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NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

558th MEETING

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FRIDAY,

DECEMBER 5, 2008

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ROCKVILLE, MARYLAND

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The Committee met at the Nuclear Regulatory Commission, Two White Flint North, Room T2B3, 11545 Rockville Pike, at 8:30 a.m., William J. Shack, Chairman, presiding.

COMMITTEE MEMBERS PRESENT:

WILLIAM J. SHACK	Chairman
MARIO V. BONACA	Vice Chairman
SAID ABDEL-KHALIK	Member-At-Large
GEORGE E. APOSTOLAKIS	Member
J. SAM ARMIJO	Member
SANJOY BANERJEE	Member
DENNIS C. BLEY	Member
CHARLES H. BROWN, JR.	Member

COMMITTEE MEMBERS PRESENT: (cont'd)

MICHAEL CORRADINI	Member
OTTO L. MAYNARD	Member
DANA A. POWERS	Member
HAROLD B. RAY	Member
MICHAEL T. RYAN	Member
JOHN D. SIEBER	Member
JOHN W. STETKAR	Member

ALSO PRESENT:

ERASMIA LOIS
SUSAN COOPER
GARETH PARRY
JOHN MONNINGER
JOHN FORRESTER (via telephone)
JEFF JULIUS (via telephone)
ANN RAMEY-SMITH
MARY DROUIN
DONALD DUBE
GIRIJA SHUKLA

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

(8:31 a.m.)

CHAIRMAN SHACK: The meeting will now come to order.

This is the second day of the 558th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting the committee will consider the following: overview of the human reliability analysis research activities, draft policy statement on defense-in-depth for future nuclear reactors, future ACRS activities, and report of the Planning and Procedures Subcommittee, reconciliation of ACRS comments and recommendations, election of ACRS officers for calendar year 2009, and preparation of ACRS reports.

This meeting is being conducted in accordance with the provision of the Federal Advisory Committee Act. Mr. Tanny Santos is the Designated Federal Official for the initial portion of the meeting.

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

Representatives of the Electric Power Research Institute are on the phone bridge line to

listen to the discussion regarding the overview of the human reliability analysis research activities and to answer any questions. To preclude interruption of the meeting, people on the phone line are not allowed to make remarks unless specifically requested.

A transcript of portions of the meeting is being kept, and it is requested that speakers use the microphones to identify themselves and speak with sufficient clarity and volume so they can be readily heard.

I would also like to remind the members that we have a Christmas party today, and, therefore, we would like to keep the meeting on schedule this morning. So the subcommittee Chairman will rule with an iron hand.

(Laughter.)

At our opening --

MEMBER APOSTOLAKIS: If he ever is given the gavel.

(Laughter.)

CHAIRMAN SHACK: Our opening is the overview of the human reliability analysis research, and George, with his iron hand, will be leading us through this.

MEMBER APOSTOLAKIS: Thank you very much,

Mr. Chairman. Your advice has been heeded.

Okay. What we will hear about today is just a meeting for your information only, but the history of it goes back to 2006 where we had a subcommittee meeting in July of '06, and then a full committee meeting in November of that year.

And the main idea, then, was that there are several human reliability models that are out there -- SPARH and ATHEANA, for example, from this agency. There are several others that have been proposed by individual researchers and also by the Electric Power Research Institute.

And the question that was raised really was: why? Why do we have all of these models? Are they consistent with each other? Are they in conflict or -- and so on.

So we wrote a report to the Commission in November of '06 recommending that the Office of Research undertake an effort to explore the differences and similarities among these models, and perhaps recommend a single model or a suite of models that would be appropriate to the various applications.

The Commission agreed with us, and there was an SRM issued in November of '06 where the Commission directed us to work with the staff and

external stakeholders to evaluate the different human reliability models in an effort to propose either a single model for the agency to use or guidance on which models should be used in specific circumstances.

Following that, we had at least one subcommittee meeting. One was in March of '07, and so on.

In our last report to the Commission on this matter, which was dated April of '07 -- more than a year ago -- we advised the Commission that the staff and EPRI are in the process of developing a plan that is intended to lead to an integrated approach to evaluate various HRA models.

We also noted that the goals and important milestones of the project would need to be clearly articulated. So we are hoping that today we will hear something about that.

So I think that's enough of an introduction. As I said at the beginning, this is a meeting for information only, unless some members feel that they need to write a letter. And with that, I will turn it over to Dr. John Monninger, who is the Chief.

MR. MONNINGER: Thank you, Dr. Apostolakis, Chairman Shack. I'm John Monninger. I'm

the Deputy Director for the Division of Risk Analysis from NRC's Office of Nuclear Regulatory Research. It's a pleasure to come down from our new location up at Church Street where I guess I'm a local traveler, so --

(Laughter.)

But, anyway, I want to thank you very much for this opportunity. I think it was a good background that Professor Apostolakis provided. I would note that it is very important for us -- the Office of Research -- to interact with ACRS in all our program areas, and in particular within the HRA area. I think we've typically met with the -- either the ACRS full committee or a subcommittee approximately two to three times a year for the past three years or so on various projects and initiatives.

Today, we will cover the SRM, our progress on addressing the SRM. But in addition to that, in recognition of the various new members of the committee, we thought it would be important to provide a broad overview of the -- all of the different projects that are going on, the projects that are going on in support of operating reactors, in support of advanced reactors, in support of waste, the proposed repository, in support of medical

applications and material applications.

So that will just be a brief overview of that, but we thought it would be important to let the full committee know about those various activities, in addition to what we're doing in response to the Commission's SRM.

So, with that, I will turn it over to Dr. Erasmia Lois and Dr. Susan Cooper.

I should also mention that from the Office of Nuclear Regulatory -- Nuclear Reactor Regulation, Dr. Gareth Parry is here also, and he is a principal member of our team addressing many of these areas.

Thank you.

DR. LOIS: Thank you. I also would like to note that Jeff Julius, ScienTech, who is contractor to EPRI is also in the -- on the phone, I believe.

MEMBER APOSTOLAKIS: Is he the only one on the phone?

DR. LOIS: And John Forrester from Sandia, who is helping us in these activities. And if needed, I asked them to really come in and say if -- at the point that they may feel that they can provide additional information. Is that okay with you, to stick up --

MEMBER APOSTOLAKIS: It might be. It

might be.

DR. LOIS: It might be. Okay.

CHAIRMAN SHACK: We'll assume they'll come in at appropriate times.

MEMBER APOSTOLAKIS: Yes. That they are mature enough to --

CHAIRMAN SHACK: They are mature enough --

(Laughter.)

DR. LOIS: That's the problem. They cannot --

MEMBER CORRADINI: That's why we asked them to.

(Laughter.)

I'm sorry.

CHAIRMAN SHACK: Can we start this meeting? Okay.

DR. LOIS: Okay. So then I think the objectives have been covered, provide a brief overview of the program, and then address specifically how we are going to deal with the SRM on the HRA model differences.

The overview covers the technical focus of what we currently do. We are going to note some key activities; some of them are completed and some of them are ongoing, and then the SRM.

Why we do the research -- quickly, the human reliabilities part of PRA. PRA has been used extensively in regulatory applications. The NRC is developing attention and resources to address PRA quality issues. However, I note that the modeling of equipment performance has matured. We have a tremendous amount of experience and data, and people stop arguing as much about the underlying assumptions and the terminology used.

And also, the approved technology in reactor design has addressed most equipment-related vulnerabilities. So very often HRA dominates the results, and, therefore, the importance of producing credible results has become more significant.

I note here that HRA is not the only area. There are some other areas -- fire and seismic -- that are also in the path of becoming more mature in development. What we tried to do in human reliability is to improve what we call tools "tools" -- methods, data, guidance, and training, as needed to ensure the suitability and quality of the HRA methods to applications.

So what we are currently doing, we have an activity which is an international activity to benchmark HRA methods, the ones that are currently in

use, primarily methods developed for full power operations, to understand the strengths and weaknesses and determine ways to improve these methods.

This is a multi-national, multi-team effort. It is about 13 countries, 15 different teams. The NRC has three different teams working in this area. We are benchmarking three or four methods -- ATHEANA, SPARH, THERP, and ASIP. Also, EPRI is participating by benchmarking the -- what we call the cold-based decision tree method. And then, there are other stakeholders -- the Swiss, the Finns, the French, both the regulatory and the industry participate, etcetera.

MEMBER APOSTOLAKIS: So this is the Halden --

DR. LOIS: This is the Halden study. So what actually we do here is we -- at Halden we run simulator experiments. We have two kinds of -- currently, we are using two kinds of scenarios -- steam generator tube rupture and loss of feedwater. We collect crew performance observations. So that's the one part of the -- of the study.

On the other hand, HRA analysts are analyzing the same scenarios, and they do predictive analysis for the failure probabilities for the human

actions that are involved in those scenarios. And there is what we call an assessment team, which looks at the HRA analyst results and then at the Halden data/observations, and compare the two and try to understand what extent the methods have identified potential drivers of human failure, and to a lesser degree to what extent the human and probabilities that they were estimated correspond to the degree of difficulty of the human actions that were simulated.

We briefed the subcommittee at least once, and this activity will be more than happy to brief the full committee. If desired, we have a big international meeting next March where -- actually, last year it was in October, and it was about 13 organizations and countries participated, about 45 analysts, and we talked about the -- what we call Pilot 1, the phase -- the pilot phase results, and now we are going to talk about the results on what we call Phase 2, which is more analysis of human actions related to steam generator tube rupture.

VICE CHAIRMAN BONACA: If I remember, these benchmarks involve actual U.S. crews of operators, right?

DR. LOIS: Actually, these are not U.S. crews. They are crews -- European crews.

MEMBER APOSTOLAKIS: All of them.

DR. LOIS: All of them. Fourteen crews from one plant.

VICE CHAIRMAN BONACA: I thought they were supposed to be a team of U.S. operators operating by their own procedures.

DR. LOIS: We have -- we anticipate that we will be able to replicate the study in one of the U.S. plants. But right now we didn't have that benefit. Although we are working with EPRI, we were not -- and we were talking about several utilities being willing to allow the -- and Halden is willing to come and replicate the status in the U.S. So far, we were not able to do it, but it's in the plan.

MEMBER BLEY: Mr. Chairman, I should make a note. I have a conflict with respect to some of this work. I have worked on the ATHEANA application. But not regarding the ATHEANA application.

I think one thing that it's kind of important to mention that we didn't mention, that Erasmia didn't mention I think, and that is that the Halden facility -- and if they were to come over -- they have capability in their simulator to synchronize the observations of all of the activities and communications in a way that doesn't really exist for

retrospective analysis after the thing has been done in any simulator at a powerplant.

So there are some real advantages to doing it under that kind of an environment, so you can study what actually happened.

MEMBER APOSTOLAKIS: But the problem is that there are no U.S. operators that are willing --

MEMBER BLEY: No, that's a separate --

MEMBER APOSTOLAKIS: Oh.

DR. LOIS: So both --

MEMBER APOSTOLAKIS: We had, in fact, recommended to the Commission at one point that we should -- they should explore the possibility of establishing such capability within the United States. I don't think that went very far.

So Dr. Powers' comment that we have Swedish operators in Norwegian reactors, right, using, what, Danish procedures --

(Laughter.)

-- what does that tell us about American operators? It's still valid.

DR. LOIS: I think we have addressed a little bit the issue I believe in the subcommittee meeting that we had. In actuality, this is the one that we ran. It's a Westinghouse-type plan, used

Westinghouse procedures, and, etcetera, but it is fair to say that we should definitely have the capability to perform similar studies here.

DR. COOPER: If I could just add -- because the purpose of a study is not so much to explore -- not so much to explore how U.S. operators perform, it's to see how the methods perform, that's not really an issue. I mean, when we apply the method, we know what the situation is.

Now, there are other limitations to the fact that we are trying to understand Swedish operators or --

MEMBER APOSTOLAKIS: Norwegian.

DR. COOPER: -- Norwegian operators in a Swedish plant with different kinds of procedures and stuff like that. But, in fact, it's -- and it's a simulator as opposed to a real-world event. So all of those adjustments we have to make in our analysis, which is not necessarily the kind of analysis you ordinarily would do with a PRA.

But so far as exercising the methods and exploring their strengths and weaknesses, I don't see that as a -- you know, which operators as being really that much of an issue. It would be good, still, to do -- have the U.S. plants.

MEMBER APOSTOLAKIS: But the cultural, though, dimension of all this is very important. I mean, the training of the operators, and so on. And, you know, if you don't have American crews there, you miss that. You don't know -- what is this, Theron?

CHAIRMAN SHACK: It's just on the telephone. If somebody makes a move some way --

MEMBER APOSTOLAKIS: Would you ask them to mute -- would you please mute your phone? Okay.

MEMBER RAY: George, in these exchanges, just going on here, we've said operators, operators, operators all the time. Are we only looking at operators as human performance? You don't consider other personnel who would be involved in events?

DR. LOIS: Okay. I think -- so there are stages of studies. These were on the benchmark human reliability study addresses -- we have -- as Dr. Apostolakis mentioned, a variety of methods are used. Actually, have been developed from the beginning of PRA, 30 years now, address full power control room-driven human actions, and actually emergency procedure-driven human actions.

Now, as we go to the second --

MEMBER RAY: But that's very narrow when it comes to --

DR. LOIS: It is.

MEMBER RAY: Okay. All right.

DR. LOIS: And what I'm saying -- the next bullet here recognizes the part that currently we are evaluating and using risk information to evaluate human actions that are outside the control room, local human actions. Probably the procedures are not as good as the emergency procedures. People may not be trained as rigorously, in addition to there are actions that are done by maintenance personnel, etcetera.

MEMBER RAY: Right.

DR. LOIS: So we have not gone -- right now, we are using existing methods, semi-expanded, to evaluate and looking at those instances. But the second bullet here indicates that we are going to -- we started earlier activities to address those issues.

MEMBER RAY: Okay. Well, I -- certainly, my thought would be a large fraction -- I don't know how many, but a large fraction of the events that are -- involve human error don't take place in the control room and don't involve operators.

DR. LOIS: In a PRA setting, though, most of the PRA applications and the risk comes -- or at least currently has been -- has been focused on full

power.

MEMBER RAY: Well, they happen in full power. I mean, if I just think over a dozen trips I have experienced, for example, you know, 10 of them would have been initiated by non-licensed operators from full power doing things in the plant.

And also, when equipment is not operable for some reason, which is certainly part of a PRA, it's almost always as a result of some human action that doesn't involve the licensed operators at all. I mean, they are important, but still very limited players in all of this. And I just wondered how your scope of analysts --

MR. MONNINGER: I think --

MEMBER RAY: -- dealing with these other areas of human interaction.

MR. MONNINGER: I think to a large extent, you know, for example, human performance leading to an initiating event, a contributor, it is brought in for the initiating event frequency, you know, through, you know, plant response, upset conditions, etcetera. So it is factored in -- the maintenance personnel contribution to performance through either the initiating event frequency or through the reliability and availability of equipment.

But what they generally talk about here is, you know, post-initiating event type of actions, whether it's a control room operator or someone out in the field. So this is typically post --

MEMBER RAY: Okay. So you think the human factors that affect plant safety outside the control room are primarily reflected in the initiating event frequencies or the plant equipment reliability?

MEMBER APOSTOLAKIS: Partly. Partly, Harold. Another thing is that for the so-called routine kind of actions, like problems with maintenance activities, and so on, the human reliability handbook that has come out of Sandia, you know, 35 years ago is still being used. This particular exercise at Halden deals only with post-initiating event, right?

MEMBER BLEY: And it's really aimed at the -- looking for problems in the cognitive process of operators during an event.

MEMBER APOSTOLAKIS: During an accident.

MEMBER BLEY: Which --

MEMBER APOSTOLAKIS: Okay.

MEMBER BLEY: -- a place where people can take the plant astray, and that's what they are looking for.

MEMBER RAY: Like I say, though, I --

MEMBER BLEY: Others tend to screw up the plan more often than the operators do. More often, but maybe not in ways that are as difficult to recover from.

MEMBER APOSTOLAKIS: Anyway, this is limited to that.

MEMBER BLEY: Got it.

MEMBER APOSTOLAKIS: Okay. Can we go on?

DR. LOIS: Okay. So, then, we are -- and a relative point is that we are actually collecting data, which a lot of those involve those types of actions, and we are going over -- hopefully, we will use this data to develop an understanding of the risk associated with the various activities in the plant.

A big portion is to improve the guidance and training for both HRA analysts and other users, and also identify and address emerging issues.

MEMBER APOSTOLAKIS: Let's talk about this a little bit, because I think it's an important slide. This is more of a research agenda, and I don't see how this addresses the Commission's SRM.

DR. LOIS: Yes. So here is part of the broad overview of what we go -- in a slide later on we have -- most of our presentation is on the SRM.

MEMBER APOSTOLAKIS: So you will tell us, you know, this is --

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: -- what we're doing to get to --

DR. LOIS: Exactly. We are going to get there.

MEMBER APOSTOLAKIS: Because this doesn't do that.

DR. LOIS: No. But --

MEMBER APOSTOLAKIS: This is much broader.

DR. LOIS: This is for the benefit of those members of the ACRS that are not familiar with the HRA program. We provide a broad overview of our activities.

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: And we try to --

MEMBER APOSTOLAKIS: So the value shouldn't be the current focus. The current focus should be the SRM.

DR. LOIS: The current focus of the HRA activities, not of the presentation.

MEMBER APOSTOLAKIS: Yes. I really want to emphasize that we really have to respond to the SRM --

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: -- at some reasonable time.

DR. LOIS: I'll be more than happy to really go through the slides and get to the --

MEMBER APOSTOLAKIS: Let's do that. Let's do that.

DR. LOIS: Okay.

MEMBER APOSTOLAKIS: We don't have to follow the order of the slides.

DR. LOIS: Okay.

MEMBER APOSTOLAKIS: I mean, the next slide shows that these people are very active with a lot of --

MEMBER POWERS: George, you may want to rethink that. You should have some consideration for members that are not familiar with the overall program. And I, for one, have to be very, very complimentary of this program, because many years ago when I first interacted we had troubles with the human factors and human reliability program, research program, and now it is extremely useful and -- to the regulatory process to have this program. And I think it's worthwhile for new members to see the breadth, scope, and depth of this objective.

