide and this was, we have looked at and I threw out the idea in the November ANS meeting about using the EPRI HRA calculator to support ATHEANA and the ATHEANA process is to develop a baseline scenario and understand nominal model and then to look for the deviations scenarios. And so the calculator provides a starting link for that where we look at the qualitative definition of this nominal scenario and you pick some form of quantification method and again, you're doing the dependence analysis but this is all embodied in the calculator.

But from that, you can do these deviation scenarios. You take okay, now given that this is the baseline, what if there was a problem with instrumentation, what if the time was significantly less? What if there was mass cues or other things. So this -- it not only develops it as a structured approach for laying out the different factors, but also provides the documentation for it.

CHAIRMAN APOSTOLAKIS: Very good.

MR. JULIUS: That concludes my presentation.

CHAIRMAN APOSTOLAKIS: Coming back to your previous list, some HRA methods provide insight sufficient to change the decision. I think this is the key question here. It really is. I'd like to know what decisions these are and then ask a question whether any HRA methods change them, because if the answer is no, there's no reason to do any of this.

This is a decision making agency, it's not a research organization. So I think that would be our first question this afternoon when we come to it. This is a great list, Jeff. Thank you.

DR. ELAWAR: Mr. Chairman, we had a conference call in the group that was a week ago and Slide Number 18 is a consensus that we were requested to present it to your commission.

CHAIRMAN APOSTOLAKIS: Very good, very good.

DR. ELAWAR: We'd appreciate it if you'd read Slide Number 18.

CHAIRMAN APOSTOLAKIS: 18, okay, tell us what you want to say about it.

DR. ELAWAR: It's a written, I believe, in good language here that we believe we have -- what matters to me there are commitments, we are often reminded to receive newer, better methods. We'll cooperate with any decisions you want to make. Basically we --

CHAIRMAN APOSTOLAKIS: So, you're actually arguing against what the SRM is asking. You said, as opposed to --

DR. ELAWAR: I would not phrase it that way. I would like to leave the impression that our members appear to be satisfied with the matters they have at hand.

CHAIRMAN APOSTOLAKIS: This is not very consistent with the list that Jeff just showed us though. I mean, you're not asking --

DR. ELAWAR: This was read and modified during a conference call with about two dozen utilities, that they want me and perhaps Jeff, to convey this to you.

CHAIRMAN APOSTOLAKIS: I understand.

MR. JULIUS: Yeah, so this was he position and then I separately drafted this brainstorming list of ideas, but I think that there maybe is a convergence, that we can lay out an integrated plan or approach that would allow some of this momentum or some of the investment, if you will, to -- maybe the integrated approach does provide through this -- you know, using SPAR at a certain level, is good enough so that there are utilities that would welcome that, figuring out where and when to use ATHEANA.

CHAIRMAN APOSTOLAKIS: Well, that's what the SRM says, or a suite of models appropriate for particular applications.

MR. PARRY: I think in license amendments space, if this is what you're referring to, that might be okay, but if you're talking about STP applications, then I think some of the questions that you raised on your slide such as the applicability of some of these methods to recovery actions in particular --

MR. JULIUS: Right.

MR. PARRY: -- we are not in a good position there. We don't have good models to deal with those to resolve some of the STP issues. So I'm surprised that the industry people are actually coming up with this position.

CHAIRMAN APOSTOLAKIS: And again, maybe there is a misunderstanding concerning the point of integration. I mean, nobody's asking for all the models to be combined into one, but for example, the issue of terminology, you know, it's important. The other issue is, you know, I mean, the industry believes that we have already got methods. Probably they mean the calculator.

Then I'm thinking in terms of SPAR-H, and I'm trying to figure out what's the connection. I shouldn't have to spend time trying to figure out the connection. I would be happy -- huh?

MEMBER MAYNARD: This is for current licenses. We're not talking future designs and stuff.

MR. JULIUS: That's correct. And also this thing with the SDP, you're right. I think the intent here was that ultimately that the NRC licensing or regulation approach would accept the methods that are in the HRA calculator as acceptable to the NRC as opposed to saying, well, that's a nice analysis that you've done but we're taking the SPAR-H for determining your greater-than-green finding. You know, there should be helping the NRCA accept the methods in the HRA calculator as opposed to having the two and saying, "Well, it's 50/50, so we're picking this".

MR. PARRY: And maybe --

MR. RAHN: This is Frank Rahn on the phone, if I might.

CHAIRMAN APOSTOLAKIS: Go ahead.

MR. RAHN: Yes, we don't view the HRA calculator as a static tool but rather one that's dynamic. Jeff has already indicated that we are working on Version 4 of the calculator which means that roughly every year or 18 months, we produce a new version with new features.

We're also very interested in improving our methodology and our techniques and we look forward to working with the NRC and others engaged in research in terms of improving our understanding of HRA and as appropriate, build those technologies and methodologies into the HRA calculator. Now, you've already indicated or there has been some discussion that certainly for new applications in Yucca Mountain, this is one that was mentioned, we probably will need new approaches and new methodologies.

On the other hand, we do view the calculator and the current licensing environment as producing a well-understood methodology where both the strengths and the weaknesses are understood and allows us to move forward in terms of confidence when we have applications to submit to NRC that we have a robust methodology that's, like I say, well, understood and we're able to convey to the NRC the scrutabilty of our methodologies and they understand exactly what we've done and why we've done it and wherever there may be holes and weaknesses.

DR. LOIS: I'd like to -- can I say something? I'm kind of impresses with what -- how much the calculator evolves and how much actually integrates the concepts that we've developed over the last few years from the good practice, et cetera, but unless we really establish this collaborative effort and then have the opportunity to understand how the calculator evolves and how -- what is behind the calculator or the other avenue to have the NRC's really blessing analysis through the calculator would be through a formal review process.

CHAIRMAN APOSTOLAKIS: Right. Yeah, I mean, the point here is not to develop new methods. I mean, the point is that I mean, today we've heard about, I don't know, several methods, there's more to come. The question is, as a community do we understand? Are we talking about the same things? Are we very different? I think there are certain points where I believe we are reaching consensus that they're done equally well. For example, the identification of scenarios in SHARP and in the first part of ATHEANA, they're not that different, okay. Maybe the language is a little different. That's another thing we need to correct. Maybe correct is too strong, but to make consistent, you know, that when we say this here, that's exactly what we mean in the other method, too.

So this is a slow process of getting toward, you know, better understanding. It's not -- nobody's asking for the development of new methods but again, you know, we have to make sure that what SPAR-H or ATHEANA is proposing and consider is important, is captured in some way by the calculator and vice versa. And maybe the standardization that the industry has pursued is something that we should also try to do in the NRC models and maybe we need a classification of problems.

I like the question about, you know, what decisions -- in what decisions does HRA play a big role? And the same question was asked about digital INC by the say and the committee and the contractors have been struggling with it, because, you know, people immediately go to the aerospace business, where they have worried about INC digital failures, but those guys use them always in feedback control systems. And our systems are not always like that. We have much simpler systems that are just actuation systems.

So to try -- you know, you're using a very sophisticated method to do something very simple. So classifying the problems where there is a need to do an analysis, and what kind of analysis you need is very, very important. So, I'm glad that you're asking those questions, Jeff. I mean, you know, goes HRA play a significant role in certain problem? How significant is it? Should I start with a calculator and then maybe in a couple of cases switch to something else like you guys did? You started with the curves and then you switched to the trees and achieve some consistency.

Okay, and I don't think -- you know, I mean to take positions like, you know, our method is better than yours is not -- that's not the point of today anyway, okay? So we're going to hear from --

MR. JULIUS: We're going to hear them.

CHAIRMAN APOSTOLAKIS: No, we're going back to this, yeah. Don't lose it, don't lose it, okay? It's one and a half hours since we started, so we'll take a break and then Erasmia, you will talk a little bit about -- how much, 10 minutes?

DR. LOIS: It depends. If you want to cover the time margin concept, it may take as long as you want.

CHAIRMAN APOSTOLAKIS: No, I don't. Cover it -- can you just tell us what it is? I mean, we already covered it, I think, in five, 10 minutes?

DR. LOIS: Okay, a few minutes.

CHAIRMAN APOSTOLAKIS: And then the benchmarking.

DR. LOIS: And then the benchmarking.

CHAIRMAN APOSTOLAKIS: That will take about an hour?

DR. LOIS: No, no, it will not take an hour because I'm covering the approach and what milestones we have. We're not going into details as to how we're doing the benchmarking because we're going through the pilot right now and it's -- so I'll give you a lot of information about the pilot, but actually --

CHAIRMAN APOSTOLAKIS: But the question really --

DR. LOIS: -- we're not going to know what results we have on this.

CHAIRMAN APOSTOLAKIS: One question will be, you know, in the context of the SRM, how does a benchmarking exercise --

DR. LOIS: That I'm going to cover.

CHAIRMAN APOSTOLAKIS: Okay, so we'll recess --

MR. PARRY: George, just before that, can I just make a point of clarification?

CHAIRMAN APOSTOLAKIS: Go ahead.

MR. PARRY: I hate to come back to power uprates, but I think it's relevant to what Dr. Bonaca said. Remember, because it's a non-risk informed submittal, the test is adequate protection, so it's a totally different test than if it were a risk informed submittal and that's why I think we find the assessment of the HRA acceptable.

CHAIRMAN APOSTOLAKIS: I can't think of a case where HRA is important.

MR. RAHN: Can you please repeat that? I'm afraid I didn't understand it or didn't hear it well.

CHAIRMAN APOSTOLAKIS: I can't. I think that -- Frank, I'm sorry, Frank, do you want to say something?

MR. RAHN: No, I was just asking I think

it was Gareth who was speaking, if he could repeat what he just said, I couldn't hear what he was saying.

MR. PARRY: Oh, okay, I'm sorry. What I was saying, we had a discussion some time ago about power uprates, and I was just pointing out that the power uprates are not risk-informed submittals and because of that, the acceptance criteria are different and in particular, I think in this case, for the staff to find it unacceptable, they have to make a case that there is a lack of adequate protection.

CHAIRMAN APOSTOLAKIS: Yes.

MR. RAHN: Thank you very much.

MEMBER BONACA: We were talking about that. But it seems to me that the key issue is the difference between the available time and time needed for an action. In a context, there are actions for which an HRA is extremely important.

CHAIRMAN APOSTOLAKIS: Like?

MEMBER BONACA: Well, I mean, you have to go through examples.

CHAIRMAN APOSTOLAKIS: The only one is SDP, the Significance Determination Process.

MEMBER BONACA: No, I made an example this morning for example, that, you know, if you look at some power plants like the early combustion engineering plant with very small charging capacity, bleed and feed is a very narrow window for success. And you know, until there was confidence that the operators would not play around, be reluctant, but they would execute the steps hopefully, then you question, you know, whether or not you have sufficient time between available time and time needed to perform the action. So that's an example of where the decision was critical.

Now, it probably is not critical any more now because they've been trained in other procedures, but I'm saying that's an example.

CHAIRMAN APOSTOLAKIS: But, that's an example, again of the importance of human performance. It's not an example of the importance of HRA.

DR. LOIS: Can I add something?

CHAIRMAN APOSTOLAKIS: Because HRA played no role in making a determination that this was acceptable or not. Yes.

DR. LOIS: So the HRA is an integral part of the probabilistic risk assessment. So if one extrapolates your suggestion that the HRA is not important and, therefore, you can create a PRA model which could be -- could assume success or failure, either one, on all different plants, then in actuality you're not representing the plant model, the plant response because many of the safety systems would come in through operator action. So you cannot -- I mean, HRA is as important as equipment failure probabilities. That's the role, that's the original role and that's how we set it out.

It's a representation of plant performance during an accident condition. If you carry it out and you say, well, since human actions are so successful, I can do it within a minute, and, therefore, I don't have -- I mean, we've had one plant Susquehanna, that assumed every human action was run and created to totally convoluted --

CHAIRMAN APOSTOLAKIS: The reliability was wrong.

