Official Transcript of Proceedings ACRS T-3279

NUCLEAR REGULATORY COMMISSION

ORIGINAL

Title: JOINT MEETING: ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS) SUCOMMITTEE ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT AND SUBCOMMITTEE ON HUMAN FACTORS

PROCESS USING ADAMS TEMPLATE: ACRS/ACNW-005

Docket Number: N/A

Location: Rockville, MD

Date: April 22, 2004

Work Order No.: NRC-1437 Pages 1-291

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

TR04

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

JOINT MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

SUBCOMMITTEE ON RELIABILITY AND PROBABILISTIC RISK ASSESSMENT

AND

SUBCOMMITTEE ON HUMAN FACTORS

+ + + + +

THURSDAY,

APRIL 22, 2004

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittees met at the Nuclear Regulatory Commission, Two White Flint North, Rooms T2B1 and T2B3, 11545 Rockville Pike, at 8:30 a.m., George Apostolakis, Joint Subcommittee Chairman, presiding.

PRESENT:

GEORGE E. APOSTOLAKIS, Joint Subcommittee Chairman

STEPHEN L. ROSEN, Human Factors Subcommittee Chairman

MARIO V. BONACA, Member

THOMAS S. KRESS, Member

GRAHAM M. LEITCH, Member

DANA A. POWERS, Member

VICTOR RANSOM, Member

ACRS STAFF:

BHAGWAT P. JAIN, Designated Federal Official

ALSO PRESENT:

ANDREAS BYE

SUSAN COOPER RES/NRC

BRUCE HALLBERT INEEL

ALAN KOLACZKOWSKI SAIC

ANDREW KUGLER RES

DAVID LEW RES/NRC

ERASMIA LOIS RES/NRC

GARETH PARRY NRR

A-G-E-N-D-A

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

8:33 a.m.

CHAIRMAN APOSTOLAKIS: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards Joint Subcommittee on Reliability and Probabilistic Risk Assessment and on Human Factors.

I'm George Apostolakis, Chairman of the Joint Subcommittee. Steve Rosen is the Chairman of the Subcommittee on Human Factors.

Subcommittee members in attendance are Mario Bonaca, Dana Powers, Graham Leitch, Victor Ransom and Thomas Kress.

The purpose of the Joint Subcommittee Meeting is to review the proposed staff's guidance regarding good practices for implementing human reliability analysis and data development for human event repository and analysis. This guidance has been developed to support Regulatory Guide 1.200 which describes an acceptable approach for determining the technologies of HERA results for risk-informed activities.

We will also hear about ATHEANA in particular a quantification methodology that is relying on expert opinion elicitation. And, as you

know, this Committee has not been too friendly to ATHEANA in the past, so we'll see today whether we can change our altitude.

And finally, we will hear from a gentleman from Halden who will what -- no, another gentleman from INEEL Bruce Hallbert who will talk about human event repository and analysis. And another gentleman from Halden will talk about the activities there on human reliability analysis.

The Subcommittee will hear presentations by and hold discussions with representatives of the staff and its contractors. The staff requests ACRS concurrence for issuing the staff's proposed guidance and good practices for public comment.

The Subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation by the full committee on May 6, 2004.

Bhagwat Jain is the Designated Federal Official and the cognizant ACRS staff engineer 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 April 1, 2004.

A transcript of the meeting is being kept and will be made available.

It is requested that speakers first identify themselves and speak with sufficient clarity and volume so that they can be readily heard.

We have received no other written comments or requests for time to make oral statements from members of the public regarding today's meeting.

So, we are ready to start.

Ms. Lois, the floor is yours.

MS. LOIS: Thank you.

My name is Erasmia Lois, and I work for the Probabilistic Risk Assessment branch of the Office of Research. And David Lew is our branch chief in PRAB now. And Andrew Kugler is our section leader. And Susan Cooper is a member of the staff. So all of us represent the staff that supports the human reliability analysis program.

In the past we've briefed the Subcommittees as well as the full Committee on plans we had for human reliability activities. These activities have progressed at a different level, but

we feel that it time to come back to discuss the status and results and obtain feedback and guidance on a timely matter. Specifically we'll focus the discussion today on the HRA good practices, the ATHEANA process and also plans on how we will improve the implementation aspects of ATHEANA, data development and also the Halden activities.

This flow chart here provides an overview of the HRA activities, mainly at the Office of Research. The staff has been using extensively PRA results in regulatory decision making. And there is a lot of activity in developing guidance on how we can use PRA results in decision making on the basis of the quality of the PRAs.

HRA is an area that can influence the results of PRAs and the quality of PRA significantly, and therefore that's an area that we're also concentrating in terms of guidance developing. As I mentioned, the good practices document will be discussed today, but however we are going to develop another document which will address the capability of the various methods that are in use today with respect to good practices for their capability to meet the good practices.

Also IEEE is revising its study on HRA

and we're supporting that activity. And they choose only the domestic activities that we have in supporting PRA quality issues.

CHAIRMAN APOSTOLAKIS: I have a question.

MS. LOIS: Yes.

CHAIRMAN APOSTOLAKIS: You said that you're developing the good practices document and then you will have a project to see whether the various methods that are being proposed can support that, which implies that their good practices come from somewhere else other than the models. And I was wondering whether this is the right approach. I mean, it is a good approach but shouldn't you also look at the models and the assumptions they make and the approach they take to make sure that if they have something good that should be part of the good practices, you put that in the document? In other words, like I think the French are claiming they're taking an entirely different approach, so they might be able to tell you, look, you know as part of good practices you also have to consider A, B, C.

MS. LOIS: And that's why we have this feedback arrow here. Good practices right has been developed on the basis of U.S. experience, if you

wish, in using all of the first generation and a lot of that has been driven by the development of ATHEANA and the insights were developed with respect to the errors of commission, etcetera. But we do plan to once we have an agreement amongst ourselves that, yes, these are good practices to go and review these other methods including the French method MERMOS, and some other ones, and incorporate that, revise our good practices document and the guidance on how to use it, as well as actually get our arms around to what they've done and how we can take the insights from these methods to improve ATHEANA or potentially develop a third generation method for HRA.

CHAIRMAN APOSTOLAKIS: I guess my questions is would it be a good idea to send the document that you have developed now in good practices to the leaders of these other models and ask them whether they feel that their intellectual approach is covered by what you have? Maybe give them three or four days to do it. I mean, it shouldn't be hard to --

MS. LOIS: It's a very good idea. And we're going to go public comment --

CHAIRMAN APOSTOLAKIS: Yes. These guys

are not going to respond as members of the public. they have to get a letter and maybe get paid, that's what I'm saying.

You go to CREAM and say, look, we developed this document. It's in draft form. We'll give you four days or three days, whatever you judge, please tell us whether you agree in detail. That's an idea.

Then you will have some input that will, I think, strengthen your position.

MS. LOIS: Could we let management speak of this?

CHAIRMAN APOSTOLAKIS: Well, you don't have to decide now. No, no. I'm just saying that it's import for these documents to be consensus documents at some high level. And I think, as I say, these guys -- I mean, Ali Mosieh and Holinagel and the French, they will never sit down and respond as members of the public. They may not even know that you are seeking public comments.

So I think that would give you maybe -- if they write back and say no I think everything is there, that's even better, you know. Clearly, that's a thought.

MS. LOIS: Yes, it is a thought. The

timing is -- I think we would be able to do that when we do have a publicly available document. And that will be easier for --

CHAIRMAN APOSTOLAKIS: Well, it's a management decision. I don't want to get into management here. I'm just suggesting, of course, you have to serve maybe concurrently with the public comment period. You send it to them, but with your approach and on a personal level and perhaps even compensate.

MR. LEITCH: I had a similar question. The HRA good practices document, the draft which we read in preparation for today's meeting, really outlines points to be considered and what could go wrong if you don't consider those points, what were the pitfalls. But it doesn't really address the methodology, which I guess is the next step.

MS. LOIS: Yes.

MR. LEITCH: But I also read an earlier document, the SPAR-H document that I guess we got 9 months or perhaps a year ago. And that seems to really have a method pretty well laid out in it. And I'm not really sure what the difference would be between that and this HRA method evaluation that you're proposing. In other words, that SPAR-H

document had in it tables, weights to be assigned, points to be considered. And it seems like you could actually go and work your way through that, whereas the good practices document was silent on how to do it.

MS. LOIS: On purpose. It was silent because the good practices document does not endorse any specific methods.

MR. LEITCH: Right. But it leaves one wondering -- you know, I wouldn't necessarily say endorsing the SPAR-H method, but suggesting that as one possible approach.

MS. LOIS: Definitely in Document 2, which would be the evaluation of the values methods with respect to the good practices, then we'll come to SPAR-H and SPAR-H will be one of the methods to review. And SPAR-H has a very good outline on how to perform, what to do when you perform a SPAR-H; that's the good aspect. However, it's been created for a kind of specific objective to support SPAR analysis, etcetera. So then the review document will critique SPAR-H for its own purpose and will identify, you know, when you do SPAR analysis or very focused HRA to invest a specific issue. SPAR-H may be the good way to go and, yes, doing a SPAR-H

you may be able to incorporate some of the performance shaping factors, etcetera, etcetera. However, when you do for example a steam generator or tube rupture analysis, which is you examine human experience during severe accidents, SPAR-H may be very limited. And then ATHEANA, for example, or even THERP may be a much better method to adopt. And then we'll discuss the strengths and limitations of those methods.

So Document 2 will address the suitability of the methods for the various regulatory applications we have and vis-à-vis good practices.

MR. LEITCH: But SPAR-H is used primarily by the NRC now, exclusively by the NRC to evaluate any significant determination process to evaluate -- it just seemed to me it wa a very good document. I do not know why we don't publicly issue that as one suggested method for doing HRA.

MS. LOIS: I think we have. I think we have adopted it. And we are using it. But we're also cognizant of its intent and purpose. I mean, as far -- yes, Alan, you want to address this?

MR. KOLACZKOWSKI: Alan Kolaczkowski with SAIC.

I think one thing I would like to add to this is that for instance SPAR-H, yes, it's a very good process for a particular type of application, whatever. But for instance SPAR-H is focused on a quantification technique and certain PSFs that you should point to any practices you should treat. But it's silent on how do you identify the human errors that ought to be in the model in the first -- excuse me. Take that back. I guess SPAR-H does address that to some degree. No, it doesn't.

It doesn't address how do you identify which events even ought to be in the model. It's silent. It assumes you're past that point and now you're going to quantify, and here's a way to quantify.

MR. LEITCH: Right.

MR. KOLACZKOWSKI: But the good practices is going to cover the entire spectrum. How do you identify the events that ought to be in the model, when you're allowed to screen them out, etcetera. and then when it gets to the quantification it'll say here's some general good practices for how to quantify human error probability.

MR. LEITCH: Okay.

MR. KOLACZKOWSKI: But it won't endorse a specific quantification technique recognizing that there are several out there and many have strengths and weaknesses.

MR. LEITCH: Yes.

MR. KOLACZKOWSKI: So it's silent, for instance, on the identification process.

MR. LEITCH: Okay.

MR. KOLACZKOWSKI: So something needs to be done to fill in that gap.

MR. LEITCH: I see. Okay.

MR. KOLACZKOWSKI: And that's where the practices is going to provide some, we hope, additional benefits.

MR. LEITCH: Okay.

DR. COOPER: If I could just ask, Susan Cooper, NRC.

The good practices document, I believe it's stated in the document, is principally focused on the process of how you form human reliability analysis. There's some amount of information support on quantification, but as Alan just stated, it doesn't focus on that. It's very process oriented. And there are other processes out there and it's been adapted from those processes. Most of

the methods are focused towards how do you quantify what kinds of information you incorporate and so on and so forth. And some of the evaluation that's going to be going on is in the second document they're resident as we've recognized things, as well as some of these topic steps, not ever method is going to be, in other words, has it's going to process capability, as you and Alan mention, for identifying the failure events --

CHAIRMAN APOSTOLAKIS: And the next slide has the documents, right? The next slide lists the documents 2 and 3 that you guys --

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Can you go to the next slide, unless you want to say something here.

MS. LOIS: No. I just wanted to finish up saying that with the good practices and guidance is one activities that we're focusing. However, we're also developing data. And with respect to developmental activity, this is the area that we're focusing more. The intent here is to use effectively the existing experience in terms of operational experience or simulator experience or even the open physiological literature experience. And in order to develop a better understanding on

how model human performance. Because still we haven't agreed or we haven't reached the maturity needed in HRA modeling.

Also, we're developing methods for using the data in estimation, and we're going to cover those activities.

With respect to action method develop, we're not doing anything right now. But given the nature of applications we're facing in the rulemaking and in licensing, we are again start at the various small activity and, hopefully, one will have enough data inherent, we'll start addressing some of the issues that the ACRS has been recommending for a long time now, latent condition, crew performance, ex-control room actions and operator performance for slowly evolving events. It's part of the advanced reactor licensing PRA issue. Also low power shutdown issues. As part of the lower power shutdown issues we have done this, that. And doing PRA for steam generator tube rupture we have to address human performance under severe accidents.

And, again, this is more on the planning stage than actual doing stage.

Also, we've done a feasibility study for

waste and materials and we're talking to NMSS as to what we're going to do next.

And this line here highlights what are the areas that we are going to discuss. For some reason did not come up red, but we're going to discuss, as is mentioned before.

CHAIRMAN APOSTOLAKIS: What is the IEEE standard you have on the right there?

MS. LOIS: The IEEE is has developed a HRA standard --

CHAIRMAN APOSTOLAKIS: They have already?

MS. LOIS: They have in the past but they're revising it. And we're supporting that activity.

CHAIRMAN APOSTOLAKIS: What would that standard say?

MS. LOIS: Well, the previous data was kind of a high level, very high level. You had to identify --

CHAIRMAN APOSTOLAKIS: So it's like your good practices document?

MS. LOIS: And now we hope that IEEE will consider our good practices document and at least use that as much as possible for developing a

more appropriate standard.

CHAIRMAN APOSTOLAKIS: Are you planning to go to this slide 5 HRA guidance?

MS. LOIS: In a minute. Here it is.

CHAIRMAN APOSTOLAKIS: Yes, we talked about the documents, right?

MS. LOIS: Yes.

CHAIRMAN APOSTOLAKIS: The thing I'm wondering about is Document 3, Evaluation of 1st and 2nd Generation HRA Methods With Respect to Good Practices. The first comment is what I said earlier that you would have to have a two way street here, not just evaluating the model whether it conforms with what you think of good practices.

The second is, and I notice that also in the SECY -- I think it was the SECY that we saw the other day regarding the phased approach to PRA quality. There are three technical issues that are really very important to PRA quality. One is the issue of model uncertainty in some instances, the issue of external events which is not relevant here and HRA.

Now, I got the feeling from reading what was in that document and also from the presentations or the documents that were sent to us today or last

week, that the HRA issue is stated separately from the issue of model uncertainty, and it should not be in my opinion. Are you planning eventually to have a single model that will combine the best of all the models or maybe say that in this situation this is the best model and in that situation it's another model, or maybe in one particular situation there are two models that appear to be applicable, in which case we'd have an issue of model uncertainty and you have to coordinate -- that's in fact my point. You have to coordinate your work with whomever is working on model uncertainty. They cannot be separate because in fact if you ask me in the level one PRA, right now the major issue of model uncertainty is HRA. I mean, there's some issue regarding pump seals failing and so on, but this is really the big one. And I think -- and you must have seen the Ispra results, right, from a century ago.

But I didn't get the feeling that there was collaboration there.

MS. LOIS: We are. We feel that in the HRA we're a little bit behind in the capability to address model uncertainty as crisply as it could have been in these other areas. We think that the

data gathering activity, the Halden study will help us improve models so that we can review the uncertainty aspects of it.

CHAIRMAN APOSTOLAKIS: Yes.

MS. LOIS: But you're right, we are talking but we haven't really developed a methodology or an approach on how we are going to feed back our --

CHAIRMAN APOSTOLAKIS: Yes. I think it's perhaps too soon to, say, develop methodology. But I think you should be aware of what the issues are of the other side and they should be aware of what the issues are on your side. And perhaps, you mentioned, come up with some sort of common --

MS. LOIS: We're in convenient discussion, and it's a very good point.

CHAIRMAN APOSTOLAKIS: But I'm sure something good will come out.

MR. LEITCH: I'd point to your previous slide where you list applications. I don't see a reference to risk-based regulations or risk-based applications. I would think one of the primary uses for HRA would be if an applicant in the future were to come in and apply for some risk-based change that we would expect a good high quality PRA to have

arrived at the answers by using HRA methods. Is that correct?

MS. LOIS: Absolutely. And I'm listing here licensing. I guess that's the primary driver of developing the good practices and then we document in document B. that's how it started out. For the matter of record NRR when they reviewed our research plan, they said if you would like to do something useful why don't you develop a good practices document, guidance on how you evaluate the results of HRA for the given application.

So I did not list here everything that--

MR. LEITCH: No, of course not.

MS. LOIS: Yes.

MR. LEITCH: But that's one of the primary --

MS. LOIS: The good practices and the guidance document here fee directly to licensee requests for changes, requests to install new human action change procedures, subsequent equipment performance with human actions, etcetera.

MR. LEITCH: Okay.

MS. LOIS: So we're working very closed with Hay and NRR in these areas and it will hopefully help.

CHAIRMAN APOSTOLAKIS: So you think that operator performance during slowly evolving events may be an issue? I mean, here you have the designers trying very hard to take the operator out of the loop so we don't have mistakes and then now you're saying well, gee, but if it's too slow, you're going to be in trouble.

MS. LOIS: I will just let Jay respond to that. He's more knowledgeable because they're looking at human performance issues.

MR. PERENSKY: I'm Jay Perensky from the Office of Research.

The issue of the slowly evolving events and operator error is one that we're still looking at. There's a potential for a change in there. The issue also come down to whether or not they're prepared for it, whether it's slowly evolving or not. So it's a change in their conduct of operations and how they work. And we're trying to do some work in that area to really get a better feel.

There's not a lot of research in other areas yet in this. We know that automation does effect operator performance because they're not a function in the loop, if you know what that is.

CHAIRMAN APOSTOLAKIS: Sure.

MR. PERENSKY: So those are some issues that we're trying to address and we'll feed any other to the HRA.

MR. ROSEN: It seems to me that when you're talking about slowly evolving events that you need to be thinking very hard about such issues as command and control and organizational performance. Because now other people will have opportunities to influence what goes on both for the good or for the bad. And so the circumstances change when you have hours instead of minutes in terms of influences on recovery.

MR. PERENSKY: That's correct. And those are the kinds of things. As I say, it's a sort of different kind of situation than we have now. We're looking at things at pre-resource management from the other techniques that have been researched in the aerospace industry as part of -- again, you're going to have different people. And the qualifications of operators may be completely different than -- you know, in the future for these advanced reactors than they are not. It may not be the same kind of person. It may not be the same kind of examinations we do.

So, those are all possibilities. We

don't know yet because we're just starting to scratch the surface in that area.

MR. ROSEN: You didn't respond at all about the command and control aspect.

MR. PERENSKY: I agree with you. I agree with your entire --

MR. ROSEN: The who is in charge thing will become very important.

MR. PERENSKY: Who is in charge, in a way I did respond by indicating that, you know, we have different qualifications, different sets of people that could be involved in this in different locations.

CHAIRMAN APOSTOLAKIS: You're not only a designer to make the -- is uncovered in two hours rather than 56 because the operator may have made a mistake. No, you will not. You will not.

Are you done?

MS. LOIS: I am done.

CHAIRMAN APOSTOLAKIS: Okay. Good.

MS. LOIS: With that, I am going to introduce Alan Kolaczkowski with SAIC, who talks about the HRA guidance. The good practices.

So, Alan, let me --

MR. KOLACZKOWSKI: Okay. I'm Alan

Kolaczkowski with Science Applications International Corporation. And I'll be presenting the discussion about the good practices document portion of today's presentations.

And I just want to note that again, Erasmia and Susan, both of NRC as well as John Forester who is also with us today from Sandia National Labs provided primary input to the presentation that we're going to go over.

Okay. In accordance to the guidance that the ACRS has provided, they say they liked the slide that says well what's the issue and what's the solution. So we'll try to address that first.

We've been talking about PRA quality. And clearly, HRA being a part of PRA we're obviously just as concerned about making sure that the human reliability analysis portion of the PRA is also of good technical quality. It needs to be that the PRA results we get are something that we, in fact, can use for making risk informed decisions. So we have to be able to get to a point where the HRA is performed in a way that's consistent in its practices and ultimately provides good credible results that can be applied to various risk-informed applications.

As the second bullet indicates, we're using PRA and HRA a lot, as the ACRS is obviously well aware. And I don't need to go over the examples of what those are. The NRC is using risk-informed information more and more and more as we progress through the years.

And clearly, as indicated by the third bullet, the HRA results need to sufficiently represent the anticipated operator performance in order to make these risk-informed decisions.

As indicted by the standard review plan, section 19, the NRC seeks that modeling of human performance should be appropriate. Well, we need to know what appropriate is.

And finally, Reg. Guide 1.200 reflects the ASME standard and also NEI's document related to that standard. But the short fall there is that Reg. Guide 1.200 and the standard, etcetera, primarily address what to do but not so much on how to do it. And so the good practices document is going to try to go, if you will, the next step and provide a little more guidance on in terms of how do you do what's required by the standards, the NEI document and so on and so forth.

So what we're trying to do in the good

practices document is develop a set of consistent good practices so that HRA analyst, reviewers and let me highlight nonexperts, HRA nonexperts will at least be able to recognize when an HRA is a good HRA and when it's not. Okay. And so the hope is that with the practices document there will be sufficient guidance in that document that people, reviewers either HRA analysts doing HRAs or reviewers reviewing a submittal that contains HRA in the submittal, that they'll be able to look at that and say yes, this is well done. We really believe to the best of the state of the art today that indeed the HRA results sufficiently are representing the anticipated operator performance, within the current state of the art.

MR. ROSEN: Do you foresee a time when this document would be incorporated into the NEI peer review documents?

MR. KOLACZKOWSKI: I can't really answer that. I don't know --

CHAIRMAN APOSTOLAKIS: I think the plan is to incorporate it in Regulatory Guide 1.200. It will be an appendix to it.

MS. LOIS: That's right.

MR. KOLACZKOWSKI: We clearly would hope

that, you know, NRC and industry will ultimately through the public comment review process, etcetera, will endorse, if you will, what's in the good practices document and say, yes, this really constitutes a good HRA. Now, how they will formally incorporate that, whether that's a formal part of the reg. guide, whether that's a formal part of an NEI document, I guess I really don't know how that would necessarily take place.

CHAIRMAN APOSTOLAKIS: I thought it will be part of the regulatory guide, that's why you're doing it.

MS. LOIS: It's more guidance, it expresses the NRC's views on good practices. It will become -- it can provide the basis for developing an SRP or a reg guide. But that by itself is more of a unit by itself where it's the position of the NRC staff on HRA good practices --

CHAIRMAN APOSTOLAKIS: But this will be one of the guidance documents that the Commission wants for the various phases of PRA quality. The Commission has said that there will be three phases essentially until 2008. And the phases are distinguished from each other based on whether guidance documents are available. If you issue a

NUREG like this, that's it. If they don't comply they're not in phase two or phase three, right? That's the way I see it.

MR. ROSEN: Yes. I think the most effective thing to do is what I suggested, which is to somehow get NEI to get it into the peer review. Because then you have all those people out there using it as part of the detailed examination of each document, each PRA. If you put aside it and decide it, say there's a risk and I'm not sure how big it is in this case of it becoming shelfware.

CHAIRMAN APOSTOLAKIS: Got it.

MR. PARRY: This is Gareth Parry from NRR.

I don't see this as being incorporated either in the NEI guidance or Reg Guide 1.200 directly. It's more likely to be a reference document that would be referred to in Reg Guide 1.200 in the same way that the data handbook is referred to.

It's very unlikely to go into NEI-00-02 largely because peer reviews have already been done. And what's being done with those is that the industry is doing a self-assessment against effectively Reg Guide 1.200.

CHAIRMAN APOSTOLAKIS: But if you refer to it in 1.200 in essence it becomes a guidance document, right?

MR. PARRY: It is the top of suite of guidance documents --

CHAIRMAN APOSTOLAKIS: Yes.

MR. PARRY: -- to be referred to in the phased approach response, that's right.

CHAIRMAN APOSTOLAKIS: Right. So in phase three somebody comes in here and with an application that deviates significantly from the good practices document, that person will be in trouble, right, according to your little boxes there? He will get a low priority.

MR. PARRY: Well, no it depends. No, not necessarily. It depends on the impact that the HRA has on the decision you're making.

CHAIRMAN APOSTOLAKIS: But that's part of the guidance? There is a screening part. If the prove to you in the screening part that it's not relevant, then of course it's --

MR. PARRY: It all would always be relevant. But if they can couch the decision in such a way that any deficiencies in the HRA are accounted for and yet the decision is robust, then I

think that's acceptable.

CHAIRMAN APOSTOLAKIS: Well now it's part of the guidance. It is part of the guidance.

MR. ROSEN: How do you expect someone to be able to prove to you or to me that latent conditions are not important? It seems like a non-starter.

MR. PARRY: I'm not sure I understand what you're saying.

MR. ROSEN: Well, this new document requires a careful look at the potential impacts of latent error.

CHAIRMAN APOSTOLAKIS: There is a screening --

MR. PARRY: It all depends -- what the statements or the standard --

CHAIRMAN APOSTOLAKIS: All these things about being relevant to the decision and so on, all that is part of the structure of the documents, okay. And they have several screening approaches here in this good practices document. The point is that if you cite screening approaches here as being good practice in Regulatory Guide 1.200, it becomes part of the guidance documents that you are referring to.

MR. PARRY: In the guidance documents, I agree.

CHAIRMAN APOSTOLAKIS: Yes. Yes. Now, the screening will come through. How can you decide in advance that something is not important?

Maybe we can move onto the second slide.

MR. KOLACZKOWSKI: Sure. Sure.

I just want to point out again that we're working towards a July 2004 draft for public comment and then a final version probably by the end of the calendar year.

CHAIRMAN APOSTOLAKIS: Why so late? It is going through eternal reviews now?

MS. LOIS: Yes. And also we look forward to your comments.

MR. KOLACZKOWSKI: Yes. We want to get, obviously, your comments.

CHAIRMAN APOSTOLAKIS: You're requesting a letter?

MS. LOIS: We would like to have a letter after we've addressed -- I mean, I don't --

CHAIRMAN APOSTOLAKIS: Yes, sure. I know. I know. We can write --

MS. LOIS: Yes. We would like to know more your feedback and guidance and then when we

incorporate on the basis of your feedback and review the document on the basis of public comment, then we would like to have a --

CHAIRMAN APOSTOLAKIS: Well, as I said in my introductory comments, you're already scheduled to come before the official meeting on May 6th.

MS. LOIS: Okay. On this specific topic?

CHAIRMAN APOSTOLAKIS: Yes. Not the other?

MS. LOIS: No.

CHAIRMAN APOSTOLAKIS: Okay.

MR. KOLACZKOWSKI: Okay. In terms of the basis and the approach for creating the good practices document, we've already highlighted some of this I think or mentioned it previously.

In terms of what we used to put together the good practices, you'll see that it's largely linked to the ASME standards, so in large part that was a significant input in creating the good practices documents.

The second bullet really comes to the point that Dr. Apostolakis had mentioned earlier. Yes, we have looked, I mean obviously, at the

existing methods and tools out there and tried to consider what they do now and how they assess the HRA process or the quantification or whatever, and reflect that in the good practices document. So it isn't like we put this together totally oblivious of what THERP does, or what ATHEANA does, or what CREAM does or whatever. We looked at that stuff, and certainly that was an input. And I'm sure there's going to be some iterations on that. So, again, we didn't put this document together and just pretended like all those other tools and methods and that sort didn't exist and we sat down and said what would be good practice in HRA. We certainly had our eye on what's already been done and the methods that are there, and where we think that there are good practices in those methods, try to reflect that in this document.

Insights from literature including literature, not only just within the U.S. but also in Europe and elsewhere. We've tried to take, again, a lot of the insights in terms of what appears to us to represent good practice and some of the other methods and reflect that here as well.

Obviously, we're learning from our PRA and HRA applications. In the PTS work, in the steam

generator tube rupture work that we've started now and other applications, we're learning as we go. And, again, gaining insights as to what would be good HRA practices. So we're trying to reflect that in there.

And then, again, the experience of the authors and reviewers, which really represents that experience that's on the previous bullets up there.

The approach for developing the good practices document is primarily to try to build originally a consensus of experts within the NRC. A large part of that is going through an internal NRC review process.

We look forward to comments from the Subcommittees today, and perhaps the full Committee in May with regards to their input on the good practices document.

And then ultimately, of course, out to the public and get industry's reaction to the good practices document as well.

The good practices document was put together largely with reactor full power internal events in mind, however we've tried to make sure that to the extent possible or maybe I should say to the extent reasonable, that a lot of the good

practices in here would in fact be good practices for handling external events and to some extent either as well other modes of operation and perhaps with even nonreactor applications. So it is focused with one particular application in mind, but we do think that a lot of the good practices here are going to have applicability across other modes and perhaps even in nonreactor applications.

MR. LEITCH: When you say "full power," in reading the document it seemed to me that you're speaking about the analysis of events that originate at full power.

MR. KOLACZKOWSKI: That's correct.

MR. LEITCH: Even though a lot of the actions that we're analyzing --

MR. KOLACZKOWSKI: Is post-trip.

MR. LEITCH: -- is post-trip. Yes, right. Yes.

MR. KOLACZKOWSKI: But we're talking about the reactor originating at full power. And then you get a trip. And then operators have to respond.

MR. LEITCH: Right. Yes.

MR. KOLACZKOWSKI: Exactly.

We've already highlighted the fact that

it does not endorse a specific method or tool. As I indicated, we've tried to reflect other methods and tools in the good practices, but it does not necessarily endorse a specific method or tool. Each method and tool, as I think we'll find in the other volume that we've talked about already, will highlight their relative strengths and weaknesses with regards to the overall good practices. And that will be done in a separate document.

I indicated it's linked to the ASME standard. It, in fact, couples very closely to the ASME standard and the way that standard is laid out.

We also talked a little bit about possible impacts of not performing the good practices. Like, well what if I don't do that, what's the risk? What is that I'm going to affect in terms of my PRA results if I don't do this?

It's focused on process and not, for example, data. I mean, you're not going to find in the good practices document where it says well if a task is complex and you have a short period of time, the failure probability ought to be ten to the minus 1. It's not going to do that. It's going to tell you the performance safety factors you need to consider and it's going to, as we tried to do in

appendix A of this document, we tried to give some guidance on how do you measure good procedures, good training, etcetera and so forth. But the ultimate how do you turn that into a probability, how do you turn that into a number is, still in large part, is where we are in the state of the art in HRA. Is going to be dependent on are you using THERP, are you using ATHEANA, are you using CREAM, whatever. This is not solving the problem of the fact that there's still many methods out there and they all have their different scales and gauges. And I don't think the HRA community is at the point yet where it's ready to say this is the scale we're going to use. I don't think we're at that point yet.

MR. ROSEN: Alan, I did see in the document what you can't do or shouldn't do without real justification at any number or incorrect action below of ten to the minus 3 or ten to the minus 4 would be immediately suspect, or words to that effect. So, you want to -- is that square with what you were just saying?

MR. KOLACZKOWSKI: Well, I mean, we certainly have tried to give guidance both to analysts doing HRA and reviewers reviewing a submittal. Say a plant wants to make a change and

it has some HRA impact and they do some HRA work, what they're saying, you know, if you start seeing numbers lower than X, you probably need to start asking questions and at least ma,e sure that you feel they have properly justified that human error probability because maybe there's things they didn't consider or whatever. So we're trying to give some guidance, but is that a hard and fast floor, you know? No, not necessarily. But it's sort of a warning flag, both to analysts and to reviewers. And we thought that guidance would be appropriate to help, again, non HRA experts to know when something to be at least to raise a flag that will raise their head and say maybe I ought to ask some questions about this particular value.

MR. LEITCH: One thing I noticed that the document says, that we're sort of omitting errors of commission for the present, that maybe later there'll be some thinking along those lines. But right in this issue of the document at least, for the time being the state of the art is such that we can't really consider errors of commission. It seems to me that's a pretty serious wall in the approach.

MR. KOLACZKOWSKI: Certainly, my comment

would be that I think we all recognize that errors of commission have some input into the overall risk. And, again, without -- we're trying to reflect where the current state of the art is, perhaps maybe a little bit beyond the current state of the art. I don't think we're at a point in PRA and HRA yet that we can get industry, NRC, etcetera to fully endorse and really get behind a full blown modeling of errors of commission in the PRAs. Now, that's not to say we shouldn't, but I think we have to walk before we can run, etcetera. And this document at least tries to take one step forward and say here's some situations that tend to set you up for errors for commission. Let's at least make sure we avoid those. But it stops short of saying let's put errors of commission in the PRAs from henceforth. We think that that's beyond good practice current. But do we need to get there? I would say yes, but it's going to take time and it's going to follow.

MR. LEITCH: It seems to me that as we move to the next generation of reactors that that component of errors, that is errors of commission, will become more significant. It seems to me that as processes become more automated and less dependent on the operator, the thing that the

operator is likely to do is something wrong rather than fail to take an action. Because a lot of the actions are going to be automated.

MR. KOLACZKOWSKI: As I said, I've commented as best I know how.

Susan, do you want to add something?

DR. COOPER: Susan Cooper, NRC.

Unless the document's been edited since the last time I looked at it, I do not think it says that we have omitted errors of commission. It doe say -- those errors explain that there is a discussion about the errors of commission. That the incorporation of errors of commission is limited at this point of time. The discussion identifies some specifics on errors where we think actually it would be good practice to consider errors of commission. So it is a step forward. It's not recommended that you -- upon errors of commission for every application that you might be faced with, but it does try to discuss some of those situations where you should.

But it does not omit it, it just does not say that you have to do it every time. And I think that's probably appropriate. I don't know that there's one time that we need to, you know,

look for errors for commission --

CHAIRMAN APOSTOLAKIS: But we'll come to the errors of commission later?

DR. COOPER: Yes.

MR. KOLACZKOWSKI: Yes.

MR. ROSEN: Well, maybe getting ready to come to it. I'm reading 5.4.3 good practices which is about recovery actions to be credited not included in the PRA, not already included. And in that section, actually 5.4.3.2 it talks about the Three Mile Island accident. And it says analysts should give proper consideration to the difficulties people often have had in overcoming an initial mind set and despite new evidence. And brings up Three Miles Island which of course, you know, they thought they had too much water and in fact they had too little.

Now, to me that's the classic cognitive error which leads to people making errors of commission, which is the right thing but for the wrong accident.

It's very important somehow to not forget what we've been through and somehow to make this technique more robust with respect to errors of commission of a cognitive kind. Because those are

the ones where the big risks are.

To me, to some degree, I think we're frittering around the edges, unless we come to grips with the cognitive errors of commission.

DR. RANSOM: I agree. And I guess all I would say is that I think we're struggling with how far this document should try to, if you will, extend the state of the art as opposed to reflect the current state and what is currently good practice. And, quite frankly, I think we're struggling with how far to push. You now, what's the next move? How do we move the HRA community a step forward? Is this the document with which to do that? Is there some other form that we should do that? And I think we're struggling with those things.

MR. POWERS: We may be saying that we're frittering around the edges of we don't address the errors of commission is probably -- has a certain ring of truth to it. But on the other hand, you don't want this "perfect" to be the enemy of the "good" here. I mean, you have to get through this step before you can even begin to think about the errors of commission step because it has an intractable quality to it. And, true, you're still in the data collection stage of errors of commission

--

MR. ROSEN: Well, I agree with everything he ways. It has an intractable quality to it. The difficulty of it is that it's likely to be so important that -- yes, I agree that we need to do it.

CHAIRMAN APOSTOLAKIS: I think we would distinguish between documents like this one which reflect good practices in certain areas in research.

MR. ROSEN: Yes. Yes.

CHAIRMAN APOSTOLAKIS: So this is not a research document. We cannot even attempt to push -- it just says, look, based on what is going on or has been going on for the last 20 years, here are some things that some people feel or why people feel that it constitute good practices.

I think that your question is probably a more one when Erasmia stands up there to talk about other things --

MR. POWERS: Why I disagree with that, it's not the HRA community that's bringing it along, it's the non-HRA community that you're bringing along with this document.

CHAIRMAN APOSTOLAKIS: Yes. Erasmia?

MS. LOIS: Yes. I do want to make a

point, and the point is that the recognition of the potential for a recognition may be more strongly filled than in our HRA guidances, but it doesn't mean that the performance shaping practice, if you will, is the prime conditions that may lead you to commit an error are being addressed as part of the performance saving practice aspects of it. And the difficulty we have is probably how do we recognize -- how to quantify errors of commissions, but how to recognize the potential for improvements of errors of commission, and I think we didn't have -- to get there and those aspects are part of the diagnoses of the guidance and etcetera and etcetera. That's --

CHAIRMAN APOSTOLAKIS: We have a paper here we'll distribute on the way to assess errors of commission as a result of a workshop that some people held in Munich. But there is active work going on. But I think the good practices document maybe shouldn't -- yes?

MR. FORESTER: John Forester, Sandia Labs.

I think we end up recommending that people do try to look for situations that could lead errors of commission.

CHAIRMAN APOSTOLAKIS: Well, I'm not

sure how wise that is.

MR. FORESTER: But they're not in the models now. The bottom line is the IPEs did not -- did not include errors of commissions.

CHAIRMAN APOSTOLAKIS: I think they did.

MR. FORESTER: They didn't do an update on an analysis, and we point out some specific conditions that maybe -- that if these situations are there, then it may be set up for a condition, and generally recommend that, but --

CHAIRMAN APOSTOLAKIS: So he'll come to this. Okay. Sometime today.

MR. KOLACZKOWSKI: Okay. And, Dana, I promise I'm not going to read the slides and go through all the words, okay.

Okay. The way the good practice's document is organized is by what we call logical analysis activities. That is those things that you would normally do in any sort of good HRA, and for that matter it coincides with the way ASME standard was pretty much laid out.

