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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

November 2, 2006

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on November 2, 2006, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

537th MEETING

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THURSDAY, NOVEMBER 2, 2006

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ROCKVILLE, MARYLAND

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

COMMITTEE MEMBERS PRESENT:

- GRAHAM B. WALLIS Chairman
- WILLIAM J. SHACK Vice Chairman
- GEORGE E. APOSTOLAKIS Member
- J. SAM ARMIJO Member
- MARIO V. BONACA Member
- MICHAEL CORRADINI Member
- THOMAS S. KRESS Member
- OTTO L. MAYNARD Member
- DANA A. POWERS Member
- JOHN D. SIEBER Member-At-Large

1 ALSO PRESENT:

2 SANJOY BANERJEE

3 SUSAN COOPER

4 JOHN FORESTER

5 JEFF JULIUS

6 ALAN KOLOKZCOWSKI

7 ERASMIA LOIS

8 JOHN MONNINGER

9 ERIC THORNSBERRY

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

(8:32 a.m.)

CHAIRMAN WALLIS: Good morning. The meeting will now come to order.

This is the second day of the 537th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting the committee will consider the following: a status report on human reliability analysis research program. Further ACRS activities -- report of the Planning and Procedures Subcommittee, reconciliation of ACRS comments and recommendations, and the preparation of ACRS reports.

This meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Sam Duraiswamy 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 sessions.

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

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1 I'd now like to proceed with the meeting.
2 I call upon George Apostolakis to get us started on
3 the first item.

4 MEMBER APOSTOLAKIS: Thank you, Mr.
5 Chairman. This first session deals with human
6 reliability analysis models. In the last year or so,
7 during various interactions with the staff, especially
8 the subcommittee meetings, the latest -- the last one
9 being last June, we realized that the agency has three
10 -- that we know of -- models for handling human
11 performance.

12 One is ATHEANA, which, of course we have
13 reviewed in the past. The other is SPAR-H. That is
14 used primarily for the significance determination
15 process and other regulatory activities. And then,
16 there was a NUREG that was discussed here that -- in
17 the context of manual actions in response to fire,
18 which also deals with human performance, but in a
19 different way. It does not attempt to reduce any
20 probabilities, but it works with margins.

21 Essentially, it says if you have a certain
22 available time before you reach an undesirable state,
23 then you have to demonstrate that the sum of diagnosis
24 time and implementation action is less than this
25 available time, and that margin has to satisfy certain

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1 criteria. So we end up with three models,
2 essentially.

3 Then, in the power uprates, we have seen
4 that in most cases the most significant impact of the
5 uprate is the shortening of the available time for
6 action for the operators. So they might have under
7 current power levels 25 minutes, and in the new -- at
8 the new level they might have 20 minutes. So the
9 question is now: what is the probability of a human
10 error because of this shortening of time?

11 And, typically, we get numbers from the
12 licensees which we understand are produced using a
13 fourth model, which is part of the EPRI HRA
14 calculator. It's a software package that allows you
15 to use a number of models, and, in particular, the
16 so-called human cognitive reliability operator,
17 reliability evaluation, which focuses on time. So
18 they claim that if time changes, the available time
19 for action changes, then they are able to produce
20 probabilities for this new interval.

21 It is my understanding that the staff here
22 has never reviewed that model, which bothers me. I
23 really think that whenever we review something that
24 the licensees submit the staff should have reviewed
25 the model that the licensees are using.

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1 So the result is that we have now three
2 models here and one -- at least one in the industry,
3 which if you look at the assumptions, I mean, they
4 share a lot of assumptions, but also the focus is
5 different, some other assumptions are different, and
6 so on.

7 So the idea of having today's session is
8 maybe to see where the staff is with respect to human
9 reliability analysis and the idea that was proposed at
10 the subcommittee meeting was first for the staff to
11 see whether the three NRC models can be merged and
12 have one model which may have different versions
13 perhaps to satisfy different needs, but essentially
14 would be one model with -- based on a common set of
15 assumptions, and then explore also the possibility of
16 bringing in the EPRI model into this. Now, of course,
17 we cannot demand that EPRI collaborate with the staff,
18 but the least we can do is to demand that we review
19 it.