DR. LOIS: Yes, they had a statement where they were saying that, "We shall not accept human errors". And the PRA model that they created did not represent the actual plant performance. So we should -- that's the point I'd like to make.

MEMBER BONACA: The other thing is that, you know, if you look at the simple procedures, as you move away from the immediate actions, you know, SCRAM, some operator action, and you move towards beyond design basis, they move into the beyond design basis, that would lead you to actions anyway. I think that that's where the HRAs become extremely important, because some of those actions maybe successful or not. They are in procedures but they are beyond design basis but they're still actions that you take because that's what you have to do. I mean, what is that?

CHAIRMAN APOSTOLAKIS: Are you babysitting, Frank?

MR. RAHN: I'm afraid it's not me, wish it were.

CHAIRMAN APOSTOLAKIS: Anyway, okay, we'll reconvene at what, 3:00 o'clock.

(Whereupon, a short recess was taken at 2:40 p.m.)

(On the record at 3:01 p.m.)

CHAIRMAN APOSTOLAKIS: Okay, gentlemen and ladies. Okay, good, good idea. Okay, we are back I session and I've asked Erasmia to give us a short briefing on what this other method does, right, that deals primarily with time, and then go onto the benchmark exercise which is really a very important future activity of the agency.

DR. LOIS: Shall I remind the committee why we developed this time method?

CHAIRMAN APOSTOLAKIS: Yeah, I mean, if

you could spend five, 10 minutes, at least we will have it in the back of our minds when we have the general discussion.

DR. LOIS: So three years ago, we had a rulemaking activity to address the issue of human actions used in post-fire conditions. Appendix R(3)(g)(2) requires those and new rules on how to separation of trains. And many licensees have done a broad interpretation of the rule and had -- and have instituted human actions to compensate for post-fire shutdown in lieu of separation.

The commission directed the staff to go ahead with rulemaking activity to allow licensees to use this human actions in lieu of separation just because there was a strong indication that the staff would be flooded with exemption requests because many, many licensees are using human actions for post-fire shutdown, achieving -- I'm sorry, achieving shutdown in post-fire conditions. We had -- a draft rule was publicly reviewed and there was a strong opposition from the industry. They believed that the criteria that we had developed for this fire manual actions were very stringent and it doesn't matter, we would have to have -- we will have to have many, many exemption requests either way.

But in doing those activities, we came to the ACRS, again it was September of `04, and presented what we called feasibility criteria for the manual actions. And the ACRS told us that we have to address also the reliability, not just feasibility criteria and if possible, to include HRA as part of the basis for the criteria for allowing this human actions.

We had an expert elicitation or the brainstorming meeting at the -- here at the NRC trying to figure out how we can address the ACRS recommendations to take into consideration the availability aspects and at the same time not do a human reliability because these meant to be deterministic criteria and we came up with the concept of the time margin and we believe that this concept can help address themselves as to the availability associated with time and that with the time it takes to diagnosis and perform and verify the desired actions.

Now, I would like to recognize Alan Koloczkowski and John Forester that came up with this idea and actually, I will ask Alan to walk us through, very quickly, Alan, through the next three slides.

MR. KOLOCZKOWSKI: This is Alan Koloczkowski with SAIC. I want to remind the committee, much like the example that Gareth just gave before the break, where power uprates are non-risk informed type submittals. That's what we're talking about here. We're talking about licensees who choose not to go NFTA 805 or develop a fire PRA and actually develop HRA probabilities or HEPs for their fire manual action but then still want to have a certain fire manual action as being acceptable even a deterministic type of an approach to the NRC and submit that fire manual action for approval and yet not provide necessarily a risk informed perceptive.

So that's why we're not doing HRA, we're not doing human error probabilities. We had to come up with a different -- the scheme, though, has many parallels to what you do do when you are doing an HEP and I'll pick it up on Slide Number 2. What the approach is, it basically lays out a number of criterias about, roughly nine or 10 of them, that should be met, show mainly that the fire manual action is certainly feasible and for that matter, certainly meeting the criteria, it does go a long way to addressing the liability. And those criteria are the very kinds of things that we look at when we're doing an HRA and actually trying to come up with an HEP.

The criteria addressed such things as you have to have procedures that address the actions that you're going to take during this fire manual action. You have to have the indications necessary and the cues so that the even know that the action needs to be taken.

You have to have the ability to communicate to one another so that if that is a requirement to carry out the action, indeed, that can be performed. They have to be trained on the action. Those are analogous to the PSF that we look at when we're doing and HEP. We say, here's the procedure, do they have a procedure and what is the goodness of that procedure? Are they trained and what is the goodness of the training? Do they have the cues that they need to be able to perform this action? Very analogous. So first of all, there's a layout of roughly nine or 10 criteria that says, "If you meet these criteria, you've gone a long way to one, proving that the action is clearly feasible, and two, it's a long way to assessing the reliability, that the action is going to be able to be performed reliably.

But just as we discussed earlier that you still have to have enough time. You could have the best procedures, the best cues, the best training, et cetera, but if you just don't have enough time to take the action, guess what, you're going to fail to take the action in the amount of time that's necessary. So you still have to meet a certain amount of time.

And so we came up with the time margin concept saying that in spite of all these other criteria, that you'd better make sure that you have enough of diagnosis time and you have enough of implementation time and with some margin, have enough of time so that we can assure ourselves that along with these good procedures and the good training and so on, that we have more than enough time to make sure that the action is going to be able to be performed.

And so, rather than going into doing HEPs, et cetera, now, I'm marching really to Slide 3, we came up with this concept of feasibility and I might add some amount of reliability which would be assessed by meeting the other nine or 10 criteria, along with showing that there is more than enough time to make sure that the action can be completed. And those two things together address high reliability. Again, there is an analogy in doing HEP. We just mentioned that time allowed versus time actually it takes to implement that action, the more that there is the more that it makes the HEP go down, given that all the other PSFs are also positive, that you have good procedures, you have good training, et cetera and so forth. So the concept is actually the same. It's just that they've been applied differently because we're looking at a deterministic set of criteria as you're trying to calculate an HEP.

I think that's really all I wanted to say about it. I know we don't want to turn this into a fire manual action discussion. I'll conclude with this statement; while I cannot speak for industry, I think industry has no problem with the concept that, yes, there needs to be margins. I think industry would just say, we've already built the margins in the way we calculate T3, that is how much time do I need, does this action have to be performed by? And that's probably where the point of contention is. That's all.

DR. LOIS: That's not the issue of discussion for today.

CHAIRMAN APOSTOLAKIS: No, no.

MR. KOLOCZKOWSKI: No, that's not --

CHAIRMAN APOSTOLAKIS: We were told earlier, though, that the industry is developing an approach to human reliability in fire conditions. So and that is done by the industry without your participation.

DR. LOIS: Not exactly, let me clarify. For risk informed applications, NFP-805, so this is a different concept, the time margin, the manual actions, that potentially licensees could come in to the NRC and request approval through the deterministic approach. Then they would -- the guidance that is in NUREG 1842 could be used by the staff --

CHAIRMAN APOSTOLAKIS: 1842 is this?

DR. LOIS: This --

CHAIRMAN APOSTOLAKIS: This approach.

DR. LOIS: Yes, this approach as documented now in NUREG 1852.

CHAIRMAN APOSTOLAKIS: 52.

DR. LOIS: 52, and it's a briefing that you're going to have pretty soon because we had that for public comment and we are going to come and brief you. Now, licensees that do not want to use risk informed methods and would like to have the deterministic approach, in order to -- they will come in potentially to request approval. Then, we have documented this methodology in NUREG 1852 that the NRC staff would use as guidance to ask questions to the licensees regarding feasibility and reliability of the human actions and approve or disapprove the human actions.

CHAIRMAN APOSTOLAKIS: But the activity that Mr. Elawar referred to earlier was risk informed, wasn't it?

DR. LOIS: That's right. That's --

CHAIRMAN APOSTOLAKIS: And in that one are you participating in that one?

DR. LOIS: We believe we will.

CHAIRMAN APOSTOLAKIS: You will --

DR. LOIS: Yes.

CHAIRMAN APOSTOLAKIS: -- but not now, okay.

DR. LOIS: We don't have --

CHAIRMAN APOSTOLAKIS: It's part of the memo.

MS. LEVIN: Yes, we believe we will.

CHAIRMAN APOSTOLAKIS: Okay, I think it's time to move onto the real thing now, the benchmarking and would you like to join us at the table here? I mean, whatever makes you comfortable. I mean, the computer is -- over here, unless you really want to be next to each other. No, here.

DR. LOIS: Okay, quickly, I will walk through the benchmarking exercise that we believe will help us address many of these questions we're struggling with today. The other objectives of the benchmarking process, the accuracies, strengths, weaknesses of methods and provide the technical basis for improving HRA guidance and potentially improving the methods themselves.

Why we do it? I have three, four slides on the motivation of the study. I don't believe that I have to cover all of those but the main points is here that we've done through the guidance development activities, we had met strong interactions with the HRA community, domestically and abroad and actually there was a strong feeling developed and recommendation that we have to move forward to address the limitations in human reliability.

And I cover that in this slide and I include that -- those interactions included the ACRS as well and also I mention in the fourth bullet that we had a meeting which was an aside meeting in New Orleans last June or June a year ago with a strong participation, as I said, with international experts as well as the industry and the decision was to move forward and also the complete recommendations were made. The NRC initiated this effort last August and Halden took the initiative to invite signatory organizations to participate in this effort.

Again come back to ACRS specific

recommendations to compare the fundamental assumptions behind the NRC models as well as the district models and the commission direction to address this issue. We believe that this study will help address many of the issues that we discussed today. How do we do the study?

Halden is performing the simulator experiments using real crews. And the scenarios simulated are similar scenarios to those modeled in PRAs. And through those simulations, we are producing human performance data. I would like to note that there is a significant participation in this study. It's about a dozen signatory countries; EDF and also the French regulatory participating so it's all done, the chair, et cetera, et cetera and from the NRC as well as the EPRI.

CHAIRMAN APOSTOLAKIS: Now, when you say participate, are they providing crews or are they providing analysts?

DR. LOIS: They're providing analysts. The crews are provided by -- Halden is running the simulations.

CHAIRMAN APOSTOLAKIS: Are the crews usually in the Halden exercises are Scandinavians?

DR. LOIS: Indeed.

CHAIRMAN APOSTOLAKIS: Are there going to be any Americans?

DR. LOIS: We hope so.

CHAIRMAN APOSTOLAKIS: There is an effort to --

DR. LOIS: There is an effort.

CHAIRMAN APOSTOLAKIS: -- convince --

MR. JULIUS: Yes, it was advertised in the January 2006 EPRI HR users group and Florida Power and Light had gone over and explored -- and they were talking about setting it up here for 2007 and in the January 2007 meeting that was still on track but we hadn't picked out the dates yet, but --

CHAIRMAN APOSTOLAKIS: So they're willing to send a crew to Halden to participate.

MR. JULIUS: Correct.

CHAIRMAN APOSTOLAKIS: At their own expense?

MR. JULIUS: I didn't ask who --

DR. LOIS: Actually, Halden is picking up the expense because Halden is paying the crews anyway. Even the European crews, when they go --

CHAIRMAN APOSTOLAKIS: I see.

DR. LOIS: -- Halden -- and they were telling me it doesn't matter if they go there from

Florida or from Switzerland. It's the same cost. So the cost is not an issue, so Halden is --

CHAIRMAN APOSTOLAKIS: That's very interesting.

DR. LOIS: Yeah.

CHAIRMAN APOSTOLAKIS: So there will be maybe Norwegian, Swedish and American crews, right?

DR. LOIS: Right now, there was --

CHAIRMAN APOSTOLAKIS: And the French maybe.

DR. LOIS: Yeah.

CHAIRMAN APOSTOLAKIS: So, but when you say the signatory organizations are participating, primarily you mean they will provide analysts that will use some method.

DR. LOIS: In actuality, in there, for example, I will make that clear in the next step, in the next slide.