That was a paid announcement that --

(Laughter.)

MEMBER APOSTOLAKIS: I don't object to that as long as we all are sensitive to the fact that there is an SRM, and we have to respond to it. As long as we understand that, and we finish with that, we can talk about that --

DR. LOIS: What we could do is we can -- we can cover this earlier, the SRM, and then go back and --

MEMBER APOSTOLAKIS: That's fine.

DR. LOIS: Because, in actuality, we have an activity on fire SRA, which is addressing specific issues, and we wanted to have the opportunity for Susan to briefly inform you about what we do and --

MEMBER APOSTOLAKIS: No, that's great. I mean, I --

DR. LOIS: Okay.

MEMBER APOSTOLAKIS: -- don't object to listening to this. But --

DR. LOIS: Okay.

MEMBER APOSTOLAKIS: -- as long as the focus is what we -- you know, what we're supposed to do. By the way, are we supposed to -- what do they think the end date will -- when do we have to report

to the Commission?

MEMBER CORRADINI: That's your problem, George.

MEMBER APOSTOLAKIS: No, no. The SRM did not specify a date, did it?

DR. LOIS: No. No, the SRM did not specify -- tell us in two years or three years.

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: So this --

MEMBER APOSTOLAKIS: Well, let's finish that, and then go back to it.

DR. LOIS: Okay. This background, you covered it, and that's why we are here, right? I think it -- what is of concern -- here is stated, what is the SRM? And what is the SRM stating? The interactions we have, the fact that EPRI in the meeting that we had in February of '07, EPRI proposed collaboration and approach for addressing the SRM, and we agreed. And then, you wrote the letter in April of '07 indicating that we are going to have a collaborative work.

And then, we briefed you, and you indicated -- the subcommittee indicated that we need to develop a plan soon.

MEMBER APOSTOLAKIS: That's why I

intervened, because I don't want to have to say the same thing again. Let's see now what focus we --

DR. LOIS: Okay. So --

MEMBER APOSTOLAKIS: Yes. Okay, good.

DR. LOIS: Okay. So what is the plan? So we initiated collaborative work with EPRI as indicated, and we have the plan -- we call it -- in three phases. And we already started working on what we call Phase 1. And it starts out with reviewing the use of HRA in the decisionmaking.

And the idea here is that there are many regulatory applications that use PRA results, but none of -- all of those potentially, not all of those in applications may be as sensitive to the HRA results as some other ones. And there is a strong indication, for example, for the ROP process where event evaluation -- where HRA has been used to evaluate the significance of an event.

We know that there is tremendous sensitivity and significance of the importance of the HRA analysis for those decisions. So the idea here is to identify the regulatory applications in which HRA plays a significant role, identify what methods are used, and what are the apparent limitations of these methods.

MEMBER APOSTOLAKIS: So this is now being done as we speak?

DR. LOIS: It's in process.

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: What we did is we -- we, the Office of Research, interviewed NRC staff.

MEMBER APOSTOLAKIS: John?

MEMBER STETKAR: Erasmia, when you say "regulatory applications," and you say you have interviewed the staff in November of this year, are you limiting that to regulatory applications looking at only PRAs of internal events from full power operation?

DR. LOIS: Absolutely not. This is where -- this is where --

MEMBER STETKAR: Many of the problems, as you well know, may address human reliability in the context of external events, seismic events, fires, floods, and, more importantly, that whole regime of low power and shutdown events where time windows are much more extended and things like that, where there is actually very little current experience in the applications area, certainly in the U.S. So I just wanted to make sure that you are --

DR. LOIS: All of the above have been

identified.

MEMBER STETKAR: Okay.

DR. LOIS: In addition to the new reactors or advanced reactors, etcetera.

MEMBER STETKAR: Thanks.

DR. LOIS: So we have identified as -- from the NRC point of view, the applications, and include all of those and also what methods are being used for those applications.

Now, EPRI is going to do a survey of their own -- industry survey, and they believe that it is going to be done by February of '09.

MEMBER APOSTOLAKIS: So are they -- I think one of the most important applications that I have seen from the industry is when it comes to power uprates, right? Where the time to act is shortened. But this will be covered by the EPRI review?

DR. LOIS: I cannot talk of --

MEMBER APOSTOLAKIS: Can we ask Jeff?

MEMBER STETKAR: You have to turn him back on.

MEMBER APOSTOLAKIS: Yes, I know.

MR. JULIUS: Yes. (Comment distorted due to phone connection problems.)

MEMBER STETKAR: Okay. Turn him off.

(Laughter.)

MEMBER APOSTOLAKIS: Jeff, did you hear the question?

MR. JULIUS: Where the power uprates will be included in the EPRI survey, and the answer is yes, it will.

MEMBER APOSTOLAKIS: Thank you very much. Turn him off.

(Laughter.)

That was Jeff Julius. Okay. All right. Erasmia?

DR. LOIS: Okay. The next scale of these activities -- to establish common terminology and what we call framework -- in the sense that we have really to identify all important aspects that have to be done as part of human reliability. And it's not just numbers. It's all of the surrounding context and performance-shaping factors that have to be incorporated.

MEMBER APOSTOLAKIS: So this will be a common framework or frameworks?

DR. LOIS: It will be framework or frameworks, common.

MEMBER APOSTOLAKIS: So I might see, for example, things like this idea of -- what do they call

that tree? Cognitive --

DR. COOPER: Cause-based decision?

MEMBER APOSTOLAKIS: Cause-based decision. That tree will be combined with ATHEANA to do something else. I mean, are we going to see things like that?

DR. LOIS: Potentially.

MEMBER APOSTOLAKIS: Okay.

DR. COOPER: Susan Cooper. Actually, think -- when you see "framework," think process as in --

MEMBER APOSTOLAKIS: Yes, process.

DR. COOPER: -- the steps that are performed in the HRA, which doesn't necessarily affect, you know, like a logic tree or whatever. That's just the quantification.

MEMBER APOSTOLAKIS: No. But --

DR. COOPER: So I'm talking about all of the HRA steps that are used to perform HRA, including qualitative analysis.

MEMBER APOSTOLAKIS: Sure. But, I mean, the tree is probably a qualitative tool. You can go beyond that and put numbers on it, but it helps you organize your thinking, doesn't it?

DR. COOPER: It documents what you might

know, but I don't know that I would use it to organize my thinking. When you collect information -- qualitative analysis, you are trying to understand what are the factors that are important. You don't use the tree and say, "Oh, these are the factors I'm going to put in," and then address them. You might be missing something.

DR. PARRY: George, maybe I can add something. This is Gareth Parry from NRR. I think what is meant by this is the whole process of HRA, which is the identification of what human failure events you should put in the PRA model, how you define those human failure events, and then you get to the quantification.

So things like the cause-based decision tree method and -- not ATHEANA, because ATHEANA addresses the whole process. But the cause-based decision tree would be associated with the evaluation of the probability of those human failure events. So I think what this process is is to define the whole process.

And if you think about it in historical terms, you can think back to EPRI's SHARP --

MEMBER APOSTOLAKIS: Yes.

DR. PARRY: -- and SHARP 1 for example.

So I think that's what is intended here.

DR. LOIS: Okay.

DR. PARRY: And it would be a process that would be consistent I think with what is in the ASME combined standard for the human reliability analysis.

MEMBER APOSTOLAKIS: Does the NRC, in its models, use a different process than EPRI's? It seems to me their SHARP, for example, as you mentioned, if you look at other models, more or less people are following the same approach, don't they?

DR. LOIS: It's in the books.

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: But it doesn't mean that people are already following the approach. So one of the things that we are learning through the empirical study is how people are really performing human reliability, and that helps us to really codify the process.

So it is a lot method-driven, it is some analyst-driven, and it is --

MEMBER APOSTOLAKIS: Let me be a little bit more blunt. I really would not want to see, again, generalities. You know, I mean, SHARP came out how many years ago? It was pretty good in my view. I mean, it's a high-level process. That's fine.

Everybody does that, more or less. So --

DR. LOIS: So I think we are going to address your concern --

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: -- in the next slide.

MEMBER APOSTOLAKIS: Fine.

DR. LOIS: So what I am trying to say here -- to say here is that, first of all, the Halden study is helping us out -- understand, enforcing common language. We had two workshops already trying to clarify the difference in performance-shaping practices. And this is going to be an iterative process as we learn we are going to revise the common framework. But we would like to have common terminology and framework.

But on the basis of what we have learned from the first phase, we are going to address what we call the adequacy and applicability of the methods in the various applications. And all that -- it was noted that we have low-power shutdown operations, none of the existing methods are suitable exactly for analyzing those type events.

LOCA actions -- fire, for example, or flooding, etcetera -- yes, Gareth?

DR. PARRY: Erasmia, I just want to

clarify here that, when you're talking about methods in this portion, you are really talking about methods to evaluate human error probabilities, given a defined context. So it doesn't -- it's a part of the process that we were just talking about. It's the final part of the process, which is the quantification of the probabilities.

MEMBER APOSTOLAKIS: Do you see having different frameworks for the various applications you just mentioned, Erasmia? For example, would I need maybe a different framework or a subframework to do a human reliability analysis under fire conditions than, say, under something else? Would that be something that we might --

DR. LOIS: It's being done, actually, so --

DR. COOPER: Susan Cooper. We are addressing that as part of a collaborative effort right now with EPRI. I think at a certain level of definition, which I assume is what's being discussed here, that they would be the same. But some of the specifics may be very different. There are different kinds of events that need to be identified in fire, HRA, and PRA. So some of the specifics are different.

And for some applications, some of the

underlying tasks in an HRA task may be much more important than in another. For internal events, PRA -- you know, you already have a body of human failure events that have been identified for previous plants or your previous PRA. You don't have to go hunting to define the events. That's different for a new application or for low-power shutdown. You're going to have to do a different search process. You're going to have to exercise a certain search process.

You may use different information. In a fire PRA, if you're trying to address spurious actuations, you're going to use some different information than you would for low-power shutdown. So there are some -- there could be some very different things that you do at a -- in a task that is defined at a high level that would be common.

MEMBER APOSTOLAKIS: So the way it's going, from what you just said, is there will be an overall -- big overarching framework, but then the details will be different, rather than having two different frameworks. That's fine. That's fine.

DR. LOIS: Yes. And so we are using the review and survey -- will help us identify the methods and the limitations and the empirical studies, filling in the information from the particular method

application in the same kind of activities.

And at the end of Phase 2, which we believe is going to be by May of 2009, done writing -- I'm glad -- we hope that we'll have a decision. Can we do with -- what the Commission recommended?

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: Or shall we retain a toolbox of methods and well-defined guidance of how we should use --

MEMBER APOSTOLAKIS: I mean, I see this not just saying, you know, this is the tool that you use for this situation, but you can also recommend improvements.

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: So we can set a research agenda to go to the next step. I mean, it's not just -- in other words, what I'm saying is that we shouldn't be working on this with the assumption that the tools are very, very good or perfect. All we have to do is categorize them. I mean, there may be some need -- but let me come back to another thing.

As you know, I have -- I really think that the time available and the time to act are really major controlling -- a major controlling factor in human performance. And in some of these models time

is used just as another performance-shaping factor, which I am not too crazy about.

Where in this process are you going to explore that?

DR. LOIS: I think right here. We have --

MEMBER APOSTOLAKIS: Well, that's a result.

DR. LOIS: Well, we have -- we have -- we are going to -- right now, we are looking at the methods through the empirical study. We are looking at the methods through the applications. So this is one consideration. These are the various methods. This is what we do.

Whether or not we can create a new method, it's going to be the result of our evaluation of the existing methods or the evaluation of a potential improvement of an existing effort to include -- or creation of a new --

MEMBER APOSTOLAKIS: Because the Halden study really tracks things in time, right? So that's a very important input. And if you have a fire situation, it seems to me time is extremely important. So to say, "Oh, and time is one of seven performance-shaping factors," it seems to me is not appropriate.

DR. LOIS: For those applications. But

when you come to low power and shutdown operations, some human actions are driven from limited time. Some other human actions --

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: -- are driven by -- so one issue that we haven't addressed is: how will we evaluate human actions for which there are several hours or days?

MEMBER APOSTOLAKIS: No.

DR. LOIS: How --

MEMBER APOSTOLAKIS: I'm not saying that -- you know, if you -- all I'm saying is that time deserves special treatment.

DR. LOIS: Okay. We'll make a note of it.

MEMBER APOSTOLAKIS: Yes, sir.

DR. LOIS: Okay.

MEMBER STETKAR: I would like to come back to something Gareth mentioned that is still bothering me a little bit. Thanks, Gareth.

(Laughter.)

And that is, if I read between the lines on all of these slides, and I listen to the discussions, including George's discussion, I hear 90 percent of the discussion focused on methods to quantify the human error probability, very little

discussion on systematic methods that are used to clearly define the human failure events within the context of these models.

My experience -- 90 percent of the problems with risk assessment is in the identification -- coherent identification of those human failure events. Once you have identified them coherently, there is actually less variability in the ways to quantify them. So, and I don't see that focus here on systematic processes to identify and define those human failure events.

I don't care what method I use -- I do in some sense -- to quantify the human error probability. But if you don't have that basic process down -- and SHARP was mentioned, but SHARP was a high-level guidance. It's a motherhood document. You should look at a few things.

And I don't hear that focus. I don't hear that 90 percent of the effort perhaps should be focused, certainly in the early stages, on methods to clearly identify those human failure events. So I was curious how you're addressing it, because, yes, I see bullets and NUREGs, and things like that.

DR. LOIS: Yes.

MEMBER STETKAR: But in terms of what you

are actually doing.

DR. LOIS: Actually, the good practices in which -- built on SHARP and the ASME studies was step number 1. First of all, we totally agree with you, and this is -- we totally agree that 90 percent of the work is qualitative -- the qualitative information that you collect, and how do you feed that in your PRA and HRA.

MEMBER STETKAR: Okay.

DR. LOIS: This is an important step.

MEMBER STETKAR: Where is that reflected in, for example, your Phase 2 type work? Which is the near-term stuff that I would be interested in.

DR. LOIS: Actually, it has been reflected in Phase 1.

MEMBER STETKAR: Okay.

DR. LOIS: Which is the framework, what we call "framework" here.

MEMBER STETKAR: Okay. If that's what you mean by "framework," that's --

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: Well, I mean, Susan's discussion earlier I thought addressed that to some extent. Where she said, you know, if I had --

DR. COOPER: I think you meant it's an HRA

process, process steps --

MEMBER STETKAR: Okay. But --

DR. COOPER: -- like SHARP or --

MEMBER STETKAR: Except that all of the words that I see tend to focus on the back end of that process. And so I just wanted to make sure that --

DR. COOPER: That's not intended.

MEMBER STETKAR: Okay.

DR. COOPER: As a matter of fact, the reason why framework or process is -- is highlighted there is because we do know and believe that those other steps need -- deserve attention for the reasons that you're talking about.

MEMBER STETKAR: The reason I bring it up, George brought up the concept of time, and time indeed is one of -- it may be a parameter that you use in quantifying the human error probability under some methods, but it is also differences in available time may be a parameter -- something that you think about to say, "Ah, this human failure event X applies during these scenarios when I have an hour available. But I need a different one -- Y over here -- because I only have 15 minutes available over here."

MEMBER APOSTOLAKIS: Exactly.

DR. COOPER: Yes. Agreed.

MEMBER STETKAR: And it may ultimately determine that there isn't any difference in the human error probability for whatever reason, but at least you need to know that you should have -- you should have two questions. So -- okay, thanks. That's enough. I'll keep the process rolling.

DR. LOIS: Thank you very much for --

MEMBER APOSTOLAKIS: So it looks like we are going to be pretty busy in the early part of next year.

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: Are you planning to ask for a subcommittee meeting sometime?

DR. LOIS: I'm going to get to that.

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: Okay?

MEMBER APOSTOLAKIS: Oh, now you are moving to --

MEMBER BROWN: Can I ask a question, George, from what --

MEMBER APOSTOLAKIS: Absolutely, Charlie.

MEMBER BROWN: -- HRA-type stuff?

MEMBER APOSTOLAKIS: Yes.

MEMBER BROWN: I am Charlie Brown, a new member. So this is useful to hear. But I guess all

of the focus I seem to hear on this is the application of HRA-type methods and methodologies and to PRA-type risk analyses. And it doesn't appear -- correct me if I'm wrong -- that it's there to help identify training or other type methods that would improve our operator responses as opposed to identifying risks in terms of how we proceed to do things.

I mean, there is a historic 30-minute criteria for manual actions. I mean, we used it years ago in the nuclear -- Naval nuclear program. I have just now learned that, apparently, I guess that has been followed to some extent in the commercial world.

MEMBER APOSTOLAKIS: Yes.

MEMBER BROWN: And you can argue whether it's realistic or not. So that's why I ask the question: is it really -- am I correct in my assumptions?

MEMBER APOSTOLAKIS: Go ahead.

DR. LOIS: No, you can answer.

MEMBER APOSTOLAKIS: Dennis is trying to --

MEMBER BLEY: No. I just wanted to say, Charlie, your point is very well taken. But, historically, not just the human reliability, but almost all of the things we've learned out of the PRAs

have worked their way into the training programs and the drill structures, and that sort of thing. So they have been used that way, and I --

MEMBER BROWN: Although not provided as a focal point of emphasis that feed -- they have been fed back into the system.

MEMBER BLEY: They have been fed back into it, and I guess I'd like to hear what the staff has to say about the intent, because it's very useful for this purpose.

MEMBER APOSTOLAKIS: I think it's both. I think if you have the framework to do things, especially if you do what John Stetkar wants to see more explicitly, then you have a knowledge base from which you can start training and things like that, because now you understand what -- where the errors might occur, and what the operators might do under different conditions.

So this is the next application, but I agree at this stage they are really focusing on structuring the process and quantifying the probabilities. But what you are saying is certainly a very useful outcome of this, but that's after this.

MEMBER BROWN: I'm just hoping that we don't have a study for study -- for study purposes.