It has -- it suggests three what we call overall or general good practices that are kind of all encompassing, etcetera, with regards to the process. And then it breaks down into pre-

initiators and post-initiators. And I won't read through the various steps, but again each one is broken down into various steps that again corresponds to generally what you do in doing an HRA and that happens to coincide with the way the ASME standard is laid out.

I will address with a couple of slides the errors of commission.

And then what is good practice and how do you document an HRA? What should go into the documentation of an HRA?

There are three overall general good practices offered in the document. The first one has to do with the fact that it is a good practice to no longer, like we used to do HRA -- and I wouldn't say that that's the way HRA is being done really anymore. But there was a time when the PRA analysts decided what the HRA events would be in the model and then went to the HRA specialists and said give me a number. Well, that's not a good practice.

The HRA has to be an integral part of the PRA development. It has to be a key participant in deciding what's going to go into the model, and then also playing a role in understanding the context of the accident scenarios that the PRA is

trying to represent. Because the more that context is understood, the better HRA person will be able to come up with a human error probability that, again, with the current state of the art and the current tools that we have is best reflective as to their estimate as to the human performance, given that that's the context and the scenario. And you can't do that by just in isolation having an HRA person off in a corner and say go give me a human probability. That HRA person has got to be an integral part of the team, it's going to be involved in the model development stage as well as in the qualification. And that's just a general good practice.

Some combination of talk-throughs, walkdowns, field observations and simulations should be used as appropriate to confirm judgments and assumptions. We should not be sitting there doing, you know, I think it'll take them ten minutes to go from this location to this location to perform that local action. You should do a talk-through process or perhaps even walking down the pathway that the person has to follow. Really get a better estimate and not be sitting in an office, you never go into the plant and you're trying to decide how long it

takes somebody to get to step four or how long it takes it somebody to get to step 32, or how long it takes to walk from this location to that location. Go walk it down, find out; that's what you really need to do. This is not an office exercise.

MR. POWERS: Take me back to the first one.

MR. KOLACZKOWSKI: Yes.

MR. POWERS: On rare occasions you could come before the ACRS and say well we've done this PRA on this subject and then have a reliability analysis. But I'm willing to bet they never came to us and say we've developed our model and when it came to the HRA part of it, we went off to this guy we had the corner and said give me a number. They're always coming, usually 12 strong, presenting a united front that says, yes, we have integrated team. Whether or not that's true or not, how do I tell whether they have an integrated team when they show their PRA?

MR. KOLACZKOWSKI: I think per se you can't tell, but when you go through all these other good practices I think you will be able to decide whether in fact that integrated team really was effective or not. Because the only way that they're

going to be able to meet all those good practices, I think, is only if that person was well integrated. So I guess that's the way I would answer it.

Yes, I mean, in and of itself you probably can't answer that question. But in looking at the submittal and seeing what they considered the PSFs they considered, and why they considered those, etcetera, they're either going to build a case that strongly suggests to you it's clear the person was very involved in the model development or they weren't.

MR. POWERS: Or in a rationalization after the fact?

CHAIRMAN APOSTOLAKIS: Of course, it just occurred to because of this question, the intended audience here you said it was --

MR. KOLACZKOWSKI: People either doing HRA or people reviewing HRA.

CHAIRMAN APOSTOLAKIS: Yes. That's going to create problems. If you have a reviewer who sees this -- he innocent to think that he really has to make sure that it was a multi-disciplinary team and all that, and he rejects it because he thinks it wasn't, that's really stupid.

MR. KOLACZKOWSKI: I understand that. I

understand that.

I guess I think it's still important to tell people that that's really the best way to do HRA; make it an integral part of the PRA.

CHAIRMAN APOSTOLAKIS: Right.

MR. KOLACZKOWSKI: I will admit that's a hard one to come back and measure it.

CHAIRMAN APOSTOLAKIS: Maybe, as Gareth said earlier, this could be a NUREG but in the actual Reg Guide 1.200 you focus on what a reviewer should do. Because it's none of the reviewer's business whether they had walkdowns or so on. The reviewer -- the reviewer's approach should be performance-based. This is a good HRA, I don't care who did it, how many people got involved, whether they walked or -- it's irrelevant.

MS. LOIS: On the basis of IPE reviews or HRAs, through the -- you really could develop a good understanding of whether or not the team work, the HRA person participated, for example, of some SLIM analysis. There were statements there that the operators were asked to respond to these questions and was a clear indication that they never walked through the actions. So it provides a good basis to ask the questions, whether or not -- and the

reviewer can ask the question to the licensee, whether or not that has been done.

CHAIRMAN APOSTOLAKIS: But it's none of his business.

MS. LOIS: It is.

CHAIRMAN APOSTOLAKIS: No. A reviewer should look at the results.

MS. LOIS: But -- but --

CHAIRMAN APOSTOLAKIS: Is this a good HRA? If it's good enough, maybe there is this super human someplace who did it all by himself. We are a performance-based agency. Now the doers have to worry about this.

MS. LOIS: But you see results that are ten to the minus five --

CHAIRMAN APOSTOLAKIS: Then the results are no good.

MS. LOIS: Well then how do you say that if they're not good. Because, you know, the operators are very optimistic, sit among themselves, they can do everything for the reviewers.

CHAIRMAN APOSTOLAKIS: Right. But the reviewer will recognize that there is also no good, the analysis is no good. And then it's the licensee's problem.

MS. LOIS: Susan?

DR. COOPER: What I wanted to say to that is that HRA -- what this good practices document is doing is trying to level the playing field so far as what information is collected, qualitative information, the right qualitative information.

Now, what number has churned up, we've already discussed and depending on what model is used, you may get some different answers. But this to try to get the right information going into the -- I mean, if they're not talking about thermal hydraulic information supporting the timing of the events and describing the context of how the plants behaved and stuff like that with an understanding of what's going on, then you know that the HRA analyst has not been talking to the TA guys, to the access sequence analysis guys and they don't have an understanding of the context to be able to base any kind of number. They don't have the right quantitative information --

CHAIRMAN APOSTOLAKIS: Yes, we agree, Susan.

DR. COOPER: So what you need to say is it's not only their business in a sense that it's

not the results, but I would not the limits to the number. I would include the qualitative information and ask to hear the evidence --

CHAIRMAN APOSTOLAKIS: Sure.

DR. COOPER: -- if they don't do this--

CHAIRMAN APOSTOLAKIS: Exactly. When I say results, I didn't mean numbers. The results are the whole analysis.

MR. ROSEN: I think you might want to temper it a little bit of your strong position when you think about errors of commission. There I think process may more important -- even more important.

CHAIRMAN APOSTOLAKIS: No. The reviewer says -- in fact I think now that we've had this discussion, I thought it was kind of obvious, but in your introduction when you say that this is useful to all these people, maybe you can add a sentence or two that says, you know, maybe there will be some other document someplace for the reviewers and that this document is intended to do what Susan just said, which I agree with.

But I don't want to find ourselves in a situation, because we are a performance-based agency. I mean, we keep saying that all the time. And I have a reviewer who asks now, yes, everything

seems to be good but how many walkdowns did you do. Well, it's none of his business. Okay.

MR. POWERS: But we do it all the time.

MR. ROSEN: Well, that's the second George, let's take that.

CHAIRMAN APOSTOLAKIS: Maybe we shouldn't.

MR. ROSEN: Let's take your specific point and analyze it for a minute.

CHAIRMAN APOSTOLAKIS: Yes.

MR. ROSEN: If someone says it takes 12 minutes to do this and therefore we gave it this kind of number. Rather than accept the 12 minutes, we say oh, what did he have to do, where did he have to go from, to, where. So we're always asking to the second of a second -- a second level question.

CHAIRMAN APOSTOLAKIS: And I agree with him. Because if I'm already hearing you're telling me it's 12 minutes, I will need some proof that it is 12 minutes or you will tell me, look, we actually did the walk. That's great. But what I'm trying -- because that's part of supporting your results. But, I mean, it's really not my business to make sure that your team for the thermal hydraulic system if you monitor liability, well, I don't care. But

then you have to recommend what you're giving me, right? Do the results make sense? Results don't mean just numbers. They make sense and convince me.

MR. ROSEN: At that stage the walkdown--

CHAIRMAN APOSTOLAKIS: At that stage --

MR. ROSEN: The walkdown is a perfectly appropriate thing to require.

CHAIRMAN APOSTOLAKIS: Exactly. Absolutely. Absolutely. I have done something like that where it was said oh the firefighters will come in six minutes. And then we went there, and it was terrible. I mean, the place was going to be full of smoke. The stairway was very steep and so forth.

MR. ROSEN: Takes a lot more than 6 minutes just to put your --

CHAIRMAN APOSTOLAKIS: Exactly.

So this is part of convincing the reader that this is of value.

Actually, we're spending too much time on this.

MR. KOLACZKOWSKI: Dr. Apostolakis, and I certainly would agree that especially these general ones, it's hard to really measure and you could even ask the question should a reviewer be measuring. Nevertheless, I still think it is good

guidance to tell the does this is good practice.

CHAIRMAN APOSTOLAKIS: Yes. Yes. Absolutely. Absolutely.

MR. ROSEN: This is good practice.

MR. KOLACZKOWSKI: The last one just focuses on the fact that, of course, we're worried about with relative to Reg Guide 1.174 kind of things. We have to equally look at human performance for dealing with preventing and/or mitigating core damage accidents as well as looking at the effects on large early releases. And that's just a reminder to not get so focused on the level one portion of the PRA that we forget about the level two or level three portions of the PRA.

CHAIRMAN APOSTOLAKIS: The more I think about it, the more important I think it is. Yes. The guidance, these guidance documents, they have to be written in a very clear way as to what they intend to use. Now maybe it's too soon for you guys. I mean --

MR. KOLACZKOWSKI: I know we have tried to say that these are not the specific questions that a reviewer should ask, but that we think that this good practices document is going to helpful for a reviewer to form their questions, but it's not

mean to be necessary the questions that a reviewer would ask or whatever.

CHAIRMAN APOSTOLAKIS: That's fine.

MR. KOLACZKOWSKI: I thought for purposes of presentation, and especially if we do start running out of time, that I figured the panel would be much more interested in talking about the post-initiator human events rather than the pre. So even though the document was written such that we talked about the latent first, if you'll give me the liberty to do so, I'll talk about the post first and then we'll go to the pre afterwards, if that's okay.

MR. ROSEN: It's okay. But our interest is in both areas.

MR. KOLACZKOWSKI: Okay. Fair enough.

MR. POWERS: But our interest is is to be four to one in the pre.

MR. KOLACZKOWSKI: I'm sorry.

MR. POWERS: I thought we were supposed to be four times more interested in pre-initiator event than the --

MR. KOLACZKOWSKI: I see.

CHAIRMAN APOSTOLAKIS: Yes. Mitigation, you're right.

MR. KOLACZKOWSKI: Okay. So I'll talk

about the post first even though, again --

CHAIRMAN APOSTOLAKIS: Until 10:15.

MR. KOLACZKOWSKI: I understand.

CHAIRMAN APOSTOLAKIS: So you may decide which slide you want to skip.

MR. KOLACZKOWSKI: Okay.

MR. POWERS: He may decide to skip all of them, too.

MR. KOLACZKOWSKI: I think I will go with as many as the Committees will allow me to go with.

CHAIRMAN APOSTOLAKIS: But make sure you cover the pre-initiator, because I agree with Steve.

MR. KOLACZKOWSKI: Okay.

CHAIRMAN APOSTOLAKIS: They are important.

MR. KOLACZKOWSKI: So you want to go with the pre first?

CHAIRMAN APOSTOLAKIS: Yes, let's go do the pre first. You haven't numbered your slides anyway, so it doesn't matter. His number and email address.

MR. POWERS: Really, he had an opportunity to fill up more of the white space --

MR. KOLACZKOWSKI: About seven or more

slides. You'll see a slide that says pre-initiator human event practices, and then that starts the pre stuff.

CHAIRMAN APOSTOLAKIS: As part of the documentation we should make sure we number the slides.

MR. KOLACZKOWSKI: Yes. I forgot that. Sorry about it.

CHAIRMAN APOSTOLAKIS: Okay.

MR. KOLACZKOWSKI: Dana would say I didn't have any room left to put the numbers on the slide.

MR. POWERS: Oh, there's lot of white space left on there.

MR. KOLACZKOWSKI: Okay. The first task, again, and much in line with the ASME standard and much in terms of what you would do in a good HRA anyway, is the first task in a pre-initiator modeling of our pre-initiator portion of HRA is first to identify what are the events that I may put in the model. Now I say may, because we'll see after this identification step that there's a screening step where we may make decisions to, in fact, not model certain pre-initiators which again is pretty typical practice in HRA PRA today.

There are four good practices under this identification task, if you will, that basically address either what to review such as calibration procedures, surveillance procedures, etcetera. There's a listing, there's guidance as to what do you need to review to determine what are the potential pre-initiator failure events that I may want to put into my model. And then what to initially include with regards to ultimately what should I come out with once I go through that review process.

You can see here actions potentially covered by effected equipment failure data, and I will come back to that point.

MR. POWERS: I sure hope so, because that implies any understanding.

MR. KOLACZKOWSKI: Okay.

MR. POWERS: There's no interpretation that is possible to give that and the parenthetical comment.

MR. KOLACZKOWSKI: Okay. So maybe I should do that now. Maybe I should -- because I was trying to remember if I had any other bullet on that, and I'm not sure I do. So we're talking about this bullet right here. Actions potentially covered

by the effective equipment failure data.

MR. POWERS: I tried to take a little -- and it's something --

MR. KOLACZKOWSKI: Here it goes. Here we go. You get the argument from a lot of people who will say I should not have to model pre-initiator errors at all in the extreme because it's in the failure data. When I said pump fails to start, some of the reasons why the pump failed to start was because there was a latent error, maybe the guy had the drawer out on the breaker or whatever and so the pump failed to start. And I've already got it included in my data value for failure to start at the pump. And so you're going to make me include that pre-initiator event or that latent event twice in the model.

Now, the counter argument to that is that knowing where most of this data comes from more than not, people don't know what the actual events were that made up that failure probability when they go to a generic data base and they go look up a number for pump fails to start on demand, three times 10 to the minus 3, and they put in their PRA model. But they don't know the history of all the events that went that were behind where that number

came from. And so, in fact, the person really doesn't know whether latent events are already reflected in that failure data value or not, and therefore -- again, the counter argument would be because you don't know, you in fact should model the latent error, you should put it in the model. And even if you are double counting that latent error, even if it turns out it is in the failure data value for the equipment and now you're counting it again as a latent error event, a different basic event in the PRA model. Yes, you're double counting its contribution. But when all is said and done, if you double count something, it's a no never mind in PRA. PRA has a larger uncertainties than worrying about whether you're counting something twice.

CHAIRMAN APOSTOLAKIS: Well, what's the purpose of identifying the latent error? What would you do with it? Why is it so important to do it?

MR. KOLACZKOWSKI: Because to the extent that it could be important and it would be particularly important, and I think the good practices document points this out, where the latent error will effect in particular redundant or multiple equipment items. Then those can be very important, in particular. Usually a single item, a

single equipment if you miss it or if you double count it, it's probably not going to matter to the results generally.

CHAIRMAN APOSTOLAKIS: It's a logic model, that's what you're saying.

MR. KOLACZKOWSKI: I'm sorry.

CHAIRMAN APOSTOLAKIS: The logic model will be different.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: But now you're saying that there is an error that effects two redundant things.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Whereas in the database it's really individual components.

MR. KOLACZKOWSKI: Yes. Although again in the database you put in a common cause failure to do -- I know -- exactly. That's the points.

MR. ROSEN: But all the arguments you just made about the signal failure and the data being -- the failure being in the database apply to common cause for sure.

MR. KOLACZKOWSKI: Exactly. Exactly. And nevertheless, because you don't generally really know where that data factor really came from,

because you don't really know what was the events that really came up with it in the generic database of three minus three is what I should put in for failure probability of a pump motor to start, we're saying good practice is go ahead and put in the action, even though it may be covered by the equipment failure data, because the worse you're going to do is double count that latent event. And you know what? That's going to be in the noise. And you may learn something by actually looking at that surveillance procedure, putting it in the model and determining what its risk contribution is. And we're rather error on that side as opposed to not putting it in at all.

CHAIRMAN APOSTOLAKIS: In one of our letters on HRA -- you know the date? May something of --

DR. JAIN: '99.

CHAIRMAN APOSTOLAKIS: That far back?

DR. JAIN: Yes.

CHAIRMAN APOSTOLAKIS: Gee.

MR. POWERS: Time flies when you're having fun, George.

CHAIRMAN APOSTOLAKIS: Yes. Do we have it here?

DR. JAIN: Yes.

CHAIRMAN APOSTOLAKIS: Okay. That was December 13, 1999. In fact, Dr. Powers signed it.

MR. KOLACZKOWSKI: Oh, my goodness.

MR. ROSEN: Quiet now while it's read.

CHAIRMAN APOSTOLAKIS: We cited the Wolf Creek event where it was an organizational screw up and they lost some water, right? Now, would that kind of thing be covered by what you're doing here?

MR. KOLACZKOWSKI: I'm not familiar with the details of that event, but it some of that is contributed by latent errors, I'm saying yes you should model those latent errors in the model.

CHAIRMAN APOSTOLAKIS: But how do you do that? I mean, it's easy to talk about model -- it's like errors of commission, it seems to me. It's easy to say, you know, let's look for latent errors. But how to actually do it is anybody's guess.

This was due to an organizational screw up. I mean, they were supposed to complete this by Friday, the didn't. They postponed it until Monday, as I recall, right? Without letting the control room know. So they weren't there. They opened their valves again. But the other guys were doing some other work somewhere else, and they created a

path and they lost what? 9,000 gallons or something.

So this was an organizational and I just can't imagine that anybody does a methodology for identifying things like that. I don't know.

MR. POWERS: I think it's difficult because a shutdown accident, it's not the kind of latent error that we're really terribly concerned about here.

CHAIRMAN APOSTOLAKIS: How do we know that, Dana? I mean, it happened.

MR. ROSEN: Well, it's a scheduling. It was a scheduling error.

CHAIRMAN APOSTOLAKIS: It was a scheduling error, yes.

MR. ROSEN: It was a scheduling error.

CHAIRMAN APOSTOLAKIS: Yes.

MR. ROSEN: What happened was they changed the schedule without reflecting it in the master plan.

CHAIRMAN APOSTOLAKIS: The letter is December 15, 1999.

MR. KOLACZKOWSKI: Susan?

DR. COOPER: I guess the short answer to your question, George, is no there isn't a method

that could do that mostly because of the organizational issues that you're talking about. And that's why latent conditions are still in the HRA research plan for something for us to attend to.

Now, the actual process of finding that sequence of events can be searched for with some of the more sophisticated search techniques like Erasmia has and looking for deviation scenarios. But it doesn't have that organization layer to it either. So right now it can't.

The kinds of latent events that Alan's talking about are very -- they're classical pre-initiator events that have always been modeled in PRAs. The kinds that have been leading to some of the more serious events and accidents we're talking about, usually are not of that flavor.

CHAIRMAN APOSTOLAKIS: You're right.

DR. COOPER: And they have this organizational element that we do not. We don't have support to address --

CHAIRMAN APOSTOLAKIS: Well, I think as a result of not just this discussion, but things that we discussed earlier, maybe you need a section somewhere or a paragraph that makes it clear to the reader what you mean by practice versus state of the

art. That this is a good practices document. It's not attempting to improve on the state of the art.

And second, things such as error supplementation are handled to some degree, a section for latent conditions are handled -- I don't know to what degree, but in other words we recognize that these are very important issues. But, hey, we are writing here a document for this purpose. Somebody else has to worry about it.

And this is a situation where you just don't say, oh, you come back with a methodology for errors of commission in 12 months and here is the kind of -- well, you just can't do that. This is state of the art now.

MS. LOIS: When I used the good practices I had a dedication to what we call Document 1, and that's going to be a journal article kind of a thing that we further intend to discuss these topics, but mainly the state of the art of HRA for the good practices and introduce -- it would be kind of an introductory document for the good practices.

CHAIRMAN APOSTOLAKIS: Yes.

MS. LOIS: And we should address clearly those aspects of the --

CHAIRMAN APOSTOLAKIS: I think section 1.3 may be a good place for the document where you talk about the purpose.

MS. LOIS: Yes.

CHAIRMAN APOSTOLAKIS: And all you need is a couple of sentences, because most of it is already there.

MS. LOIS: Okay.

MR. KOLACZKOWSKI: Okay. Moving on.

So there are four good practices that cover basically the identification portion of the process and the expectations as to the kinds of that come out of that review. So imagine if you will, you have this list of potential latent errors that you may want to consider putting in the model.

The second task, and again kind of in line with the ASME standard and the way it's broken out is the screening task. And there are three good practices offered that suggest when are you allowed to screen out certain potential latent events because you can -- basically the underlying principle is if they meet these qualitative criteria we believe that the probability of the latent error will be so small that it will never be a significant contributor to the overall risk. That's the

underlying principle here in the screening step.

So the good practices are laid out to basically offer what the screening criteria should look like, when are you allowed to screen, when you not. And it's -- and you know, a lot of it is the typical kinds of things are the equipment will receive an automatic realignment signal, there's a compelling signal of inoperable status in the control room, etcetera, etcetera.

Good practice number two clearly points out that you should not point screen out latent errors that would simultaneous effect multiple equipment items, and that's very much in line with the standard right now.

CHAIRMAN APOSTOLAKIS: In the good practice one in the test there are six bullets?

MR. KOLACZKOWSKI: Yes. There are actually many more. I mean, I could put some more on here, but I knew Dana was going to get tried of reading words.

MR. POWERS: Never miss the opportunity.

CHAIRMAN APOSTOLAKIS: But, Alan, maybe you can clarify whether if any one of these bullets is true, you screen it out.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Or all of them have to be true?

MR. KOLACZKOWSKI: No. Any one.

CHAIRMAN APOSTOLAKIS: Yes. Make sure that that's clear.

MR. KOLACZKOWSKI: Maybe that should be clearer, though. Yes. The intent was that anyone of those. Okay.

I think our experience suggests that when these conditions apply, then if you -- or any one of these conditions apply, that when you take it to a typical THERP model or whatever, you will end up with a fairly low probability of failure until -- good practice these days is to say okay, I'm not going to bother putting into the model and spending the resources to do that and carrying it along in the quantification process because I spent a lot of resources for little value.

CHAIRMAN APOSTOLAKIS: I mean maybe I didn't understand this, but let's say a group performs maintenance someplace. And they open a particular valve, which they're supposed to close, or actually they close it and it's supposed to open.

MR. KOLACZKOWSKI: Whichever.

CHAIRMAN APOSTOLAKIS: There is always

somebody from QA checking on that, isn't there? A separate check.

MR. KOLACZKOWSKI: Not always.

CHAIRMAN APOSTOLAKIS: Not?

MR. LEITCH: Independent verification.

CHAIRMAN APOSTOLAKIS: There is in dependent --

MR. ROSEN: There is a requirement for independent verification for safety related --

CHAIRMAN APOSTOLAKIS: So according to this then we shouldn't bother about these errors. And yet these are used -- in PRAs, aren't they?

MR. KOLACZKOWSKI: Well, one thing, you know -- different plants have different interpretations of what independent means. You and I could go both check a system lineup and I'm looking at it, and you say that's right. We do it together. But you're independent of me. That's one thing. But a much better method is to do it at an entirely different time where you, you know, you say I'm all done aligning this system. And then another fellow goes around and verifies.

So, you know, I have seen some situation where even with independent verification with the former method errors are made. You know, I looked

up at this valve, it looked closed to me. And you think that's closed. Yes, it's closed. Okay.

MR. ROSEN: Well, the trouble is you're looking at the wrong valve.

CHAIRMAN APOSTOLAKIS: Whatever. No, but my point --

MR. ROSEN: It verifies the status of a valve that wasn't really --

CHAIRMAN APOSTOLAKIS: PRAs do model these kind of things. I mean, errors of leaving the valve in the wrong position. In fact, at Three Mile Island didn't we have that problem, all three valves were closed?

MR. KOLACZKOWSKI: Well, again, let's keep in mind the previous good practice --

CHAIRMAN APOSTOLAKIS: So you don't want to screen those out.

MR. KOLACZKOWSKI: No. One of the good practices basically is that if you're dealing with redundant or multiple diverse equipment, you should not be screening that out.

Good practice number two does not allow screening, pre-initiated failures that simultaneous effect multiple equipment items.

CHAIRMAN APOSTOLAKIS: Okay. Okay.

Okay.

MR. KOLACZKOWSKI: We're saying if you're going to effect multiple equipment items, I don't care what the screening rules say, you've got to put it in the model and really evaluate its intent.

CHAIRMAN APOSTOLAKIS: Fine.

MR. KOLACZKOWSKI: On a single equipment by equipment item we're saying generally our experience is, yes, if you screened it out and perhaps you really shouldn't have, you're probably not making a significant problem in terms of the results anyway. But if you're going to effect multiple level instruments or whatever, sorry, no screening is allowed.

MR. ROSEN: Isn't the effect of that that most safety related equipment won't screen.

CHAIRMAN APOSTOLAKIS: That's right. They're not --

MR. KOLACZKOWSKI: Well, no. I mean, if you're taking a single train out and you're doing some maintenance on a pump, you're just effecting that pump. You know, that pump train. But if you're effecting, for instance, the level sensors that send the signals to not only HPSI but RCSI to start, well

now you're effecting the whole multiple system.

MR. ROSEN: What you're talking about is activities. What you're screening is an activity. You're saying you only a maintenance activity on one train of a three train system or a two train system.

CHAIRMAN APOSTOLAKIS: Well that's my point, that this is included. You do it first in one train and then on the second train. And there is a conditional probability of repeating the error. I mean, Swain and Guttmann that will hold -- so that is not screened out. Well, you do it one at a time.

MR. POWERS: At C Reactor at Savannah River we had the classic.

CHAIRMAN APOSTOLAKIS: Yes.

MR. POWERS: The guys came in and they maintained the pumps. Well, the same team did all the pumps. The same team left out the same ring on every single pump. So every single pump leaked in the same way.

MR. KOLACZKOWSKI: That is correct. The intent is, and I think we talked about it later in the modeling phase, if you're going to take out train A and then you're going to do the same thing on the train B and the same thing on train C, that fits under this good practice 2 case where you're

going to potential effect redundant pieces of equipment, so therefore you're not allowed to screen out.

MS. LOIS: We do recommend to emphasize that --

CHAIRMAN APOSTOLAKIS: Clarify.

MS. LOIS: Clarify that the current practices should be part of the HRA review process.

CHAIRMAN APOSTOLAKIS: No, no, no. You shouldn't screen out -- there is a little bit of confusion as to what these points that was made. But right now practice is that if you do something on train one and then you do it to train two, you actually quantify this. And there is detailed guidance in the handbook. So make sure that people understand that these are not to be screened out.

MR. KUGLER: Just to make sure I understand. This is Andy Kugler.

For clarity. So in other words even though the two events may not occur at the same time, they may be a week apart or whatever, but they might be maintenance so they're not recognized as the time -- make sure you don't screen that out.

CHAIRMAN APOSTOLAKIS: That's right.

MR. KOLACZKOWSKI: Let me just indicate

under section 4.2.3.2, which is this good practices 2 up here, it says do not screen out those actions and possible pre-initiator failures that simultaneously effect multiple redundant or reverse equipment items. And then it says see good practices 4 under 4.1.3. And if you go look at it, basically it is addressing the very point we're making where you don't also screen out these events where, because of a common tool or a common calibration error, whatever, you're now calibrating many instruments and you could effect them all because as you go from train A to train B to train C, you're going to effect them all. Those should not be screened out. Again, perhaps we can be even clearer, but that's the intent.

CHAIRMAN APOSTOLAKIS: I'm sure you didn't mean you could just take those out.

MR. KOLACZKOWSKI: No.

CHAIRMAN APOSTOLAKIS: But since you have a discussion, that means there's some clarification needed. That's all.

MR. KOLACZKOWSKI: I understand. I understand.

MR. ROSEN: You use "close proximity -- you might want to tell them what that means in your

view.

MR. KOLACZKOWSKI: Okay. Fine.

MR. ROSEN: Because they're all going to be worked on so everybody is going to have to say what did these guys mean when they said close proximity in time.

MR. KOLACZKOWSKI: Fair enough.

Okay. All right. Good practice 3 is here is just to -- it's sort of issue specific item, but it's something we want to remind analysts and reviewers. That if you're going to apply your PRA, let's say as an example looking at a plant change, that you need to revisit the original PRA screening process to ensure that issue-relevant human actions have not been deleted.

In other words, if you're going to screen out some events. Now you come along five years later and you're looking at issue X, well you need to make sure that maybe some of the events you screened out don't need to be put back into the model because they're relevant to the issue that you're analyzing. So that's just a reminder to essentially do that.

MR. ROSEN: And I think the good practices is strong in respect to it says that the

things you screen need to be documents.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: And I don't know that how well that is done.

MR. KOLACZKOWSKI: Well --

CHAIRMAN APOSTOLAKIS: Especially five years later.

MR. ROSEN: I don't think it's the state of the current practice to do that. But I think it's very valuable when you talk about your third bullet here.

CHAIRMAN APOSTOLAKIS: Or you're doing it again. You start from scratch.

MR. ROSEN: That's right.

CHAIRMAN APOSTOLAKIS: Which is most likely.

MR. ROSEN: Yes, it very often happens.

In the human reliability area, I think a lot of people would go back to square one as we move forward.

CHAIRMAN APOSTOLAKIS: So maybe you can mention that.

MR. KOLACZKOWSKI: I will.

Okay. So, now we've identified candidates, we've screened out some, so that means

the rest we're going to model.

So the next task, basically, is covering the modeling and is basically really just one practice that address --

CHAIRMAN APOSTOLAKIS: I have another question before you go.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: In these pre-initiator events is there any other model other than what's proposed?

MR. KOLACZKOWSKI: I certainly don't pretend to know what everybody is doing in Europe and in the United States or whatever, but I think it's pretty clerk that THERP is predominately the pre-initiator model that people --

CHAIRMAN APOSTOLAKIS: I would say it's the only one. Does anyone know of anything else? No. Everybody --

MR. FORESTER: There's something, a MAP, something like that, for maintenance. As far as I know, I think you're right.

CHAIRMAN APOSTOLAKIS: So if that's the case, why don't you say that's good practice? I mean, you don't want to recommend models, but on the other hand if it's the only one or if it's used

overwhelmingly, let's acknowledge it and say, you know, unlike post-initiator events for pre-initiator it seems that this handbook is widely used.

MR. KOLACZKOWSKI: Yes. Kind of clearly THERP is by far widely used.

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLACZKOWSKI: And whether there isn't some other one out there that somebody someplace is using, I'm not aware of it. Good point.

There is a good practices that basically addresses how you should put the events in the model and where to include them. And some of the things that are addressed in the good practices talk about making sure that you're linking the event to the unavailability of the effected component or train or system or overall function. It suggests that you do that so it's very clear what the effect of the latent event that you're modeling, what the effect of that latent event is.

And it talks a little bit about how you can combine multiple individual acts into a single human failure event and when is that allowable. And there's criteria offered in the good practices document that suggest when, in fact, you can do

that. And you can see the major ones listed here.

Make sure that it's clear what the failure mode of the equipment is going to be when that latent event occurs. Is that going to be leaving the valve closed, is that going to be leaving the valve open? Is that going to mean the pump can't start? Make sure that that's clear in the identification of the basic event.

Finally, it comes time to quantify and, as usual, it takes a lot of good practices to discuss good quantification.

Good practice 1 does advocate the use of screening values during initial quantifications. That's almost necessary. I mean, there's no way that you can preassume what all the dependencies are going to be among the events and which events are going to show up simultaneously in the same cut set, etcetera and so forth. And so as a result, PRA analysts typically put in "screening values" first to see which ones they really have to focus on and really consider the dependencies and try and to get a better, more realistic number, etcetera.

So we acknowledge that putting in screening values is good practice initially, but be careful how you do that. They need to be over

estimations of the human probabilities. And based on our experience of what typical individual human error probabilities in most PRA for these latent events, we've suggested a value of no lower than 1E-2 for any single HEP that you may put in at the screening stage. And that to account for dependencies across potentially multiple actions in the same sequence, the joint HEP of two or more, for instance human failure events, should be no lower than 5E-3.

Again, it provides some room to do some screening, but hopefully not get so that the screening is so optimistic that you wend up putting in values too low too quickly.

Detailed quantification is needed of the significant contributors. Again, for new issues --

CHAIRMAN APOSTOLAKIS: Now, let me ask you about the screening.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: So, okay, I ut a 10 to the minus 2 on a bunch of HEPs. They are not that important. Their sequences are not --

MR. KOLACZKOWSKI: Yes, because they're in combinations that it takes so many other equipment failures to go to core damage --

CHAIRMAN APOSTOLAKIS: Right. Right.

MR. KOLACZKOWSKI: -- that the overall HEPs at frequency is 10 to the minus 8 or something?

CHAIRMAN APOSTOLAKIS: So the suggestion is that I would just leave it alone so the final PRA will have those several dividers in it?

MR. KOLACZKOWSKI: Yes. You would either just leave that alone or it may in fact go to the point where the sequence or cutset becomes so low --

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLACZKOWSKI: -- it goes below some threshold value that the PRA analyst is just going to throw out.

CHAIRMAN APOSTOLAKIS: Yes. Let's say that it's -- have you thought about the consequences to the importance measures if I do that? Because you know, importance measures are used somewhere else in a very important way.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: And are we distorting anything now? Maybe their impact is negligible, but somebody ought to think about it.

MR. KOLACZKOWSKI: Yes. And I must admit I don't know if I've thought about it enough, but

you bring out a very good point. Obviously, you do distort the importance measures of everything. Everything does that. That you would hope that if these things are occurring in cutsets that are going to be relatively unimportant to the overall risk, that even though you will distort the importance measures somewhat, I'm not sure if I can prove this mathematically or not --

CHAIRMAN APOSTOLAKIS: Well, you don't have to answer right now.

MR. KOLACZKOWSKI: That it's unlikely that's it's going to be a large significant --

CHAIRMAN APOSTOLAKIS: I suspect you're right. I suspect you're right. But maybe somebody ought to think about it for more than a half a minute.

MR. KOLACZKOWSKI: Because remember, good practices 2 says you must do detailed quantification for the significant contributors.

CHAIRMAN APOSTOLAKIS: Yes, but significant --

MR. KOLACZKOWSKI: So you can --

CHAIRMAN APOSTOLAKIS: -- depends on the assumptions you could make.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: And basically what you're doing if you become conservative here, then this part, the importance of this part of the PRA, the other part, is in fact diminished. Because the importance measures are evident.

MR. KOLACZKOWSKI: I agree.

CHAIRMAN APOSTOLAKIS: And I think your confusion is probably correct, that it would not effect in a significant way the result. But it wouldn't hurt to get somebody to think about it.

MR. KOLACZKOWSKI: Okay. Again, as a reminder in good practice 3 that for new issues analysts need to revisit the screening process again to make sure that maybe I've got a lot of screening values in my PRA right now and I come along five years later and I'm looking at some issue, well should those screening values still apply? Should they be different? Should they become detail values because of their relevancy to the issue I'm addressing, etcetera. So, again, that's just a reminder to do that.

Good practice 4 provides performance shaping factors and related guidance that ought to be considered in coming with the number, the HEP. So a list of PSFs for pre-initiators, just like we

have a list of PSF for post-initiators.

The PSF for the pre-initiators, again, largely come from the THERP methodology and our experience. Okay. What should be considered in coming with the HEP.

MR. LEITCH: I was surprised to see no reference to supervisory involvement or supervisory oversight, management philosophy and issues such as that. You know, it seemed to me that that's a very significant part of the performance.

MR. KOLACZKOWSKI: I think the point was made earlier in response to another question that we recognize that management organizational influences are still largely not treated, and we recognize that that's still a shortcoming, if you will, of where we are in HRA.

Hopefully, some of the things in terms of are the procedures well written, are they ambiguous, etcetera and so forth, do they use check lists or not, is the labeling good or not, etcetera, hopefully catches a lot of it. But it's clear we don't catch everything by not including.

MR. LEITCH: Well, that's all true. But superimposed on that is another layer unwritten, you know, like pumping in standby liquid for example.

When is an operator really going to do that? And a lot of that comes down to the management philosophy and his direction to the operator and to the operator's supervision prior to that event. You know, if there's a clear signal sent that nobody's going to criticize if you think you need to pump in standby liquid, pump in standby liquid. Don't wait around and ask anybody, just go ahead and do it.

But, I mean, you know it's those philosophical kind of issues, maybe some would call that safety culture, but it's a little different than that I think. And sometimes it's supervisory oversight of a particular operation like the I&C technicians are out calibrating something. To what degree is there supervision involved in that process?

MR. KOLACZKOWSKI: I guess the best I could say is we look at the reflections of that safety culture in terms of the procedure, the training, did they do second verifications, do they use written check lists? It's somewhat a reflection of the safety culture, but we don't measure safety culture per se. Because quite frankly, I don't know that we know how to do that.

MR. LEITCH: But wouldn't that just

involve some consideration of that?

MR. KOLACZKOWSKI: Well, again, I think this is another question of where is it -- is that beyond the current state of the art right now. And I think I would say it is.

MR. FORESTER: Just in response to a question I had. When we actually do the pre-initiator analysis, in addition to looking at procedures, the plant also has practices in terms of they do this training on this day, we rotate these crews. So we do look at that structure and the scheduling that they do to make sure that, you know, it reduces the chances of a common cause type failures.

And then your question about, you know, when you would initiate -- because of the management philosophy because that kind of information does come out through the -- process in a sense of, you know what are the informal rules or the bias that accrues based on the management philosophy.

CHAIRMAN APOSTOLAKIS: We have to move on.

MR. KOLACZKOWSKI: Let me -- I think you're getting the flavor of what's going on here.

CHAIRMAN APOSTOLAKIS: There will be

questions.

MR. KOLACZKOWSKI: With regard to EOCs or is there something --

CHAIRMAN APOSTOLAKIS: No, no, no. First of all, we're going to move to the big room now after the break.