CHAIRMAN APOSTOLAKIS: All right. At some point, what is important for me to understand is how exactly does one test a method that produces probabilities on a simulator? That's is a key question. Okay.

DR. LOIS: So, what are the steps? We define the scenarios to be simulated and then experts agree on the measures to be used for comparison of the simulator results with analytical results and I have the measures right here. Analysts will come up with failure probabilities and with PSFs that drive success/failure, so these are the measures. Halden will conduct the simulator runs and collect data and will report them in a structure that matches the HRA needs. So they will collect data and they will try to -- will identify performance shaping factors and then percentages of errors, success -- percentage of success over the various crews. So that will be an indication, if you wish, of the probability. So these are tenuous measures. They are not -- I mean, we realize that we have constraints. We are performing human reliability on a simulated scenario and it's not the actual PRA analysis.

MEMBER BONACA: For a US crew, would it have operating procedures to operate the way that they do in a control room in the US?

DR. LOIS: Yes, the --

MEMBER BONACA: Training.

DR. LOIS: Right now the simulator scenarios and so forth, PWR-3, European plant that they have adapted the Westinghouse procedures. Now, from plant to plant, there is variability, how these procedures are going to be applied. So what we do now, were going through --

CHAIRMAN APOSTOLAKIS: Let's go back.

DR. LOIS: Okay, what I wanted to say is that we're going to pilot these to figure out how well we're doing and then do the actual study. So we have not really addressed all of the questions that we may have how to do this.

MEMBER BONACA: This is why I'm asking the question; it seems to me that depending on the international efforts, there are certain advantages, but there are some disadvantages as far as you know, providing a level field for different analytical tools to be tested. There would have been -- I mean, it seems to me that if we had used a US plant, with a US team and you go through some sequences, and you know, you would eliminate a number of unknowns that come from the fact that you have different teams from different countries from different procedural framework that they follow.

MEMBER MAYNARD: I would agree that it would be more meaningful that maybe the same test methodology but if you're not doing it on a simulator on the plant you've really been trained on, I'm not sure how you're going to end up being -- use the results meaningfully.

MEMBER BONACA: Essentially, how well you're comparing methods.

MEMBER SHACK: It will introduce a performance shaping factor.

MEMBER BONACA: Yes, we'll try that but --

DR. FORESTER: I guess I could comment on that. I'm John Forester. The -- the crews -- actually the control room, you'll have analogue control rooms in the country that the operating crews come from and we will actually have a digital control room at Halden. And they have, the procedures are slightly different, too. So they do have to come and be trained on the procedures and how to use the interface and the slight differences between what the simulators simulate compared to what goes on in their actual plant. But they do have a good training process and their impression there is that the operators adapt to that pretty well, and the operators seem comfortable with it.

So you're right, there is -- there's a little bit of a difference there but they do try to address that issue and the crews seem fine with doing it and they're apparently doing well on the task. And so if the Americans come there, they'll face the same thing. They'll have to adapt to the new control room and the slightly different procedures but there won't be -- there's no particular advantage for one country or another I don't think. So --

MR. HALLBERT: And this is Bruce Hallbert. They are planning on a debriefing approach following the crews running through the scenarios during which they can ask them about their impressions as well as their objective experiences of operating the simulator and the simulated system during transient conditions and during that process, they'll also have the opportunity to find out whether some of these prospective differences between their own plant and the simulation at Halden effect their performances some way. And that will be an important insight as well, too, especially with regard to planning for future benchmarking activities.

CHAIRMAN APOSTOLAKIS: Would a better word that measures be metrics, they would have agree on the metrics to be used? Is that a more appropriate word?

DR. LOIS: Could be.

DR. FORESTER: I think you could probably use -- again, John Forester. You know, think about an experimental research has to go back to depended measures and that's what they're looking at here in terms of what's going to reflect performance. So, you know, one thing they're asked is to come up with an HEP, but they're also asked to make predictions about what are going to be the major drivers for performance and also there is questions about, you know, what things might confuse the crews, what might lead them to take inappropriate action. So there's a specific effort to have the methods identify what are going to be influenced now for performance and get that documented because that's what we'll have from the actual data that's collected in the simulator.

They'll debrief the crews and they'll get the crews' impression They'll also have the experimenters' impressions about what's going on and what's driving performance, so there will be some data that can be compared from that. Obviously, if there's a low probability of failure, the method may predict $1E^{-3}$ when, in fact, therefore, we'll never see that in a simulator but for -- there are some higher -- we expect there will be higher probability of failure events in there, but we're mainly interested in whether there's consistency in terms of what method -- what are identified as drivers of performance.

CHAIRMAN APOSTOLAKIS: But still, I mean, it's not clear to me, if I use ATHEANA or SPAR-H, I will come up with some probability. And what is it about the exercise that will confirm or refute the probability is reasonable or not? I mean, the exercise will look at the successful handling of a scenario but the probabilities, as you said, I mean, that we are estimating usually are very low. So what would that tell me about the probability? It won't tell me much, would it?

DR. FORESTER: Well, again, there may be some higher probability events that are also models so when --

CHAIRMAN APOSTOLAKIS: But even there, okay, they failed one time out of 10 or eight. Would that be treated as a statistical sample, then?

DR. FORESTER: No, I don't think it would.

CHAIRMAN APOSTOLAKIS: I couldn't.

DR. FORESTER: No.

CHAIRMAN APOSTOLAKIS: So --

DR. FORESTER: We'd have to have a lot of crews and a lot of data to do that.

CHAIRMAN APOSTOLAKIS: Yeah.

MR. JULIUS: But, you know, a major part of what an HRA method is, is identifying what's going to be -- I mean, you're not going to come up with an HEP unless you have a set of factors you think would be driving what that HEP is going to be. So if we can at least validate that what the human error probability, the HRA method identified is going to be, what's going effect that operator's performance and we can validate that from the actual results, that's at least a surrogate measure, if not an ideal measure. It's not the HEP measure, but that's difficult to do. We're trying to include some cases where we might get some actual failures. But really the main tool we're using to validate is the actual predictions, in terms of what's going to be driving performance, and our understanding of what the crews are going to be doing.

CHAIRMAN APOSTOLAKIS: So if we use, say, five methods, and one says, you know 10^{-3} or the other says five 10^{-3}, another says five 10^{-4}, and the crews in whatever number of exercises are always successful, this doesn't tell us anything about the ability of these methods to give reasonable probabilities because all of them gave very low numbers even though they differ. So, how do we learn anything useful from this?

DR. FORESTER: Well, again, if the emphasis is on identifying what are the important PSFs based on the methods. If all the methods, for example, agree that we thought that this procedure and this context was not very good and, therefore, we think there's a higher probability of failure because of the procedure, if all the methods say that and then when they're debriefing the crews, the crews say, "We were doing fine but the way this scenario will fall, the procedure wasn't exactly right". There's a confirmation that our understanding the predictions of what the crew is doing, what would be driving their behavior was consistent with what the crews thought.

So at least to validate what the methods predict as being an important driver, you cannot validate low probability failures, but we an validate other aspects of the method, of the predictions from the methods. And also we can look for consistency across methods, too. If we have enough teams doing this, we can again see do the different methods end up predicting sort of the same major drivers? And we can compare the HEPs that we get across the different teams to see if there's at least consistency across methods for a particular human failure event to be quantified. That doesn't mean the values are necessarily correct, but --

CHAIRMAN APOSTOLAKIS: Go ahead, Alan.

MR. KOLOCZKOWSKI: This is Alan Koloczkowski, SAIC. The other thing, too, is that even if we see all successes, we might be able to infer something on the basis of if the crews are -- for instance suppose there's a wide variety of how much time it take the different crews to perform the same action, and there's quite a few crews taking a lot longer than we would expect that they would have otherwise, well, certainly, that's not a direct indicator of the HEP. It is a -- it is a -- somewhat an indicator of the fact that maybe the HEP is somewhat higher than for some other action in another condition because we're seeing a lot of crews that quote, "while they're successful", they're taking a lot more time than some of the other crews are and we're learning that in the debriefing process, such things as they start saying, "Well, you know, my training wasn't really right for this particular scenario", or whatever.

It begins to at least confirm that the HEP ought to be up in the up in the upper value as opposed to the lower value. So I guess I would say we can infer some things about the probabilities, but you're right, unless the scenario itself is so complex or so difficult or the time we give them to do an action is so short that we actually expect to see failures, we're going to have to do some inferences about the probabilities as opposed to direct measurements.

CHAIRMAN APOSTOLAKIS: Now, both SHARP and ATHEANA as opposed to SPAR-H, tried to develop scenarios and deviations from the expected scenario. Is there any way to test that here to see whether the predictions will conform with --

DR. LOIS: That aspect has not been tested at least in this phase of the study.

CHAIRMAN APOSTOLAKIS: It's being tested or is not?

DR. LOIS: Is not.

CHAIRMAN APOSTOLAKIS: Is not.

DR. LOIS: The approach is to identify specific human failure events that are going to be simulated. So all analysts know what is the scenario and what is the human failure event that is going to be validated. And they use their method then they receive the procedures, a lot of information about the plant, a lot of information about the indications they have, et cetera, so there's a whole information package that is created and has been -- for the pilot study has been already distributed to the analysts and on the basis of that information, they're going to evaluate the scenarios.

And we do have two types of scenarios.

One which is the -- corresponding to nominal scenario, if you wish, and one which is corresponding to a more difficult scenario.

CHAIRMAN APOSTOLAKIS: Yeah, but it seems to me that I mean, you can tell a crew that they will be tested on loss of feedwater. Then you can have a team of analysts who are using SHARP develop a set of scenarios how things may evolve and then the ATHEANA team does the same and then you let the crew go to the simulator and see whether they did something that nobody predicted or everybody predicted.

DR. LOIS: So that may be one of the --

CHAIRMAN APOSTOLAKIS: The scenario idea, it seems to me, will be -- is one of the easier ones to check, isn't it because it's not probability.

MR. KOLOCZKOWSKI: This is Alan again.

CHAIRMAN APOSTOLAKIS: Yeah.

MR. KOLOCZKOWSKI: Alan Koloczkowski of SAIC. George, we recognize that right now on this very first pilot we are not testing the identification of actions and the proper modeling of the actions, those aspects of the HRA. It's not that it can't be done and you just suggested a way that some of that might be done.

In this very first phase, we decided to

make it even easier right now. We're just testing the quantification part of all the various HRA techniques. So all the analysts are given the context, they're given the scenario, they're given the definition of the HEP, they're given the success, like how much time is allowed and so on and so forth. And just use the quantification portion of their tools, if their tools can do more than that.

We're just testing the quantification portion right now. We recognize that there are other aspects of the HRA that, you know, it would be nice to be able to test and maybe in the future we'll be able to do that.

MR. HALLBERT: You know, another very important aspect of this entire, you know, pilot benchmarking study is just organizational. Benchmarking has not been routinely don't in the field of HRA before and there aren't really procedures for doing a benchmarking study of this nature, especially comparing so many methods and so part of the aim of this is really to develop the method and procedures for benchmarking and so I think as a first step, you know, narrowing in one -- on several very specific questions and aspects of HRA and then trying to work out the procedures is a good approach for the larger approximation to benchmarking which could get into other issues, like the kind that you're raising here, which is how well -- what kinds of human actions are identified by different methods, how well are different classes of human actions represented by those methods and then correspondingly, do they identify the appropriate contextual factors in PSFs and how close are they in their predictions and the realm of uncertainty that they predict for these actions but this is a first step.

CHAIRMAN APOSTOLAKIS: But you may decide to do this and give appropriate instructions to the analysts, but you still don't know what the crews are going to do. De facto, you will get that information.

MR. PARRY: I think that's right, though, George. One thing that Erasmia said that bothered me. She said that she was going to define the HFEs. You can't.

CHAIRMAN APOSTOLAKIS: You can't.

MR. PARRY: What you're doing is you're defining the scenario with the expected operator responses and then you're going to look to see whether there was anything that challenged success in those responses. And maybe with luck, you'll get a human failure, but typically, you probably won't. So you're not going to be defining HFEs. You're going to be defining opportunities for human failure events, I think.