20 So with that in mind, I will turn it over
21 to Mr. Monninger.

22 MR. MONNINGER: Good morning. I'm John
23 Monninger. I'm the Deputy Director for Probabilistic
24 Risk and Applications in the NRC's Office of Nuclear
25 Regulatory Research.

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1 The staff -- we are very pleased to be
2 here this morning to talk to the ACRS about the NRC's
3 research programs into HRA methods and applications.
4 Looking back I guess over the past two years, we have
5 had, you know, quite a few different meetings with the
6 ACRS, approximately 10 different meetings, with the
7 full committee and subcommittee.

8 You know, at a high level the NRC's
9 research program in HRA it's -- we're going after
10 various different areas. We have research ongoing in
11 the use of HRA methods for materials applications, in
12 addition to all the work that you've been hearing
13 about the first two years for reactor applications.

14 We're also looking -- you know, with
15 regards to the reactor applications we're looking at
16 approaches for operating reactors in addition to
17 preparing the agency for the use of HRA methods for
18 advanced reactors.

19 We're also looking at the use of the HRA
20 methods to solve ongoing regulatory technical issues,
21 such as PTS, or as you mentioned ALFIRE. You know,
22 our approach for HRA or, really, where we see it
23 playing in predominantly right now is within the NRC's
24 -- what we call the phased approach to PRA quality.

25 Last month the staff met with the ACRS to

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1 go through Reg. Guide 1.200, which essentially
2 establishes the quality standards for PRA and endorses
3 various standards developed by ASME and ANS. Our
4 efforts here on developing additional HRA guidance is
5 in concert with that. The focus is to develop more
6 detailed technical documents to -- that would
7 ultimately be incorporated by reference into Reg.
8 Guide 1.200.

9 You know, I think we have made
10 considerable progress, and you will hear this morning
11 I guess a discussion by Dr. Erasmia Lois on our future
12 plans. One of the ones that we are most looking
13 forward to very much so is a program that we are
14 pursuing with Halden to benchmark various HRA methods.
15 We think our planned efforts in terms of that HRA
16 methods benchmarking project will go a long way to
17 addressing many of the questions and issues that the
18 ACRS has.

19 With that, we just look forward to a very
20 interactive meeting, and we thank you very much for
21 your questions and comments.

22 MEMBER APOSTOLAKIS: Okay.

23 MS. LOIS: Thank you. I'm Erasmia Lois.
24 I work for the Office of Research. I believe that
25 also on the -- through the telephone Jeff Julius of

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1 EPRI is also participating.

2 MEMBER APOSTOLAKIS: Jeff, are you on the
3 line? John, are you online?

4 MR. FORESTER: John Forester is here.

5 MEMBER APOSTOLAKIS: Okay. And who is the
6 other guy?

7 MS. LOIS: Alan Kolokzcowski.

8 MEMBER APOSTOLAKIS: Alan?

9 MR. KOLOKZCOWSKI: Yes, I'm here.

10 MEMBER APOSTOLAKIS: So we don't have the
11 industry.

12 MS. LOIS: You don't have the industry.
13 Probably they will -- they will dial in while we are
14 talking.

15 As Mr. Monninger mentioned, we are here
16 more to listen to the ACRS today, but we thought that
17 we would provide a brief overview of our activities up
18 to now and what we have planned. And also, we plan to
19 address some of the questions posed by the ACRS, so
20 that we have a more productive interaction.

21 Okay. So what we'll do today is we'll
22 summarize the HRA activities, focusing on reactor
23 applications, although the activities for NMSS also
24 are going to be mentioned. As I said, outline the
25 plans for the next four years, and also discuss with

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1 the ACRS the issues that have been raised.

2 Overall, the HRA research program
3 objectives are to support risk-informed regulatory
4 activities, and we do those by having activities that
5 support improvement of the HRA quality, supporting
6 specific regulatory issues that come -- are raised,
7 and address new needs, new applications, and we tried
8 to obtain that -- to achieve that through
9 collaborative efforts with domestic and international
10 organizations for efficiency and effectiveness.

11 The HRA quality has I guess three
12 different perspectives -- developing guidance for
13 performing tests for human reliabilities and raising
14 outstanding technical issues, and also we have an
15 activity which we call perform technology transfer.
16 And I'm going to talk to each one of those very
17 quickly, what we have done up 'til now, and what we'll
18 do next.