MEMBER APOSTOLAKIS: No. That's why there are deadlines.

MEMBER BROWN: I'm not saying PRAs. I mean, I'm a big fan of PRAs.

MEMBER APOSTOLAKIS: You see the deadlines? That's the reason.

MEMBER BROWN: The other question --

MEMBER APOSTOLAKIS: It has to be risk-informed, Charlie.

MEMBER BROWN: Oh, absolutely.

MEMBER APOSTOLAKIS: We have a comment here.

MEMBER BROWN: The other question I had -- that I wanted to ask was relative to, at least in my past experience, the controls, the panels, the equipment, hardware, has a strong effect on the ability of operators to respond. I mean, put aside the training, you can train the heck out of them, but you can still have either user-friendly controls and panels, displays, monitoring, how do you -- does this separate that out? Is that a control function as part of developing --

MEMBER APOSTOLAKIS: This is more of a human factors kind of thing, ergonomics, which is not part of this project.

DR. COOPER: But it is included in our evaluation.

MEMBER STETKAR: It's included. I mean, you have performance-shaping factors for --

MEMBER BROWN: I mean, if you have --

MEMBER STETKAR: I just --

MEMBER BROWN: -- with needles moving around, or you have graphics displays which give you an instant visualization of a potential problem, that gives you two different ways that an operator may -- or the timeliness or the reliability of his responses to particular casualties, or what have you, and --

MEMBER APOSTOLAKIS: That's true. It's an input to this process. But how to optimize that is something else. It's human factor.

DR. LOIS: Ann would like to answer that question.

MEMBER APOSTOLAKIS: Yes, go ahead.

MS. RAMEY-SMITH: Ann Ramey-Smith, Office of New Reactors, formerly of the Office of Research, formerly of the ATHEANA team.

(Laughter.)

Little disclosure there.

I wanted to make a mention of -- in sort of a broader perspective. There is a NUREG -- NUREG-

0711, which is -- the title of it is something like, "Human Factors Engineering Program Review," or something like that. And it's very important from the new reactor area, but also NRR uses much of that guidance in the review of the work that they do.

And one important part of that is it lays out a program that a utility should have in place to support reliable human actions. And an important part of that is the element of using the results from HRA to feed into the design of procedures in training and control room designs, and such as that. So, you know, it is an iterative process.

We are not as far as we would like to be, and that's why there is an important role to play for improving our HRAs and bringing those up to date. But there is -- there is that intention, and there is an actual use. So we are using, as we are going about doing our new reactor reviews and licensing, we are using the results of HRAs that were conducted as part of PRA to support those activities.

MEMBER APOSTOLAKIS: Yes. The purpose of HRA is not to produce a number. Identification of the human failure events, what may happen in time, and so on, is an essential part of this. The number is at the end, because we need a number, too. But it's not

the main focus.

Can we finish?

DR. LOIS: So what -- by September '10, we believe that we will be able to answer the question, which is, do we keep a small set of methods, how we expand the existing methods, how we improve or develop new methods, and go through documenting the results and involving other external stakeholders through public review and comments, and --

MEMBER APOSTOLAKIS: Does the Commission know this?

DR. LOIS: The Commission does not know this.

MEMBER APOSTOLAKIS: Do you plan to inform them in some way, or --

DR. LOIS: We believe that the ACRS is going to inform them, because this is -- the SRM is to the ACRS, so at least from our perspective we inform the ACRS about our activities. But I don't know -- John, do you want to add something here?

MEMBER APOSTOLAKIS: I think my term ends before September 11. Somebody else will have to do that.

(Laughter.)

MR. MONNINGER: We do have -- you know,

typically, we have annual program reviews by the Commission, and, you know, put together briefing books, etcetera, and in the past we have had background papers with this. And we could easily select this topic amongst others to actually do a verbal briefing, too, to them also.

MEMBER APOSTOLAKIS: Okay, good. So, yes.

DR. LOIS: I mean, and then documentation, etcetera, is in --

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: So here is the timeline. And when we are going to brief the ACRS, we believe in --

MEMBER BROWN: Oh. I did have one other question, if you don't mind.

MEMBER APOSTOLAKIS: Yes. Sure, sure.

MEMBER BROWN: And I don't know whether this was anecdotal that you made the comment. You were talking about French operators in a -- or a Swiss operator in a French plant using Belgium operating procedures. Now, was that tongue in cheek, or were you -- is that --

MEMBER APOSTOLAKIS: Well --

MEMBER BROWN: I mean, I would assume that, regardless of culture and nationality, you would train people before they could operate the plant, and

they would learn the procedures. But is there something that's --

MEMBER BLEY: Yes, Charlie. There's -- and one of the things that is coming up out of these studies, and you -- were presented to the ACRS, I think -- was there seems to be a real difference in the way operators from some places, including the ones who are doing these drills in the simulator, use and interpret the operating procedures. And they seem to be doing it quite differently than most people in this country do. There is some variability here, more than some people think.

MEMBER BROWN: In what way is that variability -- I mean, is it -- do you mean they don't -- they don't follow them, or they don't think they need to be followed, and that they can wing it more? I mean, does that -- I'm being --

MEMBER BLEY: Some things you would have heard if you had been at the last one. They are often given credit for jumping ahead when they see reason to jump ahead. They seem to be --

MEMBER BROWN: By "jump ahead" --

MEMBER BLEY: Skipping steps, because I think I know where this is going. They are not using the full diagnostic capability of the procedures.

They aren't following some of the continuing steps and the way people here have -- now, here people had trouble.

Continuing steps show up on -- what are at least in Westinghouse plans, on what are called "fold-out pages." People were missing them, so instead of having fold-out pages we have changed the way we do them, and the left-hand side is what used to be the fold-out page, and the right-hand side is where the procedure runs. So it's always there.

So there are things like that in the way they use them and their interpretation of what is good practice.

MEMBER BROWN: There are intermediate and follow-up type actions in that matter? Is that -- I mean, that's what we used to do in the --

MEMBER BLEY: Things are quite a bit different than --

MEMBER BROWN: Okay.

MEMBER BLEY: -- the way the Navy procedures used to be. That's the way it used to be here, but after TMI we got these procedures that are very diagnostic.

MEMBER BROWN: Well, that's fine.

MEMBER BLEY: They are using the same kind

of procedures, but they are not using them under the same philosophy. We can talk more detail, but that would interrupt the flow of this thing.

DR. COOPER: If I could just add, the differences between, for example, U.S. operators and these operators that are in the simulator runs, is important to the analysis and the analysis results. But so far as the benchmarking study, really, it just provides an opportunity to see how different methods are able to even uncover this as being an important thing to address.

And also, in a larger sense, you know, so far as HRA process steps, to identify for HRA analysts doing a different kind of application, you need to think about this. There may be some differences between the way, you know, operators at a nuclear or powerplant do things versus, you know, some other kind of, you know, NRC-licensed facility. We can't just assume that because they have procedures and training that they are going to behave in the same way.

We can't -- you know, that kind of assumption we don't want people to make. And I think going through this benchmarking study is -- that's one benefit that we might not have recognized. But, you know, so far as, you know, the benchmarking being

useful in, you know, identifying strengths and weaknesses in methods, and differences in methods, I think this is just another opportunity to be able to highlight some of those differences that we might not have anticipated.

MEMBER STETKAR: I think you're right, Susan. I'd reinforce that. Or you should not use a method that strictly relies on a mock-up of the control panel and a list of procedural steps to try to infer how reliable the operators may be, assuming that they follow every step. Everybody always follows every step in the procedure, so I think you're right. I think that's valuable insight.

DR. COOPER: Thank you.

MEMBER APOSTOLAKIS: So this is the last slide on the SRM?

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: Okay. And then, we can spend the rest of the time on the broader issues. So you say brief ACRS, this is the full committee I assume.

DR. LOIS: Actually, it could be the -- I believe that we should come to the subcommittee first.

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: To inform you about the

details. So I didn't -- so it could be -- usually a month later we brief the full committee, if desired.

MEMBER APOSTOLAKIS: So there will be a letter somewhere in there.

DR. LOIS: If you want that, yes.

MEMBER APOSTOLAKIS: Okay.

DR. LOIS: And so we have plans for June of -- this June and then next March.

MEMBER APOSTOLAKIS: This June, next March.

DR. LOIS: June of '09.

MEMBER APOSTOLAKIS: And March of '10.

DR. LOIS: And March of '10. But, of course, the Committee can request a briefing.

MEMBER STETKAR: I was just going to say, before we go to the -- do you want to get any input from the folks --

MEMBER APOSTOLAKIS: Yes, we can do that. Sure.

MEMBER STETKAR: I mean, before we go back to the sort of general overview.

MEMBER APOSTOLAKIS: But let me understand the specifics of this. Okay. So we'll talk offline about scheduling the subcommittee meetings and --

DR. LOIS: Sure.

MEMBER APOSTOLAKIS: Yes. I think we should have a letter from the ACRS before the process is completed. Maybe more than one, actually.

MR. MONNINGER: I would just throw in that typically -- you see up there the public review. Typically, we would brief before that, and we would come back and brief you after public review and comment to let you know how we resolve comments, etcetera. So --

MEMBER APOSTOLAKIS: I wonder who the public is now that everybody is involved with this.

MR. MONNINGER: Are we going to send it for comment?

MEMBER APOSTOLAKIS: Or utilities, individual utilities perhaps.

DR. LOIS: Utilities and also -- I mean, it's the public.

MR. MONNINGER: So it would seem like an appropriate time for the letter would be an ACRS meeting after a public review.

MEMBER APOSTOLAKIS: Yes, but I --

MR. MONNINGER: And comment. You would --

MEMBER APOSTOLAKIS: -- I would like to have one even before then. I mean, this is 2010.

DR. LOIS: So it's -- we plan to come

in --

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: -- next spring, May or June.

MEMBER APOSTOLAKIS: Okay. All right.

DR. LOIS: Okay?

MEMBER BLEY: I've got a question for you, and it will be for Jeff when he comes online, too. You haven't talked about this, but maybe the surveys get their -- I know some utilities in the past when they have had a review of their PRA and HRA had a hodge-podge of HRA models that they used for different events, and were asked to go back -- by the review teams that review all of those, were asked to go back and justify the models they used, and in some cases it was a real -- almost a surprise to them to wonder how they ended up with this hodge-podge, and they have done some clarifying of it.

There might be some good lessons learned out of that process. It could be included from the surveys. I don't know if you've heard anything back from EPRI or from utilities about that sort of experience.

MEMBER APOSTOLAKIS: I assume Jeff's survey will cover that.

DR. LOIS: Jeff?

MEMBER BLEY: That's why I raised it, so Jeff would hear it. I don't think he's -- is he online now?

DR. LOIS: Hello?

MR. JULIUS: Yes. Yes, I'm here.

MEMBER APOSTOLAKIS: Go ahead, Jeff. If you have any comments on what has been discussed so far, please, this is the time to give them to us.

MR. JULIUS: Okay. Well, I think the discussion so far is -- was good and accurate. In terms of -- in response to Dennis' question, the -- I'm not sure I heard it fully, but, you know, any difficulties, both in the applications or development or the response to RAIs, or what we are covering in our survey.

MEMBER BLEY: RAIs on?

MR. JULIUS: Usually, RAIs associated with applications or the use of PRA.

MEMBER STETKAR: Jeff, what about peer review comments and things like that on -- industry peer review comments on PRAs?

MEMBER BLEY: It would seem useful to get that.

MEMBER STETKAR: Or at least how they were resolved or some insights about the resolution

process.

MR. JULIUS: Okay. That's a good point. We'll make sure that that is covered as well. We have a lot of experience through our -- the eight years in the user group. We share the best practices and lessons learned, and a lot of them have come through the response to peer review comments. But we'll make sure that is explicitly addressed.

MEMBER APOSTOLAKIS: Okay. Do you have anything else, Jeff? A general comment or --

MR. JULIUS: No. No, I think this is -- this is proceeding --

MEMBER APOSTOLAKIS: Good.

MR. JULIUS: -- on plan and in the direction that it needs to, and it's fitting that the focus is on the applications.

MEMBER APOSTOLAKIS: John Forrester, are you on the line?

MR. FORRESTER: Yes, I am.

MEMBER APOSTOLAKIS: Do you have anything to add?

MR. FORRESTER: No, I don't think so. It's --

MEMBER APOSTOLAKIS: That's fine.

MR. FORRESTER: The plan is -- has been

articulated, and I think we are making progress. So --

MEMBER APOSTOLAKIS: Good. Thank you very much, gentlemen. Can you mute it again?

Let's go back now to the --

MEMBER RAY: George, are we about to move out to -- into the broader discussion?

MEMBER APOSTOLAKIS: Yes, go ahead.

MEMBER RAY: Two questions. One, does the SRM also have this -- well, I'll call it narrow, I don't mean that to be pejorative -- focus on operator actions following an initiating event? I mean, is that what the SRM is talking about, or was it --

MEMBER APOSTOLAKIS: The SRM --

MEMBER RAY: -- less specific in dealing with human reliability more generally?

MEMBER APOSTOLAKIS: It is less specific.

MEMBER RAY: Okay. Well, I was just going to say, on reflecting on what was said in response to my earlier questions, the PRAs I have seen are really -- the term used here this morning was equipment performance has matured, modeling equipment performance has matured.

I haven't seen the use of data that includes I'll call the maintenance errors. And I just

want to ask that question again. Are you sure that human performance, insofar as it involves plant equipment and systems maintenance, is included in this data you're talking about?

MR. MONNINGER: Yes. I mean, I do believe so, yes. And we can get more of the experts up here, but take for example, you know, something caused loss of condenser vacuum, you know, which could lead to, you know, some type of turbine trip scram, etcetera. That is factored into your, you know --

MEMBER RAY: Well, let me --

MR. MONNINGER: -- into the frequency of events.

MEMBER RAY: -- equipment inoperability.

MR. MONNINGER: Equipment inoperability -- that --

MEMBER RAY: A breaker racked, not racked fully, for a safety equipment --

MR. MONNINGER: Yes. It feeds directly into the reliability and availability of that equipment, and that performance, then, is frequently updated by utilities, and then also updated within the NRC SPAR models.

DR. COOPER: If I could --

MEMBER RAY: It sounds like you're saying

yes, it is.

DR. COOPER: -- we do model maintenance -- human-induced and maintenance errors as restoration errors. For example, the following tasks are maintenance. And those are modeled in the PRA. For the most part, they are not large risk contributors, and those -- the ones that I am particularly -- I am talking about are the ones that are undiscovered failures -- in other words, for standby equipment. Now --

MEMBER RAY: That's right.

DR. COOPER: -- if you're talking about things that involve initiating events, in most cases -- in most -- for the most part, the human cause initiators are captured with the equipment. They are not distinguished.

Now, there are some instances -- and I believe even the good practices mentions places where you need to -- you may need to separate them out, because there may be some different -- differences in the way the operators in the control room need to respond, if it's a human-induced initiator versus an equipment-induced initiator.

A good example of that might be something that happens in shutdown where the operators are not

completely aware of all of the -- you know, the configuration and control of things going on, so it may be much more difficult for them to identify, for example, what the cause of a draindown that is human-caused as opposed to equipment-caused.

So there may be instances in which HRA needs to do something different. But for the most part, the applications that we have addressed so far that hasn't been the case. However, you know, this larger program is positioning us for some of those other applications when, for example, human-induced initiators do have to be addressed explicitly.

MEMBER APOSTOLAKIS: John, you have a comment?

(No response.)

I guess a related question is: are we still -- I mean, are you -- for reliability handled -- because that is used for a lot of the --

DR. LOIS: Do you mean the THERP --

MEMBER APOSTOLAKIS: Yes, I mean the Swain and Gutman.

DR. LOIS: Exactly.

MEMBER APOSTOLAKIS: Are you guys using -- looking at it with a --

DR. LOIS: As part --

MEMBER APOSTOLAKIS: Do you intend to revise it if necessary, or is that still something that -- because a lot of the issues that I think Harold is raising are covered there in some way, at least from 1983. Is that part of your work?

DR. LOIS: It seems that's the area where people may feel have converged, if you wish, and feel confident about the treatment. I don't know if it's going to be revised as part of this analysis, but at the moment our main emphasis is to converge on the --

MEMBER APOSTOLAKIS: Cost initiator.

DR. LOIS: -- cost initiator accident analysis of human reliability, and also address some of these emerging issues, which are not emerging anymore, are here or -- like shutdown, fire, new reactors, advanced reactors, all of these areas, long times, short times, etcetera.

The pre-initiator aspect is important. We are collecting data here through the -- what we call here the HERA data. We are going to do qualitative analysis, find out the degree of importance and significance, and, if needed, we are going to do it, and we'll have the opportunity to rebrief you again.

MEMBER ABDEL-KHALIK: Now, you indicated that this study will focus on two events -- the steam

generator tube rupture and loss of feedwater. Why were those two events selected?

DR. LOIS: This is a -- the Halden facilities can -- actually, we use their PWR simulator, and they had the availability of a reference plan that were from -- from a PWR plan, the European plan, 14 crews that were willing to be -- to participate in the study.

As far as why these two scenarios are important from a PRA/HRA perspective, loss of feed and steam generator, it doesn't mean that they are the only ones. But, actually, for testing the methods I don't believe -- I don't know if it makes a big difference what scenario you use. What you are trying to identify is how the methods can predict human failures and characterize human failures in a given scenario.

MEMBER ABDEL-KHALIK: Does either one of these two scenarios require the control room operators to direct system operators in the field to take actions?

DR. COOPER: Yes.

MEMBER ABDEL-KHALIK: One or both?

DR. COOPER: The loss of feedwater scenarios -- actually, there are two of them that are

slight variations. There are opportunities within those scenarios where the operators could direct someone in the field to do something in the field. However, you know, so far as a simulation of that, you know, we don't know -- you know, speaking from one of the analyst teams, we don't know, because we have to predict -- we don't know exactly how the simulator trainers modeled that, but we have been told that, really, it was just sort of phone calls.

There is nothing in -- we weren't to model, you know, the success or failure of those actions out in the field. That was just part of a scenario description or setup for the performance of the operators in the control room.