DR. LOIS: Yes, yes.

CHAIRMAN APOSTOLAKIS: See, the point is that you don't know in advance what the crews will do.

DR. LOIS: Absolutely.

CHAIRMAN APOSTOLAKIS: So you will get that information whether you like it or not. I mean, they will do something crazy, maybe, some of them. So it would be nice to have already asked the people who represent methodologies that claim to identify the scenarios to try to do that because from the exercise, you will get that information. You cannot force the crew to act in a certain way. I mean, you will launch the exercise and observe what they do.

DR. FORESTER: It's the same thing for PRA in the PRA context, it's the same thing. You have accident scenarios and if you're going to use a simulator in some way, all you can do is set up a simulation where you have certain systems fail and then you have to ask the crews to follow the procedures and do whatever they do. And you're expecting certain actions to be taken. That's how we have human failure events in the models.

CHAIRMAN APOSTOLAKIS: No, but the point is, there are at least two methods that say we start by, you know, identifying the expected evolution of the scenario and then deviations. Why don't you let those methods, those analysts, try to identify deviations because then you can compare with what the crews will do.

DR. LOIS: Dr. Apostolakis, this is -- in my mind, this is not going to be just one phase that the -- and one-year shot. We have -- in the morning, we've talked many issues amongst which is at what point, assuming that we do a PRA that follows the good practices, ASME, PRA or SHARP-1 guidance. Then from the perspective of identifying the human actions, you are covered. But then at the end you suggested that probably you're going to use SPAR-H to do 90 percent of your analysis and 10 percent ATHEANA. So SPAR-H is focusing on quantification, only quantification and then does not deal with how do you get, how do you arrive with that specific human action?

So the scope of this first study which is the pilot and the follow-on is how to try out, understand the methods how they deal with -- from that perspective, quantification. If we declare success from that and we believe that we really understand how well the quantification aspects of the methods are dealing with to come up with the human error probability or the PSAs. Then we can go to the other phase of the study which is, okay, we allow these methods that have the capability to identify human failure events and we run experiments and simulations for this and for that. It's an enormous amount of scope if you take on everything in this first study.

CHAIRMAN APOSTOLAKIS: I guess I'm missing something because my point is that whether you plan on it or not, you will get that information. A crew may do something that is completely unexpected. You will receive that information no matter what. So why not have those guys who claim that they can see these things --

DR. LOIS: I believe they will, right? I believe they will.

CHAIRMAN APOSTOLAKIS: -- to do it and then compare.

MS. COOPER: Susan Cooper, NRC and on the ATHEANA team for the benchmarking exercise. We will try but although I recognize that the panel that has set up the pilot, and it is a pilot, so we'll have some lessons learned in the first time around. At least right now based on what we've seen and the amount of questions that we've asked and the number of questions we've seen the EDF team ask and other teams ask, I don't think that right now we'd have enough information to do the kind of identification of scenarios and associated human failure events that we would if we were doing a PRA and having -- you know, and had the kind of access to the plant and, you know, and it's staff that you would expect of the typical PRA study.

CHAIRMAN APOSTOLAKIS: I still don't understand that. You're going to get that information anyway.

DR. FORESTER: But the conditions that the crew see doesn't vary. They get a steam generator and tube rupture scenario. They have a simple version and the they have a complex version of it where they have a steam line break that then is isolated quickly and then followed by a steam generator tube rupture. So there's different kinds of scenarios but what the crews see are fixed. There's no variation in those scenarios. There's no deviations. You might say that there's a nominal and as Erasmia said, there may be one that might be considered a deviation.

So the scenarios are fixed. All 14 crews see the exact same scenarios. So what the HRA teams are doing, they're taking their methods and considering it from shaping factors and cleared those methods, they're trying to identify what are the factors that will be driving performance in these fixed scenarios. And some -- you know, ATHEANA may consider some different factors that the people using SPAR-H didn't consider, so maybe they won't agree on what they think is going to be driving performance but in these fixed scenarios, we will see what those results are in terms of what were the important PSFs.

MS. COOPER: I think that if we did have a chance to develop a scenario ourselves based on our own investigation that we could do what I believe Dr. Apostolakis is suggesting. As a matter of fact, we did that to some extent when we were developing ATHEANA with the one plant that was participating with us. We -- you know, we were developing the method. We were looking in a particular type of scenario, a specific initiator and we did have them go ahead and run that scenario in the simulator and were able to observe the crew response and compare it to what we had predicted. We did that.

DR. LOIS: Well, I believe that Dr. Apostolakis is saying that you may have some crews really doing some really weird things and that information will come to us and then the question is, could ATHEANA for example, do a good job in identifying those --

CHAIRMAN APOSTOLAKIS: Or SHARP.

DR. LOIS: -- or SHARP whatever. And it might, so but what we're going to do is we're going through this pilot phase to understand the way we have set up the experiment right now, is it good enough, what we learn and probably next phase we may do something different and incorporate some of these ideas. Yes.

MR. PARRY: Given that you're probably not going to get many failures, and it's the probability of failure that these methods predict, you have to find some other measure of performance against which to compare your methods. And I don't know what measures of performance any of these other methods give. I don't know what SPAR-H gives, other than the probability of failure. And I don't know what ATHEANA gives other than the probability of failure.

DR. LOIS: Identifying --

DR. FORESTER: The factors that you use to determine what that failure probability is going to be.

MR. PARRY: But what's your measure of

performance, because this is an experiment where you're having a factor that impacts performance. So you have to have a measure of performance if you're going to make some connection there.

DR. FORESTER: Well, if you're saying that the crews will likely make a mistake or not make a mistake because of this set of conditions, that is what you're predicting about what the crews will do.

MR. PARRY: But if they don't make a mistake, John, that's what I'm saying, they succeed in the action, because that's mostly what people do in simulators. Now the only measure that I can think of that you can actually use is an independent measurement of performance is the time that they took to do something.

DR. FORESTER: They're --

MR. PARRY: And none of these methods predict the time as which they do something.

DR. FORESTER: No, we can say will they complete this action within this time frame.

MR. PARRY: That's what I'm saying. That would be -- you can but then that's equivalent to asking a probability of failure. But then the measure that you're using is a measure of time. It's not a direct measure of probability. If you're going to test performance, you have to have a clear way of measuring performance and you have to have a clear way of translating the performance shaping factors in the method to that measure of performance. And since --

CHAIRMAN APOSTOLAKIS: Yeah, there are two -- the way I understand it, there are two pieces of information that they would collect. One is the actual time for doing things and the other is through interviews to get from the crews what is it that influenced them in taking certain actions or not taking certain actions. So there are two pieces of information.

But why -- I mean, I don't understand this, what would -- you have set it up in a certain way. You have a number of scenarios in your minds. Why would it be extra burdensome to ask the EPRI team and the ATHEANA team to also spend some time thinking about deviations from what is expected? I mean, it's not a major big deal. There may be deviations.

I mean, I remember in one of the exercises that Halden ran some time ago, one of the six teams took something like 11 minutes to do something when everybody else took five. So there was a deviation there for some reason.

DR. FORESTER: Well, they could do that if based on the analysis of the scenarios that the team -- they might say, "Well, we think this many crews will probably choose this and this many crews might do something else." That can be part of the prediction.

CHAIRMAN APOSTOLAKIS: So why restrict them? Why can't they say, you know, "I'm going to use SHARP. You give me the scenario, whatever it is, and I'll spend, you know, a couple of days thinking about possible evolutions", and then ATHEANA can do the same. Most likely, you're not going to see deviations because the teams are well trained and all that. But since you're going to get that information anyway, it doesn't seem to me to be very --

MEMBER KRESS: Yeah, with respect to the performance measures, I think Gareth is right, but the inputs to these models, one of them is the time that you have available to do this or the time it takes the operator to do the action. You can compare that with the action. That might be a performance measure comparing to the input and you're checking to see how well we know those inputs. I don't know if that's a good idea or not.

MR. KOLOCZKOWSKI: This is Alan with SAIC, Alan Koloczkowski. George, I think we ought to take your suggestion under consideration. Maybe that's something we ought to do sooner than we thought, so that's something we ought to look at.

CHAIRMAN APOSTOLAKIS: In other words, what I'm saying is, one should think about the information that will come to us from the exercises. Regardless of whether we like to get that information or not, it will come to us.

MR. KOLOCZKOWSKI: Of course.

CHAIRMAN APOSTOLAKIS: Some team did something crazy. Is there any way we can test the methods that are available to us in advance with respect to that particular piece of information because we are not really -- it's not up to us to decide what will come from the exercise. I mean, it will come and so if some methods -- so one of the things that may come is something crazy. Well, we have models that say that they can look at scenarios and deviations.

Let them loose, let them think about it. You know, it's not the -- it doesn't cost you anything.

DR. LOIS: There is a catch though. For example, ATHEANA, when they have the capability to predict those deviations, when they go to simulator and observe all crews, how they perform various scenarios. Then they can drive the characteristics of -- on the basis of the crew characteristics they come up with those potential insights and deviations.

Now, the analysts for the pilot study do not have that knowledge. Halden ran 16 steam generators in December. We felt that these are many, many scenarios. We should not lose the opportunity to take to use those scenarios for the pilot. So the plan was to allow teams go to Holden, interview the future crews to understand how they run the various scenarios, et cetera, how they interact but we did not have the crews -- the analysts did not have that opportunity for the pilot.

CHAIRMAN APOSTOLAKIS: When you say "pilot", what do you mean, you mean, the whole benchmark exercise is a pilot or you are doing a pilot now and then you will do the real exercise?

DR. LOIS: We are doing the pilot now. We are testing the method right now.

CHAIRMAN APOSTOLAKIS: Then there will be a real exercise. And then there will be a real exercise.

DR. LOIS: Exactly. So in a way, we're in the midst of developing the methodology.

CHAIRMAN APOSTOLAKIS: Oh, yeah, it says

up there.

DR. LOIS: So we have steam generator, tube ruptures, two, one more complicated and one which is more nominal, if you wish. And the HRA teams, they're analyzing these scenarios right now. And Halden is documenting the data and so the information from the analyst is going to go to be submitted to an independent group of experts that will look at the analysis, understand what they've done and compare it with the Halden data and then document the status, the results of the study.

We plan to have a meeting right here in Washington in October where all analysts will come and participate in Halden and will discuss the results and understand what we've done, how well we've done, what we should do next. Now, one important aspect is --

CHAIRMAN APOSTOLAKIS: Now, this is the pilot.

DR. LOIS: This is the pilot.

MEMBER SHACK: Just how many runs are we talking about here?

CHAIRMAN APOSTOLAKIS: Sixteen, I think.

MEMBER SHACK: Well, there are 16 crews.

DR. LOIS: Two variations.

MEMBER SHACK: Two scenarios, and they run it once or they run it multiple times?

DR. LOIS: Every crew did two --

MEMBER SHACK: Two, so 32 runs.

MR. KOLOCZKOWSKI: Thirty-two scenarios, correct.

CHAIRMAN APOSTOLAKIS: So these have already been run or will be run?

DR. LOIS: Yes, they did, they did.

CHAIRMAN APOSTOLAKIS: They have already been run.

DR. LOIS: In December. Halden did -- there was one plant that wanted to use the Halden facilities for training, their own training, and use that opportunity to do the -- to use it for the pilot.

CHAIRMAN APOSTOLAKIS: Okay, so this is a situation for the pilot where we have the rounds already and the HRA teams will not be aware of the rounds, but they will try to figure out the probability.

DR. LOIS: Yes.

MR. KOLOCZKOWSKI: Correct.

CHAIRMAN APOSTOLAKIS: Okay, but in the actual exercise, you may allow them to actually try to figure out whether there will be deviations. It is too late for the pilot.

DR. LOIS: Yes, for the actual, we hope that the teams will have the opportunity to observe the crews, who they run, how they interact, et cetera.