19 In terms of HRA quality, recognition that
20 the -- one of the biggest problems in human
21 reliability is the lack of consistent applications
22 among practitioners. Although the hardware
23 performance aspect of it, the practices on how you
24 model equipment, etcetera, pretty much are set and
25 people are doing it consistently, that we recognize

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1 that that was not the case in human reliability. That
2 was one of the biggest insights we got from reviewing
3 the IPs.

4 And, therefore, the first activity to
5 address human reliability quality issues was to
6 develop what we call good practices. We briefed the
7 ACRS several times on those, and with the good
8 practices I guess they -- they established the
9 framework for consistency and also quality in terms of
10 ensuring that the PRA model will include the important
11 human actions that needed to be included, and also the
12 model itself will be accurate in the sense that
13 dependencies are going to build, etcetera.

14 The next step was now to evaluate the
15 methods with respect against these good practices, and
16 the result of that NUREG is -- was that different
17 methods have different capabilities, and, therefore,
18 should be applied for regulatory applications as
19 needed, as they match.

20 So the idea that I'm choosing my HRA
21 method and I'm trying to fit it with respect to
22 my regulatory application proved to be wrong, and that
23 is the main thrust for -- of NUREG-1842 is to choose
24 the right tool, the right method for your application.

25 In terms of issues that are outstanding

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1 for human reliability --

2 MEMBER APOSTOLAKIS: Who is doing this?

3 MEMBER ARMIJO: They're on the phone.

4 They have to put their phone on mute. Whoever is on
5 the phone, just put it on mute.

6 MEMBER APOSTOLAKIS: Can you hear us,
7 guys?

8 MR. FORESTER: Yes, I can hear you fine.

9 MEMBER APOSTOLAKIS: Can you mute your
10 phone?

11 MR. FORESTER: Yes.

12 MEMBER APOSTOLAKIS: And don't speak
13 unless spoken to.

14 (Laughter.)

15 MR. FORESTER: That's okay.

16 MEMBER APOSTOLAKIS: I'm kidding you,
17 John.

18 MS. LOIS: One of the biggest problems
19 with human reliability in terms of both testing the
20 HRA methods and underlying assumptions is lack of
21 data. So we have undertaken the activity of
22 developing a repository of human events, and I guess
23 we briefed the ACRS a couple of times on this
24 activity.

25 We published NUREG/CR-6903 that describes

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1 -- provides the overview of how we do this collection
2 of data and loading into a database, and we are
3 loading data right now based on LERs -- LER -- yes,
4 LERs. And at the same time, we are developing what we
5 call quantification tools that would allow the use of
6 this data in human reliability.

7 MEMBER POWERS: Erasmia, I know that we
8 have seen the information on bid practices. Have you
9 sent us the methods evaluation against bid practices?

10 MS. LOIS: I'm sorry. I didn't get the
11 question.

12 MEMBER POWERS: Have you sent us the
13 methods evaluation against bid practices?

14 MEMBER APOSTOLAKIS: 1842. Do we have
15 that?

16 MS. LOIS: Yes, it's going to be -- it's
17 being -- in print right now.

18 MEMBER POWERS: Oh, okay.

19 MS. LOIS: But the ACRS saw it in a draft
20 form before public comment, and I guess after public
21 comment as well. So as we speak, if you look it up on
22 the web, you'll find it. It's there.

23 In terms of addressing specific regulatory
24 issues, we have done a human reliability for the PTS
25 PRAs. We supported the screening analysis. We have

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1 developed screening analysis for human reliability for
2 the --

3 CHAIRMAN WALLIS: Would you tell us how
4 you did this? I mean, George started off saying there
5 are three different models. Which model did you use
6 when you did these things?

7 MEMBER APOSTOLAKIS: And why?

8 MR. BANERJEE: And what are the models?
9 I'm completely -- if you had started -- give us a
10 brief introduction, like what is this all about? That
11 will help. What are these models? How do they work?

12 MEMBER CORRADINI: And does it only deal
13 with pipes and valves? For the new members.

14 MR. BANERJEE: In a nutshell, one
15 paragraph. What is an HRA model?

16 MS. LOIS: What is an HRA model?

17 MR. BANERJEE: Right.

18 MS. LOIS: I believe that an HRA model is
19 a framework which you use in order to identify human
20 actions that you would like to use or to take credit
21 for in your PRA, and then once you identify the
22 actions identify what would be the potential drivers
23 for not performing the actual -- the action
24 successfully.