MEMBER ABDEL-KHALIK: It would seem to me that, you know, a potential source of error is this communication process.

DR. COOPER: Certainly, that is something that ought to be addressed.

MEMBER ABDEL-KHALIK: And that is not captured in any simulator that I know of.

DR. COOPER: No. And it's something that we are addressing in the fire HRA efforts that we have going on right now, communication between the control room and ex-control room. So it's recognized.

MEMBER BLEY: Well, one aspect, Said, that is captured in simulators is the in-control room communications, which it might surprise you to know can be troublesome at times. But the outside communications of -- you know, they do show up in the event histories. Of course, things go wrong out there, too. But right now that's not --

MEMBER APOSTOLAKIS: The selection of the scenarios, though, could be by thinking about what might be important and take some -- for example, again, coming back to time, it would be good to have a scenario where the available time is really short, to see what happens.

DR. LOIS: Which is the case in some of these human actions that are modeled for the steam generator tube or loss of feeds.

MEMBER BLEY: As a matter of fact, the first of the -- I keep calling it benchmark. I forget the actual name of it -- the experiments -- looked at a scenario in which the time available and the time that it takes to complete were close. And, in fact, some of --

MEMBER APOSTOLAKIS: Yes. But it is --

MEMBER BLEY: -- a number of the failures were due to people not getting done in time.

MEMBER APOSTOLAKIS: But there may be other performance-shaping factors that you may want to think about, you know, some extreme --

DR. LOIS: So from a Halden project perspective, what -- I guess what we are talking more is collection of data, simulator data, that would help us to understand how --

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: -- where some pitfalls of the -- of the operations may come from. And that's a long-term Halden activity, to run simulator scenarios and collect the data, which we would use to perform human reliability, to benchmark human reliability, etcetera, but also, lessons learned for training, for the procedures, etcetera.

MEMBER APOSTOLAKIS: I understand these people will be here in the spring, and that --

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: -- you are going to brief the committee on what is going on.

DR. LOIS: If --

MEMBER APOSTOLAKIS: That's what I understand, that you are --

DR. LOIS: Yes.

MEMBER APOSTOLAKIS: -- recommending --

DR. LOIS: Yes, yes. Exactly.

MEMBER APOSTOLAKIS: Okay. We'll do that.

DR. LOIS: In my --

MEMBER APOSTOLAKIS: Can we spend the last 15 minutes on broader issues now?

DR. LOIS: Okay. Here is a list of NUREGs that we have produced through -- from 2005 down. I note here, this is a -- refers to the pilot phase of the benchmarking. The data -- we had data that I think is of great interest for the committee, and the guidance NUREGs.

I don't think this --

MEMBER APOSTOLAKIS: Okay. Can you tell us a little bit more about HERA?

DR. LOIS: HERA.

MEMBER APOSTOLAKIS: Yes.

DR. LOIS: Okay.

MEMBER APOSTOLAKIS: I mean, everything else I think has been covered already.

DR. LOIS: Yes. Except for this --

MEMBER APOSTOLAKIS: Okay. Well, talk about that, too.

DR. LOIS: Yes. So here are the two models. HERA is an activity that has been sponsored and is going on at Idaho. What we do is we have

developed a framework to code human events into a database in a way that matches the needs of human reliability. And we try to do both historical events as well as the events that we have from the simulators.

It has a significant amount of data now. We are in the process of developing a user interface that would enable users to come in and do various searches to develop both qualitative understanding of -- on the basis of events for their human reliability or any other needs -- human factor types of analysis, as well as potentially to use this data to help the quantification aspect of -- in HRA. That's --

MEMBER ABDEL-KHALIK: The historical data you get out of the LER descriptions of --

DR. LOIS: The LER inspections of the automated inspection reports. Actually, we do have an activity that is going on with STARS, which is a consolidation of utilities, and they are using now HERA to load their own low-level and LER events. And we are going to have the benefit of those events as well.

MEMBER RAY: And these aren't in the narrow set that we talked about earlier. This is broad.

DR. LOIS: This is broad. And these are the ones that address your concerns regarding human errors and failures outside the control room done by maintenance personnel or other types of personnel.

MEMBER RAY: So, for example, in a plant I happen to know well there is an NRC inspection team looking at loose connections on the battery terminals. That would be picked up there as a maintenance-related problem.

DR. LOIS: Yes. If it's related to programmatic limitations, human errors, etcetera.

MEMBER RAY: Oh, it's definitely a human error, so -- okay.

MEMBER APOSTOLAKIS: And the fire?

DR. LOIS: Fire. Oops, I'm sorry.

DR. COOPER: That's fine. Since Erasmia is talking about a broad view of all of the HRA activities, we thought it would be worthwhile giving the committee a heads up that there is an ongoing effort in developing fire HRA methodology. Once again, this is a collaborative effort between the NRC and EPRI. Jeff Julius on the line from ScienTech, others from ScienTech, and other contractors, are working with NRC staff and its contractors on this effort.

We will or can or even plan to brief the subcommittee at some point in time when we are at an appropriate point in the development. And I think given the time, that is pretty much all I'm going to say on it right now, unless you have a question.

MEMBER APOSTOLAKIS: Well, what is it that makes this special?

DR. COOPER: Well, what we are trying to do is to expand on the limited guidance that was provided in NUREG/CR-6850, and that particular document, which is fire PRA as whole, what's -- what guidance is provided on HRA is really just very crude screening factor -- screening values, and some discussion on what performance-shaping factors are important.

The scope of the -- even the screening values was somewhat limited, and for some things it might be quite important to model in a fire PRA, like abandoning the -- you know, failure to abandon the control room, or response to spurious indications, or something like that, are not -- you know, I think you just get ones for any human failure event that you identify there.

So the purpose of this effort -- and it's not just related to the quantitative aspects. We also

are very much focused on what sorts of activities are required to identify the events that you need to model, and techniques for doing that, the qualitative analysis -- you know, what kinds of input do you need, and what kinds of factors do you need to be aware of.

In some cases, they are quite different for fire HRA. You know, we do have some environmental effects potentially for things that are happening in the field. And also, things that just might be -- you know, procedures, for example, is something that you consider in all HRAs, but the specifics of what you might be concerned about for a fire HRA might be quite different.

You know, some plants have some very different kinds of procedures or the way they implement them are different, or they might be multiple procedures at the same time, that sort of thing. So there are some different considerations for the same performance-shaping factor that we're trying to provide guidance on, as well as the quantification types.

MEMBER STETKAR: Susan, one of the things I -- and I think I mentioned this in the subcommittee meeting. One of the things that concerns me is when you start to talk about fire HRA, then the next --

maybe there's a flooding HRA, and maybe there's a seismic HRA, and maybe there's a shutdown PWR HRA, and a shutdown BWR HRA. And maybe a shutdown -- a power operation post 72-hour advanced nuclear plant HRA.

And it's really an evaluation of human performance under different types of inputs, different types of stresses. It's the same people. If I'm an operator in a nuclear powerplant, I don't suddenly decide that I need to follow the fire HRA performance factors just because now I have a fire out in the turbine building.

So my whole point is that we've gotten to the point in 2008 with this plethora of different human reliability analysis methods, however they have been developed, and I'm hoping that this effort is trying to consolidate things, and part of that consolidation is not to benchmark -- is not to tag human reliability as different in a fire scenario, compared to a shutdown scenario, compared to a seismic scenario, compared to a full power scenario.

I think -- and just -- when you start to use the terminology of fire HRA, you are already distinguishing that subtly as a different type of performance for some reason. And that's the thing that --

MEMBER APOSTOLAKIS: But the problem is --

DR. COOPER: Yes. I guess I'm not --

MEMBER STETKAR: The performance may be different, the way you evaluate that performance. The methods that you use to --

DR. COOPER: I don't --

MEMBER STETKAR: -- evaluate that performance may be the same methods that apply during Said's scenario wherein somebody has to go out in the plant during a loss of feedwater event and manually open a valve in a very difficult location because it's hot and steamy out in that difficult location. It may not make any difference whether you have a fire or --

DR. COOPER: Right, granted. I don't disagree with you. I mean, I -- and I think actually, you know, the discussion that we had earlier, so far as addressing the SRM, is going to -- and one of the reasons why we had this discussion about the framework or the process is that at a certain level of description, yes, it is HRA.

Now, that having been recognized, there are some specific things that you might need to do differently for a different application, like fire HRA, or low power and shutdown HRA. There may be different tasks that need to be focused on or given

more effort in a different application.

If you're doing an at-power PRA, you probably aren't going to need a huge effort in identification of human failure events, whereas if you're starting an application on a new facility that has not been modeled before, you can anticipate a much larger effort.

Now, we have had decades of experience in doing at-power HRAs, and a lot of -- for example, the methods that have been developed have been focused on the quantification, and it has gotten to the point where we have really very much simplified some of the other tasks in HRA.

So what I think that -- you know, the effort that Erasmia is describing, and what the fire HRA development, and so forth, is emphasizing, is that we need to go back and remind people that all of these other steps are important. You may be able to eliminate or short-cut certain things, because they are not as important for a particular application.

MEMBER APOSTOLAKIS: It's not --

MEMBER STETKAR: That's not a different methodology.

DR. COOPER: It is not a different methodology.

MEMBER STETKAR: All it is is a different context.

MEMBER APOSTOLAKIS: That's right.

DR. COOPER: That's correct.

MEMBER STETKAR: So --

MEMBER APOSTOLAKIS: Some licensees, for example, claim credit for a quick action of the fire brigade.

MEMBER STETKAR: That's fine. I don't -- I don't -- it's the word -- if we're trying to consolidate and reach a common ground --

MEMBER APOSTOLAKIS: It's not a different methodology.

DR. COOPER: All right. Yes, okay. It's not --

MEMBER STETKAR: You know, this concept of developing -- just the idea of heading down a path that maybe the methodology is different, just because I have a fire, is something -- I'd like -- I personally would like to see it pulled back from, because --

DR. COOPER: We could -- probably this should be part of the SRM process --

MEMBER STETKAR: It's a different --

DR. COOPER: -- as to what the terminology

should be for the --

MEMBER APOSTOLAKIS: Yes. We can call it application.

DR. COOPER: -- for the process.

MEMBER APOSTOLAKIS: It's an application.

MEMBER STETKAR: In different contexts.

DR. COOPER: Yes. And different tools might be needed.

MEMBER STETKAR: Different tools or different aspects of --

MEMBER APOSTOLAKIS: And different methods.

DR. COOPER: Yes.

(Laughter.)

MEMBER APOSTOLAKIS: There is only four minutes left.

DR. COOPER: Yes, okay.

MEMBER APOSTOLAKIS: So is there anything else that is important?

DR. LOIS: I don't think there is anything important. Oh, do you want to mention the --

DR. COOPER: I can very quickly mention the non-nuclear activities that --

MEMBER APOSTOLAKIS: Absolutely.

DR. COOPER: Very quickly. Since we don't

have non-nuclear power reactors -- well, that's not even true either.

MEMBER APOSTOLAKIS: Non-power reactors, do you mean?

DR. COOPER: The applications in waste and material applications. Let's just stick with the title of the slide.

MEMBER APOSTOLAKIS: All right.

DR. COOPER: And since I have very little time, I probably can't even get to all of these bullets here. Let me just say that there are other activities that we're doing in Research that are not related to at-power nuclear powerplant operations. And we are supporting -- for example, we are supporting NMSS in the review of the Yucca Mountain repository application, and reviewing the HRA that is -- analysis that has been done in that.

We have had an ongoing activity with NMSS in this -- looking at HRA-informed insights on spent fuel handling, cask drops and misloads, and there has also been a long-time project now with the Office -- FSME on medical applications. In particular, we have developed training and job aid for NRC staff -- continue working on that and making regulatory decisions with respect to medical applications.

And, certainly, if there's any interest by -- you know, by the committee, we would be happy to come here and give you more details on any of those projects.

MEMBER APOSTOLAKIS: Isn't that part of --

MEMBER RYAN: I have a question.

MEMBER APOSTOLAKIS: Oh, you want to hear that?

DR. COOPER: I'm sorry?

MEMBER APOSTOLAKIS: Well, let me ask the Chairman. Is that part of our job?

MEMBER RYAN: How do you cover agreement state licensees? There are 35 states that control radioactive material that the NRC doesn't regulate. But the -- they have an agreement state authority. So how do we deal with this broad scope of licensees from low-level waste sites to material handling to whatever it might be? Other than medical. I understand you are going after Part 35. But most licensees are not NRC licensees.

DR. COOPER: Right.

MEMBER RYAN: And they could benefit from some of these things.

DR. COOPER: Well, this is --

MEMBER RYAN: Just a second. You

mentioned cask handling. Most casks are not fuel shipments. They are low-level waste shipments, for example. So there's a broad spectrum of activities that are under the umbrella of NRC through the agreement states program, and they could probably benefit from these kinds of analyses.

MR. MONNINGER: Maybe, Susan -- maybe I will jump in if you don't mind. And I agree with you, one of the things that has to be recognized, I guess the Office of Research is a support office, so these projects that we are working on were projects that were directly requested by the offices.

So within these other areas, you know, if we're not --

MEMBER RYAN: Well, with a little bit of creativity, you could offer the work products to others who can make better use of it.

MEMBER APOSTOLAKIS: Well, we cannot force them to do it, right?

MEMBER RYAN: No. No, I'm just suggesting to the folks that are here that that might be a way to --

MEMBER APOSTOLAKIS: Make it available.

MEMBER RYAN: -- make better use of your work products to others that wouldn't --

MEMBER APOSTOLAKIS: Chairman Shack, do we want to get into this kind of stuff? Is our committee now responsible for --

CHAIRMAN SHACK: Yes.

MEMBER APOSTOLAKIS: I guess there is no ACNW anymore.

CHAIRMAN SHACK: There is no ACNW. There is the draft SRM.

MEMBER APOSTOLAKIS: So why don't we -- ACRS, block every Friday for the next six months for a subcommittee meeting with these people.

(Laughter.)

CHAIRMAN SHACK: That's a different question, George.

MEMBER APOSTOLAKIS: So we'll cover everything.

CHAIRMAN SHACK: It's within our purview, if we can find the time and --

MEMBER APOSTOLAKIS: Oh. I think we should at least be briefed once to know what the issues are, and some members are interested. And then, we'll decide how -- to what extent we ought to get involved.

Ladies, do you have anything else you want to say?

DR. LOIS: Thank you very much for the time, and I --

MEMBER APOSTOLAKIS: That's very good.

DR. LOIS: -- and support.

MEMBER APOSTOLAKIS: Mr. Chairman, back to you at exactly 10:00.

CHAIRMAN SHACK: You are 15 seconds over.

MEMBER APOSTOLAKIS: No, that's --

CHAIRMAN SHACK: That's close enough.

With that, we'll take a break for 15 minutes. Thank you very much. It's always very interesting to hear about the HRA.

(Whereupon, the proceedings in the foregoing matter went off the record at 10:00 a.m., and went back on the record at 10:19 a.m.)

CHAIRMAN SHACK: Come back into session. Our next topic is a -- staff is preparing a Commission paper on defense -- or a policy paper on defense-in-depth. Defense-in-depth, of course, has been a topic of great interest to the NRC over -- or the ACRS over our whole history. We just finished a discussion yesterday on containment overpressure that certainly is related to the defense-in-depth question.

Since I have been on the committee, we have had the famous 1999 letter where we introduced

the structuralist and rationalist approaches to defense-in-depth. And in some ways, they are actually still useful ways to think about the problem.

We had a full-fledged discussion of defense-in-depth as part of the technology-neutral framework. But the Commission has sort of recognized that there is a need for, again, an overarching policy statement, not associated with -- strictly with non-LWR reactors, but their whole policy approach to defense-in-depth.

And the staff has been charged with developing that, and I guess we are going to hear -- this is only an information briefing. They don't have a policy statement prepared yet, but we are going to hear some of their initial thinking and approaches to the problem.

Mary?

MEMBER APOSTOLAKIS: Well, at some point, they will come with the final recommendation, and we'll write a letter. Is that how it works?

MS. DROUIN: Several times we will come, I would think.

(Laughter.)

I don't think you'll be happy with just one visit.

MEMBER APOSTOLAKIS: Back to normal, Mary. Back to normal.

CHAIRMAN SHACK: This is a policy statement, George, so I think we want a fair number of shots at this one.

MS. DROUIN: Absolutely. Good morning. I am Mary Drouin with the Office of Research. And at the table with me is Don Dube with the Office of New Reactors.

Before we get started, I wanted to see if John Monninger would like to say a few remarks.

MR. MONNINGER: Good morning, Chairman Shack, fellow ACRS members. I'm John Monninger. I'm the Deputy Director for the Division of Risk Analysis from NRC's Office of Research.

I want to thank you very much for this opportunity to brief you on our efforts as we continue to undertake this project. As you mentioned, it has been of considerable interest to the ACRS and to the Commission. I mean, the notion of defense-in-depth is a fundamental principle that the NRC has had, and the ACS had for, you know, 30, 40 years or so.

The current effort -- you know, it has largely been drawn, or it has largely been focused on the need to define it for, you know, advanced

reactors. You know, there is some history back in the early 2000 timeframe that Mary, of course, will go into, recognizing the need to more clearly state, you know, our intent, our purposes, and when we would rely upon defense-in-depth.

And with that, I just thank you very much, and we look forward to your comments and suggestions. So Mary and Don?

MS. DROUIN: Thank you, John.

We are here today to both brief, you know, and solicit the committee's input regarding the Commission's request to develop a policy statement on defense-in-depth. And, of course, because we're just in the very early stages at this point in time for this meeting, we are not meant -- we are not requesting a letter. You know, we are just here to make you aware of this effort, and let you know our early thinking.

What I plan to go through is I think it's very important that you understand, you know, the effort -- when this got started, from informing the Commission with regard to the need for the actual policy statement, to where we are now. What are the various concepts that we are considering? What are some of the issues that we have identified so far

that, you know, are going to be addressed? And where we are and what are the milestones and dates that we have laid out.

So starting with some of the history -- now, I'm not going to go through every single SECY paper, but I do want to mention a couple of relevant ones, because it's very important that we understand how we got here today.