MR. KOLACZKOWSKI: All right.

CHAIRMAN APOSTOLAKIS: I don't know why we're in here at 2:30. But this is taking a long time, and I really -- why don't you guys help us during the break, you know, with your management and decide which presentation you want to shorten a little bit. Maybe we can stay until 3:00 or do the members --

MR. POWERS: I have no limitations. I can stay until midnight.

MR. LEITCH: Yes, I have no --

MR. POWERS: That will get me halfway through Alan's.

CHAIRMAN APOSTOLAKIS: So you really have to decide. I mean --

MS. LOIS: So you recommend that we extend for the day and come back --

CHAIRMAN APOSTOLAKIS: -- how can you shorten that.

Sorry?

MS. LOIS: Can you stay for half an hour so that Alan can go for another half an hour or --

CHAIRMAN APOSTOLAKIS: What do you want to do? You decide now.

MR. POWERS: George, you're going to take a break now?

CHAIRMAN APOSTOLAKIS: Yes. I'm taking a break right now. No, the break right now. And we are meeting again at 10:31 in the other room.

But please decide what you want to do.

(Whereupon, at 10:17 a.m. a recess until 11:40 a.m.)

CHAIRMAN APOSTOLAKIS: Okay. Now we have microphones.

Okay. We are back in session. And, Alan, have you guys decided how you're going to handle this?

MR. KOLACZKOWSKI: Yes. Okay. I'll go ahead and just finish up this. This is the last line on the quantification of the pre, and then I'll quickly go over to the post and just highlight the key differences. Because as a matter of fact the tasks and many of the good practices parallel a lot of what you've already heard in the pre-initiator

areas. And then we can spend a little bit of time talking about errors -- the guidance has provided on errors of commission and perhaps finish up very quickly with the suggestions with regards to HRA documentation.

CHAIRMAN APOSTOLAKIS: Go.

MR. KOLACZKOWSKI: Just covering the last few practices in the pre, there's a good practice that addresses dependencies in terms of identifying those among related actions and addresses those commonalities that could cause dependencies, etcetera. There's guidance in there that tells you what sort of dependencies to look for and even provides some suggested quantification rules, if you will, that ought to be used in handling dependencies.

Good practice 7 addresses uncertainty. Tries to give some feeling, again for those that are non HRA experts, tiles to give some feeling for what are typical uncertainty bounds that you would likely see. Again, considering the tools that we have, the techniques that we have for trying to quantify the uncertainty, what are some typical uncertainty bounds that we should expect to see on these numbers. So good practice 7 tries to address the

fact that we need to address the systemic uncertainties and what are some typical bounds that you're likely to see.

CHAIRMAN APOSTOLAKIS: I have a question with that.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: On page 18 of the document the very last bullet, assessment of certainties are typically performed by performance sensitivity analysis that demonstrate effects on the risk results for extreme estimates of the HEPs based on at least the expected uncertainty range above the mean value.

Why would the effect on the risk results be anything that I'm interested in when I'm quantifying my uncertainty. My uncertainty should be the first bullet which reflects my state of knowledge, right? Whether it effects the results or not will probably tell me that I have to do a better job. But it shouldn't be really a factor in the actual quantification, should it?

MR. KOLACZKOWSKI: I think that's probably a valid point.

CHAIRMAN APOSTOLAKIS: Yes. And also on the next page, 19, good practice 8 the pre-initiator

HEPs should be reasonable from two standpoints. First of all relative to each other, but also it says in absolute terms to the extent of the sensitivity of the risk related decision is not important as to the absolute values of the HEPs. First of all, I don't understand what it means. And second, why again is the decision is the relevant? When we quantify uncertainty we do it, you know, based on what we know about the particular issue, not how it will effect the decision, it seems to me. So maybe some rephrase in there would be appropriate.

And the other thing in the paragraph just above good practice 8 on page 19, whatever uncertain distribution are used, the shape of normal/normal are typically unimportant. The results are usually not sensitive to specific distributions. It seems to me, I agree with the statement when you talk about skewed distribution like log normal, beta and so on. But when you use normal, which is symmetric as we know, I'm not sure that's a correct statement. Especially when you say typical uncertainties include values of HEP that represent a factor of 10 up to 100. If you tried to fit a normal distribution to something like this,

you probably have a problem. The normal distribution cannot accommodate very large ranges.

So I would soften that statement that it doesn't really matter or take the normal out. Any skewed to the right distribution probably will do, and typically we use the log normal. Because apply to fit normal to such error factors in this, you just don't get the result.

MR. KOLACZKOWSKI: Okay.

CHAIRMAN APOSTOLAKIS: That's all I have on the pre-initiator.

MR. KOLACZKOWSKI: Okay. I was going to finish -- basically that's all I was going to cover on the pre-initiator unless there's additional comments.

As I said, I would move to the post and just try to highlight the key differences.

So I'm going to go back up into the presentation that'll say post-initiator human events.

CHAIRMAN APOSTOLAKIS: You should have a team. One key is an expert in communication. Did you have a team? There are no numbers.

CHAIRMAN APOSTOLAKIS: Very similarly--

MR. ROSEN: That's why we conducted--

CHAIRMAN APOSTOLAKIS: I see that.

MR. KOLACZKOWSKI: Very similarly the tasks -- or I should say the tasks are very similar in the post, although perhaps with somewhat significant exception. I mean, there is an identification task and correspondingly, just as there were good practices with regards to how do you go about identifying the potential events you're going to put into the model for post initiator events, there's similarly again good practices that cover how to do that relatively to identifying potential post-initiators. So that part is very similar.

But you'll notice that the next task after this one talks about the modeling, and there is no screening task. And, again, that's reflective of the way PRA is largely done. It is difficult to screen a priori post-human events out of the model. You just don't now the sequences that they're likely to appear in and what the probabilities of the other equipment is going to be that brings that post-initiating event to bear. And so even though there is a practice of using conservative values for some of the post-initiator events in the model, you don't tend to just screen them out and not model them at

all, as we suggested in the pre-initiator events. So that's probably one of the key differences in terms of the good practices between the pre and the post. There is no screening step, per se. And, again, that's pretty common with what's done --

CHAIRMAN APOSTOLAKIS: There is no screening step against -- I'm trying to understand what --

MR. KOLACZKOWSKI: We don't a priori say because there is a compelling signal or an overriding signal that would override the latent error and therefore realign the equipment --

CHAIRMAN APOSTOLAKIS: Oh, okay.

MR. KOLACZKOWSKI: -- in its proper position, you don't need the model that latent error. We don't have a corresponding list of criteria that says if you meet this criteria you don't need to model this post-initiator event. There is no such step.

CHAIRMAN APOSTOLAKIS: But you may still screen some post-initiator events as being unimportant?

MR. KOLACZKOWSKI: Clearly. Clearly. You might have 1.0 failure probabilities and find out they're only occurring in ten to the minus 11

cutsets.

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLACZKOWSKI: At some point you won't worry about trying to quantify that HEP any better than that.

CHAIRMAN APOSTOLAKIS: But is there guidance regarding this?

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Okay.

MR. KOLACZKOWSKI: Yes. There is a corresponding step with regards to modeling and, again, the level of modeling and when can you combine several tasks into one human failure event, just like we talked about in the pre-initiator modeling. So, again, really there are largely parallels between the post and the pre with regards to the modeling and the good practices that cover those.

MR. ROSEN: When you used the word "linked," what I think you mean is that it shows up in the sequence for that system train or component. Is that what you mean?

MR. KOLACZKOWSKI: In the case of the first bullet?

MR. ROSEN: Yes.

MR. KOLACZKOWSKI: The first line here where it says HFE is to be modeled as a basic event linked to the effected equipment? What we're saying is that it should be clear when you put in the event in the model and you give it a description, that description should be clear as to which piece of equipment that failure event is effecting.

DR. KRESS: I was interpreting that to mean it goes into the thought train.

MR. KOLACZKOWSKI: Also in the text in the document there is a suggestion that the event be placed very close to the equipment item that you're actually effecting. And so that's sort of where do you put it in the model.

DR. KRESS: Yes.

MR. KOLACZKOWSKI: But that's more a suggestion. But we are saying that it should be clear as to what piece of equipment that error is effecting.

So for example, failure to start standby liquid control manually should probably be linked in the model in the fault tree somewhere up where the standpoint liquid control failure to start item is located. And then put this human failure event somewhere close to that and make sure the

description clear that that's what that failure is effecting. The entire system in this case.

MR. ROSEN: It shows up in the fault tree for standby liquid control.

MR. KOLACZKOWSKI: It could be in the fault tree.

MR. ROSEN: Or in the event tree if it's modeled at a higher level.

MR. KOLACZKOWSKI: That is correct. That's what I mean by linking. It's just that it's clear --

MR. ROSEN: Well, how else would you do it? I mean, I don't understand.

MR. KOLACZKOWSKI: How else would you do it?

MR. ROSEN: That's just the way it's done, I guess. I mean, I don't learn anything from that.

MR. KOLACZKOWSKI: No, you probably don't, although I have seen people not necessarily go out of their way to place the event anywhere near the equipment item that it's actually effecting in the model. And so sometimes if you're looking at the model, it's hard to see that they even have a human event effecting that particular piece of

equipment.

MR. ROSEN: Well, I know what you should do and you seem to be agreeing, so let's go on.

MR. KOLACZKOWSKI: Okay.

DR. KRESS: I also suspect that you have a sequence that has several human errors in it. People tend to add those up and say the human error contribution to this sequence is something, and you kind of lose -- you lose which parts of the equipment when you do that. I don't know if that's relevant or not.

MR. KOLACZKOWSKI: I guess I would just say good practice 1 is probably almost self-evident for the most part. But sometimes you even have to say the obvious.

CHAIRMAN APOSTOLAKIS: That's why you say in the text on page 28 the evaluation should include both cognitive. That is thinking as well as execution failures, right?

MR. KOLACZKOWSKI: Yes. Yes.

CHAIRMAN APOSTOLAKIS: Now, I had a question. I read a paper by Ali Mosieh and one of his lieutenants that was presented in the same workshop where the ATHEANA paper was. And he says that there are three -- reason distinguishes three

levels of error classification; behavioral level, a contextual level and conceptual level. The conceptual level error of classification needs a cognitive model to trace errors to their origins. most of the conventional HRA methods stay at the behavioral and contextual levels. So the conceptual level error result. But you're saying that thinking has to be included?

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: How would you do that if there are no models for that? Unless Ali is not right?

MR. KOLACZKOWSKI: Well, no. I mean I think you have to understand to the extent you can what is going on in the operator's mind based on what he has soon and how is he assimilating that information and therefore deciding what course of action he's going to take.

CHAIRMAN APOSTOLAKIS: But is that good practice, Alan? Do people do that?

MR. KOLACZKOWSKI: I think good HRA people do do it. And certainly ATHEANA would strongly suggest and tell you that it needs to be done.

CHAIRMAN APOSTOLAKIS: But ATHEANA works

at the contextual level, right, and the behavioral level? Maybe he's exaggerating.

DR. COOPER: No.

MR. KOLACZKOWSKI: I'm not sure I follow his distinction is part of my problem.

DR. COOPER: Certainly ATHEANA operates at the conceptual level --

CHAIRMAN APOSTOLAKIS: A microphone, please.

DR. COOPER: Certainly ATHEANA identifies the context and defines it, but the models underlying it and the theory underlying it addresses the conceptual level; what are people thinking, why are they thinking it, why are they reacting to this context in a particular way.

I mean, there are model, too, that have tried to do that, and I think there's an EPRI method. I'm drawing a blank on it right now. But also if Gareth was here, you probably could answer the question.

But anyway, that also tries to get at some thinking things. So I would not say that we're without any HRA models that can address cognitive failures.

CHAIRMAN APOSTOLAKIS: Now, cognitive

failure means what? That they see a signal and they misinterpret it or --

MR. ROSEN: It means they're doing the right thing for the wrong --

CHAIRMAN APOSTOLAKIS: Yes.

DR. COOPER: That's right.

CHAIRMAN APOSTOLAKIS: How on earth can you figure that out?

DR. COOPER: There actually is quite a body of literature on that. I mean, Jim Reason is famous for discussing that in pretty heavy detail and his work has permeated not just the nuclear industry, but many others.

CHAIRMAN APOSTOLAKIS: Well, but I think you used the right word "discussing." But they are not really telling you what to do and how to figure it out.

DR. COOPER: That's true. That's as far as what he's done with it. But that's part of, you know, taking that information as well as others and then putting it into a usable form for HRAs, in fact what has been done for ATHEANA, for example, and I think some of the other second generation methods have gone their own route with their own emphasis and done the same sorts of things.

CHAIRMAN APOSTOLAKIS: So there are PRAs where the human reliability analysis are, the cues are correct but the operators may interpret them incorrectly.

DR. COOPER: That's a different question. I don't know how many PRAs have done that.

CHAIRMAN APOSTOLAKIS: They don't do that.

DR. COOPER: There are methods to do that. And there are some PRA. The PTS PRA, the studies that have done, you know, sponsored through NRC and so forth would be one example.

CHAIRMAN APOSTOLAKIS: But doesn't that push again the state of the art perhaps?

DR. COOPER: Yes. But that's not necessarily inappropriate if you want to address certain issues.

DR. KRESS: Weren't systems-based procedures, if any, to sort of minimize that?

CHAIRMAN APOSTOLAKIS: Yes. That's true. Absolutely true. But I think Susan and I agree. I think the current practice is not to have events that say the operators misinterpret something. Now, there may be state of the art methods that consider these things, but I'm not sure about the state of

the practice.

DR. COOPER: Well, let me just say this. The good practices, as has been discussed previously, is to try to set up also then the method evaluation that's going to be done in the next set of work, the next document. And so you have to have good practices that are going to be able to line up with that method evaluation. So there seems to be need recognition and there is some in the document that there are different types of applications that have different requirement as far as the level of capability in the HRA method. Some of them are going to push the state of the art. I mean, that's evidence in what the NRC is doing right now in trying to address things like fire, PRA, steam generator tube rupture, advanced reactors; they're all pushing the methods, even pursuing research to address certain issues. So if you're going to address those things, you need to push the state of the art.

So, in fact, good practices document actually in some cases identifies not only good practices, but better practices. In some cases those better practices are optional, but for some options they're not going to be optional, they're

going to be what you need.

MR. ROSEN: They're be significant --

DR. COOPER: And that's going to be addressed in this other document.

MR. ROSEN: They'll change the PRA enough to where they might impact the decision, is what you're saying.

DR. COOPER: Yes.

CHAIRMAN APOSTOLAKIS: I think what you are describing is that there is really a fuzzy line between state of the practice and state o the art. I mean, you can't just write a document that repeats what everybody else is doing when you know certain things can be done better. So you're pushing a little bit the boundary, that's really what's going on, which is fine. I mean, that's fine. That's the way it is.

John, you've been trying to say something?

MR. FORESTER: Just quickly. I think that particularly item is referring to -- it's in the ASME standards. You look at both at both diagnoses and execution. And so that's what that reflect. And even the basic early models, you know, with the diagnoses curves they look at that part and

then they have another value for the implementation that they combine.

CHAIRMAN APOSTOLAKIS: Yes.

MR. FORESTER: So even at a very crude level that's done.

CHAIRMAN APOSTOLAKIS: Okay. Let's go on.

MR. KOLACZKOWSKI: The only thing I would highlight here is good practices 5. And I just want to indicate that, again, in the good practices document we have taken a stab at defining what we think is -- although I got to be careful here, but an attempt to be all encompassing set of performance shaping factors that we think should be considered in evaluating an HEP, a human error probability and a post-initiating event. Not that they'll always all apply. Some may not be applicable to a particular situation or whatever.

CHAIRMAN APOSTOLAKIS: Right.

MR. KOLACZKOWSKI: And we list them both for in control actions and ex-control room actions and they're also subdivided down to those that should always be considered and other ones that maybe depending on certain conditions should be considered.

CHAIRMAN APOSTOLAKIS: Well, I looked at table 5-1, page 30. That's what you're referring to, right?

MR. KOLACZKOWSKI: That is correct.

CHAIRMAN APOSTOLAKIS: You know, I don't know that if you look at the list there in control actions always consider the following PSFs that all these are equally important. For example, the very one, applicability and suitability of training and experience. Does anybody really get into that and say, boy, you know, this plant is using novices so I'm going to have higher probability of failure. Come on, nobody does that. Is that something that you really want to put up there, whereas the second one says suitability of relevant procedure. My goodness, of course.

MR. ROSEN: Well, I didn't read that first one that way. I read are the operators who might have to take this action trained in the action.

CHAIRMAN APOSTOLAKIS: If they are trained or not trained? Yes, that's again something that you can verify.

MR. KOLACZKOWSKI: It's really getting more at the level of familiarity. It's getting at

is this the kind of scenario and the act that we're investigating, is it something that the operators are either used to seeing quite often in a lot of the simulator training they do or is this something they run across once every five years. And that's going to effect the human error probability.

CHAIRMAN APOSTOLAKIS: I agree with you.

MR. KOLACZKOWSKI: I think that's clear in appendix A. In appendix A.

CHAIRMAN APOSTOLAKIS: Yes, but when you say --

MR. KOLACZKOWSKI: It's a table -- it's a table. And it says go see appendix A for the details. And that's where we describe what we mean by each of these.

CHAIRMAN APOSTOLAKIS: Then further down you say team/crew dynamics and crew characteristics and so on. Again, in the nuclear business we haven't really paid much attention to crew issues as opposed, say, to the guys who worry about human factors in submarines. So I don't know, I mean you're throwing something out there and there is no guidance, really, in the literature. Is that so important to put there? Well, I know it's important, but there is no guidance. There is no

literature in the nuclear business.

I mean, I look at the whole special issue from the Munich workshop and there was nothing on teams, I don't think.

MR. KOLACZKOWSKI: The ATHEANA document does address this issue. And then the PTS work that we've done, if someone wants to look at a sample application, shows how very important that was particularly to throttling HPI during PTS events.

CHAIRMAN APOSTOLAKIS: There's no question it's important. The question is whether a document that calls itself guidance for good PRA practice --

MR. KOLACZKOWSKI: I understand. Here's another place where maybe we're pushing --

CHAIRMAN APOSTOLAKIS: Remember now, you promised that you wouldn't use -- you're not recommending a method and indirectly it seems to me you really are pushing ATHEANA.

MR. KOLACZKOWSKI: No, not necessarily. Not necessarily. I mean, again, I think some methods will say and some people will argue in CREAM or whatever. They're going to say oh we addressed that in some way. And other message, clearly yes they're going to be silent on this item.

CHAIRMAN APOSTOLAKIS: Again, it seems to me there ought to be some sort of clarification or maybe prioritization that team/crew dynamics, I mean it's extremely important. I don't disagree. But I don't recall sessions in meetings where the nucs were talking about team effects and so on. ATHEANA is pushing the state of the art, obviously.

MR. ROSEN: There's a lot more going then maybe you know about. I think there's a lot of pressure in the training area, the National Academy of Nuclear Training, for operations crews to more properly deal with the teaming aspects. I mean, it follows the airline recognitions in recent years that teaming in control rooms are very difficult. This gets into safety culture, because teams in one culture in cockpit do certain things and they can fly the airplanes well and they're very different than teams do in other cultures.

So, and that's also true in plants. The cultures in plants are different. So you have to deal with the teaming aspects of culture. And I think to some degree these training programs in plants are, in fact, are beginning to deal with it.

Now, whether the crossover to PRA is being made, there I agree with you that's not likely

to be happening. But I think there's guidance here that one should consider team and crew dynamics, it's beyond the state of the practice, I grant you. But it ought to be, I think it's appropriate to be in there.

CHAIRMAN APOSTOLAKIS: I don't think that right now if your average utility does a PRA and they look at this and they're asking probably about degrees of independence on individuals, operator attitudes, biases, rules; come on.

DR. KRESS: You'll never -- yes, they never do that.

CHAIRMAN APOSTOLAKIS: You are really pushing here the state of the art. Maybe ATHEANA, that's an appropriate place to talk about it, but not here.

DR. COOPER: Just to remind you, and this, and this is a problem that we've been talking about, that it's also for users of HRA practitioners this guidance, and I would include the NRC in that. So pushing the state of the art is one of the things that the NRC has to address. And so we want to have good practices and eventually an evaluation of methods that addresses that. So we have our guidance. And we don't want to have --

CHAIRMAN APOSTOLAKIS: But I mean it's premature.

DR. COOPER: When we push state of the art a sense where's your quality of -- I mean, where does it fit in with good practices and what you're doing. And so we're just trying to address that.

CHAIRMAN APOSTOLAKIS: No, no. No. But you want to say that there are things that you should always consider for which, you know, we have experience like this training procedures and so on. And then say that there other issues which perhaps go beyond the current state of the practice and the state of the art is still evolving. And then when you guys come in here with ATHEANA, then we'll have a long discussion and so on. I mean --

DR. COOPER: It's our intention to be -- that would be addressed in the next document. So this is laying the ground work. In fact, it may develop that when we get the next document in print in text, that we find some shuffling or additions or whatever need to be made in this document so that they work together.

CHAIRMAN APOSTOLAKIS: So this is under always consider along with other stuff which we always consider. And I'm saying that maybe it

doesn't belong there. It belongs in another column.

MR. KOLACZKOWSKI: We will certainly take their comments and try to address them. We'll try to address it, George. Your point is understand.

CHAIRMAN APOSTOLAKIS: Well, I'm not questioning the significance of the issue. I thin it's very important. The question is whether it belongs in a column that says always consider the following PSFs in a document that is called good practices. That's what I'm questioning. Oh, it's very important.

DR. KRESS: Yes, and along those same lines, George, on page 31 the continuation of the table.

CHAIRMAN APOSTOLAKIS: Yes.

DR. KRESS: I would have thought these additional performance shaping factors were the more important ones.

DR. COOPER: Yes.

DR. KRESS: I mean, it seemed like you were relegating them to a less importance than call them additional. I would have --

CHAIRMAN APOSTOLAKIS: Yes.

DR. KRESS: Yes, they seem like the more

important ones to me.

CHAIRMAN APOSTOLAKIS: Accessibility? Is that with an A.

DR. KRESS: Yes. Yes. It's okay. It's spelled right.

CHAIRMAN APOSTOLAKIS: All right.

So maybe this belongs under additional PSFs and maybe take some of the additional and put them in the -- it's a matter of which column to put it in.

MR. KOLACZKOWSKI: Yes. We understand.

CHAIRMAN APOSTOLAKIS: Because either way you have the opening you want.

MR. KOLACZKOWSKI: Right.

CHAIRMAN APOSTOLAKIS: But I would hesitate to say you should always consider.

MS. LOIS: I do want to add a clarification as to why it has some, you know, flavor of the good practices. I guess the -- as when the primary reason for developing that is how we would address licensee requests for adding, deleting human actions, changing human actions. And therefore the possibility of operators not being trained well, not being able to communicate well. So underneath there is an incentive of including as

part of the PRA good practices ATHEANA concepts that would help the staff to phrase creations for plant changes. But we take your comments --

CHAIRMAN APOSTOLAKIS: I think the issue of dependence of this on ATHEANA was clear to me from the first page. Prepared by Kolaczkowski and Forester.

MR. KOLACZKOWSKI: On a pre-initiator it's a THERP.

CHAIRMAN APOSTOLAKIS: No. I really think it's very important to scrutinize all these entries and decide which one belongs to always consider versus additional PSFs to consider.

MR. KOLACZKOWSKI: Yes. And your points well taken.

That's all I was going to say on the post. And maybe we could just spend a few minutes on the --

CHAIRMAN APOSTOLAKIS: Now, the type on page 32 --

CHAIRMAN APOSTOLAKIS: Oh, okay. Is the time of day a PSF? That's an aleatory uncertainty, as you say in the text. It's not a PSF. It's the context, of course.

MR. KOLACZKOWSKI: Yes. But I guess

people think of it as a PSF.

CHAIRMAN APOSTOLAKIS: Really?

MR. KOLACZKOWSKI: And so we thought, yes, we ought to address it.

DR. KRESS: You don't need to because they always happen at 3:00 a.m. in the morning.

MR. ROSEN: Actually, close but 4:00.

DR. KRESS: 4:00.

MR. ROSEN: 4:00 in current time, local time.

CHAIRMAN APOSTOLAKIS: So why didn't you also consider time of year? For example, if it's Christmas night --

DR. COOPER: You would if it's a grass intrusion event at --

CHAIRMAN APOSTOLAKIS: So maybe it becomes a constitutional failure -- Okay. So maybe we don't want to get into that.

Now under additional PSFs to consider, communications. Yes, I think that's good.

MR. KOLACZKOWSKI: That's all I was going to say on post-initiators. And I thought maybe we'd just spend a few minutes --

CHAIRMAN APOSTOLAKIS: We're here to help. We're here to help.

MR. KOLACZKOWSKI: Okay. Okay.

CHAIRMAN APOSTOLAKIS: Good practice number 7 on page 34, and this is where I caught it but it's cited, the same idea applies to other places. Mean values for each HEP and an assessment of the uncertainty in the mean values. No, you're not assessing the uncertainty in the mean values. It's the HEP which has uncertainty. This is the mean value of those values of HEP, and this appears in several other places.

MR. KOLACZKOWSKI: Granted.

CHAIRMAN APOSTOLAKIS: And then on the next page again we have a second bullet on the top the issue of sensitivity analysis and how they effect the risk results and so on. That is not part of the uncertainty analysis. And I guess a lot of it repeats what was said in the pre-initiator. There was a comment about -- on page 36 of the shape of the distribution does not -- you know --

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Okay. Let's go on.

MR. KOLACZKOWSKI: EOCs --

CHAIRMAN APOSTOLAKIS: Oh, no, before EOCs.

MR. KOLACZKOWSKI: Before EOCs? I'll take as much time as you want.

CHAIRMAN APOSTOLAKIS: Page 39. On page 38 I'm a little bit confused. Maybe I'm missing something. Th title 5.4 Adding Recovering Actions to the PRA. Wasn't the whole discussion before referring to recovery actions?

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: They are supposed to do something and they don't do something and so on.

DR. COOPER: This is a PRA term, recovery. And a recovery event is one that would be added to -- on a cutset-by-cutset basis. In other words you might identify a cutset in your dominant sequences that has a human action in it and you had not previously taken credit for additional human actions that could have recovered the failure in that cutset. And then you can add an additional event at that point in time.

CHAIRMAN APOSTOLAKIS: Well, that's additional event.

DR. COOPER: That's why I said adding.

CHAIRMAN APOSTOLAKIS: Because you have already accounted --

DR. COOPER: That's why it says adding.

MR. ROSEN: That's right. That's where you have an operator --

DR. COOPER: So it's a PRA term.

MR. ROSEN: When you have a basic human event where the operator does or doesn't do something which he needs to do. And so you take the branch that goes to no he didn't do it and you can add a recovery event. He didn't do it, but his supervisor did something else or somebody else out in the plant did something.

CHAIRMAN APOSTOLAKIS: Wait a minute now. On page 25 it says these involve performing expected acts incorrectly. These are recovery actions.

MR. ROSEN: No.

CHAIRMAN APOSTOLAKIS: Yes. In the PRA. I mean you lose something and you try to recovery.

MR. KOLACZKOWSKI: Well, I guess I would say there is a fine distinction here. They're response actions. They're the actions called out by the EOPs.

CHAIRMAN APOSTOLAKIS: Yes.

MR. KOLACZKOWSKI: But the recovery, again it's a PRA term, means to be something beyond

that that based on the conditions of the plant there may be something that's not in the PRA model now, it's not one of the response --

CHAIRMAN APOSTOLAKIS: I understand the distinction.

MR. KOLACZKOWSKI: And yet it's a further thing that the operator could do based on what he's seeing.

CHAIRMAN APOSTOLAKIS: If you rephrase it and say additional recovery actions, that would be clearer it seems to me.

MR. ROSEN: Well it would be clearer to you, but it wouldn't be clearer to the PRA practitioners because of Alan's point about the lingo is recovery actions are things you do after you've done something and it didn't work or you failed to do something.

CHAIRMAN APOSTOLAKIS: No, not necessarily. If there is an initiating event, the operator intervention is --

MR. ROSEN: Is considered recovery action?

MR. KOLACZKOWSKI: We'll take a look at this and make sure --

CHAIRMAN APOSTOLAKIS: In the sense

that--

CHAIRMAN APOSTOLAKIS: I don't think so.

MR. KOLACZKOWSKI: We will make sure that the word "recovery" is as defined in the ASME standard. How's that?

MR. ROSEN: That'll work for me.

CHAIRMAN APOSTOLAKIS: Yes. And then on the next page 39 the fourth bullet down. Well, the following should be considered in defining appropriate recovery actions. The recovery is not a repair action. Why not? Is not what we had at Davis-Besse? Did they wait until the last moment to repair the pump in '85?

MR. ROSEN: Oh, in '85.

CHAIRMAN APOSTOLAKIS: Yes, in '95. I mean that was a repair action.

MR. KOLACZKOWSKI: It's just that PRA typically now, and again trying to stay more or less within the state of the art, and we've talked about errors where maybe we've pushed the state of the art a little bit. But PRAs typically don't allow recovery actions where you would require, for instance, you got to take the motor off the valve and put a new motor on and then that's considered again a repair action.

CHAIRMAN APOSTOLAKIS: Well you can screen that out because it would take too long.

MR. ROSEN: Well, there is a fairly good discussion here about, for instance, putting a new fuse in is a repair action but pulling a fuse is not. I mean, it's that level of detail, and that's true. So I think this is correct the way it's written about there.

CHAIRMAN APOSTOLAKIS: The way it's written the recovery is not a repair action.

MR. ROSEN: Recovery is not a repair. Repair is a separate thing.

CHAIRMAN APOSTOLAKIS: But is it written anywhere else? No.

MR. KOLACZKOWSKI: Repairs? No. Repairs, no.

MR. ROSEN: Well, not in the PRA, not usually, although there are cases I've seen where pulling a fuse is the final ultimate -- you cannot get the control rods to trip. And you do everything you know that's built in and then you finally go out and pull a fuse in the such-and-such to de-energize the circuits.

DR. COOPER: The state of the art in the PRA basically ignores those as being heroic actions.

Now that may not be realistic, as you pointed out in Davis-Besse. But that is the way it is state of the art PRA not to address those kinds of actions.

CHAIRMAN APOSTOLAKIS: So now we are espousing the state of the art. We don't want to push it, Susan, right?

DR. COOPER: I --

CHAIRMAN APOSTOLAKIS: That's okay. That's okay.

DR. COOPER: No. I didn't say that. We haven't had the occasion to do otherwise, but I'm -- if you want to be more realistic, we could.

MR. KOLACZKOWSKI: If we allowed repair in PRA, the licensees would say oh we can always fix anything before the core damages, right?

CHAIRMAN APOSTOLAKIS: Well, no, I don't think so. I think we really got to do with time.

MR. KOLACZKOWSKI: I understand.

CHAIRMAN APOSTOLAKIS: Then why don't you say that? That repair actions typically take along time.

MR. ROSEN: Well, I think it says 72 hours in here someplace, doesn't it?

CHAIRMAN APOSTOLAKIS: Not in --

MR. KOLACZKOWSKI: No, no, no. No, no.

Don't get confused with the official definition of repair and not for manual actions.

CHAIRMAN APOSTOLAKIS: Okay.

MR. KOLACZKOWSKI: This is meant to be more the way PRA people look at what a recovery action is versus what a repair action is --

CHAIRMAN APOSTOLAKIS: Now we were discussing -- I'm sorry. Go ahead.

MR. KOLACZKOWSKI: No.

CHAIRMAN APOSTOLAKIS: Earlier this morning we were discussing the long times that you will have with advanced reactors. And you're telling me that even then you would not consider recovery, I mean repairs?

MR. KOLACZKOWSKI: Well, then you might.

CHAIRMAN APOSTOLAKIS: This is a document also for future reactors, is it not.

DR. COOPER: There's no one size fits all, that's what I'm saying.

CHAIRMAN APOSTOLAKIS: Can you rephrase this bullet so we can move on.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Make it clear what you mean? Okay.

MR. KOLACZKOWSKI: Yes.

MR. LEITCH: I think a distinction in my mind might be whether a block or a permit is required to work on a particular piece of equipment. I mean, that seems to me to be a differentiation between a repair action and just some kind of recovery.

I mean, I don't know that that's always the case. I haven't thought about it long enough. But for example, if you're going to replace a motor you've got to get a permit to tag out the breaker and so forth. And I think that's beyond the scope of what you're talking about here. But if you have another pump or if you have some relay that you can clean the contacts and get it to go, why that's more in the --

CHAIRMAN APOSTOLAKIS: So it's really the time that it takes to do it.

MR. PARRY: Could I add --

CHAIRMAN APOSTOLAKIS: Oh, you're back?

MR. PARRY: Yes, I'm back.

This is Gareth Parry.

There's another distinction, and that is I think for repair actions typically you're not going to use the human reliability techniques to evaluate the probabilities. You're going to use

actuarial data. So I think that's one of the distinctions that's been made in the standard, for example. And though you'll find repair actions discussed in the ASME standard during the data section, the argument being is that a failure could be from any of a whole number of causes. PRAs don't care why an MOV failed to open. So if you want to put a repair of an MOV in there, you have to cover all the potential failure mechanisms. And the only way you can really do it is actuarially because you can't go through and identify the repair for each failure mechanism at the valve, whereas manually opening a valve which has failed is a reaction -- is a manual action that can be identified and can be treated using the NRA techniques. So I think that's the distinction between the two.

CHAIRMAN APOSTOLAKIS: But it's not here.

MR. PARRY: Well, that's why repair -- it may not be in this document, but that's why repair would not be in this document but recovery would be.

CHAIRMAN APOSTOLAKIS: The whole idea, of course, to initiate your analysis is you are doing in the context of the accident as it is

evolving. Certain things you may be able to do, other things you may not be able to do. And the message should be clear, though, there should be an investigation of what you can do and you can't do. Like what Mr. Leitch said, or what Steve said, you know, or you guys said. For some things takes too long --

MR. PARRY: There are some things that you can't --

CHAIRMAN APOSTOLAKIS: Or the modes are not appropriate or cannot be fixed. For others it doesn't. Have a blanket statement repair actions are out. That's all.

MR. PARRY: And I think typically the reason why repair is not put in there is what somebody said earlier is that the average repair time for a lot of these components can tend to be long.

CHAIRMAN APOSTOLAKIS: Except for future reactors you may have a problem with what's long.

MR. PARRY: Okay. But did anybody else could up with a good argument.

CHAIRMAN APOSTOLAKIS: Is it difficult to just say yes we'll go back and look at the --

MR. KOLACZKOWSKI: Yes, we will go back

and define repair.

CHAIRMAN APOSTOLAKIS: Thank you very much.

MR. KOLACZKOWSKI: Okay.

CHAIRMAN APOSTOLAKIS: All right. So what else.

MR. KOLACZKOWSKI: I'm waiting until you're done, George. But every time I say I'll start on errors of commission --

CHAIRMAN APOSTOLAKIS: Errors of commission. I'll wait until you're done with errors of commission. Go ahead.

MR. KOLACZKOWSKI: Okay. This document, unlike the standard; the standard is silent on errors of commission. The ASME standard is silent on errors of commission. And therefore, if you will, Reg Guide 1.200 is silent on errors of commission. So here's a place where we're probably again pushing the state of the art somewhat, but the document does try to indicate some set of conditions that we think should be searched for that would lead -- would make it more prone for operations to potentially errors of commission.

And, for instance, if plants are making plant changes and they're changing their procedures

or whatever, we're suggesting that searches be done looking for the conditions that are listed here. And if they find those conditions, then try to see if they can't make those conditions go away. Because they may be setting themselves up for a situation that at least is somewhat more prone to making an error of commission as opposed to actually putting it in the model, trying to come up with a probability and so on and so forth. We're not pushing it that far.

CHAIRMAN APOSTOLAKIS: I thought that one of the significant, as I recall now it's been a long time, advances in this business of errors of commission was this confusion matrix that somebody developed 15, 20 years ago. And I was surprised not to see any reference to that. Where the guide took all the initiating events, put them on the columns of a matrix and they rose. And he asked himself if I have a small LOCA, is there anyway I can think it's something else to do the right thing for the -- if I have this, is there anyway I can think of something else? And this was extremely enlightening because he came up with only two or three cases where you could actually misdiagnose.

And also, the other insight was that

even if you misdiagnose and if you carry it to the cases, the actions you will take are okay.

So I was a little surprised that you guys had no reference to this. And speaking of references, it's really a great coincidence I guess, but all the references are for some deal from the NRC --

MR. ROSEN: Well, there's one from --

CHAIRMAN APOSTOLAKIS: I guess nobody else has --

MR. POWERS: Well, nobody has produced anything significant.

CHAIRMAN APOSTOLAKIS: Except for Reason, I guess. Jim Reason.

MR. POWERS: Well, that's historical background.

CHAIRMAN APOSTOLAKIS: Actually, I think the reason is really a major force now because he managed to get into a list of references from Sandia.

MR. KOLACZKOWSKI: Is Brookhaven in there.

CHAIRMAN APOSTOLAKIS: Brookhaven is there, but it was U.S. NRC, right.

MR. KOLACZKOWSKI: Right.

CHAIRMAN APOSTOLAKIS: You know that's an ongoing criticism of reports from the National Labs. I mean, you guys should try to bring other people, especially if you say that you are not recommending a method.

MR. POWERS: Once other people start doing something -- if they would collaborate with us, we would reference them.

MR. KOLACZKOWSKI: That's all I was going to say about EOC unless you --

CHAIRMAN APOSTOLAKIS: Yes, and that's all I had to say.

MR. KOLACZKOWSKI: Okay. And lastly --

CHAIRMAN APOSTOLAKIS: Whoa. There's one more.

MR. KOLACZKOWSKI: Okay.

CHAIRMAN APOSTOLAKIS: Page 42. It's just editorial. But in the third paragraph down, fifth down, to the extent any EOCs are modeled; have you given them a way out? Do you want to say that?

MR. KOLACZKOWSKI: Would you say again where that is?

CHAIRMAN APOSTOLAKIS: It's the fifth down in the third paragraph. You see, to the extent any EOCs are modeled, on page 42.