CHAIRMAN APOSTOLAKIS: But another thing that it seems to me you should be doing is not focus exclusively on what Halden does because you will have an excellent opportunity here to actually compare the different methods pretty much like ESPRA tried to do, I don't know, 25 years ago. And I understand already your team has collected information about the ISPRA benchmark exercise and as you remember, there is a table there that shows that the same method -- there was once scenario that was given to all the teams.

The same method used by different teams gave widely different results. The same team using different methods came up with widely different results, so there was variability all over the place. Now, that has nothing to do with real exercises on the simulator. It seems to me that this is a good opportunity to also do a similar thing and you know, independently of what the Halden people do, you will have this group of HRA teams working on the same scenario, plot those results and see what happens. Why are they different and how -- you know, and I think -- I mean, ISPRA did a series of benchmark exercises, not just HRA related and I think the major conclusion was that the reason of the major differences was the different assumptions people made regarding the scenarios, the scenarios themselves. So will there be a same conclusion here or you know, because then or the real exercise, you may learn certain things that will help you define it better.

But I don't think you should just focus on what the simulator exercises give you. This is an excellent opportunity to also compare different methods and so on because ultimately and we'll come back to the issues that Jeff raised earlier, I mean, we would like to answer a lot of these questions and this is a good opportunity to answer.

DR. LOIS: So we believe that the experiment is tightly defined and all analysts have to not just report the results but also document why -- what is the underlying reasons for coming up with these results.

CHAIRMAN APOSTOLAKIS: Right.

DR. LOIS: So if there are differences, then we will be able to compare the reasons for which they came up and determine that. So we do method-to-method and data -- and method-to-data comparisons.

MEMBER BONACA: Is EPRI testing the model?

CHAIRMAN APOSTOLAKIS: Yes.

MEMBER BONACA: They are?

CHAIRMAN APOSTOLAKIS: Uh-huh.

DR. ELAWAR: Mr. Chairman, I would like to know who are the HRA analysts and maybe we can contribute to those, if you so desire. Who are they now and would you need --

DR. LOIS: Jeff is, you are participating.

MR. JULIUS: Yes. Well, there is 16 to my knowledge so far.

CHAIRMAN APOSTOLAKIS: Oh, you are a member of the team.

DR. ELAWAR: I'm offering myself. Suddenly, I realize I was volunteering.

CHAIRMAN APOSTOLAKIS: If you offer yourself, we don't want you. No, I understand that ERI is -- is it EPRI or --

MR. JULIUS: It's EPRI.

CHAIRMAN APOSTOLAKIS: EPRI, so you are the chairman of that committee.

DR. ELAWAR: Okay, I want to make sure they are HRA certified or qualified HRA practitioners in the industry.

CHAIRMAN APOSTOLAKIS: Do you have your team already identified?

MR. JULIUS: Yes.

CHAIRMAN APOSTOLAKIS: Is Zouhair part of the team? Obviously not.

MR. JULIUS: We talked about having multiple teams internally but we haven't shared that with him yet. We have our team within Scientech and then we have utility member teams as well, to see what they're predicting.

CHAIRMAN APOSTOLAKIS: Well, if you can have multiple teams, that's --

MEMBER SHACK: We'll have people using CREAM and MALMUS.

DR. LOIS: MALMUS, yes. MALMUS, yes.

CHAIRMAN APOSTOLAKIS: Not CREAM.

MEMBER SHACK: Different organizations.

DR. LOIS: CREAM, I don't believe they've -- they're participating. MALMUS is part, CAHR.

CHAIRMAN APOSTOLAKIS: Who developed CAHR?

DR. LOIS: Oliver, the Germans are participating. So from the methods that are not in NRC type methods or EPRI type methods is caught in MALMUS.

MEMBER SHACK: So you'll have multiple teams using things like THERP.

DR. LOIS: Yes, but everybody has modified

THERP for its own purposes, so we'll see how THERP has been modified from the various users and how -- if it makes a difference or not.

CHAIRMAN APOSTOLAKIS: But you will not have one team using two methods.

DR. LOIS: No, but it will be easy.

MEMBER SHACK: Oh, you mean, EPRI won't run all the methods through the calculator?

CHAIRMAN APOSTOLAKIS: I guess not.

MR. JULIUS: I was planning to do multiple methods.

DR. LOIS: Incentive, oh, I didn't know that.

DR. ELAWAR: We don't have all the methods in the calculation.

MR. JULIUS: Right, we don't just pick one, we look at both.

CHAIRMAN APOSTOLAKIS: Harold?

MR. BLACK: Yeah, this is Harold Black. I wanted to ask a question because I don't remember but in the dependent -- going back to Gareth's point and George's point on the dependent measure, did -- since this was a training exercise, did Halden judge the quality of the crew's responses to the scenarios, and if so, okay, if those trainers did do that, then point in fact, you would have a performance measure. And if they graded them, like happens in the nuclear industry, so that they pass, fail or a 90, 80, 60, 70 or whatever their score was, there actually would be a dependent measure to then take the performance -- well, either you could take the probabilities and you could take the performance shaping factors for each method and you could actually do a regression to account for the variability and performance. And in that way, you would at least get some insights into how much of the variability that that method is accounting for in that judged performance score.

And that would be another -- and in fact, that would be -- to my way of thinking that's much better than time because sometimes time is not that important. I mean, if they do it fast, that's fine but maybe that's not important because maybe they weren't trying to do it fast because they were taking their time in thinking about it which might be a more desirable end result anyway.

So, but I don't know whether they're doing that and if not --

DR. LOIS: I believe it is part of their protocol.

MR. HALLBERT: Their protocol.

DR. LOIS: Do you want to verify that?

MR. HALLBERT: Yeah, one of the things that we have -- we specifically have been talking with them about has been on some of the PSF data collection and we'll need to follow up on that but we have been working separately on some pilot methods to use that kind of data in models like the kind you're talking about to employ that data to test and make predictions of performance measures.

DR. LOIS: But the question is, is Halden typically collecting trainer observations.

MR. KOLOCZKOWSKI: This is Alan. The answer is yes.

MR. HALLBERT: We have to check and see exactly what the form of those observations look like but we can --

CHAIRMAN APOSTOLAKIS: I remember, Bruce, you gave us a presentation maybe two, three years ago where you really were very quantitative. Are these the kinds of analysis you're talking about?

MR. BLACK: That's what I'm talking about. Yes, that's exactly what I'm talking about.

CHAIRMAN APOSTOLAKIS: Yeah, I think that would be really great because these are quantitative results. I mean, I remember the committee was extremely impressed.

MR. HALLBERT: Yeah, we've actually -- George, we've actually written up that work now in a draft NUREG along with other prospective methods for using empirical information in the HRA. And this would be another opportunity for us, if they've collected that data, to extend those methods and to test them out and to benchmark them.

MR. PARRY: But you still have the problem then of taking that measure of performance, whatever it is, and relating it to probabilities of failure which is what -- the PRA models, so there's a big missing step.

CHAIRMAN APOSTOLAKIS: That problem is there.

MR. PARRY: Yeah.

CHAIRMAN APOSTOLAKIS: So, I guess the message here is -- or the conclusion from all of this is you really have to spend serious time deciding what metrics you are going to use to gain some useful insights. Alan, do you want to say something?

MR. KOLOCZKOWSKI: I was just saying that the answer to the question about do they have separate observers are also going to judge the performance of the crews. The answer to that is yes, and the crews are also going to -- in post-scenario interviews are also going to assess their own performance in terms that we understand in HRA. They're going to be led to talk about how well they thought the procedure followed the scenario, how well they felt they were trained on a scenario, how well they felt the HMI did or did not, you know, hamper their ability to address the issue or address the scenario or not.

So they're going to be led to discuss their own performance in terms of what we would call PSF so that we can draw closer, more direct comparisons between what they were really feeling in doing the scenario, what they thought was helpful and what they thought wasn't versus our predictions of where we think these PSFs will be negative versus these PSFs will be positive.

CHAIRMAN APOSTOLAKIS: But I'm having a problem though. Let's say Dr. Blackman wants to use SPAR-H. On what basis are you going to decide what the PSFs are?

MR. KOLOCZKOWSKI: Well, we have given them -- this is Alan Koloczkowski again. We have given all the teams things such as a summary as to how much they've been trained on steam generator tube ruptures and giving them the procedures that they're actually going to use. We've given them samples of what the control boards look like as the scenario evolves, so they have a feeling as to how fast the parameters are changing, what parameters are changing, what are the operators seeing on the indicators, what alarms are coming in, how often, so they have a lot of HMI information.

Basically, we've given them the kind of information as if, almost, they have observed the crew actually going through a sample scenario but Obviously, short of that, because we didn't have that luxury in doing the pilot.

CHAIRMAN APOSTOLAKIS: So that would be sufficient for you.

MR. BLACK: It's sufficient, yes. It's just like any other analysis, quite frankly. I mean, that's what you have to work with. I mean, it truly is. I mean, it truly is.

CHAIRMAN APOSTOLAKIS: Fine, now with respect to ATHEANA, your quantification method basically relies on expert opinion elicitation. So you will run such an exercise for this? You will assemble a group of experts and try to do it?

MS. COOPER: We have a group of three ex-operators here at the NRC; one from a Westinghouse plant, two were not. We're working around their various schedules. So unfortunately, we're not going to have all three at the time we want to do quantification but we should have at least two and we are using them, we will use them to develop failure probabilities and, in fact, we've been working with them to try to better understand the scenario and fill in at least for us, some gaps in the information as best we can, based on their US operating experience.

CHAIRMAN APOSTOLAKIS: Right, so when we say "expert" you mean, former operators.

MS. COOPER: That's correct. That's what we're -- that's really the only resource that we can identify as being equivalent to what we would have if we had access to the plant where we would have the operator trainers and the operators themselves.

CHAIRMAN APOSTOLAKIS: Okay, any other comments from anyone? Let's go on then.

DR. LOIS: So then the actual Phase 2, which is the actual study, hopefully, will materialize next year and we plan to brief the ACRS throughout this activity. Probably the next briefing will be in October or November. After we convene, then we figure it out how well we are doing.

CHAIRMAN APOSTOLAKIS: That will be on the pilot, right?

DR. LOIS: Yes, yes. So we believe that the pilot will help us a lot to answer some of the questions we've been asking today and probably will be -- it's just one of the means of addressing these questions. With that, I would like to thank you very much and also I would like to thank Frank and Jeff and Mr. Elawar for being here today and for the good words that we've got for the NRC's HRA efforts. Thank you.

MR. RAHN: And thank you, Erasmia.

CHAIRMAN APOSTOLAKIS: Okay, maybe we can take a break now and then start the discussion on plans to address the SRM issue and have some free discussion and, you know, see whether -- and clearly the benchmark exercise can be part of it, but it's not the only answer. And I understand we owe a letter to the commission, when by the end of June?

MR. NOURBAKSH: I think so, yes.

CHAIRMAN APOSTOLAKIS: So we will need a lot of help from you, ladies and gentlemen, on what to put in that letter, so that the committee will be convinced that this is a good letter and therefore, the commission will also be convinced that we are responding to their SRM. So before we do that, maybe we can take a short break and then visit that. 4:25, is that okay? Anybody object?

Oh, I don't know, do we need the Reporter for this? Do we need a Reporter for the discussion? It will help the staff, eventually, I guess, eventually to have a transcript. Let's keep him.

(Whereupon, a short recess was taken at 4:07 p.m.)

(On the record at 4:26 p.m.)

CHAIRMAN APOSTOLAKIS: Can we come back into session, please? Okay, so we have an SRM from the commission. We have to send a response by June, which means by the June committee meeting, we have to have a letter approved by the committee and sent upstairs. And that means we have what, we have three meetings, three full committee meetings from now until then. Right, April, May, June.

MR. NOURBAKSH: Two, because if you wanted to discuss this matter in June meeting with the commission, we'd better finalize the --

CHAIRMAN APOSTOLAKIS: The commission, oh, we're meeting with the commission, oh, I forgot about that. Yeah, but still -- well, yeah, you're right, we raised the issue so we probably will have to be ready. So what you're saying is we should respond by May --

MR. NOURBASKSH: May, yeah, would be

better.