If we go back to 2002, there was an initial SECY paper that was followed up by SECY-03-0047, with the need for the policy statement for defense-in-depth. And while, you know, the philosophy of defense-in-depth has been a fundamental part of NRC's regulatory philosophy, and it is mentioned in several places -- for example, it's in the safety goal policy statement, it's in the PRA policy statement, there is the Commission white paper -- specific elements of defense-in-depth are not described.

We have always said in terms of our operating reactors that we have compliance with the regulations. And in compliance with the regulations, that is what ensures defense-in-depth for LWRs.

When you look at, what is the goal of defense-in-depth, it's best described in the

Commission's white paper, which is carried through, and you'll see those exact same words in the NRC's strategic plan.

But when you look at this, and also looking at, you know, what was written up in Reg. Guide 1.174, is another place where you see it. The staff felt that, due to the LWR designs being so different from LWRs, that more explicit guidance was needed for defense-in-depth, and that this guidance should include describing the elements or the principles of defense-in-depth. And that is what was put forward to the Commission back in 2003.

In response to that SECY paper, the Commission came back in the SRM and approved the development of a policy statement, approving the development of, you know, trying to write out a definition, what are the elements, you know, and the principles.

The other thing they did ask us to consider in that SRM is that -- would it be more effective and more efficient, instead of writing a brand-new policy statement, to review the PRA policy statement? So although they did tell us, you know, to do it, you know, think about where you would actually put it.

MEMBER CORRADINI: I think you have papers on the microphone.

MS. DROUIN: No.

MEMBER CORRADINI: Okay.

MEMBER APOSTOLAKIS: Is that --

MS. DROUIN: Can people not hear me?

MEMBER CORRADINI: You can hear the rattling.

MS. DROUIN: Oh.

MEMBER CORRADINI: There you go.

MS. DROUIN: How's that? Thank you.

MEMBER APOSTOLAKIS: Is there a message there from the Commission that defense-in-depth and PRA are intimately related? Why put it there? It seems to me it's a broader issue.

MS. DROUIN: Well, we're going to come to that, if you'll bear with me. We're going to answer that question.

MEMBER APOSTOLAKIS: It's unbearable.

(Laughter.)

MS. DROUIN: What, that you can't wait?

MEMBER CORRADINI: So if you are going to come to that, I guess the other question I had is: if you were able to -- you were able to license Fort St. Vrain, you were able to license almost CRBR without --

so I'm -- there has got to be a pragmatic, empirical way where it has already been done, that didn't need PRA, and it was a non-LWR. So I'm curious, historically, how that was done and how this might deviate from that.

MEMBER APOSTOLAKIS: That also imposed an unnecessary regulatory burden in some cases.

MEMBER CORRADINI: Okay. But that's a different reason than you've satisfied defense-in-depth with already two licensed machines.

MEMBER APOSTOLAKIS: I'm telling you, that's part of the issue.

MEMBER CORRADINI: Okay.

MS. DROUIN: Okay. So as a result of all of that, you know, we initiated the effort as under the program in developing NUREG-1860. When 1860 was initiated -- and, remember, there was a primary goal. The primary goal or objective of that piece of work was to develop this alternative set of requirements for non-LWRs as an alternative to Part 50.52.

In doing that, there were a lot of byproducts that came out of 1860. And one of the criteria that had been laid down was to integrate defense-in-depth into this alternate set of requirements, so that meant that we needed to specify

what are the elements and principles of defense-in-depth for non-LWRs?

So a lot of the technical basis work was explored as we did 1860.

MEMBER APOSTOLAKIS: As a side remak, it might please you -- I hear a lot of people outside the agency who are studying this NUREG more carefully now saying very nice things about it.

MS. DROUIN: Thank you. I appreciate that.

MEMBER APOSTOLAKIS: You are very welcome, Mary. She needs that. They have gotten a lot of criticism for this, so, you know, to say that some people like -- not word by word, but, I mean, the full approach -- heaven forbid.

(Laughter.)

Some of my colleagues are surprised that we are actually praising the staff every now and then.

(Laughter.)

It's nice to hear people out on the outside saying nice things.

MS. DROUIN: Yes, it is. Yes, it is.

So I am going to jump from 2003 to 2006, because at this point the Commission asked us to solicit -- even though, I mean, it's not like we

hadn't been soliciting stakeholder input, we have been having public meetings and some public workshops, but the Commission asked us to do a formal solicitation through an ANPR.

So in that, when you go back and you read the ANPR that was issued back in May 4th on 2006, we had specific questions that we had raised to stakeholders, and they centered around three things. You know, was it best to revise the PRA policy statement? Did that make sense? You know, could we accomplish the same goals by doing that? Or was it best to have a policy -- a new policy statement that was just for defense-in-depth for non-LWRs?

We also asked their views on what we had on defense-in-depth in 1860. You know, the definition that is proposed in that document, plus the principles that were described for defense-in-depth. So we specifically asked feedback from stakeholders on that also.

We got a lot of input from stakeholders. I don't remember all of the ones, but I think there were about 20 organizations that formally submitted comments back to us. And the feedback we got was in regards to a separate policy statement. They much preferred that. They did not see that it was the

right way -- was to revise the PRA policy statement. They felt defense-in-depth was much broader and highly recommended that.

With regard to the principles, they were very supportive of the principles and the definition. However, you know, they wanted to better understand them, what did they mean, and they really emphasized, you know, a desire to interact more with the staff before the policy statement was finalized. And several stakeholders also felt like the principles should be tested. They didn't explain what they meant by that, but they just said "tested."

MEMBER CORRADINI: So I guess I have -- I guess I have -- just to clarify. So advanced notice for rulemaking means that this policy statement would become a rule?

MS. DROUIN: Okay. No, no, no.

MEMBER CORRADINI: I need some clarification.

MS. DROUIN: Okay. Good question. It goes back to the primary goal of NUREG-1860 was to do rulemaking ultimately on this Part 53.

MEMBER CORRADINI: Fine.

MS. DROUIN: Okay. But in doing NUREG -- and they also asked us to put in the ANPR other issues

related. So when you go back and look at the actual ANPR, there were I think 10 topics -- don't quote me on the number -- and one specific topic, separate than the actual requirements and whether there should be rulemaking, was also give us your views on the defense-in-depth, because it was integrally related to, you know, 1860.

MEMBER CORRADINI: Okay.

MS. DROUIN: So that's --

MEMBER CORRADINI: Okay.

MEMBER APOSTOLAKIS: But it's not necessarily going to be a rule.

MS. DROUIN: No, no, no. No, no.

MEMBER CORRADINI: Well, that's I guess where I was going to go with this. So where we are now in the evolution of this, this is a policy statement similar to the safety goal policy statement, similar to --

MS. DROUIN: Absolutely.

MEMBER CORRADINI: Okay, fine.

MS. DROUIN: The ANPR was just a mechanism to formally get comments, not only on a potential rulemaking for Part 53, but comments on some of the technical issues that were in 1860.

MEMBER CORRADINI: So one last thing about

history. If I went back in the late '50s and the early '60s, I couldn't find policy statements by the AEC on defense-in-depth?

MS. DROUIN: That's correct. I mean, I would love if you found something, because we've done a lot of search for, you know, where defense-in-depth is, where it's mentioned.

MR. DUBE: It's used, but it's not defined.

MEMBER CORRADINI: But in terms of how it rolled out, there are policy statements on containment, on ECCS, that essentially build up to a defense-in-depth. So there is individual things from the late '50s and '60s in this regard.

MR. MONNINGER: Well, there may be a couple of different things. There may be some statements or considerations, but there is another thing known as capital letters policy statements. You know, so --

MEMBER CORRADINI: Capital letters?

MR. MONNINGER: Well, capital P and capital S for a policy -- you know, do we -- you know, so there may be --

MEMBER CORRADINI: So it has never been rolled up into a --

MR. MONNINGER: An essential policy statement.

MEMBER APOSTOLAKIS: It has been, but it was in the '90s.

MS. DROUIN: The only document that is -- where you can really go back and find a description of, here is what we mean by defense-in-depth, was the Commission white paper in 1999.

MEMBER APOSTOLAKIS: That's right.

MEMBER BLEY: That's from the Commission. Wasn't there a really old TID document that talked about this is some detail?

MS. DROUIN: What document?

MEMBER BLEY: TID were the letters on those old --

MEMBER CORRADINI: No. That was just specifying a source term for --

MEMBER BLEY: Because that one -- there were other documents with that, and I'm pretty sure there was one on --

MEMBER CORRADINI: The only reason I go back to that time period is it -- I think the way you guys are describing it with the big P there wasn't. But on -- in terms of containment, etcetera, because I meant -- the former Chairman of ACRS, Bill Kerr, wrote

a relatively large -- and I still have it -- a report on the concept of containment and how it evolved from the '50s to at that time the late '80s.

MS. DROUIN: Oh, absolutely. I don't --

MEMBER CORRADINI: Okay.

MS. DROUIN: Right.

MEMBER APOSTOLAKIS: The reason why the '99 statement -- white paper came out was precisely because there was no formal statement from the Commission as to what defense-in-depth is.

MEMBER CORRADINI: Okay. Thank you.

MEMBER APOSTOLAKIS: So they did search at the time. Yes.

MS. DROUIN: I mean, and the only place in the regulations that defense-in-depth is mentioned is in Appendix K and somewhere in the siting. You know, I can give you that -- the references.

Okay. So after -- you know, when the -- the ANPR went out, at that point we also had another major workshop. We had a two-day workshop of which defense-in-depth was one of the main topics, and pretty much got the same feedback through the same -- that we saw in the formal written comments.

So we went back to the Commission with SECY-07-101, and at that point in time we felt that we

had done enough work in 1860 that we could now start working on a policy statement. And so when you go and look at SECY-07-101, we made a commitment in that SECY paper to initiate an effort to develop a draft policy statement.

And the Commission came back -- and I wanted to give you the actual quote here, because they came back and said, "The staff should develop a draft policy statement on defense-in-depth for future plants." I've underlined that, because that has caused, you know, some confusion in trying to understand what those terms mean.

Now, from my perspective -- and I'm saying my -- from my personal perspective, those words to me were very clear, because I had been living with this, you know, since 2002. And when you start following the whole series of SECY papers, you know, at the beginning we used the term non-LWR, and then we segued into just using the term "future plants" to mean non-LWRs. But it's not clear what the Commission really truly meant here by, you know, "future plants."

MEMBER APOSTOLAKIS: So it's still not clear?

MS. DROUIN: I'm going to get to that, too.

MEMBER APOSTOLAKIS: Ah.

MS. DROUIN: We have made an interpretation.

This draft could be evaluated using the insights gained through the development of the NGNP and completion of the PBMR and the stanchion-engaged members.

So these are some very important points that I will get to as we go through the presentation.

So given that, you know, we formed a task group and started just now working on this. And one of the first questions that, you know, we had to ask ourselves is, you know, what should be the scope of this policy statement? Should it only be applicable to future reactors, you know, primarily meaning non-LWRs and innovative LWRs? Or should it just be all reactors. Or should it be just currently operating reactors?

So trying to get a handle on the scope. And at this point -- well, I'm going to come back --

MR. DUBE: Can I jump up?

MS. DROUIN: Sure.

MR. DUBE: The feeling in the Office of New Reactors is that it would not be applicable to the current --

MS. DROUIN: That's the next slide.

MR. DUBE: Okay. I'll just jump ahead.

MS. DROUIN: I forgot that.

MR. DUBE: The currently -- the current designs that have been certified, or are undergoing certification -- so those would be the seven designs, some are active, some are passive, but would be applicable to certainly non-light water reactors such as liquid metal and gas-cooled, but perhaps also to some of the innovative passive light water reactors.

For example -- just as an example, the new scale modular advanced pressurized water reactor, which is almost entirely passive in nature. That is sufficiently revolutionary that it fits more in the mold of what we have in mind for future.

MEMBER APOSTOLAKIS: But it excludes the ESBWR.

MR. DUBE: Yes, probably.

MEMBER CORRADINI: His point was that everything on the docket is excluded.

MR. DUBE: Correct.

MEMBER CORRADINI: So let me just probe that. So let's say the ACO-1000 would come back. In or out?

MR. DUBE: This is the CANDU?

MEMBER CORRADINI: Yes.

MR. DUBE: I'll have to ask my bosses, but I --

(Laughter.)

MEMBER CORRADINI: I just thought I'd throw out some possibilities.

MR. DUBE: It's certainly a non-light water reactor --

(Laughter.)

MEMBER BANERJEE: But what is the rationale for, you know, sort of making this division?

MEMBER BLEY: It is not technical, I take it. It's --

MR. DUBE: Well, it's one of -- it is one of reasonableness and fairness. Would it be fair to backfit -- I hate to use the word "backfit," but loosely defined "backfit" to a currently operating reactors, the new concept and philosophy of defense-in-depth, I think almost everybody would agree perhaps not.

But now you have those that have already -- substantiate a long design that at this point in the game you may tweak the design of some of these being certified by a valve here or there, or a power supply, but you're not going to substantially change

the design in the --

MEMBER BLEY: Mary? Don and Mary, could we put this aside a little and come back to it --

MR. DUBE: Okay.

MEMBER BLEY: -- after you tell us what your ideas are? So that we can better understand why it might or might not want to apply to certain plants?

MS. DROUIN: Yes. But also -- I will do that, but what I would like to also remind everyone is that when we made the recommendation to the Commission that there was a need for this policy statement, it was a need for a policy statement strictly for non-LWRs.

And when you go and read the justification that was in the SECY paper, you know, it -- there was this whole -- I mean, I quickly went through some of it. But there was a reason why, you know, we felt we only needed a -- we needed a policy statement for non-LWRs. And if it wasn't for that, the staff would not have made the recommendation for a policy statement.

Now, we can argue, well, in hindsight, maybe we do need a policy statement, you know, generically.

MEMBER ARMIJO: What happened to technology-neutral? Why can't you have a technology-

neutral policy statement on defense-in-depth? High level.

MS. DROUIN: That's --

MEMBER MAYNARD: Until we have some discussion on what is being proposed, it's kind of hard to tell what it applies to.

MEMBER BLEY: I'd be surprised if this didn't look neutral by the time we see it, but I don't know. I haven't seen it yet.

MS. DROUIN: And the Commission did request that it be technology-neutral and risk-informed. And that was in the SECY back in 2003. We told the -- when we made the recommendation that the Commission approved in 2003, it was supposed to be technology-neutral and risk-informed.

MEMBER ARMIJO: And you're saying maybe it's not going to be?

MS. DROUIN: No. No. I'm not saying that.

MEMBER ARMIJO: I'll wait and see what you're saying.

CHAIRMAN SHACK: Even though it's technology-neutral, it still may only be applicable to be --

MEMBER APOSTOLAKIS: But it can't be too

different from what we have already done. I mean, that would be ridiculous.

MEMBER CORRADINI: Yes, that was my point.

MEMBER APOSTOLAKIS: So that --

MEMBER CORRADINI: That's my point.

MS. DROUIN: You know, as Don just indicated, you know, when we talk about -- the term "future reactors" is mean to include the current -- is not meant to include -- sorry, I left out the "not," you know, is not meant to include the current generation.

But getting into -- you know, coming up with the definition and the principles, you know, we don't think it should be written in such a way that it -- when these ultimately get implemented and applicable that they could cause something adverse, such as a backfit, or whatever, on your current generation.

So let's start -- now, we want to consider, you know, the previous work done by others. And so there is four things I am going to go through. You know, what was done by IAEA in the INSAG report, NEI -- man, I have to tell you, I took a real gamble in putting the ACRS, because I thought -- I'm going to interrupt what I think you all have written.

MEMBER CORRADINI: That's all right. We can barely understand it. Go ahead.

(Laughter.)

MS. DROUIN: But on the other hand, I thought this is something good, because if we misunderstand it, it's your wonderful opportunity to correct us.

CHAIRMAN SHACK: Yes. But you might get 15 different opinions.

(Laughter.)

MEMBER CORRADINI: Might? Or more.

(Laughter.)

MS. DROUIN: When you go to the INSAG report, what you will see, there is no specific definition of defense-in-depth provided. What they have are these five levels of defense-in-depth that have been described with objectives, and then what the -- this thing they called essential means of how you meet these objectives.

And when you look at -- the first level, for example, is prevention of abnormal operation and failures. And the essential means for doing that is a conservative design and high quality in construction and operation. I can read you all five of these, but I don't think it's necessary.

I think what's important to understand is that when you look at the essential means described in INSAG-12, it encompasses everything and encompasses all aspects of plant design and operation, you know, are considered defense-in-depth.

You know, and so, as such, they go past, you know, dealing with uncertainties. They don't focus on a specific design or operational measure. You know, that is there for just defense-in-depth purposes.

And another important point is that when you read the INSAG report, this document was written for application to current LWRs. And they don't focus on what measures should be included for future reactor design. And they even mentioned that in the INSAG report, that when you start considering future designs you might have to do some adjustment.

However, when you do look at the levels, it does provide, you know, a very good structure, because the levels are built on one another, such that if the first level fails, the second level is a backup. If the second level fails -- so that structure --

MEMBER RAY: Are the levels independent, Mary?

MS. DROUIN: I'm sorry?

MEMBER RAY: Are the levels required to be independent of each other?

MS. DROUIN: Are they required to be independent? No.

MEMBER RAY: In order to account -- credit them.

MS. DROUIN: Are they independent?

MEMBER RAY: For example, would a barrier that depended on operator action, and then operator action be separate levels of -- separate levels?

MS. DROUIN: They aren't clean in their independence. They aren't.

MEMBER RAY: Okay.

MS. DROUIN: You are going to see some --

MR. DUBE: For example, steam generator tube will be the RCS boundary. But if it fails, it could also -- there's bypass containment, so it's not completely independent of --

CHAIRMAN SHACK: The goal would be to have them as independent as feasible and possible.

MS. DROUIN: Right.

CHAIRMAN SHACK: And, certainly, any future design changes that could lead to that would be beneficial, but --

MS. DROUIN: Absolutely.

CHAIRMAN SHACK: -- in the current designs they are clearly not in the --

MEMBER APOSTOLAKIS: Is the containment a defense-in-depth measure?