MR. KOLACZKOWSKI: Your pagination is slightly different from mine, George.

CHAIRMAN APOSTOLAKIS: Oh, section 7.

MR. KOLACZKOWSKI: Okay. Section 7.

CHAIRMAN APOSTOLAKIS: Third paragraph down.

MR. KOLACZKOWSKI: Third paragraph.

CHAIRMAN APOSTOLAKIS: Starts "Given these advances."

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Okay. Five lines down.

MR. KOLACZKOWSKI: Okay.

CHAIRMAN APOSTOLAKIS: "To the extent any EOCs are modeled" do you see that line?

MR. KOLACZKOWSKI: Okay. All we're saying is that to the extent a licensee may in fact model EOCs in their PRA, they should follow this guidance.

CHAIRMAN APOSTOLAKIS: Yes. But also implies that if they don't want to, they don't do it. That's what I'm saying.

MR. KOLACZKOWSKI: That's true.

CHAIRMAN APOSTOLAKIS: And, again, I mean we don't want to show any bias, but in the

second paragraph, however more recent matters "e.g. ATHEANA." Okay.

MR. ROSEN: I'm so sensitive about that.

CHAIRMAN APOSTOLAKIS: A lot of other people are, though. They feel that they have ideas, good ideas that the staff and its contractors never pay attention to. and I think, you know -- because eventually the community will have to accept to agree that this is a good document. And if you have people not mouthing it out there --

MR. ROSEN: Well, I think it's failure to badmouth is what we have here.

CHAIRMAN APOSTOLAKIS: It's a failure to what.

MR. ROSEN: It's a failure to badmouth. We don't bring in any of the other stuff. We just reference an effects, at least ATHEANA. Though I think there's a PRA review process --

CHAIRMAN APOSTOLAKIS: Well, that's why I recommend --

CHAIRMAN APOSTOLAKIS: It will go out for public comment.

MR. KOLACZKOWSKI: That is correct.

CHAIRMAN APOSTOLAKIS: But I also suggested a more serious PRA review in the morning

has you recall, actually approaching these people and asking them what they think.

MR. KOLACZKOWSKI: This is the last slide of my presentation. So we go way to the end. This is the last slide.

And I guess I'd just say this is who this document is aimed at. It's the analysts that are going to perform HRA and particularly now it's going to be more for plants that are going to put in submittals to make changes, etcetera. And they're going to have to do some HRA analysis as part of these submittals. And we're saying this is where this good practices document is probably going to be handy. And on the other side, for reviewers who are going to review these analysis.

CHAIRMAN APOSTOLAKIS: Okay. So whose next? Wait a minute now. Yes, we're an hour behind.

MS. LOIS: Yes. The next slide is the intro slide for the ATHEANA discussion. And I just wanted to remind the Committee that we're going to address both aspects, the quantification that was developed and the overall use in more detail in the PTS human reliability analysis and probably the Committee has heard about it through the PTS review,

however it never was focused. We gave a focused presentation. And those that we're going to -- I mean, Susan is going to discuss a little bit on how we plan to improve the implementation aspects in terms of the recommendation and also technology transfer.

CHAIRMAN APOSTOLAKIS: But you are not asking for a letter on this?

MS. LOIS: This is just information on it.

CHAIRMAN APOSTOLAKIS: So at which point in the near future shall we have a Subcommittee meeting and then a full Committee with a letter on ATHEANA? Are you planning for anything like that or do we have to request it?

MS. LOIS: You have to request?

CHAIRMAN APOSTOLAKIS: Well, I mean, this is going to be a major and it already is product of this agency, right? I mean, we have to -- especially since we have been cool in the past, we may have to say something.

Is work still going on on ATHEANA?

MS. LOIS: There is no work going on in ATHEANA.

CHAIRMAN APOSTOLAKIS: So it's ready now

to be reviewed?

MS. LOIS: We feel that ATHEANA has been reviewed and --

CHAIRMAN APOSTOLAKIS: Well, you don't want to stay with a negative letter we wrote two years ago.

MS. LOIS: Oh, okay. So then that makes sense.

CHAIRMAN APOSTOLAKIS: Yes.

MS. LOIS: We can come back.

DR. COOPER: Probably after the addendum.

MS. LOIS: Yes, after the addendum.

CHAIRMAN APOSTOLAKIS: Probably what?

DR. COOPER: After the addendum that I'll be discussing.

CHAIRMAN APOSTOLAKIS: Okay.

DR. COOPER: That work should be finished. That will represent the current state.

CHAIRMAN APOSTOLAKIS: Yes. I mean, whenever you guys are ready.

Okay, John, make your points. Are you shortening your presentation at all?

MR. FORESTER: I think I can -- I can maybe do it in half an hour.

CHAIRMAN APOSTOLAKIS: Good.

MR. FORESTER: But, of course, there'll be a lot of discussion --

CHAIRMAN APOSTOLAKIS: If I interrupt.

MR. ROSEN: George won't interrupt at all.

CHAIRMAN APOSTOLAKIS: No, I'll let Steven do it.

MR. FORESTER: In my presentation I'll discuss the approach that we're using with the ATHEANA human error reliability analysis method to quantify human actions.

And the approach does include --

CHAIRMAN APOSTOLAKIS: Do you want the microphone to put on your lapel so you can stand up if you like?

MR. FORESTER: That might be a good idea, if you have one.

CHAIRMAN APOSTOLAKIS: Yes.

MR. FORESTER: I don't have to turn around.

CHAIRMAN APOSTOLAKIS: No, but I see you turning all the time.

MR. FORESTER: No, I'll look here. I'll get into this. I'll just look on the screen. It's

right in front of me here. I don't have to --

CHAIRMAN APOSTOLAKIS: Keep going.

MR. FORESTER: I'd just like to note -- okay. The reason we're doing this work, what's underlined the work we've been doing, this is a reminder that ATHEANA as represented in NUREG-1624 focused on search processes for unsafe actions, including errors of commission and for identifying error forcing context.

And it did include a quantification process, but there were some limitations in the process. It relied on existing HRA methods and as we were aware of and as the ACRS pointed out, there's not a good fit really between the existing HRA methods and the kind of information that you obtain using the ATHEANA process. So in that sense, the ATHEANA quantification process needed to be improved.

And in addition, both the ACRS and the NRC had noted that HRA quantifications had better treatment of the uncertainty, so we have been responding to that issue also.

So our solution has been to adopt a facilitator led, consensus expert judgment process.

MR. POWERS: This is where I start

running aground on this. Are there data that can lead to expertise on human error rates and error forcing context?

MR. FORESTER: Is there data -- does data exist that we could use to derive human error probabilities from, is that what you're suggesting?

MR. POWERS: Where you're going to gather people around error forcing context and how important they are and things like that. And is that because someone knows the definitions of error forcing context or because he is -- he becomes an expert because he's made measurements and has correlations or things like that? I mean, how do you define what an expert is?

MR. FORESTER: What we focus on in terms of identifying the experts for the panel is we want domain knowledge, for one thing. We want operators, trainers, procedure writers, PRA people, plant PRA people, HRA people. So we want a multi-disciplinary team participating on the panel.

The people that actually use the procedures, trainers who observe crews in the simulators on a regular basis and see what they do in these various kinds of situations.

CHAIRMAN APOSTOLAKIS: Who is an expert

in this case, I think that's the question. I mean --

MR. ROSEN: Subject matter expert.

MR. FORESTER: Subject matter experts, that's correct.

CHAIRMAN APOSTOLAKIS: But they've never seen any of these accidents.

MR. FORESTER: No, they're subject matter exerts in the domain we're examining, the nuclear power plant control room.

MR. KOLACZKOWSKI: That's why we prefer to have operators, trainers, etcetera. For example, in the PTS work which the Committee has heard about, operators when you give them a certain accident context, they often will tell you, you know, I would likely make an error in this situation because they live in the control room everyday and they know if that's what you're saying on --

MR. POWERS: Yes, but I mean they live in the control room everyday but they don't make mistakes everyday. And so their judgment is not informed by any kind of feedback. So how can they claim to have expertise?

MR. FORESTER: We do have to go through a process which we'll describe briefly here of

trying to take their qualitative judgments and help the interpret that into probability space.

MR. POWERS: Do you have any calibration of that process that you went through that says it's valid? Can you take something where there is data, a data set and where there is feedback and apply this and say, hey, yes this works here and so we'll hope that it works in these situations where we don't have that kind of feedback?

MR. FORESTER: I mean, the little bit that we have now are things like simulators and some real events. Clearly we are lacking data. We have to get more data. That's why you're going to hear later on this afternoon that we need to get more data to try to help us through this process. We have limited data sets and we try to use what we have, whether it's a qualification examine results, whether it's simulations to the extent that they approach some of these PRA sequences, etcetera. We use what is available.

And then when we have to extrapolate that, we would rather have operators who live in the control room try to do those extrapolations than some HRA analyst who has never been in a control room in his life.

MR. POWERS: The advantage of the HRA analyst is that he knows what he's trying to get.

MR. FORESTER: That is why he is part --

MR. POWERS: I mean, can you look at the community of mankind at situations where people make errors routinely and get feedback on it and see if this kind process works?

MR. KOLACZKOWSKI: That's a good thought. We certainly have done that.

MR. POWERS: I mean the most common ones -- the best example I can think of is weathermen. They make mistakes all the time, but they get feedback like the next day. So you've got a data set, you've got predications and you could run your process and see if you could get something out of that.

CHAIRMAN APOSTOLAKIS: These guys are, the weathermen, are supposed to be the best experts around predictions, precisely because of the feedback they get.

MR. POWERS: Well, with the exception of the members of the ACRS.

CHAIRMAN APOSTOLAKIS: We're predicting the weather?

MR. POWERS: No, we're the best experts

around.

CHAIRMAN APOSTOLAKIS: Oh, yes. Yes.

MR. ROSEN: We're the world's foremost authority on anything.

CHAIRMAN APOSTOLAKIS: But I'm wondering whether that's really an applicable case, because what these guys are trying to do, they're trying to deal with situations where you don't have a feedback and experience.

MR. KOLACZKOWSKI: Yes, we're talking about rare events.

CHAIRMAN APOSTOLAKIS: But not always.

MR. LEITCH: I think the simulator is your best tool, isn't it?

CHAIRMAN APOSTOLAKIS: The what?

MR. LEITCH: The simulator seems to me to be your best your tool. You take a licensed operator that was in the plant yesterday and you take him off a shift and you run him through the simulator, perhaps for a requal examine. And you can access is performance.

CHAIRMAN APOSTOLAKIS: The argument against that, Graham, is that in the simulator they know they're there and they will always do the safe thing. In real life they might not always do that.

MR. LEITCH: Yes, but in the requal examine setting when their job or their continuity and their particular position is on the line, they're pretty serious about it.

MR. POWERS: I think I would be willing to stipulate that if you could do something with a simulator to test and validate this, I'd accept it.

DR. COOPER: In fact, in the PTS PRA studies the simulator was used for at least, if not all, of the studies that were done in some cases as an information gathering tool and other times the HRA team actually constructed scenarios to put the operators through so we could have fairly direct feedback as to how the operators would respond. And in some cases the utility staff were surprised as to how the operators performed.

So there was validation to that extent. But everyone knows, I think, the problems with how well the simulator and the simulator environment, the limitations there.

We do have that validation. We've tried to use that.

MR. POWERS: How are you going to do that if you take a mean human error probability for some action and a rough round average might be ten

to the minus two?

DR. COOPER: It was never used directly as data. It was more as a qualitative input.

CHAIRMAN APOSTOLAKIS: Yes. EPRI ran some experiments and they tried to do some --

MR. POWERS: It seems to me that this is heroic --

CHAIRMAN APOSTOLAKIS: Yes.

MR. POWERS: -- to do experiments on this if you're looking for ten for the minus two error probabilities on simulators. I mean, this is an enormous thing.

MR. FORESTER: You can't use simulators to validate, because as you're pointing out, you have to run too many trials, too many crews. It's just not feasible.

MR. KOLACZKOWSKI: It's not feasible.

MR. FORESTER: But, you know, you can use simulators to gain information about seeing how the crews do behave. And you can also use them like in the kind of work that Halden does where you're actually trying to control various factors that should influence performance. And if you can begin to get a handle on what manipulations you can make and see what kind of effects occur, then you learn

what factors will influence performance. So you can learn -- it helps you build a model for doing this, I guess.

MR. POWERS: Okay. Well, I'm still struggling with the idea of somebody that's an expert.

MR. FORESTER: Okay. Well, I could make another comment on that. We think these are the best experts to use, but with respect to HRA you're always relying on expert judgments. So the same argument really applies in any context where they're using HRA. Even if you take an existing method that has values in it, those values are based on expert judgment, and usually the judgment of the analyst. And then when you go to quantify a specific action, then you're relying on the expert judgment of the analyst taking what's in the methodology trying to make it fit that particular situation. And then they use their judgment to decide how to change that probability.

Our position is that if you're going to have to rely on expert judgment anyway, you're better off getting a very good clear understanding of the context and the actual situation you're going to face, and then have people that have been in that

environment and understand the procedures, understand their training; those are the kind of people that are going to help you make the best --

MR. POWERS: You would structure the expert judgment elicitation process properly?

MR. FORESTER: Correct.

CHAIRMAN APOSTOLAKIS: Who were the experts in the PTS example? And you applied it there?

MR. KOLACZKOWSKI: Yes, we did.

CHAIRMAN APOSTOLAKIS: Okay. Give us an idea of who the experts were?

MR. FORESTER: Okay. In the case where we supported the plant in their analysis at Palisades, we had operators, we had trainers, we had a procedure writer. The plant procedure writer that wrote the EOPs. We had their PRA staff and then we had ourselves participated on a couple of --

CHAIRMAN APOSTOLAKIS: so how big a group was it?

MR. FORESTER: We had as many as five to six on the panel at any given point in time. Not everybody was there all the time.

CHAIRMAN APOSTOLAKIS: So a facilitator was one person?

MR. FORESTER: That was an independent person. The facilitator did not make judgments.

MR. ROSEN: And you're going to tell us how it worked. I mean, there's going to be like the SLIM technique for anchor actions and some kind of way to make sure you're all on the same page?

MR. FORESTER: We have a calibration process. It's basically helping them understand what we mean by what's a likely event, what's an unlikely event. Talked to them about, you know, how many crews do you think would fail given this point in time. Would you think half the crews would fail? Would one out of ten fail?

So we're trying to --

MR. ROSEN: How would they fail?

MR. FORESTER: Right. Reports how they would fail, right. But given this whole context and given this even, giving your training, the procedures you use and so forth, all the -- you know, we go through a process of structuring that context. But before that we try to get them thinking in terms of probabilities. Because you're right, these guys don't usually think in terms of probabilities.

CHAIRMAN APOSTOLAKIS: Shouldn't the

facilitator be a group also?

MR. FORESTER: Be part of the group?

CHAIRMAN APOSTOLAKIS: No. Be a group, separate.

MR. FORESTER: Oh.

CHAIRMAN APOSTOLAKIS: You don't have one person as a facilitator, do you?

MR. FORESTER: Well, we have a lead facilitator and then we might have someone else that supports them. You know, if they think of something else, they will help with the process. And, you know--

CHAIRMAN APOSTOLAKIS: Because also the facilitator has to have expertise that is difficult to find in a single person.

MR. FORESTER: That's correct. Yes. The guidance we have in the SSHAC reports talks about having an entity for the expert facilitator. So it may not be a single person.

MR. POWERS: Let me tell you what's causing me problems. It's very specific thing that came before this Committee, involved a human action where there was a change to the plant that caused decreased time available to punch a SCRAM button. Okay. And the THERP analysis was something like a

ten to the minus two probability that they would not punch this SCRAM button in the allowed amount of time. Consequently, they reduced it from five minutes to three minutes the amount of time they had to punch this button. And so they take the probability up to .013 or something like that. But throughout the people that you would have selected to be your experts here said, but it's guaranteed they'll do this. We've run 50 simulator exercises on this and no team has ever failed to punch that button within 30 seconds. Okay.

MR. FORESTER: Yes.

MR. POWERS: I mean, they're going to come into this thing based on their limited set of experiences here, absolutely persuaded that the probability is extremely small. And I think that's a characteristic of people who fancy themselves expert whether it be in partial differential equations or operator actions, that they are overconfident in their certainty that things are well known or well understood or highly probably and things like that.

MR. KOLACZKOWSKI: Can I make a comment on that? Again, talking about the PTS. I think we fought very hard against those biases. And, in fact, part of the training that we gave the licensee

staff before we actually started the elicitations was recognition that sometimes even though you may think something is very low probability, look at what has happened. And we talked about some real events, etcetera.

Pretty soon we got them to the point where they were telling us stories about remember how close when we did this, or whatever. And part of being a good facilitator is recognizing those biases and getting them neutralized before you start the process. And we worked hard at doing that.

And, in fact, when we actually did the elicitations I fully expected that the NRC contractors would have high HEPs and the licensees would always come up with low HEPs that were on the expert elicitation team. And, in fact, what we found is this.

Sometimes the licensee would come up with a higher estimate of the human error probability than the NRC contractor did.

If you get the context well understood and you get the biases neutralized as best you can, get them to understand there have been horror stories and things do go wrong. And like I said, they'll contribute on close calls they had. They

will make an honest attempt at what they think the probability of failure is and many of them, we found, they come up with higher failure probabilities than the NRC contractor did because they know how they'll actually react when that indicator is doing X, Y, Z or whatever, perhaps even better than the contractor does.

So I think there are ways to neutralize those biases, I guess.

MR. POWERS: I come away with the conclusion that you've done the best you can given the constraints here. But as a general principle in this general area of human reliability and human factors, we've got to look and search for ways to get persuasive calibration. And in some cases even very innovative. You may not be able to do it all the time, but we've certainly got to strive to do that more.

MR. FORESTER: We agree. We agree.

DR. KRESS: It seems to me like there might a database in the licensing event reports where human errors are identified as part of the root cause. And one could take those events and take them to your expert panel and say what's the probability of this thing. And perhaps, I don't

know if you have enough of those to get a probability out of it, but there might be some database there.

MR. POWERS: It's also true that when I talk to people in it about shutdown risk, for instance, you know the response is fairly uniformly true that they say "Well, we're in good shape." But the guys down the road, you really got to go look at them. And they're not doing any good at all. So maybe there's some other way of doing that.

CHAIRMAN APOSTOLAKIS: I have a question of biases. On page 213 of the paper on the left column, the penultimate bullet page 213. I guess we have to do this because there's no way you can go over your slides. You're saying --

MR. LEITCH: I'm sorry, which paper are you referring to now?

CHAIRMAN APOSTOLAKIS: The paper on expert elicitation which they sent us. That's part of the record now, I guess.

MR. LEITCH: Okay.

CHAIRMAN APOSTOLAKIS: This bias refers to the inability of people of experts to estimate uncertainty, right? They say people are fairly accurate at judging center of tendency, but tend to

significantly underestimate a range of uncertainty. People's estimates of the 98 percent intervals fail to include the true values. So they give you the first and the 99 percent value, and it turns out that true value is not there because people underestimating. And yet, the same people who claim that they have taken into account biases, ask the experts to give them the first and the 99th percentile.

I mean, shouldn't you guys stay away from that on page 210. You shouldn't have done that, I think.

MR. FORESTER: I disagree. I guess I understand what -- there's data there, but I'm not sure -- I mean, all that stuff is collected and very circumscribed and under certain circumstances. And we, the environment that we're in and the process we're using we think is a viable approach to doing that. And, obviously, it's difficult to valid. But we can see what they do and we can see the distributions that are produced. And they're reasonable.

CHAIRMAN APOSTOLAKIS: Well --

MR. FORESTER: And they seem to be able to do this.

CHAIRMAN APOSTOLAKIS: Well, there is extremely strong evidence from cognitive psychology that the people are really incapable of giving you extreme values. In fact, there is another paper. I mean, you mentioned the 98th percent. There was another paper, I think Winkler and one of his students published years ago where they did the same thing. They knew the answers to certain things and then they asked people, you know, the presumed experts. And when people -- I think the conclusion was that when people think they give you their 90th or 95th percentile, they're really giving you their 75th. And the low side, it's the same thing.

So I don't know that the first and the 99th is a good idea to ask.

MR. KOLACZKOWSKI: I think we worked, again, at using the PTS as an example. We worked very hard at trying to define what we meant by the 99th and the first percentile with the group.

And, George, for instance my recollection of all the 99th percentile numbers we got from these groups, on all of the HEPs that we evaluated, they were typically values like .7 failure probability, .5, .6. I'll bet you the true value in there is encompassed in there.

We found, it was our experience by going through this process and really forcing them to really think about what the 99th meant, etcetera, we were tending to get much wider uncertainty bounds than the ASEP approach would give or the THERP approach would give, or any other approach would give. Because I think we got them to begin to understand what the 99th and the first percentile really, really meant. And they were going to very fair extremes.

We were getting more like 3 and 4 orders of magnitude between the first and the 99th. And ASEP won't give you that. And THERP won't give you that. So I contend we're doing a better job.

Is it perfect? No. But I think it's better than what's been done in the existing methods now.

CHAIRMAN APOSTOLAKIS: Okay. I don't doubt any of that. But, I mean, if they give you .7, then obviously --

MR. KOLACZKOWSKI: Those were the kinds of values we were getting at the 99th. They could conceive of realistic conditions to take that action where they were giving us numbers like -- I could see where the failure probability is going to be

50/50, 70 percent. And that was their so called 99 percentile value. But we worked hard at eliminating those biases of considering the uncertainty is smaller than it really is. That's the only answer I can give you.

CHAIRMAN APOSTOLAKIS: Maybe some explanation then -- well, it's too late for a paper, of course. But whatever document you write in the future.

I saw that somewhere, in fact, that you had piled up all the conservatisms, right? Was it in the paper or in the document, I don't remember? When you asked them to consider the 99th?

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: You know, essentially you directed them to consider everything going wrong, right?

MR. KOLACZKOWSKI: That still has some reasonable, and I don't want to define this mathematically, but some reasonable likelihood of occurrence. But there could be nuisance alarms and there could be something else going on.

CHAIRMAN APOSTOLAKIS: Right. Right.

MR. KOLACZKOWSKI: And you can't rule those out because they're so improbable. And then

operators will say, boy, if that was the context, yes.

CHAIRMAN APOSTOLAKIS: No. If you went up there where you said .7, .8, I agree.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: Even some instances you get some like .1 or so, I would use that as 95th or 90th. Allow some probability for it. So it's really case dependent.

MR. KOLACZKOWSKI: Understood.

MS. LOIS: So your recommendation is to rethink of the way where --

CHAIRMAN APOSTOLAKIS: Explain better, I would say. I mean what Alan said made sense to me.

But I mean if you have a high value which is .7, I mean how far can it go? To one? So maybe it's a 99. Who cares. But if the five values .1, for example, then maybe I would be reluctant to call that a .99 percentile. That's personal. Because of the biases that have been observed.

And the low bound, who cares. I mean, you can ten to the minus number; I really don't care.

MR. ROSEN: I would like to hear more --

CHAIRMAN APOSTOLAKIS: Good work. I

mean it's ont --

MR. ROSEN: I would like to hear more about this facilitator led process, even if we don't hear anything else.

MS. LOIS: So go ahead and jump.

MR. FORESTER: You want me to just jump to that?

CHAIRMAN APOSTOLAKIS: Yes.

MR. FORESTER: Okay. This is the sort of the general information about what we do. Again, I want to emphasize that we do want to include the multi-disciplinary panel and the idea is you bring this knowledge to the table and you essentially investigate what people have, what evidence they have that's going to be relevant to what you're doing. And then you transform those judgments into probability distributions.

And the last two points, I think, are fairly important. Because a thing that does emphasize considering a full range of performance shaping factors as opposed to some of the earlier approaches which tended to have a small set of PSFs, treat those PSFs independently essentially and always consider them in doing the analysis. We think that's -- you're missing information probably

if you're doing that.

ATHEANA focuses on trying to assess the interactions and the dependencies between the factors which can highly influence performance.

And the idea there is that, you know, you always say and the older methods and they say procedures are good or procedures are average, and that's fine. But then they say training is great and something else is very good, there's no work load and therefore this is going to be the probability. But if it turns out there's an error in the procedure somewhere, then that is the driver. Nothing else matters. So if you identify that, that's the most important factor.

So, again, the notion is try and consider all of the factors that can influence performance together, do that holistically and consider the possibility that there's interactions between those factors or dependencies.

Now here's the process as we step through it. Knowledge. They may be experts about what goes on in the control room in response to an accident, but they may not know much about -- they just don't think in probability space that much. So we try to provide them an overview of ATHEANA, take

about how the quantification process works, some of the terminology. And then we go through this exercise of trying to calibrate them on what the different probabilities mean.

So the idea is just sort of anchor them in terms of what a "likely to fail" would be. So if they think a lot of time, if five out of ten crews would fail, well then that's a .5 probability. So this is fairly straightforward and it's fairly easy for them to understand these ideas. They don't have to pick those values, per se. They're allowed to assign any values they wish, but that's the kind of process we go through to get us all working together essentially.

MR. ROSEN: That's the whole thing? There's no comparison with -- for a given unlikely event, there's no attempt to compare it with likely events or some sort of scale emplacement on the thing? I was very impressed with that when I read that about the way at least SLIM used to be done. My understanding was that there was a process in which operators were -- you talked about an action that they knew that they did frequently, like synching the generator or something like that. Synchronizing the main generator. And you talked

about that a lot. And then said well how likely is it the guy will get it out phase. And they'd say, well not likely but it does happen and you can understand why. Maybe once in 25 tries or once in 50 tries, maybe, somebody's going to get wrong. And that's something they all talk about, and say yes that's probably about right. And it's because they really have a good feel for it. They know, because they do it a lot. I mean, they do it once every cycle. Then you set aside. Something you've had a discussion in you're facilitated session. Set that aside. And then you take another action, something that doesn't happen very often, something that you're really interested in modeling in the PRA. Describe it. And say, okay, here's a recovery action like maybe restoring auxiliary feedwater once the auxiliary feedwater pump has tripped. You have to take a recovery action. You have to go down into the auxiliary feedwater building, have to relatch the turbine throttle valve. And it's in their procedures, they know how to do it and they train on it, but it's nothing ever done in the real plant event.

And now you say compared to the synching of the main generator, the synchronizing of the main

generator, how likely is it that under the stress of needing to do because the steam generators are running out of water, you're going to be able to do that? I mean, so you have some comparison. They have some comparison.

So I think that this anchor action, this synchronizing of the main generator helps them put in context the quantitativeness, the feel for this other action which they don't ever do.

And I was sort of impressed with at least the description, I never saw it done, but I was impressed with the description of that that I read.

So you don't do anything like that?

MR. FORESTER: No, we don't.

MR. ROSEN: You just treat numbers like there's probability in it?

CHAIRMAN APOSTOLAKIS: How is it related to things that the operators understand, that's what you're saying.

MR. ROSEN: That's right. That's what I'm saying. The relation to something that they have --

CHAIRMAN APOSTOLAKIS: That's good idea. Maybe not now, you may do it in the future.

MR. FORESTER: It turns out to be not that easy, though, to identify those anchors. For one thing, you have to find anchors that have some characteristics related to the --

CHAIRMAN APOSTOLAKIS: Well, you can have a separate meeting with a bunch of operators or people like Mr. Rosen who understand these things and come up with at least --

MR. FORESTER: Yes.

DR. COOPER: Yes.

CHAIRMAN APOSTOLAKIS: You're not going to do it during the elicitation.

MR. ROSEN: No, no. You do it way before that.

MR. FORESTER: And that's what the GCAPS idea I was trying to address; trying to identify some anchors, and this is what you're saying --

CHAIRMAN APOSTOLAKIS: Now, the GCAPS are I think for the context itself. Here we're talking about training the experts. Much lower --

MS. LOIS: I still think that's a very good idea.

MR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: But, you know, even in NUREG-1150, you know, they train them. You

know, the famous question what is the rate of suicides among middle aged Japanese women. They asked them that. And fluid mechanics were great, they're crazy. They say what event is going to happen. A guy who has been doing experiments for 25 years in fluid mechanics. He comes in there to give his expert opinion, and they say now you tell me what the rate of Japanese suicides is. And then it turns out that you can actually say something useful about it if you start thinking about it in a systematic way.

Anyway, shall we move to the next slide?

Your step one is in the process of facilitator lead expert opinion.

MR. FORESTER: Yes.

CHAIRMAN APOSTOLAKIS: By the way, it's expert opinion elicitation, not expert elicitation anyway.

MR. FORESTER: Of course. Of course.

MR. POWERS: He bores the hell out of us with his complaints on a regular basis.

CHAIRMAN APOSTOLAKIS: You have to worry about English.

MR. ROSEN: Professor Apostolakis is trying to teach us something.

MR. POWERS: And it's hopeless.

CHAIRMAN APOSTOLAKIS: But, look at it, I call the paper expert elicitation.

MR. FORESTER: You're right.

CHAIRMAN APOSTOLAKIS: I wonder who the editor is?

MR. POWERS: The only way you get out of this is to stipulate that he's correct.

MR. KOLACZKOWSKI: You're correct, Dr. Apostolakis.

MR. ROSEN: We'll take it up with the others.

CHAIRMAN APOSTOLAKIS: Thank you, Susan.

MR. FORESTER: Okay. So then there's the process I just described trying to anchoring in and getting them thinking about probabilities and the way we're going to be using them.

And then the next step then is to bring in -- at this point we'll have identified unsafe act that we're going to quantify. And a context through the ATHEANA search process. We will through vulnerabilities, deviation scenarios and so, we'll have some context. And then the facilitator with the help of the analyst they take that information along with their own ideas about what's going to be

relevant in an accident scenario. And the idea is to develop this critical set of characteristics that's going to be considered.

CHAIRMAN APOSTOLAKIS: Let me understand, the facilitator develops the PSFs? I thought the experts did that.

MR. FORESTER: The facilitator brings whatever information we've collected through the ATHEANA process. Now if the panel, operators and trainers have participated in that part of the process, that would be a good thing but that may not always bee the case. So if we have information that we've identified about the characteristics of the scenario, we've described the scenario to them --

CHAIRMAN APOSTOLAKIS: So the experts would deal with the unsafe act only, not the EFCs. The EFCs from the ATHEANA process and they're subject to modification, of course, by the experts.

MR. FORESTER: Certainly.

CHAIRMAN APOSTOLAKIS: But you are not going to have an expert opinion elicitation, you know, trying to develop the EFCs?

MR. FORESTER: No, we give them the basic context.

MR. ROSEN: And just say yes that's the

way it is, is that right. This procedure relies that you've trained on in the simulator, but you don't train very often, you know. And they say yes, that's right.

MR. FORESTER: Right.

CHAIRMAN APOSTOLAKIS: Or they may modify it.

MR. FORESTER: Yes, or they may modify it, that's correct. But we do want their expertise. So when they talk about how they use these procedures and what's going to be relevant at different points and stuff, that's important to making the decision about the probability of failure. So we listen to that, and they listen to each either is the main point.

CHAIRMAN APOSTOLAKIS: Right.

MR. FORESTER: And then the next bullet, I just wanted -- this gets to the treatment of uncertainty in the sense that whatever the context that's been established is, we've identified what seems to be the driving factors, the bottom line is other influences can occur.

CHAIRMAN APOSTOLAKIS: People really worry about aleatory thing. In most places you say that these are typical and not included, but I

wonder what the state of the practice is these days? I mean, does anybody care whether it's night or day, and that's a factor of two anyway.

MR. KOLACZKOWSKI: Maybe that one, no. But other aleatory factors are what's driving that 99th percentile versus being at the mean at the first percentile. Because if a few things do line up like -- and suppose you had some other nuisance alarms and suppose you had some other failures that maybe aren't important to the sequence, but they still take time to address. That's taking time away from the time available to do the important things, etcetera. When they acknowledge that those things can occur, that starts driving the 99 percentile further and further up, but they're random events. It's random whether I'm going to get nuisance alarms or not.

MR. ROSEN: And one of my favorites is when you ask them, although my crew member here, Alan Kolaczkowski is not here tonight because he's -- he's sick tonight. And so they got somebody from a different crew whose qualified, but he's not part of this crew. Does that change? Well, yes, Alan's the plant expert on that thing.

CHAIRMAN APOSTOLAKIS: But they don't

include that -- you mentioned this example several times, and it's a valid one, but I'm not sure that the analyses accounts for things like that. There is no way they can get into.

MR. KOLACZKOWSKI: Yes. We asked them in the PTS work, we said consider all the crews that might be on shift --

CHAIRMAN APOSTOLAKIS: He's not saying see Alan.

MR. KOLACZKOWSKI: Yes. I mean not down to an individual or something. And they will acknowledge, some crews would be better at this than others.

CHAIRMAN APOSTOLAKIS: Sure.

MR. ROSEN: And the ones that aren't are good might push the --

MR. KOLACZKOWSKI: The 99th or the 70th percentile a little further up, that's correct. It's random as to which crew is going to be on shift.

MR. FORESTER: And we asked them -- we have a factor check list that we developed that we used during PTS. And we go through that and the experts decide what aleatory influences could be important.

CHAIRMAN APOSTOLAKIS: Have you ever

presented this to the Subcommittee?

MR. FORESTER: No.

MR. KOLACZKOWSKI: To who?

CHAIRMAN APOSTOLAKIS: What you did in PTS in detail to us?

MR. KOLACZKOWSKI: Yes. Dr. Apostolakis, you were gone that day that we went through that in some detail. You were not present that day. So if at some point you want to hear that again --

CHAIRMAN APOSTOLAKIS: Which Subcommittee was that?

MR. KOLACZKOWSKI: The Metallurgical Subcommittee.

CHAIRMAN APOSTOLAKIS: Oh, come on. No, you didn't present it, Alan.

MR. KOLACZKOWSKI: Yes, we did.

CHAIRMAN APOSTOLAKIS: The Chairman is here.

MR. KOLACZKOWSKI: You were not present that day, but we would gladly present it --

CHAIRMAN APOSTOLAKIS: No, it's not. It's Shack.

MR. POWERS: No, it's Ford.

No, I'd like to have a meeting where you

guys come in here and with details, this is what we did, this who the experts were, this is -- I think that would be very enlightening.

MR. FORESTER: The next slide is just what we've been talking about in terms of developing those distributions.

And then I did have an example that from PTS to illustrate the process --

CHAIRMAN APOSTOLAKIS: Go through the example now or --

MR. ROSEN: Yes, why not?

CHAIRMAN APOSTOLAKIS: Okay.

MR. FORESTER: The example, the ten examples trying to show how we were treating the aleatory factors. So to avoid confusion, I'll make the point this is a fairly simple context.

The initiating event is a stuck-open ADV. And the human action, it's a single unsafe action that we're quantifying. It's a failure to isolate that ADV within 30 minutes.

You'll see that the scenario itself is very simple. There's only a few strongly important factors. This gives you the relationship between the procedures they've had, their training and the timing of the scenario are basically the critical

drivers of performance here. Because, again, we wanted to illustrate what was done at the aleatory factors.

So in this case you have a small secondary site depressurization which can lead to over cooling. That's a PTS concern. In order to achieve this action, since the ADV is stuck-open, they have to go up on the roof and use a reach rod to complete the isolation.

And the instructions for that occur -- to closing the ADV occurs in EOP 1.0. But the instructions to go to the roof occurs later in the excessive steam demand procedure at step 14.

Just in terms of the timing, it takes me five minutes to get to the step that says close the ADV in EOP 1. To execute the action, to diagnose the need for it, assign someone to go do it and complete the action is about 15 minutes. And note that it was estimated it would take about 15 minutes for the crew to reach step 14.

So the idea is they're going to have anticipate the need for this action, prepare for it ahead of time, if not go ahead and send someone before they even get to that step in the procedure.

So, again, the issue is they have the

procedure. They had trained on how to do this. And they have the timing concerns.

CHAIRMAN APOSTOLAKIS: We should go over it in a separate Subcommittee meeting I think.

MR. FORESTER: Okay. Go over it separately.

CHAIRMAN APOSTOLAKIS: Otherwise we have questions now, and it's too detailed for today.

MR. FORESTER: And then is the list of aleatory factors that they kind of came up.

CHAIRMAN APOSTOLAKIS: Crew having a bad day. How on earth do you know that? You don't know that.

MR. ROSEN: Well, it's true they have good days and bad days. It's just an aleatory fact.

CHAIRMAN APOSTOLAKIS: A lot of things are true, but we don't model them, okay. Having a bad day --

MR. POWERS: You're looking at it, I think, in the context of creating a model here. If I'm looking at this and creating a database, I'm taking a Monte Carlo sample of a distribution here. And I've got five or six people I'm going to take that distribution. And from those results I'm going to infer a distribution, in which case I want them

to sample out of the aleatory uncertainties. Sure, when they do that because I'm going to use that to infer to distribution.

CHAIRMAN APOSTOLAKIS: But to sample then, I have to have a distribution to sample from.

MR. ROSEN: No, no, no, no. No, you do not. Absolutely do not. You're using the sample itself to infer the distribution.

In a well known paper by an esteemed member of the ACRS showed exactly how to do that.

CHAIRMAN APOSTOLAKIS: Oh. Who was that? Wallis?

MR. POWERS: I had said esteemed.

MR. FORESTER: One particular one to note, this action has to be done out on the roof. If it happens to be snowing at the time, that could be a strong --

MR. POWERS: You want people to sample that and you want them to give the weight to that that they think it should be given. One guys climbs well on snow, thinks everybody climbs well on snow, he's going to give it a different weight than the guy that's afraid to walk out of his house when it's snowing.

MR. FORESTER: Correct.

MR. POWERS: But you want him to do that as he sees it.

MR. FORESTER: At least he considered it.

MR. POWERS: Because you're taking a Monte Carlo sample that you're going to try to infer what is the underlying distribution from that sample.

MR. FORESTER: Right.

MR. POWERS: And in that respect I think this is as well founded as anything I can think of to do this.

Now, the problem is with, what did you say, you had five or six peoples doing this?

MR. FORESTER: Right.

MR. POWERS: Is that you're going to get a relatively uncertain distribution, but that's okay. You can do something with that.