CHAIRMAN APOSTOLAKIS: Which probably makes sense because whatever we have to say in May will probably the same in June. It's not that we're doing work that we're trying to finish. So do you have the SRM here?

MR. NOURBAKSH: I don't have the SRM but the wording of SRM.

CHAIRMAN APOSTOLAKIS: Yeah, the wording is the same, what a coincidence, huh? The wording is the same. Okay, "The ACRS should work with the staff and external stakeholders", oh, that's you, "to evaluate the different human reliability models in an effort to propose either a single model for the agency to use or guidance on which models should be used in specific circumstances."

It says for the agency to use, so we're not forcing anybody else to use anything. Now, a response to this would be -- I mean, obviously cannot be here is the model, right?

MR. NOURBAKSH: We have a plan.

CHAIRMAN APOSTOLAKIS: We have a plan. So now, okay, what would that plan be? I mean, that's really the question. And I thought what Jeff put up there may be a good place to start. That doesn't mean we have to do every single thing here. But since we have to work with external stakeholders, it seems to me it would be a good idea to have some sort of collaboration between the industry and the staff, wouldn't it? So how would that happen? Does it take an extra memorandum? Do we have anybody on the line there? Frank?

MR. RAHN: Yes, I'm on the line.

CHAIRMAN APOSTOLAKIS: Frank is on the line.

MR. KOLOCZKOWSKI: Frank and Alan are on the line.

CHAIRMAN APOSTOLAKIS: Okay, good. So Frank, would EPRI be willing to help the staff with this?

MR. RAHN: Yes, a short answer, yes.

CHAIRMAN APOSTOLAKIS: Okay.

DR. ELAWAR: Yes, we will. We'll cooperate also.

CHAIRMAN APOSTOLAKIS: So the objectives of the SRM are very noble. We all agree that this needs to be done.

DR. ELAWAR: And I believe we have been cooperating in the past.

CHAIRMAN APOSTOLAKIS: Yeah, but the

practical question is, how is this to be done? For example, if we want to establish common terms and make sure that, you know, we are using the same terminology, who is going to do that? Does it take collaboration to do this or just the staff can do it and so on?

DR. LOIS: If a joint project is established for this specific purpose, then it will be another research activity that is being performed by both the NRC and the industry like the fire model. So we'd get into -- we define the project, the scope, milestones and we go off and we do that but we do the work on the collaborative effort. So the industry will bring a lot of their perspectives, probably the plant specific experience, their HRA obligations and we'll bring the regulatory perspectives.

CHAIRMAN APOSTOLAKIS: Yeah, I mean, the common terms is not what bothers me. I mean, that can be done but I think Item 3 there, applications and the use of HRA in decisionmaking that's some -- in other words, the definition of a number of classes of issues where HRA may be very important or of lesser importance or not important, unimportant. I mean, that definitely will need the collaboration with the industry.

MR. PARRY: Actually, to that one, I would rephrase that, "review applications and the role of HRA in the decisionmaking" --

CHAIRMAN APOSTOLAKIS: Yeah, absolutely.

MR. PARRY: -- other than the use of it, I think.

CHAIRMAN APOSTOLAKIS: Yeah, very good, very good. So I think that's --

MEMBER SHACK: We've glossed over that integrated approach, George, which seems to me --

CHAIRMAN APOSTOLAKIS: Which one is that?

MEMBER SHACK: Number 2, that's -- yeah, that's a major effort there.

CHAIRMAN APOSTOLAKIS: You cannot do that, number 2. I mean, an integrated approach would probably be the ultimate product after you do everything else, it seems to me.

MEMBER SHACK: Well, integrated approach doesn't mean you have a single model but it gives you guidance for --

CHAIRMAN APOSTOLAKIS: But even that, I think it will have to wait. For example, I would like to have this categorization first.

MR. PARRY: Yeah, I think do 3 before 2.

CHAIRMAN APOSTOLAKIS: Yeah, do 3 before

2.

MR. JULIUS: Part of my reason for putting it as 2 was having the end in mind, knowing what is the -- overall, what are we trying to get out of it and maybe I need to have the word "draft" up there or the "the first cut." I mean, it's obviously one of these things that you --

CHAIRMAN APOSTOLAKIS: No apologies needed. I mean, we are really -- I really appreciate that you did this. It's very good. It shows a confusion of mind, of course, but --

MR. PARRY: You could actually rephrase 2 as the objection is to define common terms in an integrated approach. You could state that as the higher objective. That's true.

CHAIRMAN APOSTOLAKIS: Well, the higher objective is what the SRM says.

MEMBER SHACK: Which is really 2. Two is an objective, right?

CHAIRMAN APOSTOLAKIS: But it appears to me that the common terms is something that can be done very quickly.

MR. PARRY: Yes, there's a lot of that in ASME, already, I think.

CHAIRMAN APOSTOLAKIS: Yes, it's not a big deal. I -- well, so the way I see it and let's see if we all agree to this; first we need to make sure there is a formal way the industry and the staff to work together, and it seems like the model of the fire project is something that everybody seems to be pleased with and something like that can be initiated. John?

MR. MONNINGER: There is -- we -- I guess the agency just renewed the blanket or the broad MOU with EPRI. Now, within that there's appendices or I'm not -- attachments or whatever for specific implementing agreements and one of them would be fire.

CHAIRMAN APOSTOLAKIS: But this is not fire. I mean, you can --

MR. MONNINGER: This isn't fire. We would have to come up with a new implementing agreement and I imagine lawyers would get involved in that.

CHAIRMAN APOSTOLAKIS: As part of the overall MOU.

MR. MONNINGER: If it was the cooperative approach.

CHAIRMAN APOSTOLAKIS: Yeah, yeah.

MR. MONNINGER: Right, versus an approach where we take a lead, a strong lead or industry took a strong lead and we have public meetings and one critiques the others and provides input. The other allows you to work closer together, the collaborative project. The one requires you to take more of a lead, have public meetings, request comments, response more formal.

CHAIRMAN APOSTOLAKIS: The former, you mean the MOU.

MR. MONNINGER: The MOU allows you to work closer together.

CHAIRMAN APOSTOLAKIS: My personal preference is the MOU. Okay. There will be public meetings in his room anyway. And if you want to have other public meetings, you're welcome to do that, but the important point is to have the opportunities to work closely with the industry to produce something. And there's nothing secret about all this and the ACRS meetings are always public. So that doesn't bother me.

DR. LOIS: In addition to both entities, NRC and industry commits the resources and the resources is a very important one.

CHAIRMAN APOSTOLAKIS: Yeah, we don't get involved in that. We cannot tell the agency how to manage its resources.

DR. LOIS: What I'm trying to say is if

it's a project specific activity within the MOU, then both entities will commit to the project as well as the resources and milestones in the plan.

CHAIRMAN APOSTOLAKIS: I assume that's the case.

DR. LOIS: It's going to be an integrated approach to begin with.

CHAIRMAN APOSTOLAKIS: Yeah, Frank, that's the case, right? Frank you went silent.

MR. RAHN: Yes, that would be the case.

CHAIRMAN APOSTOLAKIS: Yes, that would be the case. John, that would be the case.

MR. MONNINGER: It sounds like a very good approach, except, we of course, have to talk internal.

CHAIRMAN APOSTOLAKIS: Yeah, we cannot tell you how to run your business. We would like to.

MR. RAHN: The only downside with the MOU may be that it's taking, for whatever reason, a long time for the lawyers to get things like this, but putting that aside, I see no reason why we shouldn't do that.

CHAIRMAN APOSTOLAKIS: But if there is already an MOU and all you are negotiating an appendix.

MR. RAHN: Yeah, there are various

agreements that are replaced now. Maybe instead of doing something new, we can --

CHAIRMAN APOSTOLAKIS: Yeah, now a long time means what?

MR. RAHN: Excuse me?

CHAIRMAN APOSTOLAKIS: What do you mean by long time?

MR. RAHN: It depends what issue we get wrapped around but occasionally it takes a year.

MEMBER SHACK: Yeah, an agreement by June sounds awful rapid to me for a lawyer.

CHAIRMAN APOSTOLAKIS: Not by June but not a year. I mean, what is --

MR. RAHN: Well, we can guarantee a year just as long as --

MR. RAHN: I mean, by June if we just don't mention which year we're talking about.

(Laughter)

DR. LOIS: But six months is a very realistic time.

MR. RAHN: Theoretically, six months is doable.

CHAIRMAN APOSTOLAKIS: And during these six months, you cannot talk to each other, you cannot do anything.

DR. LOIS: Well, the benchmarking activity give us a lot of opportunity to --

CHAIRMAN APOSTOLAKIS: So you already have an agreement there to work together.

DR. LOIS: It's through the Halden project.

CHAIRMAN APOSTOLAKIS: Okay.

MR. MONNINGER: We're both members of Halden, so we don't have the joint meeting or joint agreement with EPRI there. We both have agreements with Halden.

CHAIRMAN APOSTOLAKIS: I see. So then you can say hello and talk to each other.

MEMBER MAYNARD: Can I ask what -- make sure I understand what the scope or what the intent of this collaborative or group effort would be. Is it to pick one or two of the methods and see if it can be resolved to where everybody uses that or is it come up with a new method? I'd be hesitant to start an integrated project like this if the idea is to come up with a new -- another way.

CHAIRMAN APOSTOLAKIS: No, not another way.

MEMBER MAYNARD: I haven't heard any talk about picking one of these and trying to flesh it out to see if it's something that meets both needs.

CHAIRMAN APOSTOLAKIS: We will eventually -- we hope that eventually such a collaboration will respond directly to what the SRM says. For this class of problems -- and we may come up with new insights on the way but let's say for this class of problems, this model or these models are acceptable. Both NRC and industry agree and on the way we may have harmonized the terms, you know, other things that will come along, that kind of thing, but not to start a new research project to develop a new method.

I don't think anybody feels that there is a need for that. We have exhausted the different ways of looking PSFs, you know, and all that. Okay, except for Susan.

MS. COOPER: Oh, I'm exhausted, don't worry.

MR. PARRY: But I'm not sure that we don't need some new approaches actually, for dealing with ex-control room diagnostic type actions.

CHAIRMAN APOSTOLAKIS: That's what I'm saying that we don't know what else will come up.

MS. COOPER: Or at least a new knowledge base. So there's certainly things that we don't understand as well as we'd like, advanced reactors.

CHAIRMAN APOSTOLAKIS: There may be -- there may be as part of the answer a conclusion that there are certain -- that's why this categorization is important.

MR. PARRY: Right.

CHAIRMAN APOSTOLAKIS: There is a new class of problems for which the existing methods are not applicable or they will have to be improved. In other words, I think we said it earlier today that for LWRs we're pretty confident that certain things we understand very well. Now, if you move onto gas-cooled reactors or whatever, lead-bismuth-cooled reactors, you may need some new approaches.

So that very well can be another category. But we don't have to develop that model in this effort. Okay, that's the way I see it unless somebody else sees it different. So the objectives are really harmonization, what are the common elements, loosely speaking, what can each method do, which you have answered already to a large extent in the Good Practices document, and then item 3, it seems to me, is extremely important.

Here are the cases where that all of HRA is very important in decision making and here are the suggestions of what to do. Here are other ways and so on. I mean once you guys start talking to each other and we have periodic briefings here, I mean, I'm sure there will be some ideas that will come up and so on. We can't predict everything right now, but Otto, did we answer your question?

MEMBER MAYNARD: Yeah.

CHAIRMAN APOSTOLAKIS: It's not a new research. Well, everything is research because it comes out from the Office of Research but it's not a new method development.

DR. LOIS: Potentially not.

CHAIRMAN APOSTOLAKIS: No, we may identify needs for new method, but this particular --

MEMBER MAYNARD: I am concerned that if we don't put some -- if somebody doesn't put some overall objectives out, I think it will end up resulting in -- sometimes it gets too hard to make a decision so rather than make a decision on one, we end up developing another and I'd hate to see us start down another path here.