MEMBER RAY: Yes.

MEMBER APOSTOLAKIS: Wait. Is it? I'm not sure it is.

MEMBER RAY: Sure it is.

MEMBER APOSTOLAKIS: No.

CHAIRMAN SHACK: It depends on what you mean by "defense-in-depth."

MEMBER APOSTOLAKIS: Exactly.

MS. DROUIN: See -- thank you.

MEMBER APOSTOLAKIS: If I want to meet a 10^{-5} large release --

CHAIRMAN SHACK: Defense-in-depth --

MEMBER APOSTOLAKIS: -- I heat the containment, so it's not defense-in-depth.

CHAIRMAN SHACK: Mary had a -- you know, there's a design philosophy that says you meet your safety goals by a defense-in-depth approach, which means that you use multiple means to meet your safety goal.

MEMBER APOSTOLAKIS: That's right.

CHAIRMAN SHACK: There is also the structuralist one that says, "Even if I've met my safety goal" --

MEMBER APOSTOLAKIS: That interpretation is extremely important. Extremely important.

MEMBER BLEY: The earliest interpretations, though, that I recall of defense-in-depth started with you had the radionuclides embedded in a matrix inside of a clad inside of an RCS inside of a containment. From that point of view, it's saying we got it at the first one and all these others. Once you add probability to it, then maybe you do need it, but --

MS. DROUIN: You know, I am going to skip to the next slide and come back to this one maybe, because -- well, this is an important discussion. And this was critical when we started looking at defense-in-depth.

MEMBER APOSTOLAKIS: But I had a comment on the previous slide.

MS. DROUIN: I'm going to come back to it.

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: But if you want me to go back now, I will.

MEMBER APOSTOLAKIS: Well, you didn't

include the 1.174 in the list, which was really one of the most practical --

VICE CHAIRMAN BONACA: There is a significant discussion there.

MS. DROUIN: We did --

MEMBER APOSTOLAKIS: Regulatory Guide 1.174 says --

MS. DROUIN: We did consider it. I apologize that I didn't put it on the slide.

MEMBER APOSTOLAKIS: All right.

MEMBER BLEY: You said work by others. Of course, ACRS is -- they can't say you didn't put the framework up, which you already talked about, too.

(Laughter.)

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: But, you know, when we started looking at this under 1860, you know, there were some very fundamental questions that we had to ask. And let me tell you, and they aren't easy questions, and we -- we grappled with them over months and maybe even years in trying to get them answered. And the first one was actually we thought quite easy to answer, you know, is why is there a need for defense-in-depth?

But some people can still -- do still

argue on what is there to need? And we thought it was very straightforward. It's to compensate for uncertainties. It's to compensate for, you know, the unexpected and the unanticipated. It's to deal with all those unknowns. If you knew everything perfectly, I would argue, you know, you would not need defense-in-depth.

And over the time as we were dealing with this, people would come back and say, "Oh, no, no, no. You don't need it for this. It's not really for pieces for this." And then, as we had a discussion with them, and got into it, it always came back to something they didn't know about. And so that was very, very fundamental.

CHAIRMAN SHACK: Well, I mean, I would actually argue about that, because I'm a structuralist, that, you know, I -- it comes back to this thing that -- if I use -- if I'm going to meet my goal, I can meet it in many ways. And I think there is a defense-in-depth approach to meeting that where I don't put undue emphasis on any particular one aspect.

I may need them all to meet my goal, but I meet my goal by a design that has multiple elements than -- you know, so there is that aspect of defense-

in-depth as a design philosophy, and then there is a defense-in-depth to address uncertainty. Even after I have met my safety goal, I always have uncertainty.

MEMBER APOSTOLAKIS: But I think your first interpretation does address this uncertainty.

CHAIRMAN SHACK: Well, it does and it doesn't.

MEMBER APOSTOLAKIS: Because you are saying I would --

CHAIRMAN SHACK: There's my known unknowns and my unknown unknowns. I don't trust one by itself, you know?

MEMBER APOSTOLAKIS: You are saying, if you tell me that the core damage frequency will be 10^{-6}, so I don't need a containment, then this issue of unknown and knowns comes into the picture. Say, well, maybe you can have 10^{-4} or 10^{-5} for the core damage, put an extra thing with .1 probability for -- based on what you know. But it also covers you in case you made a mistake.

So I think that interpretation is probably the best. You meet a goal, but you do it so -- by having a multiplicity of barriers. I think that -- ultimately, I think we are going to --

MEMBER BANERJEE: But, then, they have to

be pretty independent of each other.

MEMBER APOSTOLAKIS: To some extent. They cannot be completely independent.

MEMBER BANERJEE: I realize.

MEMBER APOSTOLAKIS: To some extent.

MEMBER BANERJEE: Then --

MEMBER APOSTOLAKIS: But if you miss something, say, in the core damage domain, you are hoping that the containment at least will protect you.

MEMBER BLEY: And they can't all be dependent on the same thing as kind of --

MEMBER APOSTOLAKIS: That's right.

MEMBER BLEY: You want one thing that can break them all down.

MEMBER APOSTOLAKIS: Some degree of independence, yes. But --

MEMBER BLEY: Those comments interest me, because I think any rationalist would come to the same conclusion.

MEMBER BANERJEE: I think you need to define what you mean by "some."

MEMBER APOSTOLAKIS: Well, as I said --

CHAIRMAN SHACK: Some rationalists feel that the unknown unknowns are probably small enough --

MEMBER APOSTOLAKIS: No. No. You are

misinterpreting the rationale.

CHAIRMAN SHACK: Or you're picking a poor one.

MEMBER APOSTOLAKIS: No. I think the interpretation you gave is really what I would subscribe to.

CHAIRMAN SHACK: Well, you're a high-level structuralist.

Let's let them go on before we get into our own internal debates.

MS. DROUIN: Well, these are all the kind of, you know, debates we had had. And I think what happens in a lot of this is there is -- why do you need it, then, versus how do you implement it?

MEMBER APOSTOLAKIS: Right.

MS. DROUIN: And I think too many times we confuse the two, and our implementation we argue as why we need it. So we have tried to separate out -- okay, first, why -- just simply, why do you need it? And then, how you go about defining it and implementing it is when you start getting into the discussions of the structuralist, the rationalist, and everything.

MEMBER APOSTOLAKIS: But I would add to your first bullet/sub-bullet there, why is there a

need? What you have there is correctly, but I would also add, "Because we are dealing with rare events."

If we were dealing with probabilities on the order of .1, you probably wouldn't need it. But we are dealing with rare events. Therefore, the uncertainties are significant, and you want to --

MS. DROUIN: Oh, absolutely.

MEMBER APOSTOLAKIS: I would just add that.

MS. DROUIN: Okay. The other part of trying to understand and developing an approach is actually understanding what these words mean. Now, separate out the fact that we're nuclear powerplants or anything. Just what English dictionary -- what does the word "defense" mean and what does the word "in-depth" mean. So just trying to get a handle, then, of what do we mean by this term "defense-in-depth."

So, you know, we went back to the dictionary and -- went to several dictionaries, in fact, and tried to understand. And when you separate out what you see from the dictionary is that, you know, "defense" are those measures or actions, you know, that are taken on to prevent or mitigate you from danger or harm or attack. and then, the "in-

depth" is those additional measures or extra measures that you put in place.

So then, when we take that definition and now apply it, you know, to a nuclear powerplant, then what we're getting into is: what are those additional measures to prevent or mitigate you from harm? To prevent the public from harm, you know, associated with your nuclear material. I don't remember our exact words, but the key thing I want to point out is that it's those additional things, and that's--

VICE CHAIRMAN BONACA: Because you presume, you know, that you want to cover for failures.

MS. DROUIN: I'm sorry?

VICE CHAIRMAN BONACA: You want to cover for failures of this -- I mean, you said defense-in-depth means that you put lines of defense. And you want to add lines to compensate for the potential failures of some of the lines. I mean --

MEMBER ARMIJO: Well, if you have something that you just put into the design simply to make it work, like fuel cladding, is that a defense-in-depth feature by your definition?

MEMBER BANERJEE: In the classical definition it was.

MEMBER ARMIJO: It used to be, yes.

MEMBER BANERJEE: Yes.

MEMBER ARMIJO: And the reactor vessel.

MS. DROUIN: I've got somebody raising their --

MR. SHUKLA: Yes, Mary. Let me give you a layman's definition. When I started working in this country from India, in 1976 or '79 timeframe, Dr. Blago was my first boss here. I am very lucky to have him in this room.

But this term puzzled me when I started my job. To me, it means the layers of defense, not the extra measures. How many layers do you have of defense? Just call it defense-in-depth.

MS. DROUIN: That's the traditional definition.

MEMBER APOSTOLAKIS: Let me give you an example. When we were reviewing the in-service inspection, risk-informed in-service inspection, what struck me was that the probabilities of failure were awfully low. So I asked: why do we need to inspect? And our Chairman said, "Defense-in-depth."

So here is a measure. If you are doing all of this, just because you want to know, to have reassurance that the thing is not deteriorating, but

if you go strictly by probabilities you shouldn't really be inspecting, because you -- those guys were talking about 10^{-11} -- you know, incredibly low numbers. So that was in the name of defense-in-depth, and that would meet your definition of doing something extra.

MS. DROUIN: Right. See, this discussion that we're having right now is an excellent example of -- because as you go around and you talk to people, and what you mean by "defense-in-depth," every single person you talk to you are going to literally get a different definition, a different idea.

And what we had told the Commission, you know, back in 2003 is that we were trying to get specific -- is what were those things that needed to be put into the design for these non-LWRs because the fact that we have these new designs that had a lot of uncertainties with them, so what did we want to put in there for defense-in-depth?

So we really had to stop and divorce ourselves away from it being, well, it's embedded in the regulations, or it's -- so, you know, trying to start from a clean piece of paper, be very specific is -- this is what we mean. This is what we want to see in the design and operation.

I'm just talking about this was the approach in laying this out and trying to come up with a definition and the principles that were laid out in 1860. That doesn't mean that this is what we want to do in the policy statement, even though ultimately that's, you know, hopefully where it was going to go.

But trying to get a handle on what did we mean by these terms, why did you need it, to then help us lay out, now what are the specific elements you want to see for defense-in-depth incorporated?

MEMBER BANERJEE: Let me try to understand what you're saying. So there are physical barriers, and associated with these physical barriers are certain actions which might be needed to maintain the integrity. So the defense-in-depth concept you are proposing is sort of an amalgamation of these two things, right? So your defense-in-depth now includes not just the cladding but whatever actions are needed to maintain its integrity, and --

MR. DUBE: Programs, inspections.

MEMBER BANERJEE: Yes. And also for the RCS and also for the containment. Right. So --

MEMBER APOSTOLAKIS: That's part of it.

MEMBER BANERJEE: But is there --

MEMBER APOSTOLAKIS: There's more.

MEMBER BANERJEE: -- something I'm missing?

MEMBER APOSTOLAKIS: For example, in 1.174, they state that extreme reliance on programmatic activities should be avoided.

CHAIRMAN SHACK: Well, but I think we're starting to get Mary's problem here. She started up with the level as -- why is there a need? What is the objective and purpose? We are down into implementation.

MS. DROUIN: Exactly.

CHAIRMAN SHACK: How do we get it?

VICE CHAIRMAN BONACA: And it seems to me that, what is the need? The need, it seems to me, again, is the protection of the public.

CHAIRMAN SHACK: Right.

VICE CHAIRMAN BONACA: I mean, you have to -- what is the fundamental objective of defense-in-depth? I mean, it's to protect the public.

CHAIRMAN SHACK: I need assurance that you're protecting --

VICE CHAIRMAN BONACA: Yes.

MEMBER APOSTOLAKIS: But that's too high level, Mario.

VICE CHAIRMAN BONACA: Well, no.

MEMBER APOSTOLAKIS: I mean, I think this is better.

VICE CHAIRMAN BONACA: It's not too high level, because after that you begin to say, "Well, do I want -- what do I have?" I have containment, I have RCS, and you have -- you go down to the barriers. I mean, that's the process that has been taken.

Programmatic activities support all the activities that there are in the plant to protect the three layers, and so on. And so I'm saying that it's not so much high level.

MEMBER ARMIJO: I guess I object to the fact that it's -- this meaning that Mary proposes is things that are in there that do provide a defense-in-depth function are also necessary just to make the system produce electricity to work. And so I don't like to see defense-in-depth viewed as an extra thing or an extra feature. It's all of these things.

VICE CHAIRMAN BONACA: But if you think about the --

MS. DROUIN: Well, I would argue --

VICE CHAIRMAN BONACA: -- they are still focused on maintaining the integrity of the barriers during accidents. For example, you are taking the cladding, and you are doing a lot of things to it to

make sure that during an accident --

MEMBER ARMIJO: Right.

VICE CHAIRMAN BONACA: -- it would behave in a certain way. You know, we just had a meeting on --

MEMBER ARMIJO: Right. You could have more of it. But it seems to me that if you put something in the design for -- just needed to make the thing work, lose power, it also has built into it a defense-in-depth function. Very important.

CHAIRMAN SHACK: Well, maybe you should go to the next slide now.

MS. DROUIN: And I would not argue with that. You know, there is -- let me give you an analogy. You know, there is many systems when you're doing a PRA, and you're looking at the function of core coolant, you know, and what systems you are going to take credit for.

There are systems that are -- their function is core coolant. But when you model your PRA, there are systems that you will take credit for that provide core coolant, but that was not their original function.

MEMBER ARMIJO: Right.

MS. DROUIN: Okay?

MEMBER ARMIJO: I agree with that.

MS. DROUIN: The same thing can happen here. You know, the danger is -- let's put ourselves 20, 30 years down the road. Okay? And you are now wanting to make changes, and you don't -- and you want to maintain your defense-in-depth. If you now have called everything in your design and operation of the plant defense-in-depth, we are trying to move away from, you know, everybody saying, "Oh, well, you can't do this because that's defense-in-depth." We call everything defense-in-depth.

So, and -- but this is getting into I think the implementation of it, and that's going to be the real challenge, I think, coming up with the definition and the principles. You know, we may argue over some of that and some wording, but I -- maybe I'm more optimistic, but I think on the principles we won't have -- it is -- what do you mean by these principles, and how will you implement them?

MEMBER CORRADINI: So since you are thinking about this for non-LWRs, as to what you are currently -- your non-traditional LWRs, I assume you looked at, like, biological hazards and chemical hazards, and how they are now currently designed for defense-in-depth.

In other words, if I went into a -- if I went into a university that is doing work in anthrax, I have to have a functional way in which I deal with it, then I have to have a containment, then I have to have -- in other words, I just assume that you are looking at how other agencies are doing defense-in-depth for chemical agents and biological agents.

MS. DROUIN: I don't want to say that we've done a lot of that. Some of us, you know, who have -- who worked on 1860 in that defense-in-depth aspect of it were aware of some of it. Did we make a concerted effort to go out? No, we did not.

MEMBER BANERJEE: I think, Mike, in general, all things I know about, work more or less in the same way. There are physical barriers, and there are policies, procedures, and other things that you take to communicate the integrity. That's -- and to minimize interactions between them.

So there has been a broad challenge. The same philosophies apply to chemical plants, to biological hazards. I mean, it is done everywhere.

MEMBER SIEBER: But these things change over time. The first commercial reactor, it was assumed the reactor coolant system would not break. Part of it ran outside containment, and ran that way

for 30 years.

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: Okay.

MEMBER SIEBER: Didn't break.

MS. DROUIN: And, again, just remember, I'm just describing to you what we did in 1860.

MEMBER SIEBER: That was a long time ago.

MEMBER BANERJEE: The year or --

(Laughter.)

MS. DROUIN: They were very smart back then, right before the Civil War.

So when you look at 1860, there's two things that are provided in 1860 -- you know, a definition and six principles. When you look at the definition that is proposed in 1860, you'll see very close similarity to what the Commission has in their 1999 white paper, which actually says, "Defense-in-depth is an element of NRC safety philosophy that is used to address uncertainty by employing successive measures" -- I'm sorry. I'm reading to you what's in 1860. "Successive measures, including safety margins, to prevent and mitigate damage if a malfunction, accident, or naturally-caused event occurs at a nuclear facility." So that's the definition that was proposed in 1860.

As I said, you know, we try to take insights from, you know, the INSAG report. We did look at Reg. Guide 1.174. We looked at what the ACRS had done. We looked at the Commission white paper. There might have been other things that I'm just forgetting about that we also looked at.

MEMBER BANERJEE: What do you mean by "principle"? It seems very abstract as written there.

MS. DROUIN: They are principles.

PARTICIPANT: Yes. But I think Sanjoy's point is what I was -- I was reacting to. Principles are precise enough that I know what I'm going to do to act upon them, and they don't seem actionable.

MEMBER SIEBER: Those are concepts.

MEMBER BANERJEE: They're very abstract as defined, unless you have a definition which you haven't put up there. Maybe you need to define it more precisely.

MS. DROUIN: Well, we didn't define the term "principle," but I know when I went and looked it up in the dictionary, you know, it's -- they are pretty abstract. "Principle" really isn't as precise as you would think it needs to be.

The principles that were proposed in 1860 is -- measures against intentional as well as

inadvertent events are provided. I think it's pretty specific, but I would also argue a lot of questions on how that would get implemented.

The design provides accident prevention and mitigation capability.

MEMBER APOSTOLAKIS: Would it be better to say "developed guidance based on" rather than "principle"?

MS. DROUIN: Again, this is just what was 1860. You know, whether we end up with these principles, whether they're a modification of this --

MEMBER APOSTOLAKIS: But the statement is, "Develop principles based on," so you are not listing the principles.

MS. DROUIN: I'm not listing the principles here.

MEMBER APOSTOLAKIS: Okay. This is what the principles are based on.

MS. DROUIN: That's right. I'm sorry, I got right into stating what the principles are.

MEMBER BANERJEE: But the question is: what is a "principle" here? I guess that's what I'm not --

MEMBER APOSTOLAKIS: Can you remember --

MEMBER BANERJEE: Unless you have said it

somewhere and I have missed it.

MEMBER BLEY: It would be nice to have a slide with the principles on it.

MS. DROUIN: Right.