MR. FORESTER: We'll show you what we got on this one.

MR. POWERS: Okay.

CHAIRMAN APOSTOLAKIS: Ninety-ninth percentile is one. So there is one percent to go above one? Ah.

MR. FORESTER: That expert was making a

point.

CHAIRMAN APOSTOLAKIS: There goes what's his name --

MR. POWERS: George, if they'd written out .99995 you'd been all over their case for excessive precision. I mean, they can't win on this one.

CHAIRMAN APOSTOLAKIS: So?

MR. POWERS: Fair.

CHAIRMAN APOSTOLAKIS: Why do you relate it to the theory of probability here, but that's okay.

MR. POWERS: The point is it is highly likely they will fail, and they recognize that.

CHAIRMAN APOSTOLAKIS: That's right. That's right.

MR. KOLACZKOWSKI: The bottom line is what went into the PRA model. A histogram was built form that.

CHAIRMAN APOSTOLAKIS: The consensus? But you don't have to do that?

MR. KOLACZKOWSKI: And then that was put into the model.

CHAIRMAN APOSTOLAKIS: They agreed, no? That's good.

MR. POWERS: And then you can end up with a nice continuous distribution from this--

MR. FORESTER: Yes, we actually used the histogram.

MR. POWERS: What's more, if you treat this as a Monte Carlo sampling, and it probably isn't because it's not truthfully random sampling, but if you treat it that way, you can understand what your uncertainty in each one of the categories are.

MR. KOLACZKOWSKI: But for instance, this was very typical of the kinds of results we got during the PTS work when we did these elicitations. This is typical of the order of magnitude difference between the upper and lower bounds. Typical of the kinds of -- you know, if you approximated the mean value in this case, it would probably be around I'm guessing .1 or .2. They didn't give a high chance of success for this action in 30 minutes.

MR. POWERS: If you want to think about this distribution in or is it really the median.

MR. KOLACZKOWSKI: Well, as I said, really what went into the model was the whole histogram.

MR. POWERS: Yes. But when you

characterize this distribution, because it is so "tallish."

MR. KOLACZKOWSKI: That is true.

MR. FORESTER: So what?

MR. POWERS: It has such a long tail.

MR. KOLACZKOWSKI: Yes, it has a long tail. Skewed. Right.

MR. POWERS: Well, I can simply say I know what you're doing and -- I mean, it's as you say, I don't know how you do it any better than that given the constraint.

MR. KOLACZKOWSKI: It's an attempt because no one else has done it.

CHAIRMAN APOSTOLAKIS: No. I think this is the best you can do. I mean, I don't see what else you could do.

MR. POWERS: You can use anchor actions.

MR. LEITCH: With analysts 1 and 3, the 25th and 50th percentile numbers seem to be reversed from one what might expect. Is there some particular reason for that?

CHAIRMAN APOSTOLAKIS: What is this?

MR. LEITCH: One and three.

MR. KOLACZKOWSKI: Oh, yes, there must be a typo there. I'm sorry.

CHAIRMAN APOSTOLAKIS: One and three. What happens there again?

MR. KOLACZKOWSKI: I'm sorry. There's got to be a typo on this line. Something's wrong there.

MR. FORESTER: Yes, something happened.

CHAIRMAN APOSTOLAKIS: Something happened?

MR. FORESTER: Well noted. Well noted.

CHAIRMAN APOSTOLAKIS: Okay. Let me ask you a couple of questions because your next slide is your conclusions here.

One of the things that has bothered this Committee is when some real licensing actions like power uprates are submitted -- well, first of all, they use one model for HRA which was democratically elected as the proper model. And then they say, you know, in the baseline model the available time for the operators was 42 minutes. This was the probability. Now it goes down to 39 minutes after they operate and would change the probability a little bit.

All that is really arm waving and a qualitative argument that it is not going to change much, would have been good enough. But the question

is, though, because it will come up in the future, too, how do -- by the way, the same problem appears to be present in the case of common cause failures where now people are trying to design new reactors and they go to the PRA guy and say help me here. And the PRA guy says well common cause failures dominate. Why? Beta, delta, gamma. And the designer says tell me what to do to reduce them. They say I don't. I mean, they are .1 always.

And I think we're almost going the same way here. What can one do to figure out what the difference of 39 versus 42 minutes make? What difference it makes to the estimate? Do I have to go through the whole expert opinion elicitation process again? How do I figure out how sensitive the consensus distribution is to individual factors?

That's not your job right now, but is that something that we can think about for the future?

MR. KOLACZKOWSKI: I would just comment, like taking this example and the previous slide, I think John had a list at the end that showed these were main -- that last bullet. These were the things that the experts thought really, really drove the number. So if time available, for instance --

now, granted, we established a set time so that's time is sort of out of the equation. But, you know, I guess what we're saying is if you're looking at factor that they don't think is really dominate to the performance of that particular act, then you wouldn't have to go back and redo the whole thing. You'd say time is not an issue here, or at least we're talking about a few minutes time is not an issue.

CHAIRMAN APOSTOLAKIS: But you say problems in execution were an issue.

MR. KOLACZKOWSKI: Yes.

CHAIRMAN APOSTOLAKIS: And I'm coming back to you if that's the issue, I'm going to have special training in this particular action so Mr. Rosen will be happen and Mr. Leitch. They will see it, this is what we do.

Then if I come back to you and I say I have established this and I've spent some money doing it, can I change the distribution now? Probably you can't with what we know now, we can't. And as long as we were dealing with assessments for existing reactors, this was not a major problem. But future reactors, I think we are -- and I see it already in the common cause failure area where

people are throwing their arms up and saying --

MR. POWERS: Here's the problem, George.

CHAIRMAN APOSTOLAKIS: What?

MR. POWERS: It seems to me that the guys that are designing advanced reactors don't have the table that we saw before and they don't have the redlines that see here.

CHAIRMAN APOSTOLAKIS: For human, you're right.

MR. POWERS: And so -- and I think their desperately handicapped because if you looked at those tables and you told me that I have an EOP action that at the 99th percentile three out of four guys that know this plant pretty well think there's a greater than 50 percent chance of failure on this thing, I'm going to be upset. I'm going to want to know why. And --

MR. ROSEN: And I want to know what I can do about it.

MR. POWERS: And if they tell me that the potential for bad weather, then I'm going to figure out some way that they don't have to go out into the weather to fix that thing.

MR. KOLACZKOWSKI: Exactly.

MR. POWERS: And if they tell me that

it's slow and nonaggressive truths, I'm going to go talk to my trainers and say you got a problem in the way you're training these guys. And they tell me the ADV indicator sucks, I'm going to say fix the damn thing. Because I can't live with -- it's not the low numbers that bother me, it's the higher percentiles. And that's the thing that these guys are getting out of this stuff that's so exciting is instead of giving me it's .01 at 41 minutes and it goes to .13 at 39 minutes; they're telling me in the extreme when the crews do have bad days, when there is bad weather I've got a problem. I don't have a problem at the median. I got a problem on those rare bad days.

MR. ROSEN: There's some actionable stuff that comes out of this.

MR. POWERS: And it's actionable. And I agree, one of those is actionable.

CHAIRMAN APOSTOLAKIS: I agree. But the question is can we do a little better in providing guidance? I mean, that's not your job here. Maybe in the future as to how these numbers -- I mean according to what Dana said, I can always go back to the designer lists and say now I've done this, would you still give me this 90th percentile, right? But

that means repeating the expert opinion elicitation process, which is kind of --

MR. POWERS: Well, I mean, what I can do is go through and look at the documentation --

CHAIRMAN APOSTOLAKIS: I can do it myself. I can do it myself.

MR. POWERS: I mean the redlines here tell me everything I need to know if I had that table, and the redlines -- if I'm designing or fixing a plant --

CHAIRMAN APOSTOLAKIS: Yes. Yes. Absolutely.

MR. POWERS: -- I don't need to know anymore.

CHAIRMAN APOSTOLAKIS: Absolutely. And in the common cause failure area, unfortunately, we don't have that.

MR. POWERS: Well, what I see is the advanced reactors running are running around making plausibility argument; oh this is tough to do and this other thing's not tough to do. And they don't have this.

CHAIRMAN APOSTOLAKIS: They don't have it. They don't even want to think about it at this stage.

MR. POWERS: Yes, they don't even know how to think about that.

CHAIRMAN APOSTOLAKIS: At this stage it's really can we reach this temperature and so on.

MR. POWERS: You guys ought to go do about a zillion of these and publish a book of them.

CHAIRMAN APOSTOLAKIS: In general, though, anytime you rely on experts to create some consensus, you have that problem; that the result we don't know how sensitive it is to individual, even though we may take action to remedy some of the problems we have, like in this case problems with execution. You know, we do something about it.

But that's not your problem. I mean, I'm just saying that this is something, especially the CCF issue, I mean the guy's .1. What if I do this? Well, .9. Hey, big deal.

MR. POWERS: I mean you're complaining about something that these guys can't fix for you.

CHAIRMAN APOSTOLAKIS: I know.

So you're done, John. Thank you very much. You did very well.

MR. FORESTER: Thank you.

CHAIRMAN APOSTOLAKIS: Susan, we're supposed to go to lunch at 12:00. How long do you

need? You have 15 minutes. Can you do it in ten?

DR. COOPER: I could do it in five, it just depends on how much you want to talk.

MR. POWERS: George, she can do it in five. You can't do it in five.

CHAIRMAN APOSTOLAKIS: Plans for improving ATHEANA practices.

MR. POWERS: Let me go eat.

CHAIRMAN APOSTOLAKIS: Let's go eat. But you will shorten it a little bit and meet back at 1:00?

MR. POWERS: Why don't we be back at 20 minutes after 1:00.

CHAIRMAN APOSTOLAKIS: One hour from now? Okay. A full hour. We're back here at 1:20.

(Whereupon, at 12:20 p.m. the Subcommittee adjourned, to reconvene this same day at 1:22 p.m.)

A-F-T-E-R-N-O-O-N S-E-S-S-I-O-N

1:22 p.m.

CHAIRMAN APOSTOLAKIS: So the next presenter is Dr. Cooper.

DR. COOPER: Yes. Are we ready?

CHAIRMAN APOSTOLAKIS: Yes.

MR. POWERS: How do you know if she's ready? You only know that you're ready.

CHAIRMAN APOSTOLAKIS: We have a quorum here. Well, there's on quorum in the Subcommittee meetings, right?

MR. POWERS: You cannot have a Subcommittee by yourself.

DR. COOPER: Yes. This portion of the talk is to address the improvement in ATHEANA implementation.

And we have just a short presentation. We only have to do this one time.

The issue with regard to ATHEANA implementation is that in the past we have had comments that the implementation of ATHEANA is cumbersome, the document is large. As you know from some of the presentation this morning, we've done some additional work since NUREG-1624 Revision 1 was published. And we also have had some applications

of ATHEANA, and there's some lessons learned from those applications that we could share with potential users.

The solution to those issues is to have an addendum to NUREG-1624. This addendum would include an up-to-date description of the quantification approach including the approach to the uncertainty analysis, although we're just in the planning stages for what this addendum would include. Other topics that we think that would be appropriate to address would be to focus in on some of the specific tools that are discussed in 1624 that would be most useful to a HRA practitioner. For example, we could exclude from this addendum the lengthy description of the knowledge base, you know, the theoretical background. Also the approach for evaluating events. But we would include the process, the HRA process that ATHEANA provides including the search process for human failure events and the search process for deviation scenarios.

Additional new information that we could include in this addendum would be some more practitioner guidance what we could call "fast-track" approaches for applying ATHEANA.

The way ATHEANA is written right now

there's the implication that you do all of ATHEANA or none of ATHEANA. And that's not really the way the applications have worked out, for example with PTS. We discovered that we did not need to exercise fully the deviation search process and there were some other aspects of the tools that ATHEANA provides that didn't need to be used in doing the application for PTS.

In addition, there are lessons learned from the ATHEANA applications that we could discuss. Some of those may include some of the things that we discussed this morning about the expert opinion elicitation directed by the facilitator and some improvements there.

Anyway, these are some of the examples of topics that we think would be appropriate to include in the addendum to NUREG-1624. It is in the planning stages right now. We have a draft that should be ready soon of what might be included, but that work will be probably starting this summer.

MR. POWERS: Are you proselytizing ATHEANA?

DR. COOPER: Well, you mean in this document or as I'm speaking this moment?

MR. POWERS: Generally.

DR. COOPER: I'm one of its developers, so I guess you could say that I am one of its apostles.

MR. POWERS: Well, no. I'm wondering is, I mean are you trying to convince the world to use ATHEANA?

DR. COOPER: I would say that --

MR. POWERS: Proselytizing means with religious fervor that you're trying to --

DR. COOPER: I would say trying to make it more accessible to people so that they're not dissuaded from using it because of some of the criticisms that it seems like it's too big of a project to undertake and that -- of course, we have a quantification process that's not been document in NUREG, just in a paper. So there are bits that are not there.

So I guess in a sense you could say that's true, but really it is more of a users guide to try to better be able to use the tools in ATHEANA and also to have the up-to-date tools for ATHEANA. Provide some examples also as to how it was used. The examples in the NUREG are realistic in the sense that there is real plant information in it, but we did not exercise the process as we did for the PTS

studies.

MR. POWERS: Are there things like ATHEANA user groups and --

DR. COOPER: Not that I'm aware of.

MR. POWERS: And trying to convince the Europeans to adopt this?

DR. COOPER: Not specifically.

MR. LEITCH: Could you contrast for me between ATHEANA and SPAR-H? Was SPAR-H derived using ATHEANA or are they similar, or am I going two different tracks on that --

DR. COOPER: I'm not very familiar with SPAR-H, but my understanding is that SPAR-H was supposed to incorporate some insights from ATHEANA. But SPAR-H was not developed from the ground up. You know, from basic behavioral models and stuff like that using event analysis and stuff like that, moving forward with the model and so forth. That's the way ATHEANA was developed. SPAR-H is trying to use, as I understand it, tries to use some of the insights from ATHEANA but is not developed the way ATHEANA was. Nor does it have the same intent.

MS. LOIS: Bruce, you want to try to answer.

DR. COOPER: Yes, that's probably a good

background.

MR. HALLBERT: The SPAR-H method was developed in a response to a request from NRC to support their reviews of event information operating experience that was coming in and for a method that could be used in trying to update the conditional core damage probability and other risk matrix.

I think that it did benefit a lot from the thinking that was present in ATHEANA. It does rely upon some behavioral models and provides information about behavioral sciences literature that was inspired by.

It does provide a very direct and very accessible approach for analysts to conduct quantification.

I think the initial inception of SPAR-H sort of assumed that the errors were brought to the analysts and so there was not as exhaustive a search strategy, nor was there necessarily an attempt to try to identify base cases and deviation from base cases, which is very much the flavor of ATHEANA.

So I would say, you know, I think that they do different things. They were probably inspired by different needs. I think that they would probably suit different applications very

well.

I mean, I could imagine in my own mind using them for different things.

MR. LEITCH: Okay. Thank you. It helps.

MR. HALLBERT: If that helps you.

CHAIRMAN APOSTOLAKIS: Next slide?

DR. COOPER: That's it.

CHAIRMAN APOSTOLAKIS: Okay. Next speaker then.

MS. LOIS: Yes. The next slide is on data development and probability transition slide for Bruce Hallbert to talk to us about the domestic criteria on developing data. I just want to remind you that last year we did all of the prototype and we developed the processes for collecting information and now we're more into loading the database with events and are looking at the quantification aspects. So with that, Bruce. Go ahead, Bruce. Go ahead.

MR. HALLBERT: Okay.

The presentation I'm providing this afternoon is on the project system we call HERA, the Human Event Repository and Analysis System.

CHAIRMAN APOSTOLAKIS: She was the wife

of Zoos.

MR. HALLBERT: As we discussed this morning, HRA influences the uncertainty of PRA results and specifically the problem in the strength of available date contributes to this. So the issue for us is that data are needed to develop models and to estimate probabilities for use in probabilistic risk assessment.

Recognizing this need and the fact that data are sparse, while they may be sparse is there is still a lot of information or we might evidence about human performance available through a number of sources. And our thinking has been to both look at Bayesian methods that would allow us to use this type of information in developing estimates of human error probabilities.

Our solution then in this project is to develop a system called HERA to develop data that are relevant and qualified for use in human reliability analysis, and along with that to develop and apply the techniques to use the information from HERA to estimate human failure event probabilities.

The background for this, as we all know, human reliability methods do use structured processes to identify potential human failure

events, as well as to estimate the likelihood of human failure probabilities. Most of these methods also either permit or direct the analyst to take account of conditions that are present at the time that performance occurs, as well as a context in which they're going to happen.

Many of the approaches do identify the types of conditions that may be important and provide some guidance on how to account for their effects. Although there is some variation among human reliability methods as to which performance shaping factors to account for, and specifically how those performance shaping factors are accounted for. And by that I mean the types of ways they are assigned, the importances that they're assigned, the specific mathematical models, whether the performance shaping factors or coefficients have a linear model or whether they're in the exponent of an exponential distribution.

So as a result of these things, there is still considerable analyst judgment that is applied. And as a result, these things sort of all combine and contribute to the fact that differences both in the magnitude of these types of effects as well as qualitative differences as to which performance

shaping factors are accounted for continue to contribute to the uncertainty in the resultant risk metric.

The objective of HERA is to provide information about human performance from PRA relevant settings that includes information about the kinds of conditions that affect human performance that are consistent with the way that human reliability analysis treats human performance. So we want to support both human factors as well as human reliability analysis activities.

The approach in general to this project, if I were just to summarize it into these five steps, has been that we have reviewed a number of information sources and we've identified some sources of information that we believe can be used to inform human reliability analysis activities. And the last time that I came here before the ACRS we talked about some potential sources of information.

We have worked on developing a formal process for analyzing these kinds of information and on the methods to extract HRA-relevant aspects from those information sources.

Based on that approach, we have

performed of analyses of information on these candidate information sources and we have extracted information, HRA-relevant information. Along with that, we have developed a repository that we use to store information about this. And the intent there is to make the information available not only within a stand alone system but to integrate it or to design it with integration in mind with other NRC information systems.

Along with that, as I mentioned earlier we are enhancing the capability to use this information using Bayesian type methods.

CHAIRMAN APOSTOLAKIS: Now this information you're collecting will be made available to the experts during the process we discussed earlier by the facilitator?

MR. HALLBERT: That's one of the things that could be done with it. I want to point out that right now the HERA system does not have a front end to it. It does not have a user interface. So what I'm describing right now are basically data develop and extraction activities that are going into a system. The next phase, you know, we would hope would be that we would look at some of the kinds of activities that HRA analysts would use the

information and how we would structure the front end to support different users and uses of that information. We still need to do that.

CHAIRMAN APOSTOLAKIS: Right. But, I mean, when you develop Bayesian methods, you're developing some sort of distributions.

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: And you don't want to preempt the expert opinion elicitation process that ATHEANA has?

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: So presumably these kind play the -- like in the SSHAC report where all sorts of analyses that were done on various models, you have the attenuation model of this guy and these are the results. So all this information is presented as a group of sensitivity analysis perhaps to the experts and then you go through the process. But you have to have some idea.

MR. HALLBERT: Yes.

MS. LOIS: Exactly.

CHAIRMAN APOSTOLAKIS: You're objective is not to develop the distributions for --

MR. HALLBERT: No. Exactly not.

MR. ROSEN: You're not giving this stuff operating crews like was described earlier, are you suggesting that?

MR. HALLBERT: We're not doing anything with this in terms of --

MR. ROSEN: Yes. I mean, that seems to me -- I'm not sure that that would be particularly useful.

MS. LOIS: The intent here is more for the analyst to chose event situations, context that are similar to those that he/she will have to analyze and create a distribution that would help him enhance his capability to make decision about the current situation or just straightforward an approach and update his estimates.

MR. ROSEN: Yes. What I was saying is you're using it in that way is fine. But to give it to subject matter experts like trainers and operators and all that, they'd just be dumbfounded.

MR. HALLBERT: I agree. This is something that's specifically designed to support, you know, PRA and HRA analysis. And it is, as I said and I would really emphasize, we haven't completed development or really started development of the front end or the user interface to figure out

how to extract the information or how to present that for different purposes.

MR. LEITCH: Right. So that I understand here, the NRC information system might be something like licensee event reports, for example?

MR. HALLBERT: Exactly.

MR. LEITCH: And you would look through those and screen them for where human reliability issues were involved?

MR. HALLBERT: That is in fact -- that's a couple of slides from now, but that's exactly what we're doing. Yes.

MR. LEITCH: Yes.

MR. HALLBERT: That's one of the human resources we're using.

MR. LEITCH: The hard thing about that, when assessing probability of failure, and maybe that's not one of the purposes of this, but you don't know how many times that operation was done and went perfectly without a hitch. You tend to find out just about the times there were problems.

MR. HALLBERT: True. And then there's been a problem, you know, in the past with human reliability data because if we take sort of the frequentist approach where we want to count the

number of opportunities and identify the number of errors, we simply have never had access to that kind of information.

MR. LEITCH: Yes.

MR. HALLBERT: But if we take more of a Bayesian approach and we look at events where there are opportunities to succeed as well as to fail and try to understand the conditions that were present at the time, and collect events in which successes and failures occur, then I think we can treat that information to develop more conditional failure probabilities. And that's more also in line in thinking with sort of the type of calculational approaches that more of the second generation methods are trying to employ.

MR. LEITCH: You're not going to get that kind of data from LERs, right? I mean, there may be other sources that would be helpful, but --

MR. HALLBERT: We'll get some information from LERs that can contribute to that that we'll say, for example -- I'll come to some of that in just a couple of slides here.

MR. LEITCH: Okay. Okay. Yes.

MR. HALLBERT: Hopefully, I can -- okay. So initially, we consider several

courses of information such as operating experience, the behavioral sciences literature, simulator studies data as well as from other industries. And we began and are currently working with the operating experience sources such as LERs and augmented inspection team reports and the like. We also have access to other information beyond that.

The reason for that is that this information is highly applicable to the NRC mission. It's implicitly risk-relevant. It's been reviewed fairly well.

From the perspective of providing sort of a complete record of what happens in some of these events, these sources provide information about what goes wrong sometimes in events, as well as what goes right. So with some additional analysis we think that they also provide information about the kinds of performance shaping factors that are sometimes present in operating experience and that may contribute to human performance.

The structure of HERA and specifically the kind of information that we're working on extracting from these sources are summarized in this slide here.

The first is that there is an event

summary which are the basic demographics of operating experience: Dates, licensees, the plant, the initiating event, the basic events and things like that as well as the source documents that were employed. So if we're working for LERs, for example, there will be links directly to the LER source documents. If an AIT, we'll link as much as possible to information from the LER that's available.

It's frequently the case that there are multiple sources involved in every analysis that we perform. So it's not just one source that we use. We try to use as many sources are available and provide information.

The next thing that we do is we provide a graphic time line and descriptive information for what we call subevents. In other words, in many of these cases you have some pre-initiator failures that you identify after the fact. You then have an initiating event and you have a combination of human performance, some of those successful and some of those unsuccessful. And we try to document those on a time line so that an analyst can see the most salient things that occurred and that contributed to the event, both in terms of its initiation as well

as its recovery.

We identify within our system, you know, the performing organizations that were involved and contributed to the performance of the systems, the types of activities that occurred. For example, we use sort of a taxonomy of action and diagnoses which is consistent with most HRA methods these days. We further subdivide that information into, as I said, pre-initiator, initiator and post-initiator actions, which is consistent with PRA.

Provide information about successes as well as failures, distinguish between active failures versus latent failures. And we describe information as best we can about performance shaping factors.

The specific performance shaping factors that we describe are consistent with the type that are described in the SPAR-H HRA method. The reason for that is that there was a very thorough review of performance shaping factors in HRA methods that was performed as part of the SPAR-H development and we feel like most of the PSFs that are used in HRA, at least by many of the methods, are addressed by those SPAR-H performance shaping factors.

We then describe information in there

about plant conditions, specifically the factors that contributed to the events involved in the operating experience. And then we talk more about the function system unavailabilities, and very importantly we try to identify where possible dependencies.

CHAIRMAN APOSTOLAKIS: Are you doing the root cause analysis? It sounds to me like what you're doing.

MR. HALLBERT: No, we're not doing a root cause, per se.

CHAIRMAN APOSTOLAKIS: But a lot of it is root cause analysis, is it not?

MR. HALLBERT: I think some of the information in here might be.

CHAIRMAN APOSTOLAKIS: I mean, the PSF information, the plant conditions and all that; is that what you're trying to find in --

MR. ROSEN: Well, the LER will have some kind of root cause analysis, assuming this is an important event, which I think you are.

CHAIRMAN APOSTOLAKIS: The AITs have--

MR. ROSEN: The LER will be, you know, a quick one. Be what, a 24 hour, a 72 hour LER. And then a follow up report usually 30 days from the

date of the occurrence, which has the root cause analysis in it. And that will be rich, if it's a good one, in PSFs and whether it was a pre-initiator, initiator, post-initiator. Something about the dependencies, function system --

CHAIRMAN APOSTOLAKIS: But are these available to the NRC?

MR. ROSEN: Yes.

CHAIRMAN APOSTOLAKIS: They are?

MR. ROSEN: Yes.

CHAIRMAN APOSTOLAKIS: So it sounds to me like that's what you're doing. Essentially a lot of what you're doing is really the root cause --

MR. ROSEN: No, they're not doing a root cause analysis. They're extracting it from the LERs.

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: Right. But it's a root cause analysis information?

MR. ROSEN: Yes. Root cause analysis information or the human actions described --

CHAIRMAN APOSTOLAKIS: Yes. Yes. With human actions involved.

MR. HALLBERT: Well, some of this information is very similar to the types of things

you do in a root cause analysis. But I think root causes analysis has a different connotation that what we're trying to -- what we're intending to perform here.

CHAIRMAN APOSTOLAKIS: Yes. You are not actually doing the analysis because you don't have access to the information at the plant.

MR. HALLBERT: Exactly.

CHAIRMAN APOSTOLAKIS: That's why the augmented inspection team reports --

MR. ROSEN: You'll have that report in some cases

CHAIRMAN APOSTOLAKIS: -- are really very useful here.

MR. HALLBERT: Yes.

MR. ROSEN: But you're going to extract what those reports, the augmented inspection report and the licensee's root cause analysis from his follow up LER, extract the important in that. For instance, you have in this slide from that and then put it in the database.

MR. HALLBERT: True.

MR. ROSEN: You're not trying to make any independent -- draw any independent conclusions about the event?

MR. HALLBERT: Occasionally where the information has not been collected in the way that you're talking about, we try to integrate that from whatever sources are available to us. So we use whatever sources are available, as much as possible, to integrate and provide as complete a record and description of these things as we can.

CHAIRMAN APOSTOLAKIS: Wouldn't it here, especially when you're talk about performing organizations, wouldn't a work processes be important there?

MR. HALLBERT: Absolutely. I know of no other way to assess the issue of dependency because, you know, many of the pre-initiated failures, those work processes imply that dependency, the major dependencies is that sort of one might believe, as I do, contribute to those pre-initiative failures.

CHAIRMAN APOSTOLAKIS: We did something like this at MIT some time ago. And it turned out that the prioritization part was really prominent everywhere.

MR. HALLBERT: In fact, I was hoping if we had the time here to ask you some more about some of that because I was hoping to follow up on some more of that information.

Okay. So in general, the process model for this extraction works something like this. At sort of a lower level we're calling event description information, which is fairly objective from the reports and information that are available to us. And then from that we're trying to analyze the events to identify, first of all, what were the errors and what types of errors occurred. And then as we move up -- move through the information we try to identify the types of things, the types of information that tells us about what contributed to those errors. For example, did we have people that were working without their qualifications current. Was there some lack of communication between two performing organizations doing something on a common system at the same time. Or, as we move up higher, were there some cognitive linkages between actions, and this is where we might start getting into the issue of dependency.

For example, you know, somebody sees something. They believe it's one thing until their actions sort of follow from what they believe.

MR. POWERS: Maybe it's trivial, but I'm going to ask anyway.

It sounds to me as you go through this

thing you're digging deeper and deeper into it. Your slides shows you going upward and upward. I mean, am I missing some significance here?

MR. HALLBERT: Maybe this is the inverse of the how best human factors --

MR. POWERS: The triangle doesn't mean anything?

MR. HALLBERT: Well, I guess you could say that as we move up the triangle that there's less and less information to extract because we're extracting it.

CHAIRMAN APOSTOLAKIS: Or you're moving to higher levels of abstraction.

MR. HALLBERT: Higher levels. Right.

CHAIRMAN APOSTOLAKIS: Put that in a parallelogram.

MR. POWERS: It could have been left off altogether.

MR. HALLBERT: Maybe next time I'll make a Venn diagram and see how that works. Okay.

CHAIRMAN APOSTOLAKIS: Error types, what does that mean?

MR. HALLBERT: On the slide previous as we talked about whether it was an active failure of execution, whether it was more of a cognitive

failure.

CHAIRMAN APOSTOLAKIS: Oh, these are not phenotypes and genotypes?

MR. HALLBERT: No. No. Nothing like that.

CHAIRMAN APOSTOLAKIS: Everybody has his own nomenclature, except me.

MR. HALLBERT: And we're not espousing a particular HRA method here. We're trying to provide information that will support --

CHAIRMAN APOSTOLAKIS: But you guys today are so above the fray. We're not espousing anything. We're just up there.

MR. POWERS: But you ought to use ATHEANA, nevertheless, right?

CHAIRMAN APOSTOLAKIS: Out of our references, six out of seven are ATHEANA.

MS. LOIS: I definitely used SPAR-H.

CHAIRMAN APOSTOLAKIS: What?

MR. HALLBERT: So this slide tells us a little bit about the kind of information that we have extracted so far. I'd like to emphasize that to this point this project has been an R&D project; big R and sort of small D. We've been working on the process to extract information. And so during

our first fiscal year we focused on events that involved emergency diesel generator failures. The reason why we focused on that particular subset because the systems were fairly similar and so in the process, as we're trying to extract information, that would give us a chance to develop our method with similar systems.

MR. LEITCH: And does that mean failure to side and synchronize on demand? Is that what you mean by failure or is --

MR. HALLBERT: These were any tech spec violations or LERs that related to emergency diesel generator failures.

MR. LEITCH: Okay. Now, was 12 -- certainly not all of them, right? They selected these 12?

MR. HALLBERT: I think that there's a time period in here, I don't recall what the time period was, but over some period of time they identified 12 EDG failures from LERs.

MR. LEITCH: And then you looked at all 12?

MR. HALLBERT: Yes.

MR. LEITCH: It wasn't like these are 12 selected ones? I mean, they're selected by a

particular time period?

MR. HALLBERT: Yes.

MR. LEITCH: Right.

CHAIRMAN APOSTOLAKIS: This is the totality of the events in a particular time period?

MR. HALLBERT: Exactly. That's our entire sample.

MR. ROSEN: There are probably hundreds out there.

MR. LEITCH: Not in this time period.

MR. ROSEN: No, no. But if you look at the whole from say from whenever we started taking good data, from say back 1980 maybe?

MR. HALLBERT: Yes. It was a more limited focus I think in terms of the number of years.

And from those 12 events --

MR. ROSEN: Well let me ask you another question.

MR. HALLBERT: Yes.

MR. ROSEN: How recent was it? And the reason I ask it is that the reporting in LERs has improved progressively over this time, say from 1980 to the present. And in the early days what we got was something broke and we fixed it. And now it's

okay because we tested it. And that's all. You don't get any of the human performance context in the early years.

CHAIRMAN APOSTOLAKIS: Right.

MR. ROSEN: You have to look for some quite more recent stuff before you get any --

CHAIRMAN APOSTOLAKIS: That's why the AITs are really the most important source, because they go into human --

MR. ROSEN: But even the LERs now do that. But --

CHAIRMAN APOSTOLAKIS: To some degree.

MR. ROSEN: My point is that there is a spectrum as you go back in time to where you get almost no information on human performance.

CHAIRMAN APOSTOLAKIS: Right.

MR. HALLBERT: These were within at least the last five years.

MR. ROSEN: Okay. And I want to make one more point. Is if you picked the wrong time frame, again, you get exactly the wrong answer on human performance. I mean, if you pick, you know, this thing broke and we fixed it, no human had any hand in it.

MR. HALLBERT: Yes, I understand that.

MR. ROSEN: And you're going to get the wrong answer because they simply didn't talk about it.

CHAIRMAN APOSTOLAKIS: You were self-healing.

MR. ROSEN: Yes. That was right.

Self cause and self healing.

MR. POWERS: Probably intimately related to the retirement of people that had their training I or from subordinates of the Admiral Rickover.

MR. ROSEN: A complicated point, I'm sure.

MR. POWERS: And he simply didn't believe in human factor.

MR. HALLBERT: We're now processing this year information from events related to common cause types of failures.

CHAIRMAN APOSTOLAKIS: Involving humans?

MR. HALLBERT: Involving humans, yes.

CHAIRMAN APOSTOLAKIS: What kind of common cause failures are you talking about?

MR. HALLBERT: I can't -- I can't tell you that right now because I honestly don't know.

CHAIRMAN APOSTOLAKIS: Okay. Fine.

MR. HALLBERT: But we'd be happy to come

back and brief you on that.

CHAIRMAN APOSTOLAKIS: I mean, except besides just normal ones that we consider, like maintenance related and so.

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: Because we've looked for those and it's very hard.

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: Very hard.

Okay. Go ahead.

MR. HALLBERT: In addition --

MR. LEITCH: We heard an example last week that would be interesting. I think it was at a foreign plant, though, so it wouldn't be in this database. But I just thought it was interesting. A miscalibration of a torque wrench. And it was a common potential failure. As I recall, they found it before there was any problem, but they mis-torque, seriously mis-torqued a number of valves.

MR. ROSEN: Hopefully, it was too little torque, not too much.

MR. HALLBERT: So as I was saying --

MR. LEITCH: I think it was too much. I think they found it, though.

MR. POWERS: It's really easy to do too

much.

MR. ROSEN: Too much, you can damage the components.

MR. HALLBERT: So as I was saying, in these event analysis -- or sorry, in these extraction activities we consider both examples of successful human actions as well as failures. And in the time period where we were analyzing the emergency diesel generator failures as well as a couple of AITs that we looked at as well, we identified approximately 80 activities or 80 events. We produced 80 records in that period in which we analyzed all these things that I was telling you about previously. And typically what we find is that between four and five on the average unsafe acts or human errors and two positive human actions which are successful human actions in the LERs. And similarly when you look at the augmented inspection team reports, those are typically more significant, more serious and we typically find between nine and 14 unsafe acts per AIT analyzed event.

MR. POWERS: If the LER events had been analyzed in the depth and care that the AIT events were analyzed in, would your three to four go to nine to 14?

MR. HALLBERT: I don't know if there is something qualitatively different between the AIT events themselves per se and the LER events or whether it's merely a matter of the degree of detail that's been applied to them. I suspect there are some qualitative differences. How much that would effect what we would find if we analyzed --

MR. ROSEN: Well, the LERs are probably written in accordance with the LER requirements, the guide. And the AIT is done in accordance with its procedures. So they have to go back to the procedure for doing AIT and buck it against the procedure for writing LERs, and there may be differences.

MR. HALLBERT: So that sort of describes the process and the status of developing data and extracting data from one source operating experience. The question then that we asked ourselves is how might we use some of this information, how we might imply it to inform our analyses of human reliability for risk-informed applications.

So concurrent with this data development and extraction activity, we've been working on methods to produce quantitative results. And as I alluded to earlier in this presentation, we're

focusing on Bayesian methods as being an approach for using information that we extract.

The reasons for that are, as you can see here, Bayesian methods allow a greater use of information. We can use them to produce parameter estimates from the observations that we're extracting from these operating experience.

Another thing that's important is that the Bayesian methods account for casual and conditional nature of performance and context. And that is important, that was important to us from the outset that whatever method we choose should be sensitive to these types of issues and provide some sort of linkage to them.

On the right side here, it's just sort of a description of the general approach and process. And there really is nothing unique at this point about applying it to this type of data versus any other type of data.

CHAIRMAN APOSTOLAKIS: You don't need to convince this Subcommittee of that.

MR. HALLBERT: Okay. Here's an example. I don't want to focus in too much detail on a particular system that we chose here, which was service water, because there are a number of plant

specific differences between plants.

But essentially in an analysis the person that did this found four sources of information that had provided estimates of human probability to recover a failure of service water, nuclear service water. And they're from these four sources. One was NUREG-5319, which I believe was the Oconee PRE for sensitivity to human error. The second was the former system NUCLARR. The third was an analysis that these people performed using the SPAR-H, and this is a previous version of the SPAR-H, like one revision past. And then the fourth was in the ATHEANA document it describes also human error for nuclear service water recovery.

Yes.

MR. ROSEN: When you say failure of service water, do you mean a train of service water or a complete function failure?

MR. HALLBERT: That's one of the challenges of what we have right here. This has both in it. It's not just the recovery of one train or two trains. There was not a complete failure to recover service water in --

MR. ROSEN: I should think not. We'd be hearing all about if there was.

MR. HALLBERT: Yes. Right.

MR. ROSEN: So it's the failure of function of maybe one portion, one train perhaps?

MR. HALLBERT: I think the human reliability analysis here was for the human failure to recover service water given a failure.

MR. ROSEN: But there is no failure. So it's when you have two trains of service water, or three as some plants do, you're usually running one train or maybe two. And if you have a train failure, well you're going to start getting heat up and the other operators have to take an action to secure the failed train and start the standby train, or maybe operators don't have to do anything in some cases. It may be automatic.

So, we're talking about failure recovering the train. There is never a loss of service water.

MR. HALLBERT: Right.

MR. ROSEN: I mean, except in extreme cases, and it could happen.

MR. HALLBERT: And I personally don't recall exactly what these HEPs up here correspond to if it was for one train or two trains.

MR. ROSEN: -- train or functional

failure.

DR. COOPER: The analysis I think is for a total service after failure.

MR. ROSEN: Now that point 6 days if you have to total service water failure, you're not going to recover --

DR. COOPER: Reports a certain set of circumstances defined in the analysis, which is 1624 revision 1 appendix D I think.