CHAIRMAN APOSTOLAKIS: No, no, we will definitely not -- as far as I understand it, -- start a new method from scratch. But we may identify research needs, for example, what --

MEMBER MAYNARD: And I understand for

other -- for new reactor types and I'm talking about for the existing things.

CHAIRMAN APOSTOLAKIS: For existing reactors, I don't think there is a need for that but there is a need of harmonization, I think. Okay? So the first item then that we were mentioning in our response will be that the staff and the industry through EPRI will establish, what, an MOU or what is the legal term?

MR. MONNINGER: I guess, is it an appendix to the existing memorandum of understanding?

CHAIRMAN APOSTOLAKIS: You tell me, I don't know.

MR. MONNINGER: Yeah, we'd have to check into it.

DR. LOIS: It would be an appendix.

MR. RAHN: I believe it is an appendix that you would attach to the existing MOU but in this case it will say something along the lines of we're going work together to address the commissioner's SRM issue in HRA or something.

CHAIRMAN APOSTOLAKIS: Is that reasonable?

MR. MONNINGER: Not to put any words in, but I figure it will probably be the ACRS recommends that the staff and EPRI enter into a joint, yada,

yada, and then of course that would go to the EDO and then we would respond after discussing it.

CHAIRMAN APOSTOLAKIS: So we can't say that during the subcommittee meeting there was willingness expressed from you and the industry to do this? I mean, if we just recommend it, it's as if you guys are ignorant of what we're proposing or you're indifferent.

MEMBER MAYNARD: Oh, I would think we could recommend and we could say that they -- everybody expressed a willingness to work together. I'm not sure we can get into the details of like memorandums or the legal process that it would take on.

CHAIRMAN APOSTOLAKIS: Well, we can mention the existing MOU, can't we? The budget we cannot, we cannot say anything about it but I think we have already brought it to the attention of the commission and in our meeting in June, maybe we can bring it more to the attention of the commission. So the resources probably will become available, but that's not our business.

So this is then a recommendation on our part but, you know -- okay, okay, so we took care of -- at least we took care of it, you guys have to work on it. Now, I -- I mean, as part of this then, we have to give some high level issues or items that will be dealt with as part of this collaboration. We can't go into details because it's too soon. And we will say the details will be worked out later, but I would like to bring up, you know, something along the lines of three there because remember now in the commission, they never miss an opportunity to emphasize this. This is a regulatory agency, this is not a research agency, this is not a national science foundation.

Tell me why I should spend money on something and that why has to involve a decision that the commission has to make. So by identifying classes of problems where -- that all of HRA is important, I think we will make a good step forward.

DR. ELAWAR: The most important, I think is the second bullet there.

CHAIRMAN APOSTOLAKIS: Second sub-bullet?

DR. ELAWAR: Yes, that's right.

CHAIRMAN APOSTOLAKIS: Ah, okay, yeah. The SDP, well, I also like, you know, the comments by Erasmia and others that it's not really decision making but I mean, if you are using -- the agency now is following a risk informed decision making process. Part of that is having good risk models for the plants, right, and HRA is an integral part of those, so that's a first.

I mean, if you don't do a good job in the HRA, you don't have a good model. And you can risk inform forever but it will be the wrong risk information. And maybe we can mention specific situations, like significance determination process. What is management directive 8.3?

MR. PARRY: It's the management directive that decides what level of response to an incident.

MR. JULIUS: The inspection team or whether you get a drive-by, a special inspection, IIT, AIT.

CHAIRMAN APOSTOLAKIS: Sounds to me like a detail but it can be mentioned. Do all of you agree that this is a reasonable thing to pursue, this development of the classes? What?

DR. LOIS: At 5:00 o'clock in the afternoon, George, absolutely.

(Laughter)

(All talking at once)

CHAIRMAN APOSTOLAKIS: But now that I know this, a flood of questions.

DR. LOIS: I just want to -- I mean, from my perspective, I believe this is a very good plan and again, thank you very much for --

CHAIRMAN APOSTOLAKIS: But let's not accept everything he said.

MR. RAHN: Well, this is Frank Rahn.

CHAIRMAN APOSTOLAKIS: Yes, Frank.

MR. RAHN: Yeah, just off the top of my head idea, just for discussion purposes what if the HRA calculator had a special SDP part to it that would be useful for self-determination processes?

CHAIRMAN APOSTOLAKIS: This would be a question to be asked after the joint team is formed. It's not to be answered now.

MR. RAHN: I wasn't expecting an answer now. I was just throwing out an idea that people might want to think about.

CHAIRMAN APOSTOLAKIS: It could be. It could be. It could be some sort of amalgamation of what you guys have in the calculator and what SPAR-H does. I don't know that that's a no, no.

MEMBER SHACK: The SDP requires the whole PRA. I don't see how you'd put that in the calculator.

MR. PARRY: The SDP relies on parts -- on the relevant parts for an application.

MEMBER SHACK: Relevant parts.

MR. PARRY: But I think what --

MEMBER SHACK: It requires more than HRA though.

MR. PARRY: Yeah, but I think what Jeff was pointing out and I think it's right that many of the arguments that come between the staff and the licensees are often related to operator recoveries and whether they are valid recoveries that would change the color from green to white or whatever. I think it's that aspect of things and they're typically the types of actions that are not addressed by the current methods that we use because they're primarily a focus towards in-control room responses of crews and procedure driven ones, too.

So I think there's a strong interest there in that area.

DR. ELAWAR: I agree with that, there's a very strong interest in it and I'd like to make a desire, if I may, classify it that way. I believe that like we have in the industry, only qualified HRA practitioners do HRAs. We really desire to see the same with the NRC the decision making or the SDP that is based on HRA value, we'll appreciate it if the decision was made by the PRA group, for example, you instead of it being left to the hands of people in the region whose competency is not necessarily in HRAs.

CHAIRMAN APOSTOLAKIS: That's a management issue. I cannot --

DR. ELAWAR: That's the problem that we are facing.

CHAIRMAN APOSTOLAKIS: This is -- you know, you can express this view.

MR. MONNINGER: I guess, just a little comment there, I mean, you know, all the detailed analysis that is done out in the field does go through the regional what we call the SRAs, the senior reactor analysts. They have gone through qualification programs, they have typically then, you know, inspector, senior resident inspector for years and then they take a plethora of various PRA courses. They go in front of a qual board and, you know, even some of I guess their evaluation -- then some of their evaluations even come back here to our headquarters for Gareth's group to review.

MEMBER MAYNARD: What's referring to are not necessarily in the analysts part within the NRC. The question is the differences between SPAR-H and the human performance calculator. And I think those differences is what's needed to get worked out.

MR. MONNINGER: The model differences.

CHAIRMAN APOSTOLAKIS: Yeah, the models. So after the categories according to three, it seems to me that within each category the various applicable models should be identified and their assumptions and approaches compared. That's really --

DR. LOIS: And the issue that you brought before is when are we going to use screen-level tools.

CHAIRMAN APOSTOLAKIS: What level?

DR. LOIS: Screen, screen analysis versus more detailed analysis.

CHAIRMAN APOSTOLAKIS: Yeah, yeah.

DR. LOIS: What tools are more appropriate for a screening analysis. What advice to us to do a detailed analysis?

CHAIRMAN APOSTOLAKIS: Yeah, all these questions that -- I suspect that after this agreement is in place, you guys will think about the more detailed plan to attack with and maybe we can have another meeting like this to discuss details but these are exactly the questions --

DR. LOIS: I mean, the questions that Alan discussed in the morning are kind of supplementary -- complimentary to these questions that Jeff is --

CHAIRMAN APOSTOLAKIS: What questions were these?

DR. LOIS: Remember the observations of HRA --

MR. JULIUS: The five issues.

DR. LOIS: The five issues. Shall I bring them up or --

CHAIRMAN APOSTOLAKIS: Yes, please, if it's easy. So that's from Alan?

DR. LOIS: That's from the NRC presentation this morning.

CHAIRMAN APOSTOLAKIS: Okay, I must have it somewhere. What number was that?

MEMBER SHACK: 26, 27.

CHAIRMAN APOSTOLAKIS: Yeah, yeah. Yeah, I think these are very relevant questions, starting with 25, I believe, huh?

DR. LOIS: Yes.

CHAIRMAN APOSTOLAKIS: Yeah, yeah.

MR. PARRY: And in a way the going imposition ought to be that whatever quantification method is used, that at least the process of identification of the HFEs and the definition is a given for all of them done appropriately.

CHAIRMAN APOSTOLAKIS: No, we found it. Okay, so let's go back to the -- now what is the role of the -- I mean, where do we stick the benchmarking?

Is it part of this evaluation of the models in each class?

MR. MONNINGER: I think it can contribute to addressing the issue. I don't think it would fall within the -- necessarily within the agreement though.

CHAIRMAN APOSTOLAKIS: No, but we're doing here is we're trying to conceptualize a plan of attack.

MR. PARRY: But you know, if one of the conclusions of this review is that it really doesn't matter which quantification method you use as long as you've defined the HFEs appropriately, then the benchmarking has no relevance to that.

CHAIRMAN APOSTOLAKIS: But the major issue -- a major conclusion of the benchmarking will be what is important. That's what I say. It will give you very little information regarding the actual quantification but it will tell you -- I mean, John said it several times earlier.

MR. PARRY: It's not giving you the information on whether you have the right human failure events right now, not the way it's currently configured. Maybe phase 2 of the benchmarking will but the phase 1 certainly is not.

MS. COOPER: Yeah, the pilot is intended

to address that.

CHAIRMAN APOSTOLAKIS: The polit -- the pilot has already -- but I'm talking about the whole benchmarking.

MR. PARRY: Okay, then --

CHAIRMAN APOSTOLAKIS: I mean, if it's irrelevant, then that is a blow.

MS. COOPER: Yeah, and I guess the other thing is, you know, you're anticipating that one of the conclusions from number 3 is that the quantification isn't going to matter. Now, there may be cases where that's not true in which case having some insights as to how well the methods compare and evaluating and identifying important influences on human performance, may be very relevant to deciding which methods are appropriate for different applications.

MR. PARRY: Yeah, but that's not 3. That would be a follow-on from --

MS. COOPER: Well, it's A under the last bullet.

MR. PARRY: Oh, yeah, it's the last one, okay. I'd separate that out.

CHAIRMAN APOSTOLAKIS: Which one?

MS. COOPER: A or B under the last bullet.

CHAIRMAN APOSTOLAKIS: "Some HRA method as appropriate".

MR. PARRY: I'd actually make that a separate task.

MS. COOPER: Yeah, it's a little bit --

CHAIRMAN APOSTOLAKIS: Well, yeah, after we have the classification, then we start comparing models, comparing models, assumptions. Maybe some models can play a screening role, and other models more detailed quantification. Then it seems to me the insights from the benchmark exercise will be helpful there.

MR. PARRY: Yeah, okay, I agree with that.

CHAIRMAN APOSTOLAKIS: Now, when I say insights, I don't mean just what comes out of the actual exercises of Halden, also the comparison of the team approaches, ala, ISPRA, I think will be very valuable, the assumptions people make and why they make them and so on.

After we have all this, are we ready to reach a conclusion as to which models can be used or not?

MS. COOPER: We should know. Anticipating that answer is a little bit difficult.

CHAIRMAN APOSTOLAKIS: Well, but I mean,

we have to -- the thing is that if you are a commissioner and you had issued this SRM, and the response is a plan, the plan should say something, you know, "this will lead to the answer and what you want".

MR. PARRY: Yeah, I think it almost has to.

MS. COOPER: I think if the plan recognizes, as you just have already described and I think others have described, that different methods may have application or usefulness is in different applications or different settings. As long as that's the expectation, that's the kind of answer you're going to get. There's -- I think that we've got a common -- we've got an objective we can reach.

CHAIRMAN APOSTOLAKIS: But it says, "Identify a suite of models".