MEMBER BANERJEE: Is it a set of rules or is it a set of -- is it sort of a mixture of physical things or --

MS. DROUIN: Principles are more, you know, what you expect. A principle is not rule. A principle is more of an expectation.

MEMBER SIEBER: Okay.

MS. DROUIN: When you think of what --

MEMBER APOSTOLAKIS: It's high level.

MS. DROUIN: -- of what the word "principle" means, I mean --

CHAIRMAN SHACK: Almost like the 1860 principles. That's --

MEMBER APOSTOLAKIS: Okay.

MS. DROUIN: That's what I was leading --

MR. DUBE: They're a little -- perhaps a little broader than the GDC, but along those lines.

MS. DROUIN: They're aren't rules. I mean --

CHAIRMAN SHACK: It considers intentional as well as inadvertent event, accident prevention and

mitigation, ensure key safety functions are not dependent on a single element; the design, construction, maintenance, or operation; consider uncertainties in equipment and human performance and provide appropriate safety margin; provide alternate capability to prevent unacceptable releases of radioactive material; and site plants at locations that facilitate protection of public health and safety.

MEMBER APOSTOLAKIS: That's pretty good.

MEMBER BROWN: From what were you reading?

CHAIRMAN SHACK: That is from 1860.

MEMBER BANERJEE: That defines your principles, then.

MS. DROUIN: Those are the principles that were proposed in 1860. And what I was -- what George mentioned here is that in developing those principles, in getting there, you know, we took a lot of ideas and insights from what we saw in the INSAG, what we saw in the white paper, you know, what was in Reg. Guide 1.174. We looked a lot at, you know, the structuralist and rationalist approach proposed by ACRS.

And so in doing that, you know, like the first one, the structure of one principle being built

on the next one, you know, that kind of structure, we liked that structure that was in the INSAG report. We thought that was a good way to lay out a set of principles, you know, starting from preventing an event all the way to dealing with the mitigation of the consequences of the event.

The one thing that ours dealt with that we do not see anywhere else was addressing security. And the reason we had security in there is that in all these SECY papers, starting with the 1-2003-0047 up to SECY-07-101, the Commission kept telling us that we should integrate safety and security. So we did bring in one principle in security that was a cross-cutting principle across the others.

MEMBER ABDEL-KHALIK: Clarify something for me, if you would. Is the focus primarily on physical design characteristics, or would, for example, staffing beyond minimum shift requirements be considered a defense-in-depth measure?

MR. DUBE: George brought up a good example. The in-service inspection, we rely on the reactor coolant system pressure boundary, yet there are uncertainties, there are unknown unknowns, unknown perhaps material degradation measures, and ISI is one way of addressing the unknown unknowns. So it's a

program as opposed to a physical structure.

CHAIRMAN SHACK: Yes. Now, 1860 also has to the protective strategies, which I think sort of get at Said's question, where you have physical protections, stable operation, protective systems, barrier integrity, and protection action.

MS. DROUIN: Right. And what you will see is that the principles are closely aligned with those protective strategies, and that was deliberately done.

Said, in regards to your question, again, that is another implementation. I mean, the issues on implementation, these are all -- how do you -- you know, how do you achieve that principle? You know, does staffing come into play in implementing a particular principle? You know, how does that affect the design? How does that affect the operation?

CHAIRMAN SHACK: Okay. Well, that strikes me as a protective strategy. Stable operation is --

MS. DROUIN: Right.

CHAIRMAN SHACK: -- clearly related to that.

MS. DROUIN: I'm going to skip over -- so, you know, where we are right now -- where we are right now is, you know, do we start with all this work that has been done in 1860? Or do we just say, okay, we're

going to just word for word adopt what was in the 1999 white paper, which now shows up in the strategic plan? Do we come up with some other approach in developing principles? So these are the things that we're exploring right now.

MEMBER BANERJEE: I thought you had already defined "principles" that Bill was reading out.

MEMBER CORRADINI: No. Those are 1860.

MS. DROUIN: No. Those are 1860.

MEMBER ARMIJO: And are they so different from the Commission description?

MEMBER APOSTOLAKIS: Yes.

MS. DROUIN: The Commission has not described any principles.

MEMBER ARMIJO: You used Commission description of TID philosophy.

MS. DROUIN: Okay. As the definition for defense-in-depth. Remember, there's two things we have to do in this policy statement. We are providing a definition, and we are providing principles. Okay? 1860 provides a definition, and it also provides a set of principles. And I've tried to walk you through how those came about.

Now, as we start working on the policy

statement, do we use the actual definition? Well, let me rephrase that. Do we start, you know, as a starting point? That doesn't mean that we would just blindly type what's there.

But do we start -- think about, you know, things that maybe had not been looked at, other things to take into consideration, and start massaging -- I mean, we may totally decide, well, we don't like this one principle, or there's another principle that's needed, or, you know -- but it's -- or do we -- and, again, there might be other approaches. I just put two here.

MEMBER BLEY: Can you briefly summarize anything about the Commission's description? Because I don't remember it.

MEMBER APOSTOLAKIS: It is multiple physical barriers.

MR. DUBE: Excessive compensatory measures.

MEMBER APOSTOLAKIS: Compensatory measures.

MR. DUBE: Compensate against uncertainties in equipment, human performance, and address unexpected events and event sequences.

MS. DROUIN: The definition of --

MEMBER BLEY: They are complementary at least.

MS. DROUIN: Well, they are almost word for word. They were -- what I recall is that when we wrote the definition in 1860, what you see in there is the word "safety margin." We brought "safety margin" into the definition. Otherwise, we pretty much used what was in the Commission paper.

MEMBER BANERJEE: I actually don't get what you are looking for on this slide, because they seem to be strongly related to each other, right? I mean, why do you say "all"? I mean, is there something mutually exclusive about it?

MS. DROUIN: No.

MEMBER BANERJEE: So why is that "all" there? Start with that, "all" that?

MEMBER SIEBER: Well, you've got to decide what you're going to start with.

MS. DROUIN: Yes.

MEMBER BANERJEE: So you've already --

MEMBER SIEBER: Tell them it an exclusive --

MEMBER APOSTOLAKIS: It's not an exclusive or -- all right. But you are not intending to show us any principles today. You are --

MS. DROUIN: Not.

MEMBER APOSTOLAKIS: -- just telling us -- okay, okay. That's important, yes. This is preliminary.

MS. DROUIN: Very preliminary.

MEMBER BLEY: This is --

MS. DROUIN: Yes?

MEMBER BLEY: -- are any people involved with this suggesting this isn't -- not a reasonable way to begin, from what -- the work you had had before?

MS. DROUIN: I would not think so.

MR. MONNINGER: I think one thing that is worth mentioning -- this is John Monninger. For this new effort ongoing, there is an interoffice task group that has been formed with reps from NRO, Research, NRR, FSME, NSER, NMSS, etcetera. You know, so we want the product to be reflective of agency product.

There was a lot of good effort done within 1860, and at that time, you know, it reflected some understanding, and, you know, the feasibility, you know, study, predominantly with Research but with some other offices' participation. So it is, you know, one option out there. But now that we are fully involving other parts of the agency, you know, we want to make

sure that the product that comes out reflects the views of all the offices. So --

MEMBER APOSTOLAKIS: It is the difference between a NUREG and a policy statement.

MS. DROUIN: Right.

MEMBER APOSTOLAKIS: Now it's serious.

MS. DROUIN: So the comments I got before were not serious comments from the ACRS?

(Laughter.)

I'm sorry, George. I couldn't resist.

MEMBER APOSTOLAKIS: I know.

MEMBER SIEBER: On the other hand, the work in 1860 is very good. It would seem to me that if you are going to start with principles you would start with that, and make sure you have not missed any concepts for -- for extensions that the Commission has put in their statement.

MS. DROUIN: Correct.

MEMBER BANERJEE: When is this due?

MS. DROUIN: Okay. That's my last slide.

MEMBER BANERJEE: Oh, okay.

MS. DROUIN: I think we have, you know, talked about -- sorry, my mind went on to something else.

When you look at what was in the SRM, you

know, the Commission said, you know, that in developing this draft policy statement you could use insights, you know, from the NGNP. On this one, I'm just focusing on the PBMR part -- again, from the completion of the PBMR, pre-application review.

So here is another thing, you know, that we are trying to grapple with, because the words there were "completion." Now, you know, at the time, you know, I mean, things changed. So, you know, one question is: do we hold up the draft policy statement to the completion of this review?

(Laughter.)

The really big issue, you know, is implementation. You know, to what degree do we have to figure out all of the different ways that this thing could be implemented in all of the issues? You know, from a personal -- and I'm talking now from a personal perspective, you know, I think you have to deal with some of it up front.

You have to let some -- you have to let at least at some level stakeholders know what you mean by these principles, because otherwise there is just these expectations of -- so there needs to be something. But when is that balance done?

I mean, if you look at, for example, the

safety goal policy statement, we are still dealing with implementation. The PRA policy statement, we are still dealing with implementation issues on that. So I --

MEMBER BANERJEE: Can you clarify what you mean by "implementation"? Like let me give you -- make this more specific.

MS. DROUIN: Okay.

MEMBER BANERJEE: Suppose you wanted to maintain the integrity of the cladding, so you have an emergency cooling system to do this in an accident. There may be other ways to do it in an accident. Do you mean by "implementation" this emergency core cooling system? Or what is it? Because that will depend on the designs and all sorts of details of how you go about doing it. Or do you mean something completely different by "implementation"?

MS. DROUIN: Let me give you -- and I'm not picking this one for any particular reason. Principle number 2 that was in 1860, you know, "The design provides accident prevention and mitigation capability." I think if you went to 10 different designers, you'd get 10 different ideas of how to accomplish that principle.

MEMBER APOSTOLAKIS: Right.

MS. DROUIN: And is that what that principle meant? Are the -- the way that they're accomplishing it, is that acceptable? So, and I think you have to have some things, because, you know, from a -- again, a personal perspective, I think it would not be helpful -- you know, if the designers kept coming back with other things, or later on I should say -- oh, but wait a second, that's defense-in-depth. We're trying to get away from everything being defense-in-depth to being specific. So trying to --

MEMBER BLEY: Are you almost saying you need an SRP to go along with this thing?

MS. DROUIN: Personally, I do think that you will need some kind of implementation guidance. That would be more lengthy, but I think up front -- and in coming to an agreement on these principles -- you need to have some kind of understanding of what they mean.

MEMBER ARMIJO: By "implementation," do you mean whether this -- this policy statement and the principles would have teeth, regulatory teeth, that would --

MS. DROUIN: No, no.

MR. DUBE: Not clear about that, no.

MEMBER ARMIJO: Okay.

MS. DROUIN: No. Policy --

MEMBER ARMIJO: This is philosophical.

MR. DUBE: It might be guidance, but I don't think it would be --

MEMBER ARMIJO: If you had a principle -- let's say hypothetically you wanted to run reactor coolant pumps or heat removal pumps in cavitation mode for long periods of time, and it violated one of these principles. Would it mean anything?

MEMBER CORRADINI: No. I think the answer to that is no.

MEMBER ARMIJO: Just no.

MEMBER CORRADINI: Yes.

MEMBER ARMIJO: Then, what does it --

MEMBER APOSTOLAKIS: I don't understand that. Why?

MEMBER ARMIJO: What's it good for, then? Why are you doing it?

MEMBER APOSTOLAKIS: Wait a minute. Wait a minute. I think what Mary is saying -- and I'm sure she will correct me -- is you can't just declare principles without thinking a little bit about how these principles will be implemented in practice. I think that's really what -- I mean, there will be another effort to give guidance how to implement them

later, but even when you formulate the principles you have to think a little bit about it. Is that correct?

MS. DROUIN: Yes.

MEMBER APOSTOLAKIS: Okay.

MEMBER ARMIJO: Principles will drive regulations.

MEMBER APOSTOLAKIS: Right. Well, essentially, yes. Yes, they would. It also will drive what a designer does, what Westinghouse does, what --

MEMBER ARMIJO: What the operator does.

MEMBER APOSTOLAKIS: Yes. So you can't give them principles that are non-implementable, for example.

MS. DROUIN: Again, they are a set of expectations. Let me try and use maybe perhaps the PRA policy statement, because you have -- I'll use the word right now -- "things," you have four things, four statements, and the PRA policy statement. Your expectations, you might even argue they are principles. But they are not regulations.

MEMBER CORRADINI: All right. So can I just get back to practical things? I guess I'm hearing where you guys are going, which I think is good. But you said you want to test this off the

PBMR. Why not test it on the two machines you have already licensed? Why not go back to Fort St. Vrain and CRBR and ask yourself the question: do they fit within the principles? Right?

MS. DROUIN: We could do that.

MEMBER CORRADINI: Why not go to the CANDU 6 -- it's not here, but it operates, or the ACR-1000, which they are now having -- they are doing a PIRT in Canada on, and check it out. Well, the NGNP is essentially -- is even more cloudy to me than the PBMR.

But my only reason I'm asking this is, so let me give you one that I'm not sure fits the principles. They operate a molten salt breeder reactor at Oak Ridge. Does it fit the principles? I had the fuel, it moved here, it moved there, it was -- it was the coolant and the fuel all in one thing. Does that sort of reactor, if you could make it work, fit the principles?

It seems to me you've got 50 years of crazy ideas out there that you could apply empirically and say, does it fit your -- well, no, not --

(Laughter.)

Fifty years of test reactors and experimental reactors, right? Non-LWRs to see if they

fit the principles.

MEMBER BLEY: And you are looking for a place to apply it and see if it would work.

MEMBER CORRADINI: Right.

MS. DROUIN: I personally think that's a great idea.

CHAIRMAN SHACK: Did you -- the PBMR people have a different framework. You know, they've got Fleming's design defense-in-depth process, defense-in-depth scenario, defense-in-depth -- do you find that a useful way of looking at things? Since you are supposed to use insight from completion of that review.

MS. DROUIN: A lot of what they have is very similar. They know, they took a lot of their concepts from the INSAG document. I would say they even went past INSAG and every single -- everything in that thing is defense-in-depth. You can't separate anything out.

MEMBER SIEBER: They still concluded they didn't need it for --

(Laughter.)

CHAIRMAN SHACK: But they had defense-in-depth.

MEMBER SIEBER: Which was a perfect

example.

MS. DROUIN: Okay.

MEMBER BLEY: I think they're not interested in the study right now.

MS. DROUIN: Okay. So where we are now in our schedule, you know, we are working on, you know, how to move forward. We plan to go in front of the -- our Advanced Reactor Steering Committee on the 15th. So this meeting was very timely. We're going to start initiating public meetings specifically for the policy statement now endeavor. I don't want to, you know, allude that we haven't been interacting. You know, of course, many, many interactions in developing 1860.

The draft statement -- I want to emphasize the draft statement is due to the Commission at the end of 2009, and it's a draft, not a final statement.

MEMBER BLEY: Mary, your last slide hinted at it, and the discussion took us there. Is there anything in your plan for the current -- coming year that looks at trying to do an application of the principles that some designed?

MS. DROUIN: We are still working that out, Dennis, and a lot of that will fall out, you know, after we have this meeting on the 15th, hopefully.

MEMBER BLEY: I sure hope you can do that, because I think that's the test, is to see --

MS. DROUIN: Because, you know, I think these were some good ideas presented today.

MEMBER APOSTOLAKIS: Is it possible that defense-in-depth is like pornography?

(Laughter.)

PARTICIPANT: That's a very interesting analogy.

MEMBER APOSTOLAKIS: You know it when you see it, but you cannot define it. Because we are -- this discussion could go on forever.

MEMBER POWERS: George, you are exactly right.

PARTICIPANT: We are going to talk about pornography?

MEMBER POWERS: I think that the only successful way to approach is definition is this specification. Otherwise, it's like obscenity, not pornography. You recognize it when you see it.

MEMBER APOSTOLAKIS: Yes, you recognize it when you see it. But to put it in words, it's so hard. I think that's why you have a problem, and you are hearing different views from different people.

I really like the way Dr. Shack put it

earlier. Okay? Because it's not rationalist, it's not structuralist, it's really a combination, and I think this is really what defense-in-depth is all about.

MS. DROUIN: I would --

MEMBER BROWN: Why isn't it more simple like something that's just any plant design should have a layering of barriers to protect the public from adverse action, or something -- that's what it is. I mean, you just keep --

MEMBER POWERS: That's called a specification. It has existed for a huge amount of time.

MEMBER BROWN: But that is always -- there is no definition of when you stop. It's driven by the design.

MEMBER APOSTOLAKIS: That's the problem with it, Charlie.

MEMBER POWERS: It's unbounded.

MEMBER BROWN: But nobody has ever been restrained?

MEMBER POWERS: Yes.

MEMBER SIEBER: That's one of the last approaches -- where do you stop?

MEMBER APOSTOLAKIS: I think the way Dr.

Shack put it is -- I think that paper from '99, that's how I would put it.

MS. DROUIN: See, I would still -- and, again, this is my personal view -- I think putting in an actual definition is not difficult. I think it becomes difficult because then we start thinking of all the different implementations of it, and I still would argue that we keep mixing implementation with the definition of those words. Is how do you -- you know, how do you implement this concept of putting in these measures, you know, to protect you from harm?

I mean, actually, you know, understanding the words are not difficult. We make it difficult, because, well, what does that mean now? You know, does it mean successive layers of barriers? You know, or is it the structuralist -- you know, to me, that is how you implement the definition.

MEMBER APOSTOLAKIS: Well, what --

MS. DROUIN: And I think that is where we just --

MEMBER APOSTOLAKIS: What would be --

MS. DROUIN: It's very difficult.

MEMBER APOSTOLAKIS: If the PBMR people came to you and they said, "You will never have core damage, and here are the reasons," and they list

physical laws, so you can't dispute them, can you still claim that there is an unknown unknown?

MS. DROUIN: Absolutely.

MEMBER SIEBER: You can? Why?

MEMBER APOSTOLAKIS: No. It's an issue of confidence, really. I mean --

MS. DROUIN: Well, I think it's --

MEMBER SIEBER: It is what it is.