MR. ROSEN: Oh, I'm not arguing the point. I'm just saying what it means.

DR. COOPER: Yes. Well, anyway -- I was trying to find it in here. But I think it is for the total loss.

MR. ROSEN: Is your point also that these numbers are very different, all the way from 10 percent to 60 percent?

MR. HALLBERT: Actually, my point here would be that when you combine the information from these different sources -- when you try to pool them, you have a likelihood function in the Bayesian method and each of these four sources were used. And you know that the sums of these have to sum to one.

CHAIRMAN APOSTOLAKIS: Wait a minute.

Let me understand here.

MR. HALLBERT: I think that this simply reflects the likelihood that --

CHAIRMAN APOSTOLAKIS: What likelihood is that? Is that a likelihood function or just probability?

MR. HALLBERT: This is the likelihood of -- the likelihood that the analyst assigned --

CHAIRMAN APOSTOLAKIS: So it's the probability?

MR. ROSEN: The probability of not recovering service water.

CHAIRMAN APOSTOLAKIS: According to -- because one line above you say the likelihood function. So you say the word likelihood in two places, but they mean different things?

MR. HALLBERT: Right. They do. These are the likelihood.

CHAIRMAN APOSTOLAKIS: So let's call this probability.

MR. HALLBERT: I think that this is the likelihood function, actually. This is the likelihood function here and we're saying that in terms of when you have these four sources and you're trying to pool them, you have to wait them.

CHAIRMAN APOSTOLAKIS: Yes.

MR. HALLBERT: And so the analysts said that they gave it a weight of .6 --

CHAIRMAN APOSTOLAKIS: Oh, these are the weights? They're not probability?

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: Oh, these are the weights. It's not even likelihood then, these are the weights to the sources?

MR. HALLBERT: These are the weights to the source --

CHAIRMAN APOSTOLAKIS: Okay. It's not likelihood. The second word likelihood should not be there.

MR. ROSEN: The weights to the sources. Now I understand it because now you're not talking about a train or a function, you're just talking about how much you believe each source.

CHAIRMAN APOSTOLAKIS: But you still don't know what each source or not is.

MR. ROSEN: No. No, we don't know that.

MR. HALLBERT: Yes, and that's not presented.

MR. ROSEN: You're saying you believe ATHEANA a lot more than you believe SPAR-H?

MR. HALLBERT: Exactly.

CHAIRMAN APOSTOLAKIS: Which is a coincidence, I guess, of course.

MR. HALLBERT: Well, no. Actually, what it was was they -- and I talked to the people that performed this analysis. And what they said was that ATHEANA developed about 30 pages of write up to considering the scenario and the context and the conditions that would give rise to human failure.

CHAIRMAN APOSTOLAKIS: That's fine.

MR. HALLBERT: The SPAR-H, the analysts understood the event and these other two they just picked information out of the source.

CHAIRMAN APOSTOLAKIS: One of the problem -- well, that major problem that people could try to pool different sources of information together is the dependencies among the sources.

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: And in the PRA business, you know, when you are about to produce something the first thing you do is go back and see what exists, right? So I don't know that the SPAR-H HRA is really independent of the risk sensitivity to human error or NUCLARR. Not that -- you know, this is a natural way people do business. So when you

see .1 NUCLARR and .1 NUREG-5319, who did -- which regulatory developed 5319?

MR. HALLBERT: That was Brookhaven.

MR. ROSEN: Yes, we don't believe them.

CHAIRMAN APOSTOLAKIS: Brookhaven. Okay.

MR. HALLBERT: That was a risk sensitivity human error study where they showed more of the bathtub curve --

CHAIRMAN APOSTOLAKIS: Yes. Yes. Yes.

So I think that's really where the issue is, when you put information together.

MR. HALLBERT: I agree. I mean, I think that that's -- and we -- now I'm not trying to say that we have solved that issue. I was just trying to show --

CHAIRMAN APOSTOLAKIS: No, no. I'm just pointing out that this is really one of the major issues.

MR. HALLBERT: It is. As well as the priors.

CHAIRMAN APOSTOLAKIS: So you're saying that the ATHEANA estimate is the most believable one?

MR. HALLBERT: Only for the illustration

here. We're not trying to suggest that this is a result that we want to communicate. What we're trying to say is as an example if you assign these weights to these prior probabilities here, then you would get something like what I'm going to show you now.

CHAIRMAN APOSTOLAKIS: Yes. Right.

MR. HALLBERT: And what you would see is that if you combine the four sources of information that I showed you previously, you would end up with a prior probability distribution that looks like this. If you use the operating experience information, and I think they had something like -- I think they had something like 12 failures -- 12 failures of this nuclear service water system, different types. And I think of those five of them were recovered within the time that was required that was defined, just for the purposes of this analyses. And so you're operational history gives you some sort of an empirical curve like this.

If you take the information about, you know, human performance and you combine them with the operating experience, you can get a -- looks something like this.

CHAIRMAN APOSTOLAKIS: Yes. You know,

there is a lot of literature on this combining expert opinions where each source is an expert and people have used multivariate normals and normals and all that. Another way that you can do, of course, is the so called behavioral approach that they're using in ATHEANA --

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: -- where you have a bunch of experts who evaluate the sources. They look at what the sources are using and all that, and then put everything together.

Is there a report from this?

MR. HALLBERT: Is there what?

CHAIRMAN APOSTOLAKIS: A report?

MR. HALLBERT: No, not yet. This is work in progress. We're drafting a NUREG.

MS. LOIS: And the purpose of this briefing is to just let you know what we are doing.

CHAIRMAN APOSTOLAKIS: But not how?

MS. LOIS: I guess what we would like --

CHAIRMAN APOSTOLAKIS: I want to have a Subcommittee meeting where we discuss these things in detail before you guys finalize it.

MS. LOIS: We have this meeting in Brussels, too. Right now we're --

CHAIRMAN APOSTOLAKIS: Ah, but in Brussels. I was just one of the attendees.

MS. LOIS: But here what we tried to do is to say that this is where we're heading and what do we think about it.

MR. ROSEN: Here you are more equal than the other.

CHAIRMAN APOSTOLAKIS: More equal, yes. They pay attention here.

Well, that's fine. I can listen in Brussels. But I think the Committee should be aware of what you're doing. I mean, I'll be alone in Brussels.

MS. LOIS: What I am trying to say is that the development.

MR. HALLBERT: What you're seeing is very early development and --

CHAIRMAN APOSTOLAKIS: No, I'm not questioning that, Bruce. All I'm saying is that there will be a lot of interest in this. And the sooner that you educate the Committee or Subcommittee as --

MR. HALLBERT: Yes.

CHAIRMAN APOSTOLAKIS: -- to what you're doing, the better off we'll all be.

MR. HALLBERT: I agree.

CHAIRMAN APOSTOLAKIS: I don't want you to come here with a final report and say this is what we've done and we have no money.

MR. HALLBERT: And actually, hopefully, the vision for this is, you know, we are able to help address the problem of -- and that's two slides from now actually. You know, in the approach that we take here, we are trying to extract information from information that's relevant to nuclear power operations in a risk-element settings. And so we hope to be able to provide a source of information as well as considering that the types of ways and frameworks in which you can employ that information to produce estimates of human error probability or human failure event probabilities so that we can address some of the issues that were raised this morning.

For example, one of the things that you talked about was well are there any reference values or something you could use with your experts or is there a source of information that you could extract from to inform your judgment and decision process. We hope that this system will be that system.

Currently, as the second bullet on here

says, we're currently implementing HERA within a component failure information system that we're developing for NRC and maintaining for them. And we're going to see how analysts employ it and what they think about the information specifically supporting SPAR-H types of things as well as other things.

CHAIRMAN APOSTOLAKIS: Okay.

MR. HALLBERT: We're developing or actually demonstrating the Bayesian framework for extracting information, specifically from HERA, to inform estimates. And we hope later on this year to have a workshop on this.

In parallel, as we've talked about previously, there is a need for other sources of information, and one of those sources we're looking very closely at is from the Halden Reactor Project. They, as you know, do research with operators and they've been moving to do more risk information in human reliability oriented types of research. So we actually have a staff member from our laboratory in Halden working with them on their research plans.

CHAIRMAN APOSTOLAKIS: Whose that? Curtis?

MR. HALLBERT: Yes, Curtis.

And our hope is that through this collaboration that we'll also be able to identify additional sources of information that can be drawn into HERA.

CHAIRMAN APOSTOLAKIS: Good.

MR. HALLBERT: Thank you.

MR. LEITCH: It seems as though you're developing a process here. Now the issue is populating the database with all this information. I mean, there's a huge amount of information. And I guess it would seem to me if you just picked significant events, you may lose some important information. Some rather insignificant events may still have some interesting human reliability issues buried in them.

So, I don't know how you make a selection other than, you know, looking at all the data for a given period of time.

MR. HALLBERT: We started --

MR. LEITCH: I mean it's a huge effort.

MR. HALLBERT: What you're saying makes an awful lot of sense. I mean, we've had these discussions about what data we would start with. We had a meeting and discussed the different types of information we might start with. And so we selected

operating experience because of its immediate relevance and appeal. Because very often times we get initiating events and other things that are of interest, and for which there may have been SPAR analyze and other analyses that provide some indication of a level of risk and the importance o the operator performance in those events. But I agree, that other events where they were insignificant are also valuable as well because they say here were some challenges and here's how people did. And that's not also a viable source.

So, this is just sort of a picture of where we started. But we really would welcome your input on directions for this as all.

MR. LEITCH: We heard about an episode a week or so ago where a plant had tried to automatically start the HPSI system and it didn't start. And they found that the surveillance tests a month before had -- they had failed to reland the lead after the surveillance test. So for that whole month the HPSI was unavailable due to an improperly performed surveillance test.

I mean, what you don't know with that kind of thing is the other side of the coin. How many plants for how many months after months after

months have tested these HPSIs with any problem? I mean, I just don't -- it's hard for me to understand how you're going to get meaningful failure data when all you're looking at is the failures.

MR. ROSEN: Well, there is some information, Graham, about the denominator, which is what you're asking --

MR. LEITCH:

MR. ROSEN: -- of failures per demand, how many demands. You know how many failures pretty well, but you don't know much about the demands.

But then that data is in EPIX where you get number of demands as well as number of failure, and you also get runtime data for normally operating systems. So you can failures per operating hour or something like that.

MR. HALLBERT: And that is one of the sources we're working with.

MR. ROSEN: Okay. Now, I'm going to offer you a caution, and a conclusion. Let me give you the conclusion first, our rule. Start with the most recent events of risk significance that are documented in AITs or LERs and work backwards. And the reason for that is in the early days, let me just be kind and say, LERs weren't all that clear.

My evil twin would say LERs purposely obfuscated the organizational and human performance dimensions of the problem. In other words, they just didn't tell you or they blamed things on anything but a human or an organizational problem or a procedural issue or an interface issue, or a timing issue like we talked about earlier today.

So, I think to the extent that you go back in history, your data gets more and more suspect. So start with the stuff that's most recent that's documented.

MR. HALLBERT: Our thinking in the same, too. We have through projects we've done for the NRC, we've analyzed LERs and AITs and we found very much the case that you're describing, you know. The more recent ones since a rule change have produced information that does contain more information about human performance where it's there.

CHAIRMAN APOSTOLAKIS: Yes. I think we're going to have another Subcommittee meeting on this. And we have to arrange it, you know, with Erasmia.

Shall we move on to the Halden project?

MS. LOIS: I guess so.

Bruce did a transition from this --

CHAIRMAN APOSTOLAKIS: Now, you will have to finish.

I want to go around the table and get my colleagues views on the good practice document, because that's the one we're going to write a letter on.

So, can you finish a few minutes before 3:00? Some of your slides are pictures, do -- you have to make sure you speak through the microphone. Please move the microphone. And tell us who you are. We know the other guys, that's why we didn't ask them. Would you please tell us?

MR. BYE: Okay. My name is Andreas Bye coming from the Halden Reactor Project in Norway.

MR. ROSEN: Now I think we've got a picture of Sun Valley, Idaho.

MR. BYE: Well, we have the corporation.

Just a few words about the Halden Reactor Project and its international research program directed at safety at the nuclear power plants with 19 sponsoring member countries now. Experimental programs within nuclear fuels materials in our test reactor and within man-technology organization where we have an experimental facility called HAMMLAB, Halden Human Machine Laboratory and

the Virtual Reality Center.

We worked on four chapters in this MTO, man-technology organization is dealing with human performance and today I'm going to talk about human reliability.

In this area, we have worked very closely with NRC for the last two or three groups, in the NRC group together with Alan and Bruce also. Currently Curtis Smith is in Halden for ten months working with us on these issues.

CHAIRMAN APOSTOLAKIS: But you have been working with the NRC for 15, 20 years?

MR. BYE: NRC has been our U.S. member since 1958.

CHAIRMAN APOSTOLAKIS: And so would you tell us briefly what made products you produced before this?

MR. BYE: Before the human reliability work?

CHAIRMAN APOSTOLAKIS: Yes.

MR. BYE: Within the human performance we were very active on the human factors with J. Perensky especially doing studies on staffing, for example and alarm systems.

CHAIRMAN APOSTOLAKIS: So this is your

first taste of human reliability?

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: Are human reliable, do you think?

Go ahead, next slide.

MR. ROSEN: You don't answer every question.

MR. BYE: The issue is the need for empirical data for HRA. And especially date for post-initiating event operator actions. What we wanted to do is to improve understanding --

CHAIRMAN APOSTOLAKIS: Well, I have another question that has been inspired by questions from my member on the left. You say improved understanding of human performance. Do you think one can talk about human performance in the abstract or does it matter whether the human is from Korea or from Sweden or from America? Can in fact experiments be done in Norway that you would involving Finnish reactors, Korean operators and American dollars?

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: Okay.

MR. POWERS: Well, there's more to the question than that. You have to tell him why. Now

I've got a different question. If you want to understand -- reduce uncertainty in HRA and PRA, you know, with this I mean you've got a numbers problems. I mean, Halden's been into reactors since the dawn of time, but it's still -- could not have run enough experiments to effect probabilistic elements on a human error.

CHAIRMAN APOSTOLAKIS: No, but if you remember what Alan told us where they take all the bad stuff and they say that's how you get the high percentile. If these guys come back and say by doing certain things you can remove some of the bad stuff, then there's uncertainties reduced. I mean, you don't do it on a statistical basis.

MR. BYE: No.

CHAIRMAN APOSTOLAKIS: You're trying to remove some of the causes. That's why he got the 99 percentile in there, right? You lined up all the bad things that can happen to you. Now, if these guys come back and say, well gee you know here is a clever way of doing something. Although I suspect the third bullet there is really for marketing purposes. Because you know uncertainty is something that this Committee loves. That's okay. You're not the first.

MR. BYE: Okay. We'll go directly to slide five.

CHAIRMAN APOSTOLAKIS: Very good.

MR. BYE: Where we provide empirical human performance data for accident situations. And the purpose is to understand human performance in accident operation and address cognitive aspects of human performance and looking at to why errors occur.

MR. POWERS: I know how you can do it. Just put untrained people in to run this reactor, and then you get a lot of errors and then you could see what causes those errors.

CHAIRMAN APOSTOLAKIS: You can do a lot of things sensitivity. You remember the Committee actually recommended that we build a simulator here, that was flexible, and the NRC built it the next week.

MR. ROSEN: Well, we were recommending something more like this, like what they do, not a real control room simulator, but --

CHAIRMAN APOSTOLAKIS: Yes. Something that's flexible to go -- Jay, you remember, you were here.

MR. ROSEN: Not a replica, but a --

MR. PERENSKY: Well, the kind of simulator I think you were talking about was sort of, perhaps, a part task simulator or something that could be very flexible, as the HAMMLAB simulators are. So, we of course haven't gone out to build anything yet. We've looked at what our options are, and one of which is to continue with Halden.

CHAIRMAN APOSTOLAKIS: You know, the Electric Power Research Institute -- you must be familiar with it, the ORE experiment project, Operator Reliability Experiments. And they did it to EDF, I believe, in France, part of it.

Are your experiments different in any way or are they just an independent verification, perhaps.

MR. BYE: I could go through the way we do it, how we measure job performance.

CHAIRMAN APOSTOLAKIS: Yes.

MR. BYE: Because the main core of the answer to your former question is how do we operationalize the various issues, how do we decompose questions and which issues can we look at and which we can't actually.

CHAIRMAN APOSTOLAKIS: Okay. Let's go on then.

MR. PERENSKY: But quickly if I can answer that, George. They are different. Most of the ORE's experiments were based on the use of training simulators --

CHAIRMAN APOSTOLAKIS: Right.

MR. PERENSKY: -- with a certain set of scenarios and they didn't vary much what's going on.

The kind of the experiments that we've done at Halden have to do with varying the conditions, primarily the human system error phase conditions in the plant, whereas that you didn't see. You always had the same -- the operators from plant A worked on the plant A simulator.

CHAIRMAN APOSTOLAKIS: Yes.

MR. PERENSKY: Whereas this will allow different -- they're working on a different kind of situation here.

MR. BYE: So what we do is controlled experiments in realistic settings. And the realism then given by two scale simulators of real nuclear power plants.

In 1983 we started with a simulator of the Lovilsa Nuclear Power Plant in Finland. Currently we have two simulators, one of the Forsmark Nuclear Power Plant in Sweden, which is

BWR. And the Fessenheim Nuclear Power Plant in France, which is a Westinghouse three loop PWR. It's a sister plant of Ringhaus in Sweden, so we use Swedish operators. And it's also a sister plant of Indian Plant 2.

We use licensed operators and crews form the simulated plants and PRA relevant scenarios. And it's not a replica of control room, but it's a computerized control room. This means that we cannot study everything in which is topics in normal control room, but we can study a lot of things, for example, task complexity, the instance of alarm systems and things like that.

So what we aim to do is to understand this human performance, address cognitive aspects, look into decision based errors and dependencies among actions, for example. Also look into the context and performance shaping factors, especially, and focus on those specific causal factors. Assess a range of effects of PSFs in accident scenarios, improve the data basis for PSFs and interaction between them. And this can be done through experimental manipulation.

CHAIRMAN APOSTOLAKIS: So you have examples of these?

MR. BYE: Yes, I have one example I'll go through afterwards.

CHAIRMAN APOSTOLAKIS: Yes. I think that we should go to the example.

MR. BYE: Yes. The example is task complexity. And I'll take an example of this method, how we design the experiment and the measures we use.

In this case we have defined task complexity by three items: Information load, time pressure and masking.

CHAIRMAN APOSTOLAKIS: Masking means?

MR. BYE: It means both -- can mean two things. First, masking in terms of a process of plant conditions which, for example, two parallel faults one masking the other. The other is masking by the instrument I&C, if the interface is not working. There's a signal lacking and so on.

So during the process operation we use these simulators. And test subjects in the control room.

When we designed the experiment and designed the scenarios, one example of this when they want operationalize, they study on complexity. We can manipulate, for example, time pressure, the

masking and the information load in different ways. Let me take one example now for high complexity scenario when they manipulate the time pressure by -- when SCRAM occurs. The closed main relief valve is open. If this is not closed immediately, the risk is high for feedwater isolation due to the high level in the reactor tank. And if feedwater isolation occurs, the level in the reactor tank will decrease fast due to -- this is a LOCA scenario.

In the low complexity we have low time pressure and it's possible to use a feedwater system for a long time. So here you can see that we actually do the manipulation by doing manipulating the scenarios, by manipulating how many safety systems are out of order, for example, which valves and pumps are available and not. Normally --

CHAIRMAN APOSTOLAKIS: Let me understand something here.

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: This is not something that has anything to do with Halden, right? This is something that anybody with knowledge of plants and human performance could put down. Are you confirming this? Are you --

MR. BYE: We are doing this to

manipulate the scenarios in our study to study the task complexity.

CHAIRMAN APOSTOLAKIS: So with what objective? To see whether these are true or something else?

MR. BYE: To see how they influence the human performance.

CHAIRMAN APOSTOLAKIS: To become more quantitative then to -- I mean, how much the complexity of the task effects human performance? Is that what you're after?

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: In numerical terms?

MR. BYE: There's various ways of getting this out. But we measure the human performance in various ways and those are done mainly quantitative measures.

CHAIRMAN APOSTOLAKIS: So if you're successful then, you will answer the question I asked earlier this morning if I have the human reliability distributions and now I go to a higher power, I have a power uprate and the time goes down by 3 minutes, I can go back to your work and see well gee, this is how that effects that? Is that

what I'm going to get?

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: At some point?

MR. BYE: At some point.

MS. LOIS: You have the capability of--

CHAIRMAN APOSTOLAKIS: Well, that would be great. I mean if you're successful --

MS. LOIS: -- so you can collect that information.

CHAIRMAN APOSTOLAKIS: This could be very, very useful.

MS. LOIS: Yes.

CHAIRMAN APOSTOLAKIS: Even if you are not precise in terms of numbers, at least giving us some guidance that if this factor goes up or down by this much, this is what happens to human performance. I think that would be really useful.

DR. KRESS: Yes, but it would depend on these other complexity --

CHAIRMAN APOSTOLAKIS: Well, they will tell us.

DR. KRESS: So you have to have some sort of complexity index or something like that.

CHAIRMAN APOSTOLAKIS: They will have to tell us the context.

DR. KRESS: Yes. Yes.

CHAIRMAN APOSTOLAKIS: I mean, it's not just in the abstract. But it's still in the right direction.

Jay?

MR. PERENSKY: Well, if you want to go to the next slide, you'll have the list of the kind of data that they can collect and then, as Bruce had said earlier about HERA, that the kind of information we're trying to collect, the stuff that would feed directly to that data system of HERA --

CHAIRMAN APOSTOLAKIS: Well, that's good.

MR. PERENSKY: -- which then we could go back and probe at different times doing a PRA.

MR. BYE: Okay. So if we now look how measure the human performance and what data we are after here. And if you look at the performance data, there are many ways of measuring this.

CHAIRMAN APOSTOLAKIS: OPAS?

MR. BYE: OPAS. OPAS is what we call operator performance assessment system.

CHAIRMAN APOSTOLAKIS: Oh, okay.

MR. BYE: Where we measure human performance and the operator activities. And

beforehand, process expert sets up the scenario with goals and the subgoals and activities that operators should do in order to perform a good scenario. And then online the process expert is ticking off whether they do this or whether they don't do it, or also specific operator actions can be taken from the logs. So in this way we look at both the detection, we look at the situation assessment and planning and also the action parts.

CHAIRMAN APOSTOLAKIS: And the weight there is what?

MR. BYE: The weight is what the process expert before the scenario think that this is an important action to fulfill in order to reach the goal for the scenario. So that you can weight various operator action, you can weight various --

CHAIRMAN APOSTOLAKIS: Develop some sort of an overall index --

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: -- is that what you're trying to do?

MR. BYE: Yes.

MR. ROSEN: What's the I and the D on my far right, your far --

CHAIRMAN APOSTOLAKIS: At the very end

of the slide. It says I and D.

MR. BYE: Okay.

DR. COOPER: Increase/decrease.

CHAIRMAN APOSTOLAKIS: Increase/decrease.

MR. BYE: Because the system is made so that you can actually online also value the weights if you see that the scenario develops differently than you thought beforehand. Because very often the process expect just sets up the scenario and they really do something else.

CHAIRMAN APOSTOLAKIS: So what is the final result of this?

MR. BYE: The final result is a performance score for each scenario, which I can show you. We have the final --

CHAIRMAN APOSTOLAKIS: Oh, okay.

MR. BYE: So, for example, this just some additional slides. Here you have the performance scores from all the scenarios. For each scenario here we have the low complexity scenario so we left the medium complexity on the high complexity scenarios. And this is a OPAS performance score telling that with the weights and with everything in that, you get an overall performance score for each

scenario for all the crews.

So what we saw here was that there was a significant difference between what we had studies and is stated as low complexity scenarios and high complexity in terms of human performance of this measure.

DR. KRESS: What happened to scenario three?

MR. BYE: What happened --

CHAIRMAN APOSTOLAKIS: Wait a minute now. You say there is a difference. I mean, let's take -- yes, the high scenarios you have something like 63 percent, but in the low --

MR. BYE: If you aggregate this over the higher one --

CHAIRMAN APOSTOLAKIS: So this is the measure of success? The index is a measure of success.

MR. BYE: Yes. Yes.

CHAIRMAN APOSTOLAKIS: So I got from 62 percent to 75 percent.

DR. KRESS: No, 40.

CHAIRMAN APOSTOLAKIS: Huh?

DR. KRESS: Forty to 70.

MR. BYE: Yes, if you aggregate --

CHAIRMAN APOSTOLAKIS: No. Take scenario 2.

MR. ROSEN: That's 3 data points for the same thing.

DR. KRESS: That's three sets of crews.

MR. PERENSKY: He's doing an analysis of variants. You would combine those scenarios together so that you have a high complexity score and a low complexity score. And there's a statistically significant difference between the two groups.

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: What I would say is that as the complexity, the degree of complexity increases, these are different groups? Then you have aleatory uncertainty that's pronounced. For low complexity it's about the same.

DR. KRESS: If you had a lot more data.

MR. PERENSKY: No. It's all the same crew using the within subjects design.

MR. BYE: Yes.

MR. PERENSKY: So it's repeated measures and they all do the different scenarios, but they do them in different orders.

CHAIRMAN APOSTOLAKIS: So there's scenario-to-scenario variability assessment?

MR. PERENSKY: Yes. Sot he variability would --

CHAIRMAN APOSTOLAKIS: But the variability is more pronounced for high complexity tasks? I think that's clear there.

MR. BYE: Yes.

CHAIRMAN APOSTOLAKIS: Right. On the right I have bigger differences than on the left.

MR. BYE: These are classified the low complexity -- these three high complexity scenarios were beforehand evaluated to be high complexity scenarios of process expert.

CHAIRMAN APOSTOLAKIS: So one message you're sending is if you have high complexity scenarios, it's more difficult. The variability of performance is higher?

MR. BYE: Yes. Sure.

CHAIRMAN APOSTOLAKIS: But it's not clear from this histogram that for high complexity scenarios the performance is much worse. It is in scenario 8, but in 2 it isn't.

MR. ROSEN: That's right. The operators -- what it says is that some operators can get it right even if the scenario is complex, but not as many.

CHAIRMAN APOSTOLAKIS: That's right. Not as many. Exactly. That's a nice way of putting what I tried to say.

MR. BYE: And it also depends whether your operating within evaluation of high complexity scenarios is really -- was correct after you have done the study.

If you look at other ways of measuring, this, was only the OPAS measures. If you look at other ways of measuring the performance, one thing is to look at the safety functions, the plant system that's on the components and taking from the logs. And the other is subject matter expert rating. But also operator ratings. And there we use questionnaires. For example -- and then afterwards we can compare the subjective complexity with the more objective measures.

So these are questionnaires where we utilize -- we have web systems just to make the data collection easier looking at unclear or ambiguous process picture, misleading or missing process indication, for example or also the 4, 5 and 6 there are looking at the time available --

CHAIRMAN APOSTOLAKIS: What does it mean that the time is very difficult? You mean very

short?

MR. BYE: Yes. These are just standard phrases, but --

CHAIRMAN APOSTOLAKIS: For the worst and best, that's what you mean? Worst and best.

MR. BYE: For each question here there is --

CHAIRMAN APOSTOLAKIS: No, I'm sorry. Best may be in the middle, right?

MR. BYE: For each question there is a quite brief description or a detailed description of what the end points mean for the operators before they fill them out.

CHAIRMAN APOSTOLAKIS: That's what SLIM does. Not SLIM. Yes, SLIM. SLIM. Yes. Okay.

MR. BYE: So that's one example.

Another example of the questionnaires we use have been PSF rating questionnaire where we look into, for example, a lot of PSFs where they rate which one is is difficult in this scenario and which one was good. For example, looking at procedures, training experiments, indications in the human system interface and so on. And these various PSFs are taken from, for example, combination of SPAR-H, PSFs and also other PSFs from other HRA methods.

So together these subjective ratings together with also the more objective or the more nonintrusive measures give us a rich information source, also together with debriefings of the operators give us a rich information source for the -- also for the activities they're doing and --

MR. POWERS: I guess I will concede it gives you a lot of information. I'm just not sure what do you do with it?

MR. BYE: One thing we can do is to look at, for example, to validate or to validate HRA methods and PSF weights and so on.

Also it can be used to -- in looking at thresholds for HRA analysts, looking at what is really the time available, what is little time in this kind of scenario? How should you --

MR. POWERS: Yes, but your summary has just invented things. If I come back to my SCRAM button pushing, they say okay tell me how all this is going to tell me where I've got a long time or a short time for SCRAM button pushing, how do you do that?

MR. BYE: If you look at -- you have a very good description of the whole context here in the simulation. So we have a very rich contextual

description of what is happening. Then you can actually use the results, you can actually manipulate the time if you want to do such an experiment.

MR. POWERS: You can't simulate my control room.

MR. BYE: Well, maybe not exactly that one, but if you have other similar examples --

MR. POWERS: And what do I do with it? I mean, you can't simulate my control room. You can't simulate my context. What do I do? I mean--

MR. BYE: At some point we have to generalize from some of this from the context here.

MR. POWERS: Yes, that's the part that I don't understand is that we've made a consistent thrust at every plant in this country to say you'll have your own simulator because we don't know how to generalize. Okay. Now you're telling me I have to generalize and I don't think I can.

MR. BYE: If you are dealing with issues also like sort of unexpected events, you still have to generalize from some events to other types of events. So at some point you have to generalize. Also from one place in the event to another place.

What we are doing is we're trying to

look at the nature of the operator task and look at the nature of the task and see how -- when the context in so-and-so, the errors were in context, the nature of the task is so-and-so; then that can be generalized to a context where you are going to push your SCRAM button based on the cognitive issues for the operators.

MR. POWERS: The cognitive is pretty simple. He's got an alarm going off like crazy and a reactor power that's oscillating around like crazy. Okay. And he's got three minutes to go over and punch a button.

MR. ROSEN: If he knows which one to punch.

MR. POWERS: I mean, I'm just struggling to understand why --

MR. FORESTER: With respect to pushing the SCRAM button, if you could identify some variations in the way the scenario to that point evolved, you could show that with these characteristics it took longer to push the SCRAM button. And even though that might not be exactly the same the way it is in another control room, the fact that he could manipulate or control how long it look him to push a SCRAM button would be interesting

information, would be useful information that may generalize to other control rooms.

Now, the SCRAM button may not be a good example because it is a very simple task and the fact they need to SCRAM is so obvious that --

MR. POWERS: The difference is that that's a real regulatory task. It's very pertinent right as you would power up.

I'm sure that lots of this stuff has great things to do with the theory of human performance, but that's not my performance. My problem is licensing power uprates. And I've had one critical human task arises in there, and I'm in a conundrum. I don't know what to do. And this stuff doesn't get me any closer.

MR. FORESTER: I'm not sure what the issue is there.

MR. POWERS: When I jack up the power I have less time to go over and push that SCRAM button.

MR. FORESTER: Yes.

MR. POWERS: Okay. With THERP I come up there's a one in a 100 chance at the power uprate that the guy will not punch that SCRAM button soon enough. Okay. With THERP if I change the -- if

shorten the time, the probability that he won't punch the SCRAM button goes a little higher.

MR. FORESTER: Yes.

MR. POWERS: The problem is that the guys that run the plant train on this with sufficient regularity, they have about 50 different training scenarios, presumably with all five or six crews -- six crews, I guess it would be that have trained on it, not one of which failed to punch the button in less than 30 seconds.

So now what probability do I use? I've got a zero to one, right?

MR. FORESTER: Right.

MR. POWERS: That's the range of got.

MR. HALLBERT: There's a couple of different ways of sort of characterizing that problem. As you were discussing through it I was listening. And one aspect is, you know, first of all do they understand they have to SCRAM. And then the second thing is if they do understand they have to SCRAM, what's the likelihood that they don't SCRAM. You know, it seems like the manual action itself is trivial. Once you understand it, you need to --

MR. POWERS: Yes, it's a big button. You

can't miss it.

MR. HALLBERT: Exactly. Right.

MR. POWERS: You aren't going to fail once you do it.

MR. HALLBERT: Even in your sleep you can probably do it. But the question is then more so how do these other factors of -- what other factors might contribute to their not performing the SCRAM. And that's where I think some of the Halden research like looking at time pressure -- you know when Andreas was presenting here, you know time is one of the variables that they looked at along with others. The question is, you know, is there enough information in that research or would more need to be done to look at the effects of time or perhaps some other cognitive factors that you might identify as being especially important to this reactor trip--

CHAIRMAN APOSTOLAKIS: I think that's what's missing here from the presentation. What exactly are your objectives and how do they help Erasmia's ATHEANA and Susan's ATHEANA? A crisp. statement. I mean, just saying we're going to reduce uncertainties doesn't mean very much.

MR. POWERS: A little more understanding. I mean we're not getting anywhere.

CHAIRMAN APOSTOLAKIS: Yes. Yes. Something specific like, you know, ATHEANA needs A, B, C and we are subbing it.

MR. BYE: When we are beginning -- or understanding in performance, we do these case studies and a detailed description of some narratives so that we can -- it is possible for ATHEANA, for example, to read the context and if it's a similar context as --

CHAIRMAN APOSTOLAKIS: And if it is, what value do they get out of that?

MR. BYE: If it is, then they can look into the PSFs present.

CHAIRMAN APOSTOLAKIS: Right.

MR. BYE: And this can inform the HRA methods by looking into threshold differences, for example, to look into how much or when do you apply the different weights, for example if you look at SPAR-H, when do they apply the different levels of these PFS rates. Because you can see it effects their performance directly.

CHAIRMAN APOSTOLAKIS: Okay. I'm not saying that you haven't really thought about. All I'm saying is that your presentation didn't come across. So if we ever meet again, I don't know how

often you come from Norway here, that --

MR. POWERS: If we treat him like this all the time, he may not do it very often.

CHAIRMAN APOSTOLAKIS: He will come, but to the other building.

And you have to realize we're treating you very nicely. He's a guest from another country.

But really, what are the needs that you are trying to fill and what the results? Maybe it will help you also with your research. I mean, if you ask yourself that. How is Susan going to use your results; that's really the issue here. Because we are regulatory agency, don't forget. We are not a research. We are the United States National Science Foundation. You have to show to us that whatever you do will help the regulators make better decisions. That's all.

So you're done? We really appreciate you coming here.

MR. BYE: Thank you.

CHAIRMAN APOSTOLAKIS: We really do.

MR. BYE: I will just mention at the end that we are working together on the HERA to -- also our data --

CHAIRMAN APOSTOLAKIS: That may be

another objective to help Bruce, because Bruce needs help.

MR. HALLBERT: Where does that come from.

MR. ROSEN: Well, we thought you had gotten away.

CHAIRMAN APOSTOLAKIS: Yes. Yes. We left you alone for too long.

I'm sorry. I don't want to cut you. You want to say anything else?

MR. BYE: There is a --

CHAIRMAN APOSTOLAKIS: You don't have to. Okay. Sorry.

MR. BYE: There is also a source here for direct input quantification with the Bayesian stuff.

CHAIRMAN APOSTOLAKIS: Okay.

MR. BYE: If you look -- we discuss a denominator, and that was -- that's maybe not the right to do it in this classic way, but when we use Bayesian methods we have actually, lots of time we have maybe 124 runs with 8 crews and the various simulator. And so there are some source of updating.

CHAIRMAN APOSTOLAKIS: Very good. Thank

you very much.

MR. BYE: Thank you.

CHAIRMAN APOSTOLAKIS: Anything? Other comments? Erasmia?

MS. LOIS: Well, I guess the reason that Andreas here is that we wanted to give the ACRS the opportunity to hear firsthand what Halden is doing. And we are still setting up the planes and how to figure it out how we can help human reliability. And they are building the expertise in human reliability, so it's still the evolution here is not--

CHAIRMAN APOSTOLAKIS: That's fine. Okay.

Well, ladies and gentlemen, thank you very much for coming. I wish we had more time, and we will create more time.

Now, the staff requests that we concur that they release the good practices document for public comment. And they will come back on May 6th, I believe, at the May meeting of the Committee, make a presentation taking into account, I assume, some of the comments.

Erasmia, where you go?

MS. LOIS: I'm here.

CHAIRMAN APOSTOLAKIS: Take into account some of the comments we made. So, shall we go around the table and see if you can give me some input.

I see, Dana, you want to be first? You appear to be anxious.

MR. ROSEN: He's always saying that.

CHAIRMAN APOSTOLAKIS: I would go to Graham, but you're about to eat your microphone. Go ahead.

MR. POWERS: No, you let me have lunch.

DR. KRESS: We usually start -- so it's good to randomize it every now and then.

CHAIRMAN APOSTOLAKIS: Randomize every now and then.

MR. POWERS: The Monte Carlo approach to comments.

George, I think the good practices document is useful simply because it's the distillation of a lot of expert judgments on what should be done.

I seriously doubt that the document could survive some skeptical examination by asking if each and every item in there, it was of crucial significance and proof that it was -- quantitative

proof that it was in fact a good practice. But I think it's useful, and this lies to the nonspecialist when he's trying to understand what his HRA team is telling him he has to do.

Okay. And so in that sense I certainly stand behind doing it. I think it's a real contribution that the group has made here. I think it's a significant first step in an overall strategy that they surely have. So I'm supportive on that.

I will go on and say I'm really quite impressed at what they're doing in the quantification of human performance using this expert opinion elicitation process for the ATHEANA operation. It does us stuff that's qualitatively better than we were getting with THERP. You know, we were making comments to the effect of go through all this effort with ATHEANA and end up getting the same damn number that I did with THERP. And you're obviously getting a lot more, and I certainly hope they can continue that with --

MR. ROSEN: That's not really a comment on this HERA.

MR. POWERS: And I didn't intend it to be. And once he gives me the floor I'm asserting myself.

MR. ROSEN: You're freelancing now.

MR. POWERS: I am asserting myself.

CHAIRMAN APOSTOLAKIS: So what I really need is input on the good practices but feel free to add direct comments if you like.

MR. ROSEN: Right. So now his comment is now made legal.

MR. POWERS: But you fail to understand, I'm the Chairman of the Research Subcommittee and I've got to look at this overall thing. I'm doing -- I'm pretty sure it was legal from the beginning.