MS. COOPER: As long as it doesn't say we're going to have one --

CHAIRMAN APOSTOLAKIS: He was very careful in drafting it. I can assure you.

MEMBER SHACK: The SRM said, either propose either a single model or --

CHAIRMAN APOSTOLAKIS: Or as single model.

MEMBER SHACK: It's the or that's going to save the day.

MR. NOURBASKH: Or guidance on which model should be used.

CHAIRMAN APOSTOLAKIS: Or guidance. Couldn't vaguer than that.

MEMBER MAYNARD: George, one other thing that I think we should at least discuss are -- I don't know if we'd put it in a letter or not, but I think it's important as part of this to develop a schedule, have a schedule to be working to. This is an effort that could drag on for a long time if there's no schedule or goals or something to try to accomplish something within a reasonable amount of time here.

CHAIRMAN APOSTOLAKIS: Yeah, this has always been a problem with our letters. We can't really put any deadlines. The most we can say is expeditiously. On the other hand, when the staff gets together with the industry and they start planning thing, they normally tell us, you know, by this time we're going to have this and that. But certainly this is not intended to be a five-year project.

MEMBER MAYNARD: And I agree that we probably shouldn't put a schedule in our letter, but part of our proposal could be that one of the deliverables they come back with is a proposed schedule or something to take a look at.

CHAIRMAN APOSTOLAKIS: Oh, well, yeah. We can do that? I mean, this is a free discussion. How long do you think it's going to take to do this? Let's say that the attorney is agreeing in six months, okay? So you have this. We subtract this time according to their calculator, okay, this is --

MR. RAHN: The time delay.

CHAIRMAN APOSTOLAKIS: Yeah, this is the delay time, six months. How long will it take to come up with some reasonable answers to these things we have discussed?

MR. PARRY: Beyond the delay or --

CHAIRMAN APOSTOLAKIS: Beyond the delay, yeah, beyond the delay?

MEMBER BONACA: Is it a budget issue, is it a resource issue?

MEMBER SHACK: All we can do, George, is recommend that they set up this project. Somebody has to go out and find the money to do it.

CHAIRMAN APOSTOLAKIS: I'm trying to understand that if the resources are available, how long would it take?

MEMBER MAYNARD: But if we don't ask for a schedule -- and don't get me wrong, I'm not -- I know myself if I'm not working to a schedule, things -- but I think it would also be beneficial for them. They're going to have to sort out what the resources are and their management is going to have to make decisions as all part of that. If there's not a schedule involved then everybody kind of get of the hook by not providing the resources and just letting things be studied for a long time.

CHAIRMAN APOSTOLAKIS: Is it a two-year project?

DR. LOIS: I personally believe that some of these issues may be shorter, like identifying common terms. Probably we're pretty close into establishing that. Probably the pilot will give us some insights as to the method-to-method comparison on how far away we are. It may give the -- it may happen and show that most methods are really converging and therefore, we'll have -- we may not have to do a tremendous amount of work to understand the methods farther, but as a minimum, a three-year project.

You have to realize that we have hundreds that sometimes goes into continued resolution and that hampers tremendously our activities this year. So there are realities and realities here. And this is a very aggressive project. I think it's more realistic to say three.

MR. PARRY: I think that's -- I don't think you should go for three. I think you should go for something shorter because I think the first part of three, like the first three bullets there actually can be done pretty quickly.

CHAIRMAN APOSTOLAKIS: It seems to me a knowledgeable staff member can sit down and do this in a couple of days.

MR. PARRY: Right, and the results of that -- and the results of that actually might drive a lot because if you decide that for a large number of our licensing applications most of the methods are actually applicable, that's a big plus. So then you can focus on the things that are really significant. And I'm --

CHAIRMAN APOSTOLAKIS: That's my impression, too, Gareth and Erasmia, that we are not really -- leave aside the comparison of the benchmarking, which really will take some thinking, the rest here is pretty straightforward, it seems to me. We have experts in this agency that will answer these questions where is HRA important very quickly. The NRR guys, they know, they know when it is important. They -- what they don't perhaps know is how well it's done. But they know that -- you know, power uprates, for example, they know it's risk informed and so on. So -- it's not risk informed. So we're not talking about a major investigation here.

MR. PARRY: Not for that.

CHAIRMAN APOSTOLAKIS: Now, of course, you guys have internal reviews and all that, but, I mean, which tends to delay the -- yeah, go ahead, John.

MR. MONNINGER: Two thoughts would be. One thought would be, you know, within the SRM you could say something like, you know, "We would be interested in working with the staff in reviewing the plant and schedule for accomplishment of this project", would be one option. The other one, I'd do a little notice about, but it would be, you know, recognizing we're supposed to come back to the full committee in about three weeks, see if we could come up with some type of time line or schedule and --

CHAIRMAN APOSTOLAKIS: Because we have to discuss that, too. My understanding is that you're scheduling to come to the full committee in April, which is two weeks from now.

MR. MONNINGER: Correct, yes.

CHAIRMAN APOSTOLAKIS: Can you put -- you don't have to go through all this presentation again because it's only an hour and a half, right?

MALE PARTICIPANT: Yes.

CHAIRMAN APOSTOLAKIS: So my suggestion, you don't have to follow it, but with the SRM start from the end and here is an outline of how we plan in working with the ACRS to answer the SRM and then you have an opportunity maybe to bring up a few of the models that were discussed today, discuss the benchmarking exercise in light of the discussion today, maybe you can formulate it a little differently, what you expect to learn from it and so on. And it seems to me that would take up all the time and then see what the full committee says.

But the main idea would be to start with the SRM and work backwards.

DR. LOIS: Which also -- do you suggest to also include a discussion of the models such as ATHEANA, SPARS, et cetera?

CHAIRMAN APOSTOLAKIS: Well, you have to mention them somewhere, yeah.

DR. LOIS: But shall we go through this characteristics, et cetera?

CHAIRMAN APOSTOLAKIS: Shall we go what?

DR. LOIS: Through the characteristics of the model, the underlying assumptions, the whole --

CHAIRMAN APOSTOLAKIS: I'll leave it up to you but some of the things we said today, I think are useful insights without going into details. For example, SPAR-H starts with a PRA. It's really focusing on quantification. I think a very important thing to emphasize is the scope, why each model was developed. What is intended, in that context you can mention SPAR-H and then you can say EPRI has -- regarding the actual scenarios, EPRI has SHARP, we have ATHEANA, you know. They are not that different. There are some difference in terminology perhaps, or maybe others. Then the quantification is very different.

EPRI tends towards standardization more for certain reasons. We go the other way for our own reasons. In other words, keep it at a higher level without going into details as to who exactly EPRI does it, like today we had the diagram with the time and all that. If somebody asks, I'm sure you can answer it but I wouldn't go into that detail.

DR. LOIS: Is EPRI invited to the full committee meeting?

CHAIRMAN APOSTOLAKIS: Well, yeah, you are invited, but I don't know that you have to come. If you want to be here, that would be great. That is a matter of budget. Frank will have to decide that. We cannot tell him what to do but you're certainly invited. But this is a response of the staff and the ACRS to the commission really.

MR. MONNINGER: I guess you said a response to the staff and ACRS. I think the actual response is just from the ACRS, the staff wasn't ticketed with anything to respond.

CHAIRMAN APOSTOLAKIS: Yeah, the ACRS is an advisory committee. So when we get an SRM that involves work, you do it.

MEMBER SHACK: It says work with the staff and external stakeholders.

MR. MONNINGER: Yeah, right, but we were not planning a separate letter also to the commission.

CHAIRMAN APOSTOLAKIS: No, no, it will be our letter, it will be our letter. Yeah, since they mention external stakeholders, we'll have to mention that there was a discussion with representatives of the industry and put some words there to the effect that they were agreeable.

MEMBER SHACK: Wildly enthusiastic.

CHAIRMAN APOSTOLAKIS: Huh/

MEMBER SHACK: Wildly enthusiastic.

CHAIRMAN APOSTOLAKIS: Well, Frank

actually is wildly enthusiastic, you just can't see him.

MEMBER SHACK: he's got his phone on mute.

MR. RAHN: I'm always enthusiastic.

CHAIRMAN APOSTOLAKIS: You are always enthusiastic.

DR. ELAWAR: Still we need to emphasize that the EPRI represents about three-quarter of the US reactors. We don't represent all of them.

CHAIRMAN APOSTOLAKIS: Well, I mean, I don't know when we say industry --

DR. ELAWAR: 103 reactors, let's put it this way. We represent about three-quarters of them.

CHAIRMAN APOSTOLAKIS: If we get agreement between the staff and you guys with the calculator, I'll be happy. The other quarter can do something else.

DR. ELAWAR: You may consider soliciting stakeholders from outside as well, the reason I'm making that comment.

CHAIRMAN APOSTOLAKIS: Is anybody else doing anything?

MR. JULIUS: Steward Lewis had done something.

CHAIRMAN APOSTOLAKIS: Who?

MR. JULIUS: Stewart Lewis. He also worked with us on the calculator. Energy in progress use a similar approach that Stewart Lewis -- a separate tool but a similar approach that Stewart Lewis developed.

CHAIRMAN APOSTOLAKIS: So how do we bring him into this?

MR. JULIUS: I don't know.

DR. ELAWAR: EPRI members then through Frank they would be included.

CHAIRMAN APOSTOLAKIS: Yeah, if they are EPRI members.

MR. RAHN: Yeah, Stewart works with us on the calculator. You know, we can discuss with him maybe you know, what we can do.

CHAIRMAN APOSTOLAKIS: Very good. Do we have to go to NEI, Bill?

MEMBER SHACK: I don't know. Do they care?

CHAIRMAN APOSTOLAKIS: Do they care? This is more of a technical issue.

MEMBER SHACK: This is a technical issue.

MEMBER MAYNARD: Well, first of all, we don't have to. NEI is not a licensee. We do post these meetings. The subjects are posted, noticed and anybody who has an interest, has an opportunity to come and participate. I think as a courtesy, I would think that the industry member and EPRI and others might contact others or through NEI or whatever, but I don't see that it's our obligation to contact NEI.

CHAIRMAN APOSTOLAKIS: Well, but since the SRM says the ACRS in consultation with external stakeholders, I mean, that's why we invited EPRI. It didn't occur to me that we had to invite anybody else but -- well, does this sound like a plan or that would not create any headaches for anyone? Susan?

MS. COOPER: Yes, George.

CHAIRMAN APOSTOLAKIS: Tell us what you think.

MS. COOPER: I think it has -- like it could be doable, yes.

CHAIRMAN APOSTOLAKIS: Could be doable.

MS. COOPER: Yes.

CHAIRMAN APOSTOLAKIS: And would be useful, too?

MS. COOPER: I think so.

CHAIRMAN APOSTOLAKIS: Good, so I didn't know that but we also have face-to-face meeting with the commission in June, the ACRS does. So I guess we'll propose this to be one of the items and if --

MEMBER SHACK: We have already proposed. But they may --

CHAIRMAN APOSTOLAKIS: They may not agree.

MEMBER SHACK: They may get you off the hook, George. We propose, they dispose.

CHAIRMAN APOSTOLAKIS: Well, last time it was not on the agenda, was it? And somehow it surfaced.

MEMBER SHACK: As I said, we propose, they dispose.

CHAIRMAN APOSTOLAKIS: They dispose. So we left it that the insights and the item 3 there, I will go back and look at the three or four slides that are in the NRC presentation to see whether we can -- but are you happy now? You know what to present next time we meet with the full committee?

MR. MONNINGER: Yeah, I believe we have a good handle on it.

CHAIRMAN APOSTOLAKIS: Okay, any other comments from anyone? The members? Anybody else around the table? This is the time to speak. Well, thank you very much, all of you. This was a very useful meeting. I feel much better now than I felt in the morning. So I think we know where we're going. Thank you very much. Especially thanks to our industry colleagues here who traveled all the way from the West Coast to be here with us. Thank you very much.

(Whereupon, at 5:12 p.m., the above-entitled matter concluded.)