MEMBER APOSTOLAKIS: It's one thing to say, you know, I have designed it and I have 10 redundant names and --

MEMBER BANERJEE: George, what do you mean by "physical laws"?

MEMBER APOSTOLAKIS: Well, the thing will not melt.

MEMBER CORRADINI: But it still can release radiation. Who cares if it melts? If you cook it enough, things start coming out.

MEMBER APOSTOLAKIS: But it doesn't release anything of significance.

MEMBER CORRADINI: Well, I don't know.

MEMBER APOSTOLAKIS: No, you don't tie me to the PBMR. I'm asking the question: what if somebody came to you with very convincing arguments that you will not release anything?

MEMBER CORRADINI: You might.

MEMBER APOSTOLAKIS: Then, you are going to say "no containment"?

MEMBER BANERJEE: No. If you don't have any material to release, or very little, that might --

MEMBER APOSTOLAKIS: Right, if you don't build a reactor. I mean, it's --

MEMBER BANERJEE: No. If you have a molten salt reactor, you might be there, actually, but --

MEMBER APOSTOLAKIS: I think --

CHAIRMAN SHACK: Well, it's still ultimately the structuralist question. What if you're wrong?

MS. DROUIN: Absolutely.

MEMBER APOSTOLAKIS: It's a key element.

MS. DROUIN: That concludes our presentation, unless there is other questions.

(Laughter.)

MEMBER APOSTOLAKIS: So are we going to have a subcommittee meeting at some point to have more time to discuss these things?

CHAIRMAN SHACK: Yes. I think what we want is for them to be in a little bit more concrete position, you know, to --

MEMBER APOSTOLAKIS: Late spring sometime?

CHAIRMAN SHACK: Sometime, yes, that would seem reasonable.

MEMBER APOSTOLAKIS: So we might have that moved to Washington.

(Laughter.)

MEMBER BLEY: There's a second set of weekly meetings.

MEMBER ARMIJO: Even though your marching orders and your thinking is that this applies to future reactors, as you define it, is there any chance that whatever you come up with wouldn't be full -- those principles or -- wouldn't be fully met by existing light water reactors?

MS. DROUIN: Well, that comes back to what I had on our earlier slide, is that we don't want to create anything here that ultimately would have an adverse impact. So, you know, we want to be cognizant of that, even though, you know, it may be technology-neutral, which implies it could be -- you know, we want to make sure we are not going to do anything that would have a negative impact in implementing it.

MEMBER APOSTOLAKIS: On the other hand, you are -- you do have an appendix to 1860, where you show that LWRs do not meet the staircase, right?

MEMBER BLEY: A particular LWR is --

MS. DROUIN: All right. But that was a good thing.

MEMBER APOSTOLAKIS: It's okay.

CHAIRMAN SHACK: Any further discussion?

(No response.)

I think, you know, this is a discussion that obviously could go on for a long time.

PARTICIPANT: Do you think?

(No response.)

CHAIRMAN SHACK: But I think, you know, to aim towards the policy statement will -- you know, we'll come back to it next time when we have something more concrete to work with.

Thank you very much.

MS. DROUIN: Thank you.

MEMBER CORRADINI: Thank you.

MEMBER APOSTOLAKIS: We actually finished early. Wow.

CHAIRMAN SHACK: We finished -- don't run away, gentlemen. We have some work we can do.

(Whereupon, at 11:34 a.m., the proceedings in the foregoing matter went off the record.)

Human Reliability Analysis Research

An Overview and Plan for Addressing the SRM on HRA Model Differences

Erasmia Lois, PhD and
Susan Cooper, PhD
Division of Risk Analysis

Presented to
Advisory Committee on Reactor Safeguards
USNRC Headquarters • Rockville, MD • December 5, 2008

Briefing Objectives

- Provide an overview of the NRC's Human Reliability Analysis (HRA) activities
- Inform the Committee on NRC/EPRI joint efforts for addressing the, November 8, 2006 SRM on HRA model differences

Overview

- Technical Focus
- Key activities
- Plan to address the SRM on HRA models

Why HRA Research?

- HRA is used to model human performance in various PRA scenarios
- With the increased use of PRA results in regulatory matters, the NRC is devoting attention and resources to improve the quality of PRA/HRA
  - Modeling and assessing equipment performance has matured
  - Improved technology in reactor design addressed most equipment related vulnerabilities
  - As a result, HRA very often dominates the results
- In some areas (e.g., fire and seismic), there are several needs associated with HRA
- The RES HRA activities focus on improving HRA tools (methods, data, guidance, training) as needed to ensure suitability and quality in the various applications

Current Focus

- Benchmark HRA methods to understand strengths and weaknesses and determine ways to improve them
- Expand existing or develop new methods to address suitability to an application
  - Reactor oversight/inspections
  - HRA for Materials and Waste applications
- Develop data
- Improve Guidance and Training
  - HRA analysts
  - Other users
- Identify and address emerging issues

Recent HRA Research for Reactor Applications

- NUREG-1792, HRA Good Practices, April 2005
- NUREG-1842, Methods Evaluation Against the Good Practices, Sept. 2006
- NUREG-1880, "ATHEANA User's Guide," Addendum to NUREG-1624, April 2007
- NUREG/CR-6903, Human Event Repository and Analysis (HERA)
  - Volume 1, Framework, July 2006,
  - Volume 2, Coders Manual September 2007
- NUREG/CR-6949, The Employment of Empirical data and Bayesian Methods in Human Reliability analysis: A Feasibility Study, December 2007
- NUREG-1852, Demonstrating the Feasibility of Operator Manual Actions in Response to Fire, October 2008
- Draft NUREG/IA-0215/HWR-844 International HRA Empirical Study Description of Overall Approach and First Pilot Results from Comparing HRA Methods to Simulator Data, October 2007

Ongoing HRA Activities for Reactor Applications

- Participation and support of the International HRA Empirical Study (benchmarking HRA methods using simulator data)
- NRC/EPRI collaborative work to address the SRM on HRA model differences
- NRC/EPRI collaborative development of a HRA methodology that addresses fire-specific human performance issues
- Human Event Repository and Analysis (HERA)
  - Coding Human Events
  - Developing Interface

HRA Activities for Waste and Material Applications

- Yucca Mountain waste repository application
  - Assisted in the development of Interim Staff Guidance for HRA (preclosure operations)
  - Supported NMSS in docketing review of Yucca Mountain licensee application
  - Currently, supporting NMSS with HRA review of preclosure and postclosure aspects of of Yucca Mountain licensee application
- Spent fuel handling
  - Provided HRA-informed review of spent fuel handling events and issues for misloads and cask drops
  - Developing HRA-informed insights on cask drops (for a wider range of designs)
- Medical applications
  - Developed and presented to FSME staff HRA-informed training related to understanding of human performance issues in medical applications
  - Developing an HRA-informed job aid (or structured knowledge-based) that can be used to support regulatory decision-making for medical applications

SRM on HRA Models Background

- SRM to ACRS, November 8, 2006
  - Work with staff and other stakeholders to address the issue of HRA model differences and determine whether we can have a single model for the Agency to use or more than one with well-defined guidance on their use
- The ACRS invited the staff and external stakeholders to discuss how they will address the SRM, February 2007
  - EPRI proposed collaboration and an approach for addressing the issue
  - RES agreed with the EPRI proposal, April 2007
  - ACRS letter to the Commission (April 23, 2007) stated that:
    - "The staff and EPRI are in the process of developing a plan that is intended to lead to an integrated approach to evaluate the various HRA models. The goals and important milestones will need to be clearly evaluated."
- NRC/EPRI subcommittee briefing on the HRA Empirical Study, Feb 2008
  - ACRS indicated that we need to develop a plan soon

Plan & Status to Address the SRM on HRA Models

Phase 1 (to be completed by April 2009)

- Review the use of HRA in decision making
  - Identify regulatory applications in which HRA results play a significant role in the decision
  - Identify what methods are used in the various applications
  - Identify any apparent limitations in the obtained results
  - Interview NRC staff—completed Nov 2008
  - EPRI survey of industry applications – Tbd, Feb, 2009
- Establish Common Terminology and Framework (iterative process)
  - Two workshops have been convened (Spring and Fall 2008)
  - International Empirical Study supporting this phase by developing a common language and performance shaping factors in order to conduct comparisons using the same bases.
  - Revise as needed

Plan & Status to Address the SRM on HRA Models (continued)

Phase 2 (to be completed by May 2009)

- Develop insights from Application Review & the International HRA Empirical Study
  - From Review - assess the adequacy/applicability of the methods used in the various applications
    - Identify where some HRA methods were limited in supporting applications
    - Identify issues contributing to the limitations
  - From HRA Empirical Study - use lessons learned/insights
    - Identifies strengths and weaknesses of a wide range of methods
    - Identifies general limitations in application of HRA methods
- Use findings from the Review and the Empirical Study to recommend consolidated HRA approach
  - General improvements to HRA process
  - “single model/method” or “tool box of models/methods” and associated guidance

Plan & Status to Address the SRM on HRA Models (continued)

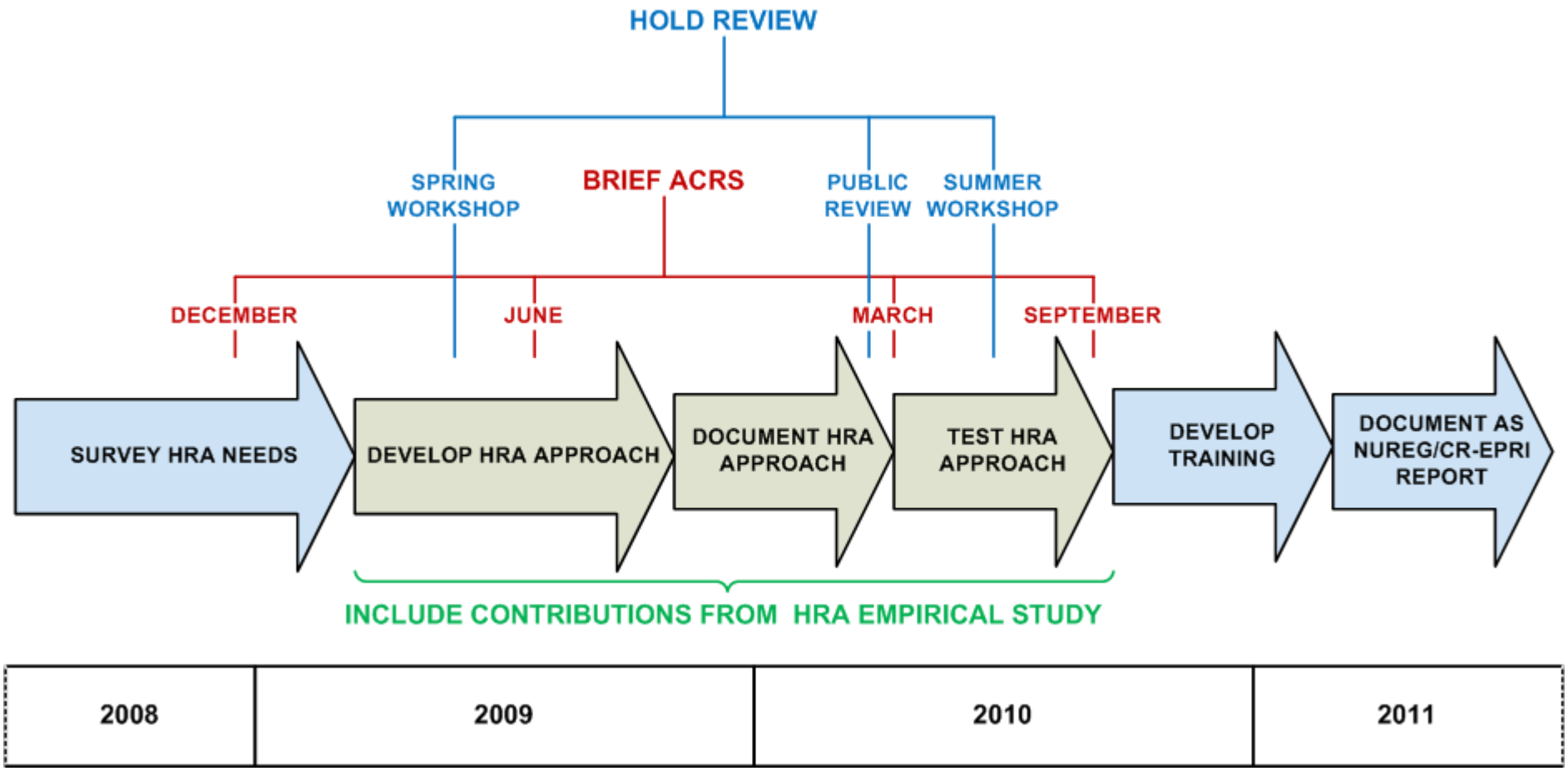
Phase 3 (to be completed by September 2010)

- Develop a single HRA approach or a small set of HRA methods and associated improvements for use by NRC and industry
  - Method selection determined by the strengths and weaknesses of the methods and the level of analysis needed for the regulatory applications and the safety needs being addressed
  - Document the results/Public review and comments

Phase 4 (to be completed by September 2011)

- Test the method(s) and develop guidance and training materials
  - Testing thru field applications
  - Use of simulator data
    - Potentially by US simulator data generated

Project Timeline



U.S.NRC
United States Nuclear Regulatory Commission
Protecting People and the Environment

Defense-in-Depth Policy Statement

Advisory Committee on Reactor Safeguards

Mary Drouin, NRC, Office of Regulatory Research (301) 251-7574
Donald Dube, NRC, Office of New Reactors (301) 415-1483

December 5, 2008

Purpose of Meeting

- Brief ACRS on staff effort to develop a draft policy statement on defense-in-depth (DID) for Commission consideration

Agenda

- History/Background
- Approach/Concepts
- Issues
- Status/Schedule

History/Background

- SECY-03-0047 – staff recommended development of a policy statement on DID for nuclear power plants for non-LWRs that describes:
  - the objectives of DID (philosophy)
  - the scope of DID (design, operation, etc.)
  - the elements of DID (high level principles and guidelines)
- SRM, dated June 6, 2003, the Commission approved and
  - requested the staff to consider if more efficient and effective to update the Commission Probabilistic Risk Assessment (PRA) Policy Statement instead
- Staff initiated effort (technical basis) as part of the "Framework" effort (NUREG-1860)

History/Background

- Advanced Notice of Proposed Rulemaking (ANPR) issued on May 4, 2006, the staff solicited stakeholder input regarding:
  - A new policy statement
  - Need for better description of DID
  - Approach and principles proposed in NUREG-1860
- Stakeholder input:
  - Supported development of a separate policy statement on DID, rather than a revision of the PRA policy statement
  - Generally supportive of work on DID in NUREG-1860
  - Desire to have further interaction with the NRC

History/Background

- SECY-07-0101, June 14, 2007, staff
  - Provided stakeholder input from the ANPR
  - Committed to develop a draft policy statement for Commission consideration on DID
- SRM, September 9, 2007, the Commission requested that
  - "the staff should develop a draft policy statement on defense-in-depth **for future plants** for Commission consideration. This draft policy could be evaluated using the insights gained through the development of the NGNP licensing strategy and completion of the PBMR pre-application review. The staff should engage members of the public, ACRS, the industry and other stakeholders as they develop this policy statement."

Approach

- Define the scope of the policy statement; e.g., applicable to:
  - Just reactors?
  - Currently operating reactors?
  - LWRs and non-LWRs?
- Consider work by others; e.g.,
  - IAEA/INSAG
  - NEI
  - ACRS
  - NUREG-1860

Scope

- SRMs
  - SECY-03-0047: non-LWRs
  - SECY-07-0101: future reactors
- Staff proposal
  - Future reactors is not meant to include current-generation as well as the evolutionary and passive LWRs that have been certified (or undergoing certification)
  - Definition and principles should not be written in such a manner that when implemented, could have a negative effect on current-generation

Previous Work by Others

- IAEA/INSAG
  - Five levels based on structure that if one level fails, next level available as backup
  - Encompasses all aspects of plant design and operation
    - Any aspect of plant design and operation considered a DID provision
  - Written for application of current LWRs
- NEI
  - A process to be applied on a design-specific basis
  - Applied in an iterative fashion and design and operation changes made to address uncertainty
    - Define a risk management activity
    - Increase performance monitoring
    - Add safety margin
    - Add redundancy or diversity
- ACRS
  - Structuralist and rationalist approach
  - Structuralist – deterministic engineering judgment defining the elements of DID, developed generically or on plant-specific basis
  - Rationalist – utilizes PRA whereby the elements of DID are the items necessary to compensate for uncertainties

NUREG-1860

- Approach based on answering some fundamental questions and considering previous work by others (NRC, IAEA, PBMR, NEI, ACRS)

- Why is there a need for DID?
  - To compensate for uncertainty resulting from the unexpected or unanticipated
- What is meant by the term “defense-in-depth”
  - Measures or actions that are incorporated into the design and operation specifically for DID purposes
- What is the objective and purpose of DID?
  - Compensate for unexpected events or unanticipated events
    - Resulting in potentially adverse equipment and human performance
    - By maintaining the effectiveness of barriers and protective systems

NUREG-1860 (cont'd)

- Developed definition using
  - Theme stated in Commission philosophy on DID
- Developed principles based on
  - Structure that if one principle not met, next principle available as backup
  - Consistent with Regulatory Guide 1.174
  - Balances accident prevention and accident mitigation
  - Addresses security
  - Deterministic (structuralist) and probabilistic (rationalist) approach
    - Defined in a structuralist manner
    - Probabilistic insights to identify where DID is needed and the extent to which a principle needs to be implemented

Possible Approach, for example

- Start with work in NUREG-1860

OR

- Use Commission description of DID philosophy as definition and develop principles using a different approach

Example Issues

- Commission SRM also indicated that staff could use insights gained from completion of the PMBR pre-application review
  - Should development of the draft policy statement be delayed until ***completion*** of the review?
- Implementation
  - The degree to which implementation issues need to be identified and resolved

Status/Schedule

- Working on approach
- Advanced Reactor Steering Committee meeting scheduled (December 15, 2008)
- Plan to initiate public meetings to interface with stakeholders
- Draft statement for Commission consideration due December 2009