What I really think needs to get a lot of thought here, there's a lot of good stuff coming out of this human factors and human reliability research. But it has a sales problem with people who are skeptical of that. And the sales problem is there's not a real good strategy on where you are and where you think you need to be. And that's crucial, because this stuff is not just important for the existing reactors, it's important for the advanced reactors. It's the one research program that really undergoes no change whatsoever as we go from current to future reactors, still equally important. So you need a strategy.

I don't understand exactly what the

objective of ATHEANA is, whether it's really a standard that will benchmark things like SPAR-H against or it's something that's going to take the place of SPAR-H in the sometime future, or whether it is something that's local to the NRC or are you going to proselytize it for use around the world the way we do a lot of our other thermal hydraulics codes and severe accidents codes and things like that. I don't have strong opinions on what it should be. I just wish there was a strategy, because that dictates what kinds of things should be done in the research program on it.

And I'll conclude by saying, echoing what Professor Apostolakis said, I think Halden holds the promise of being useful in this ATHEANA development. It's not clear to me how and it's not clear to me what needs to be done. But I fully believe that it is, but it needs to be explained a lot better and in some sort of a more definitive strategy for where we're going in this program.

And it's not that I doubt the principles, don't know where they're going here. I think from the quality of products we've seen coming out of these organizations over the last six months, I'm convinced they know exactly what they're doing.

But I do know that we're having a very difficult time selling it to people how do not specialize in this area, but unfortunately do specialize in controlling the purse strings.

CHAIRMAN APOSTOLAKIS: Graham?

MR. LEITCH: Well, I'd like to say that I appreciate the presentations of the day. I thought they were well done, professional and very, very interesting to me.

The bottom line is I have no objection to releasing the document for public comment. It is, as it claims to be, a listing of good practices and not methodology. I was perhaps myself more interested in seeing just what the methodology would be. And we've been told that that is yet future, and I'm interested in that. But these are indeed a listing of good practices.

I was a little surprised to see that the performance shaping factors did not include the influence of supervision or management on the processes. Although difficult to quantify, I think that's a very definite factor that needs to be considered.

I think there are some plants where the decision to SCRAM, for example, we talked about how

much time is allowed to SCRAM. And a lot of that is the decision time, not the time to push the button. And I think if the operator has clear management direction that, you know, when in doubt SCRAM, that's what I want you to do. You don't call anybody, you don't think about it; when in doubt SCRAM it, that's an important factor there that I don't see considered. I mean, some plants I believe that direction is more clear than others.

MR. ROSEN: Could I comment on that for a minute?

MR. LEITCH: Yes, I'm not quite finished. But go ahead.

MR. ROSEN: Just while you're on that point.

Most plants these days, I think it's pretty much accepted that the automatic system is backup operator action. So when a SCRAM occurs due to an automatic system doing it, the operators have missed the chance to demonstrate how smart and quick and aggressive they are.

MR. LEITCH: There's always the possibility of a malfunction.

MR. ROSEN: Of course.

MR. LEITCH: But eliminating that --

MR. ROSEN: Eliminating that, yes.

MR. LEITCH: -- I'm inclined to agree with you.

MR. ROSEN: Yes. So I think our operators have gotten that message that they are the operators of the plant, not the automatic systems. The automatic systems are there to back them up. And so it used to be thought about the other way around. And I think that correction is important and has gotten through.

That's all I have to say.

MR. POWERS: Are we going in the advanced plants, are we going the other way?

MR. ROSEN: Perhaps.

MR. POWERS: And is that a mistake?

MR. LEITCH: I think definitely they're going the other way.

MR. ROSEN: I think it's been energizing to the operators to get the --

MR. POWERS: I would think it would be.

MR. ROSEN: -- message from management that we think you're in charge here. The command and control statement should be read literally and you decide when the plants no longer in service, to take out.

DR. KRESS: Yes. We heard one of the advanced plants say the operator is not to any action at all for so many hours, like 24 or 73 --

MR. ROSEN: Well, the reactor, when he thinks it needs to be SCRAM it includes don't take any action.

MR. POWERS: I mean, I think Steve's raising an interesting dichotomy here. I agree with everything he said, that it has been energizing, that it has made the plant safer and yet we seem to be going design wise the other direction. And I'm wondering if this is a mistake.

DR. KRESS: Well, I personally don't think so. I think there's a balance between what the operator needs to do as opposed to getting him this power. I think the safer and more self controlling you make the reactors, the better off you are. But, you know, we can debate that --

CHAIRMAN APOSTOLAKIS: I think it depends on the comparative reliability of the automatic systems as compared to the operator.

DR. KRESS: Yes. Of the lack of need for such --

MR. ROSEN: The operators are thinking human beings, well trained and understand the

circumstances.

CHAIRMAN APOSTOLAKIS: Yes. That's right.

MR. ROSEN: The automatic systems are hard wired or computer based into which some artificial intelligence has been put, may not understand the circumstances. It may be a lot worse than the automatic system --

CHAIRMAN APOSTOLAKIS: Yes. The operators could beep into the structural difference --

MR. ROSEN: Right. And so that they are expected to operate the plant. And when they don't, one asks them after the fact weren't you getting ready to SCRAM the plant. Oh, yes, I was but it beat me by three thirds of a second. Oh, yes. Yes.

CHAIRMAN APOSTOLAKIS: Okay. Graham.

MR. LEITCH: I think, as I say, I think some of that is the culture, the management expectations that are set for the plant. Clearly the operator has to at least confirm that the automatic actions have taken place when they should take place. But if he sees a situation deteriorating, he ought not wait for the automatic actions to occur.

CHAIRMAN APOSTOLAKIS: Right.

MR. ROSEN: He can take actions earlier.

MR. LEITCH: But as I say, I think a performance shaping factor is somehow related to -- one performance shaping factor ought to have some measure of how close management is involved with and watching the process. I understand the difficult of that and I have no objection to releasing it in his present form even without that, George. I mean, it's just a comment.

I guess I would say that I may be one of those unbelievers that Dana was referring to. And a number of times in today's presentation I had the feeling that we were trying and spending a great deal effort, and not to in any way diminish effort it's a very professional effort, but we're trying to almost to know the unknowable and the uncertainties associated with it really swamp what we're trying to do. And I just question the degree of effort that's being placed on this area.

MR. POWERS: I think that's a view I have been extraordinarily sympathetic with until I started seeing what they were doing with these quantification efforts and trying to identify, not that their numbers have any exactitude to them, why

they were moving probabilities up and distilling out some coherent view of what otherwise is a very uncertain situation.

MR. LEITCH: Yes.

MR. POWERS: And maybe that's not a -- Dr. Kress and a good portion of his professional career working in a discipline where the uncertainties were huge and I mean his accomplishments were to distill some order out of that chaos. So we know it's doable, you know. And this is just another chaotic effort. And it seems to me that they've grabbed a hold of an approach that starts yielding some products and things you can take action on and that you can do to fix things out of this. So I'm less convinced it's the unknowable nowadays.

DR. KRESS: Perhaps I spoke too strongly. I believe there are some significant insights that come out of this. I just -- I'm a little concerned that we're trying to push it beyond where it can be pushed, that's all.

MR. POWERS: And just remember this is all cheap compared to heavy section steel variation.

MR. ROSEN: Shack's not even here and you beat on him.

MR. POWERS: I'm trying to develop allies.

CHAIRMAN APOSTOLAKIS: Well, it's because of the efforts like this, though, that we really understand human performance now much better than, say, 10, 15 years ago. And eventually you may be right. Eventually we may decide that certain things that we're trying to quantify now, perhaps should be left out and handled in a different way. But right now I see this as exploratory. People are trying to understand. And I don't think it's a major issue.

But I don't think Graham is proposing any action on this issue. It's just a view. Yes.

MR. LEITCH: No, no. My bottom line is I think we ought to issue this good practices document.

CHAIRMAN APOSTOLAKIS: Okay. So let's move on then.

MR. ROSEN: And coming back to the point that Dana just raised, he's really asking what good are these studies in terms of giving you your absolute values for HRA. It's the same question that was asked about PRA; what good is a PRA when we don't have a lot of confidence in the absolute

values. And the answer ha always been, well but that may be true but it still gives you rich information about the sequences and the things that are important in whatever value you get. This is very true about the HRA the stuff we're seeing, and it's really a subset of the other piece. So I think we should keep that in mind.

CHAIRMAN APOSTOLAKIS: Okay.

MR. ROSEN: With regard to the document itself, I think it's a very useful document and it should be released for public comment.

I think it's useful in part, although there's a lot of reasons it's useful, it's useful in part because it's very tightly linked to the ASME standard.

I do think it needs more emphasis. In section 5.4.3.2 or some other place, but that's where it comes up, more emphasis on the recovery actions that are not included in the PRAs. Those actions are the high risk actions -- high pay off actions that one can take. They are also the high risk ones if you take them wrong, because they are the cognitive failures that we've seen, unfortunately, in the big nuclear accidents such as Three Mile Island and Chernobyl.

Finally, I would like to make a point about what Dana asked about sales, how do we sell this. Now that we've concluded, maybe it is useful in the context of maybe absolute values, but certainly in sequences and what's dominate and important about human performance. Well, I think human reliability analysis tells us what things most effect human performance. And human performance has, as we know, big effects on PRAs, the results, in both absolute values and the sequences in PRAs. And PRAs are telling us a lot about core damage frequencies and core damage frequencies tell us a lot about nuclear safety. So if you make that track all the way back, back, back you eventually get to what it is we came here to talk about, which is nuclear safety. And if human reliability analysis can continue to mature and further illuminate the issues that are relevant to nuclear safety, then it's worth it.

MR. POWERS: Yes, Steve, let me ask you this question: Can we have useful numbers on what amounts to -- it may not be exactly, but amounts to the risk achievement worth the risk reduction worth the human in plants?

CHAIRMAN APOSTOLAKIS: No, I'd say no.

MR. ROSEN: I don't think so. But --

MR. POWERS: But could we get that? I mean, it seems to me that in the --

MR. ROSEN: Well, you could get number, but whether you want to believe it or not is another question. I think what's more important is what I've alluded to, is that it tells you the sequences in which human performance is important.

MR. POWERS: Yes.

MR. ROSEN: And it tells you why it's important. And I think maybe you can draw your own conclusion.

DR. KRESS: Well, I think it's easier to get the risk -- the importance measures than it is to quantify the actual probabilities. I think you can get the importance measures.

MR. POWERS: I'm sure.

DR. KRESS: I mean, does it do this or not and then you get the importance measure right out of that. And you don't have to know the probability.

MR. ROSEN: But whether you believe it or not.

DR. KRESS: But that's lack of importance measures.

CHAIRMAN APOSTOLAKIS: Well, the actions that have been modeled in the PRA, you're right. You can get the importance measures.

DR. KRESS: Sure.

CHAIRMAN APOSTOLAKIS: The importance measures of human performance, though, I don't think you can because there are so many things that are outside the PRA.

DR. KRESS: Well, yes, if they're outside the PRA. They have to be the in the PRA to get them.

MR. POWERS: What you'd really like to know is do we have a problem with human performance in these plants now or not or is it, you know, basically okay. I mean we're back to the SCRAM button. The guys are punching the SCRAM button every time, then there's nothing I can do to improve on that performance.

CHAIRMAN APOSTOLAKIS: I think we have a problem. It's not a big problem. And it's not been addressed by this.

DR. KRESS: I think the LERs tell me that we do have a significant human error problem. And I think the quantification of the human error is at a primitive state. A lot of things have already

been said that should say, for example, I have a lot of sympathy with Dana's position. But I would concur that this document needs to be released and it would serve as an impetus to carry on the work in this. I think it's needed work.

CHAIRMAN APOSTOLAKIS: Yes.

MR. POWERS: I think it's rally important to learn specialists.

DR. KRESS: It's important. And, you know, there are some things here that I would -- that I would --

CHAIRMAN APOSTOLAKIS: Some details?

DR. KRESS: Yes. Like I would get things out of there that try to deal with the state of the mind of the operator. You're never going to quantify that. And things like time of day. Yes, the PRAs don't know anything about the time of the day. You know, there are things like that I'd quibble about, but you know they can -- there can be an evolution of thinking on those things if they get it out and start trying to convert it more into an actual human reliability model.

CHAIRMAN APOSTOLAKIS: Now you're talking about the good practices.

DR. KRESS: Yes, that's in the good

practices.

CHAIRMAN APOSTOLAKIS: Okay. Okay.

DR. KRESS: But, you know, I view the good practices as a first step to go on how you actually go about quantifying a model or developing models and quantifying them. And, you know, I think we're on the right track with the performance shaping factors and trying to use those.

So, in general I think --

CHAIRMAN APOSTOLAKIS: Yes, you support it?

DR. KRESS: -- it's a good thing to be doing and it's a good start.

CHAIRMAN APOSTOLAKIS: On the practices? Go ahead.

MR. ROSEN: One more point. What I think has happened is that in the early days there was so much equipment unreliability that human performance was a small fraction of the CDF. What's happened is the smoke the equipment reliability stuff, a lot of that out of the plants. We have much higher reliability and availability of the equipment. We haven't done a similar good job on human performance, so as a function of the total remaining CDF I think it's a larger piece than it

used to be.

CHAIRMAN APOSTOLAKIS: Right.

MR. ROSEN: In fact, it may be the dominate piece. So to the extent that we work on understanding human performance and improving it, I think we have leverage on the overall CDF.

CHAIRMAN APOSTOLAKIS: Okay. I also think that is a very good effort, that it should be released for public comment. I do believe -- I mean, we will have, perhaps, minor comments. Already we've given a lot to the staff. I think in the letter we can always put things in the discussion.

But I do believe it has to be embraced by the community. The community of human reliability experts. Because, you know, all politics is local, as one of the Boston oldtimers said once. You have to convince your own community first before you have any chance to convince the wider community. So if you leave those guys out and they come out and say the NRC does this, but I have my own -- that's a mistake. So I think you should really pay attention to this recommendation to have a special peer review group. They don't have to meet as a group. You can send it to them individually, but ask them

specifically to comment and maybe add -- I mean, you don't have to take their advice, but at least get their views.

DR. KRESS: Would these include international reviewers?

CHAIRMAN APOSTOLAKIS: I would include the French and other international groups like the University of Maryland.

MR. POWERS: You bring up the French, but remember at our tripartite in Japan the only group that was interested in the human factors submeeting that we had were the Germans.

CHAIRMAN APOSTOLAKIS: No, the EDF has done a lot of work, so I'm not speaking the whole of France. EDF has a very good tradition in this. They are really willing to look at issues and so on. So -- and every time you talk to them, oh the Americans are doing something else. Well, I want them to stop saying that. Give them the documents, they're here. Tell us where you disagree and then you decide. Maybe you have some dialogue with them. Because this is, as you said, a fairly high level document that gives good practices. So they should be able to agree, because you are not blessing one particular method.

So I think it's very important to do that, to get the blessing of the 4 or 5 key players in the community. It may cost you some money, but I think it will be money well spent.

And the other details, you know, we made all sorts of comments this morning, but I think the main recommendation is yes to go ahead and issue it for public comment.

And I'm not going to say anything about the other stuff. I mean, I'm really happy to see that there is all this activity and see this effort, but I think we should meet some other time to really give you something more meaningful, because you will give us something more meaningful as to what you're doing.

So on that happy note, unless somebody's really dying to say anything, I propose that we adjourn.

Any member of the public wants to say anything? No.

Thank you very much.

(Whereupon, at 3:15 p.m. the Subcommittees adjourned.)

CERTIFICATE

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

Name of Proceeding: Advisory Committee on Reactor Safeguards Joint Meeting: Subcommittee On Reliability and Probabilistic Risk Assessment & Subcommittee on Human Factors

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.

Rebecca Davis
Official Reporter
Neal R. Gross & Co., Inc.

United States
Nuclear Regulatory Commission

Human Reliability Analysis Program
Overview

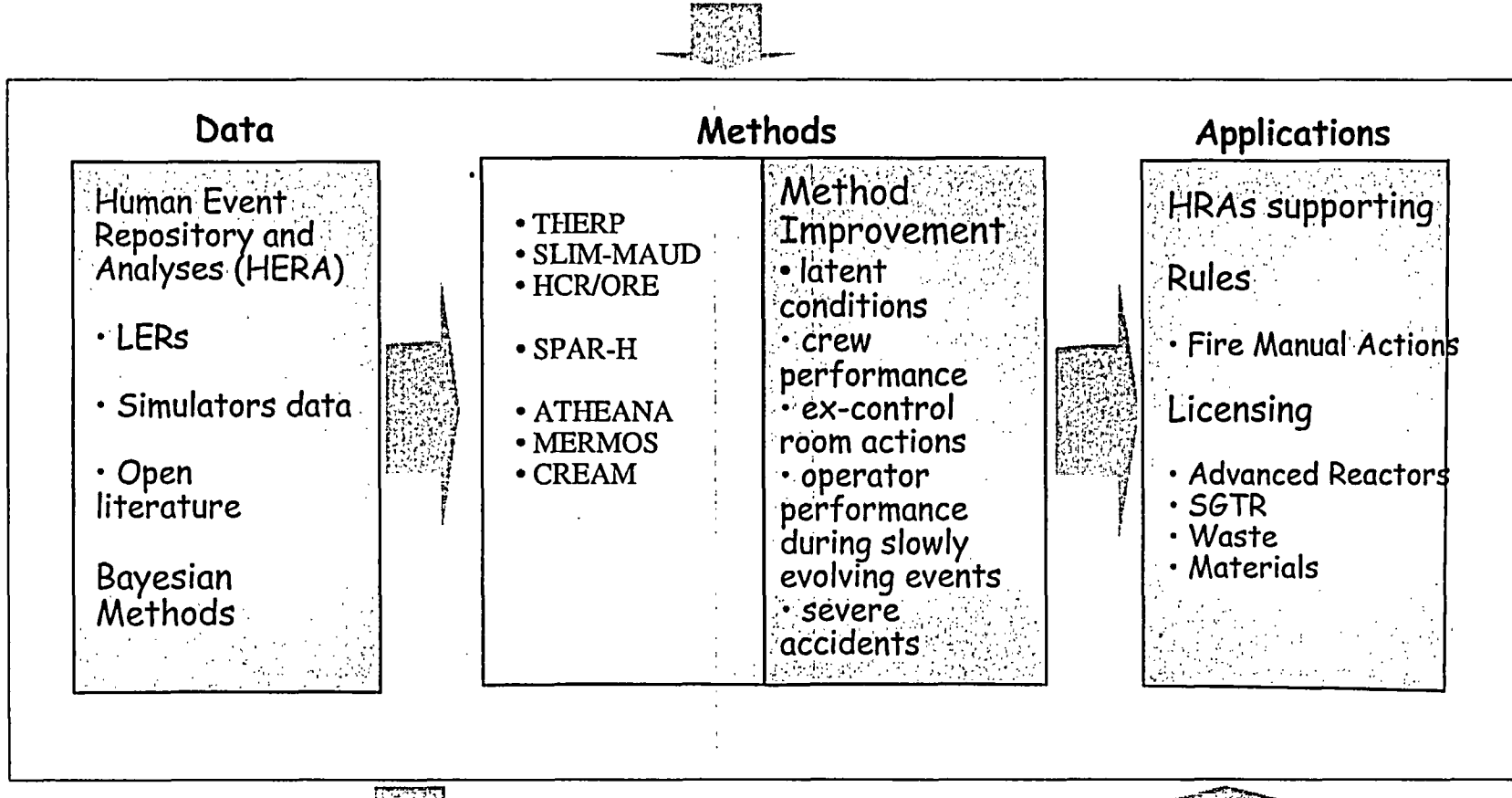
David Lew, Erasmia Lois, Susan Cooper
Division of Risk Analysis and Applications
Office of Nuclear Regulatory Research

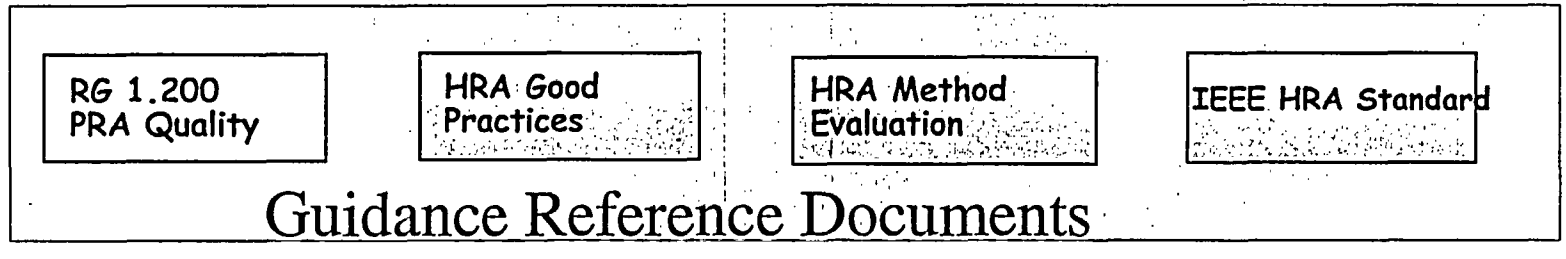
Presented to
Joint Meeting of Subcommittees on
Reliability & Risk Assessment and Human Factors
Advisory Committee on Reactor Safeguards
USNRC Headquarters • Rockville, MD • April 22, 2004

Briefing objective and overview

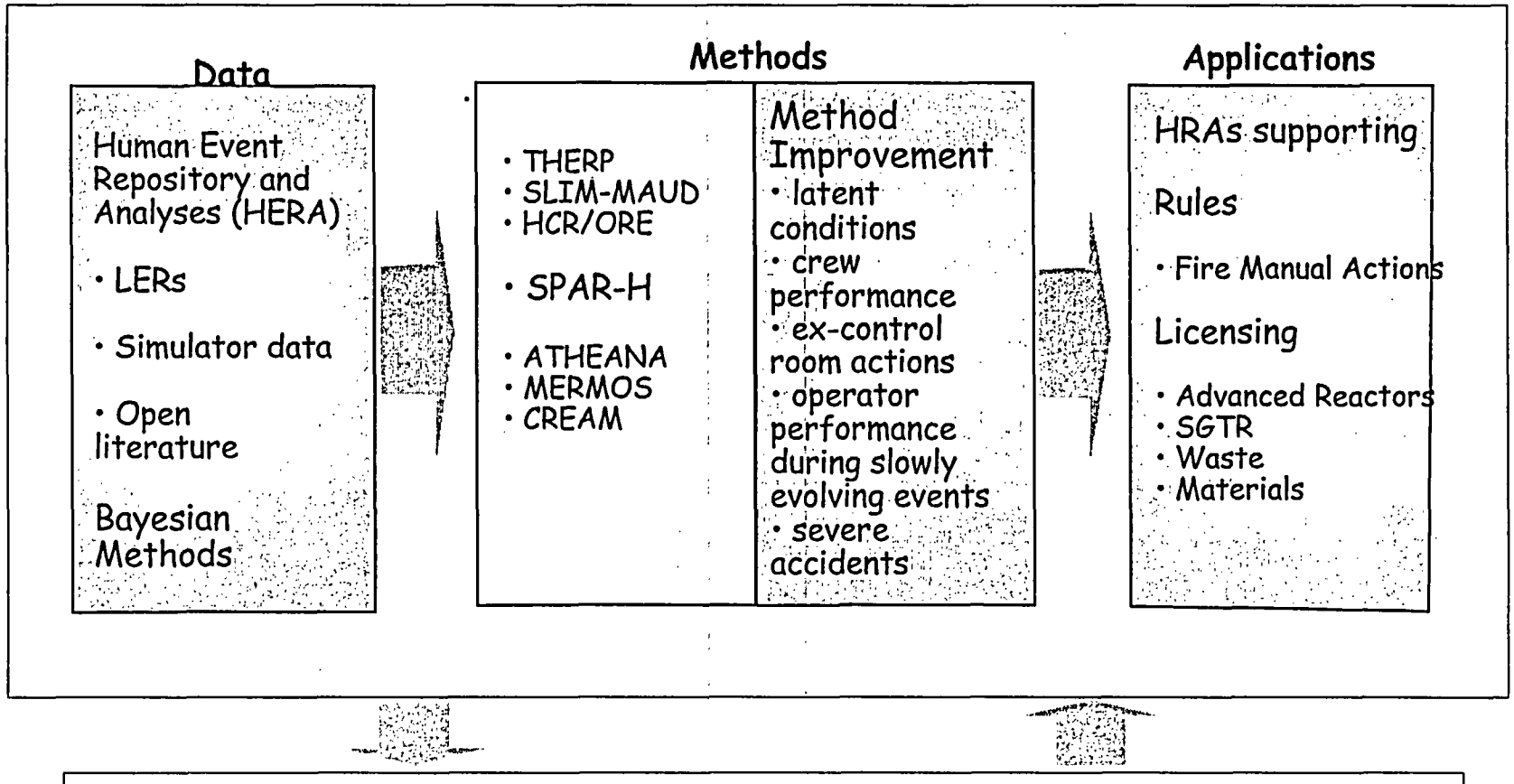
- Objective
  - Discuss status and results of HRA activities
  - Obtain feedback and guidance
- Overview
  - HRA good practices
  - ATHEANA quantification and implementation
  - HRA data development
  - Halden HRA activities

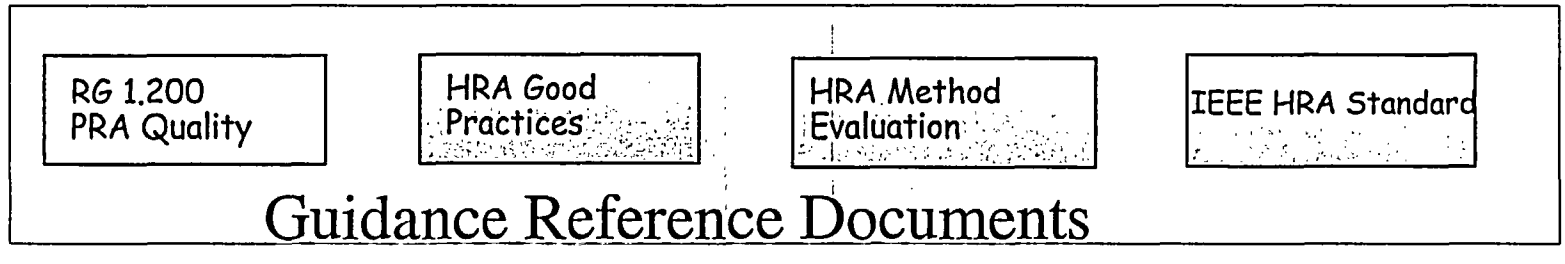
Human Reliability Analysis Activities





HRA activities dicussed today





HRA Guidance

- Supports Reg Guide 1.200/ASME PRA standard
- 3- step Approach
  - Document 1: High level summary of the HRA state-of-the-art
    - Final Dec 04
  - Document 2, "HRA Good Practices," provides technical guidance for performing/reviewing
    - Public Review: July 04
    - Final Dec 04
  - Document 3: Evaluation of 1st and 2nd generation HRA methods w/r to good practices
    - Draft Sept 05
    - Public Review and Comment: June 06
    - Final: Dec 06

GOOD PRACTICES FOR IMPLEMENTING HUMAN RELIABILITY ANALYSIS

Presentation to ACRS

Reliability and Probabilistic Risk Assessment and Human Factors Subcommittees

April 22, 2004

Alan Kolaczkowski, SAIC

Erasmia Lois, Susan Cooper, NRC-RES

John Forester, Sandia National Laboratories

Issue

- Need to address HRA quality:
  - Consistency in practices
  - Credible applications
- PRA/HRA continuing to be used:
  - Assess current operating risks
  - Estimate Δ risks from plant changes
  - Examine the risks of newer generation plant designs
- HRA results need to sufficiently represent the anticipated operator performance for making risk-informed decisions
- NRC seeks, per SRP 19, that "modeling of human performance is appropriate"
- Reg. Guide 1.200 reflects ASME RA-S-2002 & NEI 00-02
  - These address "what to do" but less on "how to do it"

Solution

- Develop a set of consistent, good HRA practices
  - HRA analysts and reviewers need to know what constitutes "good HRA" for risk decisions
  - Guidance needs to reflect what has been learned in HRA
  - HRA non-experts need to be able to recognize an appropriate HRA
- A "Good Practices for HRA" document is being created
  - Provides working level practices to meet requirements
  - Following these practices will produce the desired HRA
- Working toward a July 2004 Draft for Public Comment and a final version December 2004 for the industry's/NRC's use

BASES & APPROACH FOR HRA GOOD PRACTICES

- Bases for HRA Good Practices
  - ASME Standard
  - Existing HRA methods and tools
  - Insights from literature
  - PRA/HRA applications
  - Experiences of authors & reviewers of the document
- Approach for development of HRA Good Practices
  - Consensus of experts at NRC
  - Internal NRC reviews
  - ACRS feedback
  - Public comment

Scope of the HRA Good Practices

- Specifically for reactor, full power, internal events; but should be useful for external events, and to some extent other modes & non-reactor applications
- Does not endorse a specific method/tool
- Linked to the ASME Standard – includes summaries of ASME requirements
- Provides possible impacts of not performing good practices and additional remarks
- Focused on HRA process (not, for example, data)
- Many good practices are aimed at ensuring the context for human actions (plant conditions & performance-shaping factors) is addressed in modeling and quantification

HRA Good Practices Are Organized by Logical Analysis Activities

- Overall/general
- Pre-Initiators:
  - Identify potential human failures
  - Screen out from the above human failures those that do not need to be modeled
  - Model specific human failure events (HFEs) corresponding to the human failures
  - Quantify the corresponding human error probabilities (HEPs) for the specific HFEs
- Post-Initiators:
  - Identify potential human failures
  - Model specific HFEs corresponding to the human failures
  - Quantify the corresponding HEPs for the specific HFEs
  - Add recovery actions to the PRA
- Errors of Commission (EOCs)
- HRA Documentation

Overall/General Good Practices

1. HRA is a multi-disciplined, integrated effort within the PRA

2. Some combination of talk-throughs, walkdowns, field observations, and simulations is used as appropriate, to confirm judgments and assumptions

3. HRA addresses both core damage and large early releases

Post-Initiator Human Event Good Practices

Identify Potential Post-Initiator Human Failures

- Covered by 3 GPs that address:
  - GP#1: What to review
  - GP#2: How the review should be done (review process)
  - GP#3: The expected potential human failures that are to be identified
- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Model could be incomplete and/or inaccurate, potentially resulting in misinformation as to the risk dominant plant features (including the important human actions).

Model Specific Human Failure Events (HFEs)

- Covered by 2 GPs that address:
  - GP#1: Each HFE is to be modeled as a basic event linked to the affected equipment in the model; criteria are provided for deciding the appropriate level of the modeled basic event (i.e., function, system, train, component level)
  - GP#2: Each HFE needs to be defined based on plant & accident sequence specific characteristics including sequence timing, cues, procedures, training, & location of the act, with insights from talk-throughs, walkdowns, and simulations as necessary
- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Allowance for use of generic timing information provided:
    - There is a reasonable basis
    - It is sufficient considering resolution of the HRA quantification tool
  - Misinformation can result as to the risk dominant plant features (including the important human actions); e.g., HFE has wrong effect in the model

Quantify the Corresponding HEPs

- Covered by 8 GPs that address:
  - GP#1: HEPs need to include both cognitive and execution failures
  - GP#2: Conservative HEPs are acceptable provided:
    - Values are clearly over-estimations (generally not lower than 0.1)
    - Dependencies among multiple HFEs in a sequence are accounted for (joint probability of two or more HEPs generally not lower than 0.05)
  - GP#3: Detailed HEPs (not conservative) are needed for dominant human failure contributors
  - GP#4: Analysts need to revisit the use of conservative vs detailed HEPs for each PRA application
  - GP#5: Specific performance-shaping factors (PSFs) are to be considered for each HEP
    - Separate PSFs for in-CR vs. ex-CR actions
    - Some are always considered; others depend on certain conditions
    - Appendix A provides guidance on "measuring" each PSF & addresses interactions among PSFs

Quantify the Corresponding HEPs (continued)

- GP#6: Dependencies among HEPs in a sequence need to be addressed; criteria are provided for deciding the potential for dependency
- GP#7: Mean values and uncertainties (via distributions, sensitivity studies, qualitative analysis) are to be used for the dominant HEPs to the extent necessary to make the relevant risk decision
  - Include both epistemic and important aleatory factors not already addressed in the PRA (e.g. presence, or not, of nuisance alarms)
  - Factors of 10 to 100 are typical between the lower and upper bounds
- GP#8: HEPs need to be reasonable (i.e., make sense)
  - Relative to each other
  - In an absolute sense to the extent that the relevant risk decision is not overly sensitive to the HEP value(s)
  - Strong negative PSFs – HEP ~0.1; strong positive PSFs – HEP ~E-4

- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Misinformation can result as to the risk dominant plant features (including the important human actions) especially in light of uncertainties
  - Could inadvertently screen out human actions as unimportant

Add Recovery Actions

- Covered by 3 GPs that address:
  - GP#1: Add recovery actions considering-
    - The failure(s) to be recovered
    - The most logical recovery actions
    - Cues, procedures, training, timing, resources (staffing) available
    - Action is not a repair
    - Equipment needed is accessible and available/operable
  - GP#2: Address dependencies among recovery actions and between the recoveries and the other HFEs in each sequence
  - GP#3: Quantify using relevant data (e.g., offsite power recovery) or HRA analytical techniques
  - Note: these are just another HFE/HEP – prior good practices apply
- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Primary concern is applying recovery credit too optimistically

Errors of Commission (EOCs)

- The Good Practices document encourages EOC searches and provides guidance specifically to ensure that future plant changes do not introduce conditions prone to make operators vulnerable to EOCs
- These conditions include:
  - Information input to the operator could lead to a higher potential for misdiagnosis
    - There is a reduction in the redundancy in indications
    - An action will be decided based on just one indication or multiple indications subject to one common fault
  - Procedures and/or training are such that they could lead to a greater chance of implementation errors
    - The procedure/training is ambiguous/unclear
    - Repetitive procedure steps appear to have "no way out"
    - Dilemmas exist without solutions
    - There is a reliance on memory especially for complex or multi-step tasks
    - Calculations or other adjustments are required during time-sensitive situations

Pre-Initiator Human Event Good Practices

Identify Potential Pre-Initiator Human Failures

- Covered by 4 GPs that address:
  - GP#1: What to review
  - GPs#2-4: What to initially include
    - Actions potentially covered by the affected equipment failure data (i.e., in spite of possibly being covered in equipment data)
    - Actions associated with any other equipment credited in the analysis, e.g., fire barriers, seismic restraints
    - Cases where redundant or multiple diverse equipment can be affected by single or "common mode" failure acts
- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Model could be incomplete and/or inaccurate
  - Number of cautions are provided

Screen Pre-Initiator Human Failures

- Covered by 3 GPs that address:
  - GP#1: Criteria provided for screening, e.g., equipment will receive an automatic realignment signal, compelling signal of inoperable status in the CR, etc.
  - GP#2: Does not allow screening pre-initiator failures that simultaneously affect multiple (redundant or diverse) equipment items
  - GP#3: For "new issues," e.g., plant change, analysts need to revisit the original PRA screening process to ensure issue-relevant human actions have not been deleted from the PRA
- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Emphasizes that important pre-initiators can be missed (tend to be those affecting multiple equipment)
  - Number of cautions are provided

Model Specific Human Failure Events (HFEs)

- Covered by 1 GP that addresses:
  - GP#1: How and where to include the HFE in the model
    - Place in the model such that it is linked to the unavailability of the affected component, train, system, or overall function
    - May combine multiple individual acts in a single HFE – addresses relevant criteria:
      - Are the acts and effects related?
      - Will the same performance shaping factors (PSFs) be relevant during quantification?
      - Will some of the acts have dependencies with other actions in the model that might be missed?
    - Clear specification of failure mode reflecting effect of HFE
- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - The model could misrepresent the effects of each human failure

Quantify the Corresponding HEPs

- Covered by 8 GPs that address:
  - GP#1: Advocates the use of screening values during initial quantification
    - Must be over-estimations of HEPs - no lower than 1E-2
    - Conservative accounting for dependencies across multiple actions in a sequence - joint HEP no lower than 5E-3
  - GP#2: Detailed quantification is needed of significant contributors
  - GP#3: For "new issues," e.g., plant change, analysts need to revisit the original PRA screening process
  - GP#4: Provides PSFs & related guidance to be considered – Cites: procedures, checklists, ergonomics, etc.
  - GP#5: Provides "recoveries" that can be applied, e.g., post-maintenance, calibration tests performed by procedure, shiftly or daily checks, compelling signal, etc.