25 And with that, you develop an algorithm or

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1 a framework that would help you to come up with a
2 probability, and there are several models. For
3 example, the arm that is the latest one, ATHEANA, in
4 order to come up with a probability estimate you use
5 expert judgment.

6 Some other models, SPAR-H, the one that
7 Dr. Apostolakis mentioned as being a different one, is
8 -- it has guidance, starts out with what we call a
9 generic human error probability, and then guide you
10 through -- through different ways of, if you assume
11 that, for example, stress is the most important
12 factor, multiply your human -- your generic human
13 error probability by a factor of 10 or 50 or whatever
14 it is, if workload is another factor, multiply it by
15 a factor of three. If now things are very good,
16 reduce it with generic error probability. So it's a
17 -- kind of a lookup table and cookbook, if you wish,
18 guidance on how to come up with this -- with a
19 probability.

20 MR. BANERJEE: Does a model try to predict
21 the probability of success in performing a particular
22 action?

23 MS. LOIS: If you put it in the positive
24 -- I'm not sure --

25 MR. BANERJEE: Negative way --

1 MS. LOIS: That's right.

2 MR. BANERJEE: -- not performing.

3 MS. LOIS: Probability of failure.

4 MEMBER APOSTOLAKIS: Also, the factors
5 that would affect that action. That's a major piece
6 of these models. What is it -- as Erasmia said, first
7 of all, the accident sequence context. Then, various
8 what they call performance-shaping factors, like the
9 stress level, whatever, all these -- the psychological
10 factors.

11 MS. LOIS: Quality of training.

12 MEMBER APOSTOLAKIS: ATHEANA calls it the
13 context. And the context is defined both by the
14 control room context, the indications that they
15 receive, and so on, plus the psychological factors.
16 The SPAR model is more procedural, and it has levels
17 of stress, levels -- I forget all the other factors.
18 Give me a few.

19 MS. LOIS: Training procedures --

20 MEMBER APOSTOLAKIS: Training procedures.
21 Okay. They say if -- this is the level of training,
22 this is a factor that you multiply the basic human
23 error probability, and so on. So they share a lot of
24 assumptions, but also they differ in many ways. And
25 then, you have EPRI that has curves over time that

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1 give you the probability of an error, given the
2 available time, with variations now. They refine it
3 using the decision trees, and so on, so they focus on
4 time.

5 This is one of my major problems here.
6 ATHEANA and SPAR-H treat time as one of the
7 performance-shaping factors. So you have stress, you
8 have time, you have training, and so on. EPRI focuses
9 on time and says, "How much time do they have?" They
10 have five minutes. Now, what are the other
11 performance-shaping factors that affect their
12 performance? But the focus is always on the five
13 minutes and what's the probability they will do it
14 right or wrong. Okay?

15 So this is a major difference between
16 models, and that's why EPRI -- and then, they use
17 simulation exercises to claim that, you know, here is
18 a curve applicable to these conditions. Here is
19 another curve applicable to other conditions.

20 So, and this is a major difference between
21 the --

22 MR. BANERJEE: What is the purpose of this
23 presentation? Is it to tell us what's in these
24 models, and how --

25 MEMBER APOSTOLAKIS: No. The complaint --

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1 MR. BANERJEE: -- to rationalize them, or
2 what?

3 MEMBER APOSTOLAKIS: The complaint from my
4 party is, first of all, why should this agency have
5 three different models?

6 MR. BANERJEE: Right.

7 MEMBER APOSTOLAKIS: Second, why haven't
8 we reviewed the EPRI model, which is used in licensee
9 submittals? And, third, why can't the community, the
10 HRA community, develop -- start moving towards the
11 development of a single model? So we don't have
12 different assumptions, different --

13 MEMBER BONACA: You may want to mention
14 the benchmark --

15 MEMBER APOSTOLAKIS: What?

16 MEMBER BONACA: You may want to mention
17 the benchmark exercise that we always talk about.

18 MEMBER APOSTOLAKIS: Yes. And there was
19 a benchmark -- there was a benchmark exercise
20 conducted at ISPA more than 20 years now ago, where
21 they had groups -- it was a European Commission at the
22 time exercise. They had groups from the -- at that
23 time there were I think 10 or 11 nations part of the
24 Union, plus an American team.