Quantify the Corresponding HEPs (continued)

- GP#6: Assess dependencies among potentially related actions – addresses commonalities that could cause dependencies and provides quantitative guidelines
- GP#7: Address epistemic uncertainties in the HEP mean estimates (aleatory factors as needed – but generally not applicable). Factors of 10 to 100 are typical between the lower and upper bounds
- GP#8: HEPs need to be reasonable (i.e., make sense)
  - Relative to each other
  - In an absolute sense to the extent that the relevant risk decision is not overly sensitive to the HEP value(s)
  - Strong negative PSFs – HEP ~0.01; strong positive PSFs – HEP ~E-4

- POSSIBLE IMPACTS OF NOT PERFORMING GOOD PRACTICES AND ADDITIONAL REMARKS:
  - Misinformation can result as to the risk dominant plant features (including missing of important pre-initiator human failures)
  - Cautions are provided

HRA Documentation

- Summary of approach, disciplines involved, and extent that talk-throughs, walkdowns, simulations were used
- Summaries of methods, processes, tools to:
  - Identify pre- and post- human actions
  - Screen pre-initiators from modeling
  - Model HFEs
  - Quantify HEPs
- Assumptions, judgments & their bases including impacts on results/conclusions
- More detail on important HFEs (e.g., PSFs, specific dependencies…)
- Sources of data and their bases for quantification (including uncertainties)
- Results (listing of important HFEs/HEPs) and conclusions

HRA Good Practices Document should be useful to:

- Analysts performing HRA and particularly for plant change submittals
- Reviewers reviewing HRA and when examining plant changes for acceptability

ATHEANA IMPROVEMENT

- ATHEANA Improvement
  - Quantification
    - Addressed ARCS comments on quantification
    - Adopted an expert elicitation process
    - Developed approach to explicitly address uncertainties
    - Used in the PTS PRA
    - Status: completed, CY02
  - Implementation
    - Addressing ACRS concerns for resources needed to apply ATHEANNA
    - Build on lessons learned from applying ATHEANA
    - Create an Addendum to NUREG-1624
    - Technology transfer
    - Status: just initiated

Quantification And Treatment Of Uncertainty In ATHEANA

John Forester, Alan Kolaczkowski, Erasmia Lois and Susan Cooper

Presentation to the Advisory Committee on Reactor Safeguards, PRA and Human Factors Subcommittees

Rockville, MD April 22, 2004

Presented By

John Forester

Sandia National Laboratories

Other Contributors to the Development of the Quantification Process

- Dennis Bley
- Nathan Siu
- John Wreathall

Issue

- ATHEANA (NUREG-1624, Rev. 1) focused on search process for unsafe acts (including errors of commission) and error forcing context (EFC)
- Quantification process relied on existing HRA methods
- ACRS - Quantification process needed improvement
- ACRS/NRC - HRA quantification needs better treatment of uncertainty

Solution

- Adopted a facilitator led, consensus expert judgment process
- Provides a better approach for incorporating the effects of context as identified and represented in ATHEANA
- Striving for more formal and systematic treatment of uncertainty
- Goal is more realistic results

ATHEANA Prospective Search Process

- Identify important human failure events (HFEs), unsafe actions (UAs) and the contexts that could cause them to occur (EFCs)
- Key aspects:
  - Identify operational vulnerabilities that could set-up potential unsafe actions
    - Procedures, knowledge, biases...
  - Identify potential deviations from expected conditions that might cause problems
    - Are there ways the scenario could evolve that could confuse the crew?

Basic Formulation

- $P(HFE|S) = \sum_i P(EFC_i|S) \times P(UA|EFC_i,S)$
- HFEs are human failure events modeled in PRA
  - Modeled for a given PRA scenario (S)
  - Can include multiple unsafe actions (UAs) and error-forcing contexts (EFCs)
- First determine probability of the EFC, including plant conditions and performance shaping factors (PSFs)
- Determine probability of UA given the identified EFC

Facilitator Led, Consensus Expert Judgment Process

- Integrates the knowledge of informed analysts (trainers, operators, plant PRA/HRA staff) to quantify UAs and treat uncertainty (Based on SSHAC report, NUREG/CR-6372)
  - Investigates information and "evidence" "brought to the table" by experts
  - Transforms informed judgment into probability distributions
  - Considers a full range of PSFs, though quantification ultimately dependent on those believed most significant
  - Assesses interactions/dependencies between factors in terms of their influence on performance in the context being examined

Step 1 - Guidance to Multidisciplinary Panel About the Process

- Overview of ATHEANA, quantification process, terminology, etc.
- Try to "calibrate" on what the different probabilities mean
  - "Likely" to fail ~ 0.5 (5 out of 10 would fail)
  - "Infrequently" fails ~ 0.1 (1 out of 10 would fail)
  - "Unlikely" to fail ~ 0.01 (1 out of 100 would fail)
  - "Extremely unlikely" to fail ~ 0.001 (1 out of 1000 would fail)
- Analysts are allowed to assign any values to represent the probability of the UA (e.g., 3E-2, 5E-3 can be used)

Step 2 - Structure Scenario Context and Identify Important Aleatory Factors

- Results of ATHEANA prospective search process (UAs and EFCs - vulnerabilities and deviation scenarios)
- Facilitator (with help from analysts) establishes critical set of event and scenario characteristics, PSFs etc.
- $P(UA|EFC_i,S)$
  - EFC_i,S may not initially include everything that can influence performance, e.g, aleatory factors such as crew differences, possible instrument problems, etc
  - HRA/PRA has not typically addressed such factors explicitly
- Created a factor checklist to help identify potentially important aleatory factors, i.e., those could have strong effects and that have a reasonable likelihood of occurring
  - Plant context, crew behavior factors, environmental factors, etc.
  - Compare against factors identified by searches

Step 3 - Translate Contextual Information into a Probability Distribution for a given UA

- Each analyst independently develops a probability distribution for the likelihood of the UA
  - Begin by asking what the worst case for the probability of failure would be (determine 99th percentile)
    - e.g., worst case for reasonably likely/important aleatory factors – middle of the night, least aggressive crew, significant unexpected instrument problems, etc.
  - Next ask what the best case for the probability of failure would be (determine 1st percentile)
  - Estimate UA probability at which 50% of the crews would have a higher failure rate while 50% would have a lower failure rate
  - Fill-in the distribution with other estimates (10th, 25th, 75th, 90th)
- Discuss distributions, facilitator attempts to control for bias, revise distributions, strive toward consensus

What Does the Distribution Represent?

- Each distribution for a given $P(UA|EFC_i,S)$ represents:
  - The probability distribution of a UA given a particular EFC in a given accident scenario, *S*, including the uncertainty due to the effects of strong aleatory factors and "error" in the estimate due to lack of knowledge about the precise effects of all influencing factors (epistemic uncertainty)
- If quantify multiple UAs or EFCs, then would need to combine the obtained distributions for a given HFE

Quantification Example - Failure to isolate a stuck-open atmospheric dump valve (ADV) within 30 minutes

General Context

- Creates a small secondary side depressurization.
- Since the ADV is stuck open, requires that an AO go to the roof and use a "reach-rod" through the wall to perform the isolation.
- While instruction to close any open ADV is indicated in EOP 1.0, the explicit instructions to go onto the roof indicated in EOP 6.0, Step 14.
- Estimated that the crew would get to step in EOP 1.0 in about 5 min. and that it could take 15 min. to diagnose SO ADV, assign AO, and complete the action on the roof.
- Since it was also estimated that it would take about 15 minutes for the crew to reach step 14 in EOP 6.0, crew would probably need to begin the process of getting an AO ready to go before reaching Step 14 in EOP 6.0
- A sheet of instructions are provided to the AO as to how to go up on the roof and isolate the ADV. The action is practiced occasionally

Quantification Example - Failure to isolate a stuck-open ADV within 30 minutes (continued)

Aleatory Factors Addressed

- Instrumentation or controls unavailable due to maintenance or failure. In this case, particularly those displaying ADV position.
- Support system failures that affect control of other systems (can cause very confusing plant response, e.g., instrument air, instrument AC, instrumentation and control system.
- Aggressiveness of the crews with respect to anticipating actions, planning ahead, and "taking control" vs. methodically applying procedures
- Whether they enter EOP 6.0 or EOP 9.0. Entry into EOP 9.0 could lead them to take a little longer to reach the isolation step.
- Crew "having bad day" (for any number of possible reasons), weaker crew, or a minimum crew present at the start of the event.
- Time of day, weather, and random hardware/equipment problems could have an effect on the crew's ability to complete the action. Limited lighting on the roof and wet, cold, icy, snowy weather could make the task more difficult. Also, if late at night, AOs immediately available to take care of ex-control room actions might be limited.

Quantification Example - Failure to isolate a stuck-open ADV within 30 minutes (continued)

Basis for the Consensus Distribution

- Likely that crew would diagnose the presence of the stuck-open ADV during Step 7 of EOP 1.0.
- But not as clear that all crews would send an AO up to the roof immediately upon reaching Step 7 in EOP 1.0.
- Agreed that if did not send someone during EOP 1.0, most crews would at least begin the process of preparing an AO for the task before reaching Step 14 of EOP 6.0.
- Staff noted that in a recent training simulation of the scenario, an AO was dispatched to the roof to close the ADV during EOP 1.0.
- Agreed that not all crews would initiate the action that quickly – likely to be fairly busy.
- Main considerations for failing to perform the action within 30 minutes (aleatory factors) was
  - Potential for bad weather and problems executing the action.
  - Potential for slow or "non-aggressive" crews
  - Problems with ADV indicators

Uncertainty distributions for: Failure to isolate a stuck-open atmospheric dump valve (ADV) within 30 minutes of the initiating event.							
Analysts	Percentiles						
	1st	10th	25th	50th	75th	90th	99th
#1	0.01	0.05	0.08	0.03	0.4	0.8	1.0
#2	0.001	0.003	0.008	0.02	0.07	0.1	0.8
#3	0.001	0.01	0.06	0.03	0.4	0.6	0.9
#4	0.005	0.01	0.02	0.033	0.1	0.6	0.8
Consensus	0.001	0.01	0.03	0.04	0.2	0.5	0.9

Conclusion

- Overall process appears to work well
  - Initial estimates of HEPs and distributions reasonably consistent (order of magnitude)
  - Consensus generally easy to reach (analysts have opportunity to listen to rationale of other analysts after initial estimates obtained)
  - Analysts generally more confident in consensus distribution than in original personal distribution
- In spite of limitations of using expert judgment, best existing approach for a realistic analysis
- Need more operational and empirical data to support HRA

United States
Nuclear Regulatory Commission

IMPROVEMENT TO ATHEANA IMPLEMENTATION

Presented to ACRS

April 22, 2004

Dr. Susan E. Cooper

ISSUE

- ATHEANA Implementation
  - Comments indicate that ATHEANA implementation is cumbersome
  - NUREG-1624 is voluminous
  - Additional work has been done that is not included in NUREG-1624, Rev. 1
  - Applications of ATHEANA have/can provide useful lessons learned

SOLUTION

- Create an Addendum to NUREG/CR-1624
  - Description of up-to-date ATHEANA quantification approach
- Description of up-to-date approach for uncertainty analysis
- Selective focus on HRA tools given in NUREG-1624
  - Exclude knowledge-base, retrospective analysis approach, etc.
  - Include HRA process
  - Include search process for HFEs
  - Include search process for deviation scenarios
- Guidance on "fast-track" approaches for applying ATHEANA
- Lessons learned from ATHEANA applications (including illustrative examples)

Data Development

- Human Event Repository & Analysis (HERA)
  - Effective use of existing information
  - Currently focusing on NPP operational experience
  - Future plans include other sources
  - Status
    - CY 03: Developed prototype and loaded limited number of operational events
    - CY 04 and Beyond
    - Finalize software
    - add events
    - Develop Bayesian type methods to use the events

Idaho National Engineering and Environmental Laboratory

Human Event Repository and Analysis (HERA)

Presentation to the Advisory Committee on Reactor Safeguards

April 22, 2004

Bruce P. Hallbert

Issue

- *HRA influences the uncertainty of PRA results.*
- *The strength of available data for HRA is an important contributor to the uncertainties*
- *Data are needed to build models and estimate probabilities for PRA*
- *While hard data may be sparse information/evidence about human performance is available*
- *Bayesian methods allow the use of this type of information/evidence in estimations*

Solution

- *Human Event Repository & Analysis (HERA):*
  - *an effort to develop data that are relevant and qualified for use in HRA.*
  - *Develop Bayesian methods for using HERA data to estimate human failure event (HFE) probabilities*

Background

- *HRA methods use structured processes to identify potential human failure events and to estimate their likelihood.*
- *Most methods permit or direct the analyst to account for performance conditions and context.*
- *Identifying important conditions and accounting for their effects continue to be a challenge for HRA.*
- *HRA methods may account for different Performance Shaping Factors (PSFs) and may treat them each differently.*
- *As a result, considerable analyst judgment is required.*
- *Differences in the magnitude of effect of such factors contribute to the uncertainty in the resultant risk metric.*

HERA Objective and Approach

- *Objective: Provide information about human performance in PRA-relevant settings that includes information about conditions affecting the outcome(s) consistent with HRA methods.*
  - *Support both human factors and HRA activities*
- *Approach:*
  - *Identify information sources that can be used to inform HRA activities.*
  - *Develop a formal process for analyzing information from sources to extract HRA-relevant information.*
  - *Perform analyses and extract information from candidate information sources.*
  - *Develop a repository that is used with other NRC information systems to make information readily available.*
  - *Develop Bayesian type methods to allow the use of various types of evidence in estimations.*

Human Performance Information Sources

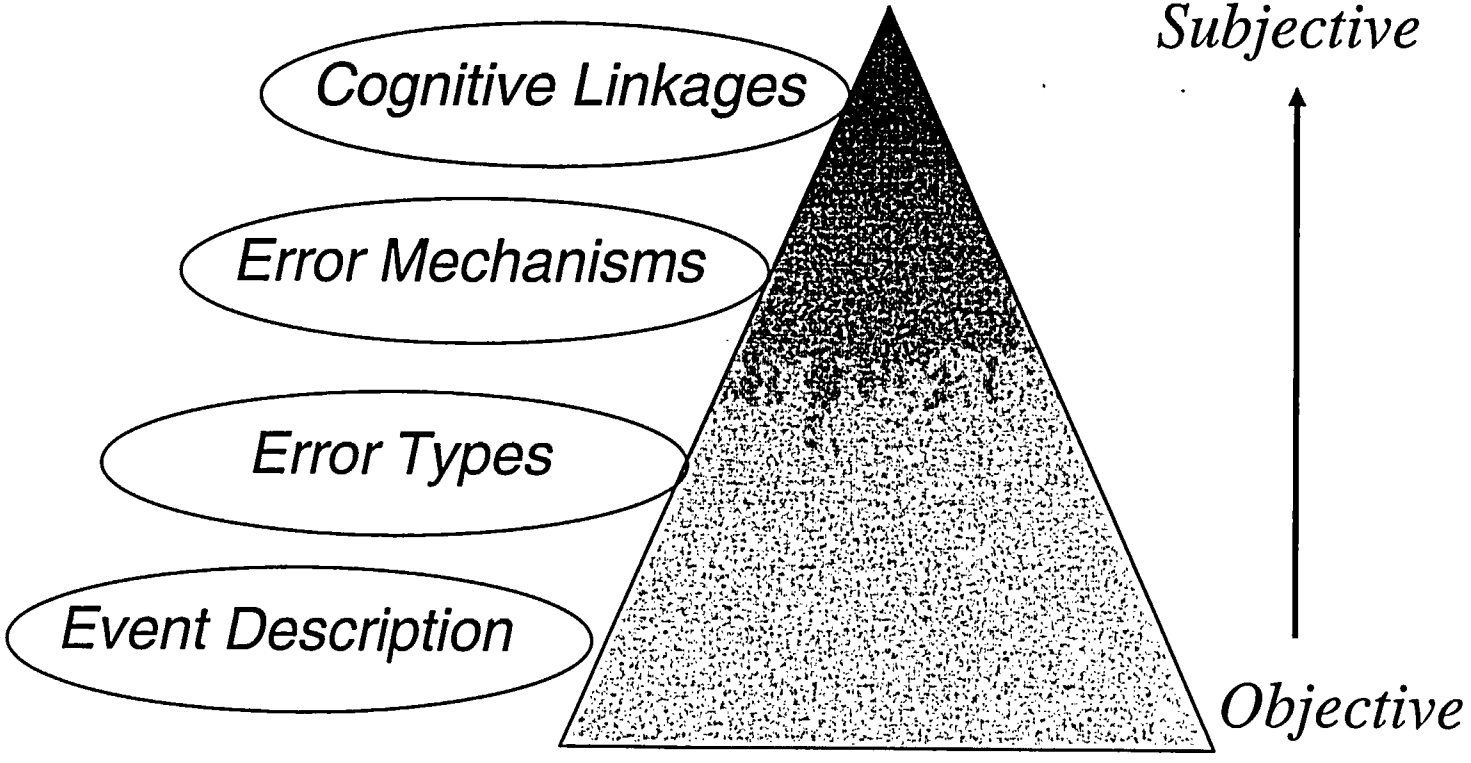
- *Considered several initially: Operating experience; behavioral sciences literature; simulator studies, data from other industries.*
- *Began and are currently working with Operating Experience:*
- *Highly applicable to NRC mission; implicitly risk-relevant.*
- *Using an available, NRC- and industry-reviewed, source.*
- *Indicate what kinds of things have gone wrong (as well as right) during events.*
- *Can be used to identify credible Unsafe Acts (UAs) and Human Failure Events (HFEs) given same or similar contexts*
- *Allows for identification and assessment of PSFs*
- *Accounts for the role of personnel during accident mitigation*

HERA Structure

- *Event summary*
  - *Date, Licensee, Plant, Initiating Event, Basic event(s), context(s), operating mode(s), source documents employed.*
- *Graphic timeline and descriptive information for sub events*
  - *Equipment conditions, human failure or success, dependency between sub events.*
- *Performing Organization (e.g., maintenance)*
- *Performance Type and Action or diagnosis task description*
  - *e.g., pre-initiator, initiator, post initiator action or diagnosis*
- *Success or Failure information*
- *Active versus latent failure distinction*
- *PSF information; 8 PSFs used for HFEs and successful actions*
- *Plant conditions (factors contributing to operations and maintenance)*
- *Function, system, and component unavailability*
- *Dependency*

Process model

- Based on concept of layering:



Status

- *LERs from NRC system studies – EDG failures (12 events)*
- *Now Processing information from common cause failure events*
- *80 data records (end of CY 03)*
- *Approximately 3 4unsafe acts and two positive human actions (HAs) per LER*
- *Roughly 9 - 14unsafe acts per AIT*

Bayesian framework development

- Concurrent with information/evidence development, working on method(s) to produce quantitative results.
- Bayesian methods
  - Use all available information
  - Can be used to produce parameter estimates from observations
  - Account for causal and conditional nature of performance and context.
- Probability is quantification of degree of belief
- Begin with a prior distribution about hypothesis
- Observe performance
- Develop a posterior distribution for hypothesis.
- Estimate probability that a hypothesis is true, conditional on all available evidence.
- Differs from classical statistical and "frequentist" methods.

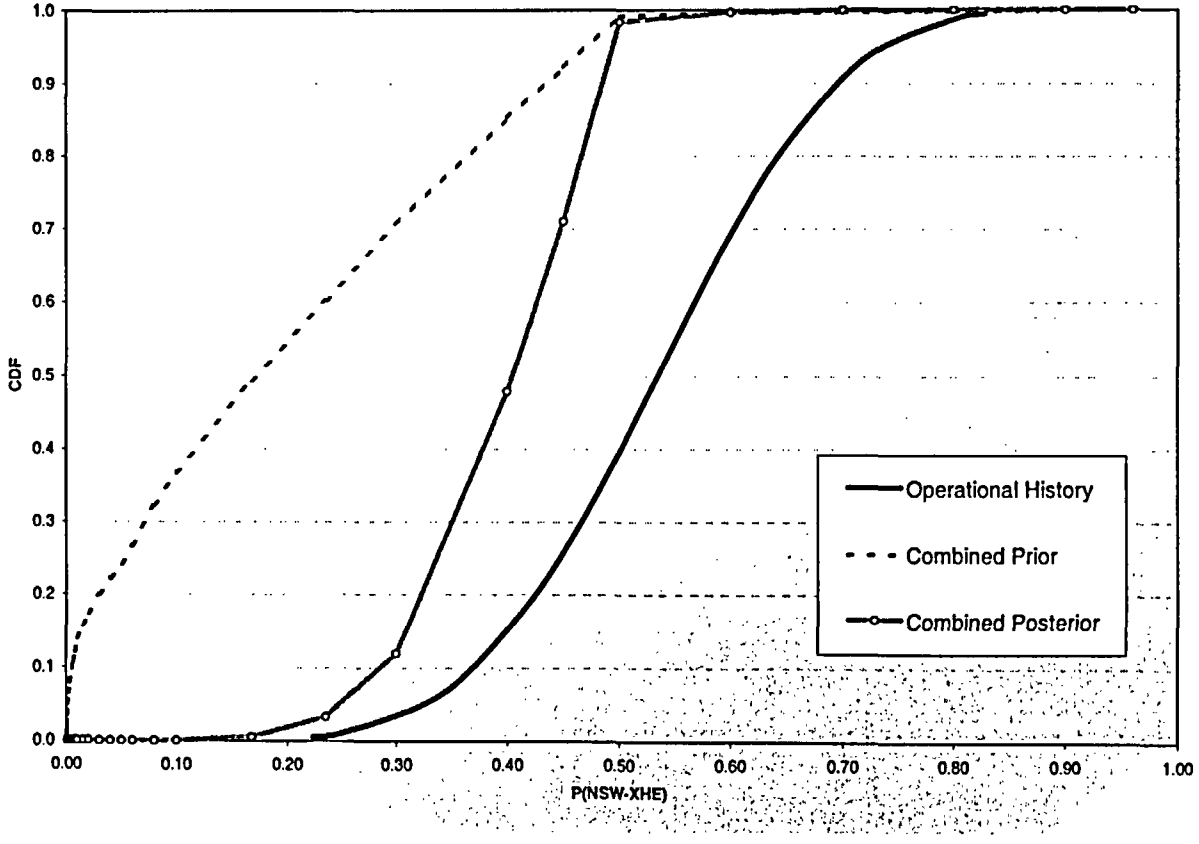
Bayesian Example – Service Water

- *Collected recovery of **service water** data, failures versus successes*
  - *We also have four **HRA** results for this recovery*
    - *NUREG/CR-5319, Risk Sensitivity to Human Error*
    - *Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR)*
    - *Standardized Plant Analysis Risk (SPAR) HRA*
    - *A Technique for Human Event Analysis (ATHEANA)*
- *We could **combine** sources of HRA information to make our prior (includes HRA models, expert elicitation information); joined in example via probability (i.e., in the likelihood function)*

Source	NUREG/CR-5319	NUCLARR	SPAR-H	ATHEANA
Likelihood	0.1	0.1	0.2	0.6

Bayesian HRA – Pooled Information

- *With prior from the **pool** of four HRA information sources, we **update** our service water recovery data*



Bayesian HRA – Analysis Types

- *Two types of analysis are possible*
  - ***High** level -- human performance, measured at "sharp end," and represented by fail/succeed*
  - ***Low** level- - human performance from causal interactions that affect performance*
- *Inference methods based upon Bayesian analysis **do not differentiate** between constructs like "high" or "low"*
  - *Are **allowed** to shape Bayes' Theorem into a useful inference tool*

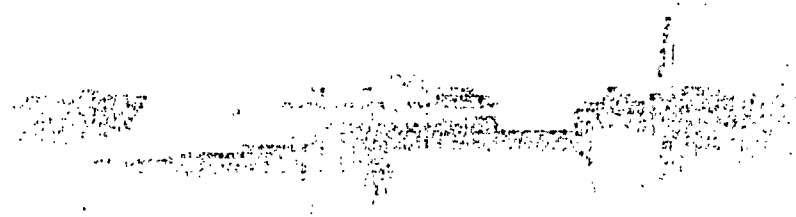
Summary

- *Developing a source of HRA information - HERA - and a framework for employing the information in analyses.*
- *Implementing human performance coding in NRC hardware reliability system.*
- *Develop and demonstrate Bayesian framework for using information from HERA to improve estimation of parameters used in human reliability.*
- *Bayesian framework workshop planned to review:*
  - *Concept of Bayesian Framework*
  - *Examples of Bayesian applications using HERA*
  - *Identify main priorities for framework development.*
- *Working with Halden on cooperative arrangement for integrating results of research into HERA.*

Halden Simulator HRA Studies

- Design simulator experiments specifically for HRA
  - Experimental data is the best thing next to "real"
  - Improve understanding of both successes and failures
  - Examine operator and team performance
- Benefits
  - Capability to test hypotheses employed in HRA methods
  - Achieve rigorous (systems-type) modeling methods
- Status
  - CY03 initial attempts to use the simulator for HRA
  - CY04: more focused experiments

Halden HRA activities



Advisory Committee on Reactor Safeguards

PRA and Human Factors Subcommittees

22 April 2004

Andreas Bye

OECD Halden Reactor Project

OECD Halden Reactor Project (HRP)

- 19 sponsoring member-countries
- 3 year program periods
- Experimental programs
  - Nuclear fuels and materials, Halden Boiling Water Reactor (HBWR)
  - Man – Technology – Organisation
    - HAMMLAB, HAlden huMan Machine LABoratory
    - Virtual Reality (VR) center
- Human Performance
  - **Human Reliability**
  - Design support

- Currently working with NRC on HRA informed research

HRA in Halden

Issue

- Need for empirical data for HRA (CSNI, 2004)
  - Data for post-initiating event operator actions
- Improved understanding of human performance
- Reduced uncertainty of HRA and PRA

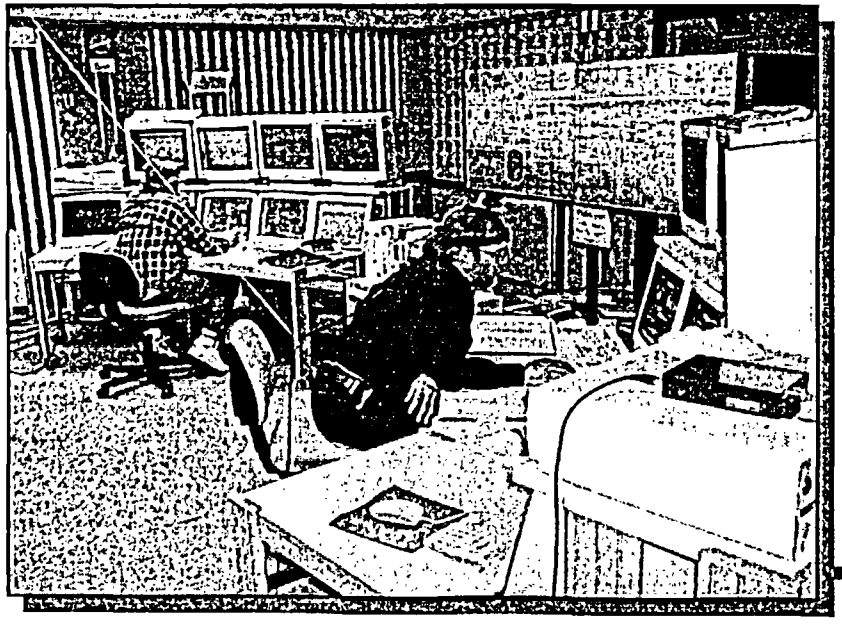
Solution

- Simulator experiments to provide HRA data

(CSNI, 2004) CSNI Technical Opinion Papers No. 4
Human Reliability Analysis in Probabilistic Safety Assessment for Nuclear Power Plants, OECD 2004, NEA No. 5068

HAMMLAB

- Controlled experiments in realistic settings
  - Full-scale simulators of real nuclear power plants
    - Forsmark 3 NPP (ABB Atom BWR)
    - Fessenheim NPP (Westinghouse 3-loop PWR)
    - (Loviisa NPP (VVER))
  - Licensed operators, in crews, from simulated plants
  - PRA relevant scenarios
  - Not replica control room, but computerised



HRA data from simulators

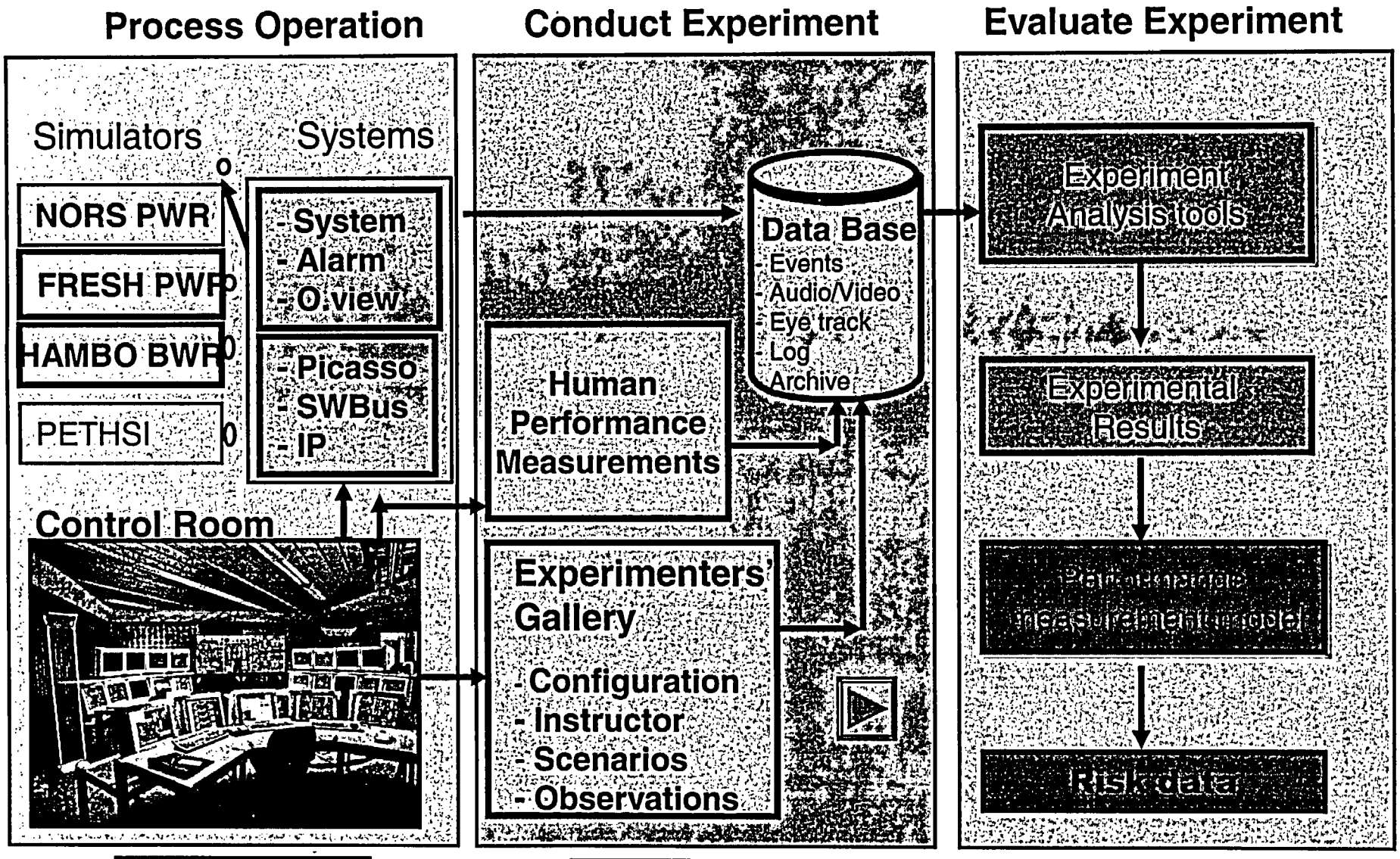
Empirical human performance data for accident situations

- Understanding human performance in accident operation
  - Address cognitive aspects of human performance, why do errors occur
  - Decision based errors
  - Dependencies among actions
- Context, Performance Shaping Factors (PSFs)
  - Focus on specific causal factors
  - Assess the range of effects of PSFs in accident scenarios
  - Improve data basis for PSFs, and interaction between PSFs
    - Through experimental manipulation
- Input to direct quantification
  - Bayesian approach

Experiments for HRA

- Task Complexity
  - Example of method, design and measures
  - Task Complexity in our terms defined by
    - Information load
    - Time pressure
    - Masking

HAMMLAB Experiment Execution



Example of Conditions defining Complexity

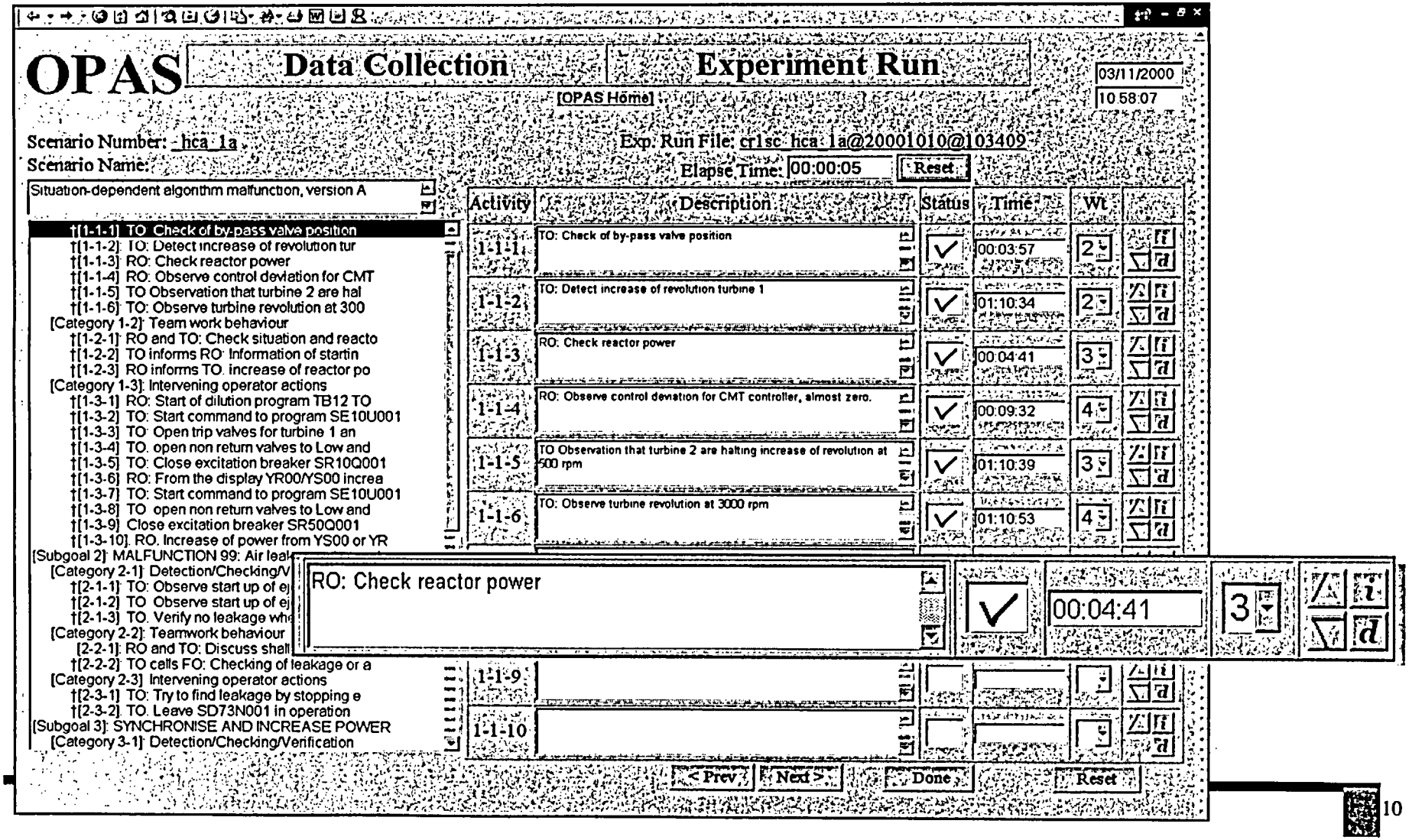
	Time Pressure	Masking	Information Load
High Clx Sce-nario	• When SCRAM occurs, the closed 314-valve open. If this is not closed immediately, the risk is high for Feedwater Isolation (due to high level in Reactor Tank). .	• The loss of voltage on busbar 641 will last just some seconds. It will be difficult for the operators to understand why relatively many pumps stops and restart. • Indication for released condition for feed water isolation is missing in the 516-picture	• First the loss of voltage on busbar 641 and short time after that Feedwater Isolation (IM). High load because they do not have time to follow up the loss of voltage and IM before containment isolation occurs.
Low Clx Sce-nario	• Low time pressure. It is possible to use the feed water system a long time. .	• It is reasonably difficult to understand why Turbine Trip (TS) occurs, but it has no direct significance.	•The initial turbine disturbances do not affect Containment Isolation (II). Relatively small load and no problems with the feed water.

Performance data

- OPAS Sheets
  - Detections, situation assessment, planning (observed)
  - Actions (log)
- Safety functions (plant system, components)
  - Log of process and components
- Subject Matter Expert (SME) ratings
- Operator ratings
- Observations
  - Unexpected / deviations
  - Narratives
- Crew's own debriefing after scenario

OPAS (Operator Performance Assessment System)

- Human performance: Operator activities
  - Detection, Situation Assessment, Planning, Action



Subjective Complexity Questionnaire

1. Unclear or Ambiguous process picture, misleading or missing process indication	**Very difficult**	☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Easy**
2. Ambigious, misleading or missing process feedback on process actions	**Very difficult**	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Easy**
3. Unexpected or ambiguous process development given the actual event	**Very difficult**	☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Easy**
4. Time available to assess the process situation	**Very difficult**	☐ 1	☒ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Easy**
5. Time available to carry out needed actions	**Very difficult**	☐ 1	☐ 2	☐ 3	☐ 4	☒ 5	☐ 6	☐ 7	**Easy**
6. Time available to plan and verify work	**Very difficult**	☐ 1	☐ 2	☐ 3	☐ 4	☒ 5	☐ 6	☐ 7	**Easy**
7. Many simultaneous tasks making it difficult to perform the individual tasks	**Very difficult**	☐ 1	☐ 2	☐ 3	☒ 4	☐ 5	☐ 6	☐ 7	**Easy**
8. Collecting and using large amount of information was required to do the work	**Very difficult**	☐ 1	☒ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Easy**
9. Conflicting tasks	**Very difficult**	☐ 1	☐ 2	☒ 3	☐ 4	☐ 5	☐ 6	☐ 7	**Easy**

PSF rating Questionnaire

1. Procedures
2. Training/experience
3. Indications in HMI
4. Actions in HMI
5. Team management
6. Team communication
7. Individual work practise
8. Available time for the tasks
9. Number of tasks/information load
10. Masking
11. Degree of severity

Summary, Collaboration with NRC

- Experiments tailor-made to support HRA data needs
- Exchanging staff with INEEL as part of cooperation
  - Curtis Smith in Halden Sep 2003 – July 2004
- Integrating efforts with NRC HERA development
  - HERA training in Idaho March 2004
  - Design of studies to support HERA development
- Two Halden process experts to Chattanooga, two weeks training to learn more about U.S. plants, April 19-30 2004

Summary

- Simulator experiments can inform HRA
- Data for post-initiating event operator actions
- Improved understanding of human performance
- Reduced uncertainty for HRA