25 They gave them an accident sequence in a

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1 German reactor, explained it very well, and so on, and
2 then they let them loose -- you go home and come back
3 and give us probabilities for these human actions.
4 And, of course, they were all over the place.

5 The same model at the time, which
6 admittedly the models were not as sophisticated as
7 today, the same model used by different teams led to
8 widely different results. The same team, using
9 different models, produced widely different results.
10 In essence, it was a mess.

11 And somehow the community has ignored
12 this, and we keep bringing it up, and, you know,
13 nobody is willing to --

14 MR. BANERJEE: Are there experiments like
15 simulators and --

16 MEMBER APOSTOLAKIS: Well, the staff --

17 MR. BANERJEE: -- virtual reality, or
18 whatever?

19 MEMBER APOSTOLAKIS: The staff is
20 sponsoring the simulator exercises at the Halden in
21 Norway.

22 MS. LOIS: So I guess I should go to --

23 MEMBER APOSTOLAKIS: Right.

24 MS. LOIS: -- slide 11.

25 MEMBER APOSTOLAKIS: I think so.

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1 MS. LOIS: Okay.

2 MEMBER APOSTOLAKIS: Now, the other thing
3 is, for example, you started talking about the PTS and
4 ATHEANA. In the spirit of my questioning today, I
5 would ask, why ATHEANA? Why didn't you use SPAR-H for
6 that? Why didn't you use the EPRI model for that?
7 See, this is the comparative evaluation that we want
8 to see eventually.

9 And, again, I'm asking these questions not
10 to blame people for not doing this or that. I mean,
11 whenever you have a new field, especially in the soft,
12 so to speak, sciences of human reliability, it's
13 natural that different teams around the world develop
14 their own model. But it has been now more than 20, 25
15 years. Don't we need to start converging somewhere,
16 especially as an agency? Why are we using SPAR-H for
17 actual regulatory decisions and ATHEANA for research
18 primarily?

19 MEMBER CORRADINI: What's the third one?

20 MEMBER APOSTOLAKIS: The third one is
21 claimed -- claims to be deterministic. That was
22 developed in the context of fires. So there is a
23 fire, and somebody calculates that there is 18 minutes
24 before there is core uncover, for example, if you do
25 nothing.

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1 So now the analyst says, "Ah, okay. They
2 will figure out there is a fire at that location
3 within six minutes. They will develop a strategy, and
4 then they will put it out or control it in seven
5 minutes, so six plus seven is 13, you had 15, you have
6 four-minute margin, you are okay." Nothing to do with
7 probabilities.

8 These performance-shaping factors do not
9 appear anywhere. They are a completely different
10 approach developed by the same agency.

11 MS. LOIS: But could you -- could you
12 clarify, what do you mean the performance-shaping
13 factors do not --

14 MEMBER APOSTOLAKIS: Well, there is an
15 appendix --

16 MS. LOIS: -- do not appear?

17 MEMBER APOSTOLAKIS: They appear in some
18 sense, but it's not -- it's different from ATHEANA.
19 It's different from SPAR-H. It just deals with time
20 and takes the difference.

21 MS. LOIS: No. To the extent that we
22 would have done an ATHENA analysis, all of the
23 performance-shaping factors, if you will, are taken
24 into consideration in NUREG-1852, we would have
25 considered it, which is, do you have the staff? Are

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1 they trained? All of these are part of the
2 considerations. Does it matter what methodology you
3 use -- SPAR-H or ATHEANA?

4 The only thing we did in the fire manual
5 actions, because it was a deterministic approach, we
6 believed that the acceptance criteria with respect to
7 the adequacy of procedures, training, etcetera, are
8 kind of the most basic criteria in order to ensure
9 efficiency. And then, what -- what you ensure
10 reliability?

11 Well, we thought that given that all of
12 these things may not happen the way we anticipate,
13 let's take the step to require a margin of time.

14 MEMBER APOSTOLAKIS: Well, yes, and I
15 agree. And, obviously, in a short, brief summary, I
16 cannot go into the details.

17 MS. LOIS: Yes.

18 MEMBER APOSTOLAKIS: But this is exactly
19 what I would like to -- this is exactly -- I would
20 like to see the three models next to each other, and
21 the assumptions, and comparison, and so on, because if
22 I were a licensee right now I would go with that.
23 It's an easy way out. Calculate the times, give an
24 estimate -- why bother about --

25 CHAIRMAN WALLIS: Does the word

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1 "verification" appear in the vocabulary here? The
2 word "verification" doesn't appear on any slides.
3 Does it appear in the vocabulary of HRA?

4 MEMBER APOSTOLAKIS: No.

5 CHAIRMAN WALLIS: No? There's no
6 verification of any model?

7 MEMBER CORRADINI: This is actually -- can
8 I just -- I think this is what Sanjoy was eventually
9 getting to, which I was wondering, which is, if I'm
10 looking for some sort of experiment -- some sort of
11 comparison, whether it be model to model, or
12 something, because that's where I'm trying to judge
13 something.

14 CHAIRMAN WALLIS: If you could start off
15 with verification procedure or something --

16 MS. LOIS: Yes, that's what we plan for
17 benchmarking. But we haven't been so far, but -- we
18 haven't done any --

19 DR. COOPER: Yes, and I guess -- Dr. Susan
20 Cooper, Research. Verification, in the sense that you
21 can go out and do an experiment and exactly duplicate
22 what operators can do, is not going to happen in HRA,
23 nor are we going to be able to collect data. But it
24 doesn't mean that there isn't anything behind these
25 models.

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1 The second generation HRA models, of which
2 ATHEANA is one, and there are others like REMROS for
3 media, have a lot of psychological, behavioral
4 science, and cognitive science behind them, in
5 addition to the fact that they've looked at a lot of
6 operational experience from the nuclear power industry
7 as well as others.

8 CHAIRMAN WALLIS: You answer questions
9 such as, what's the uncertainty in your estimate? And
10 you come up with a number of .1 that the person will
11 make the right decision -- probability. How do you
12 assess how good that is?

13 DR. COOPER: Well, that's a different
14 question, and most HRA --

15 CHAIRMAN WALLIS: But isn't that the sort
16 of question we are asking, should be asked?

17 DR. COOPER: I don't know that I've heard
18 anyone ask, really, what uncertainty is.

19 CHAIRMAN WALLIS: Well, I see -- I mean,
20 I see numbers. It's either .1 or it's --

21 DR. COOPER: No, I think that's a quite
22 different --

23 CHAIRMAN WALLIS: -- 01 or it's --

24 DR. COOPER: -- question, to be real
25 honest. I think uncertainty has to --

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1 CHAIRMAN WALLIS: When someone gives it to
2 me, I say, "Well, where does it come from, and how
3 sure is it?" And there doesn't seem to be an answer.

4 MS. LOIS: Okay. So, then, I would
5 appreciate if the committee lets me go through the
6 slides. I just jumped to slide 11. This is the
7 treatment of the difference between the fire manual
8 actions and --

9 MEMBER APOSTOLAKIS: The committee hasn't
10 seen my questions, I think. Have they seen my
11 questions, Eric?

12 MR. THORNSBERRY: In the status report
13 they are discussed.

14 MEMBER APOSTOLAKIS: All right. If you
15 have that slide. Okay. So they know what it is.

16 MS. LOIS: So these are the questions.

17 MEMBER APOSTOLAKIS: Okay.

18 MS. LOIS: All right? And we'll try --
19 and we believe that we have some answers to these
20 questions, and we believe that the benchmarking using
21 simulator data activity will help us address some
22 additional questions.

23 MEMBER APOSTOLAKIS: Okay.

24 MR. BANERJEE: In a simulator, what is
25 actually measured? Like suppose the simulator has to

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1 shut down something, that's the activity the human has
2 to undertake. What do you measure, and how do you
3 measure this? How does the simulator --

4 MS. LOIS: The coding facilities where we
5 plan to have this -- what we call benchmarking
6 exercise, they have -- their facilities is to perform
7 -- are set to perform experiments for collecting human
8 performance data. So, in actuality, what happens is
9 they have operator crews, real crews, mostly from
10 European countries, although there is a very good
11 possibility that U.S. countries are going to be used
12 as well.

13 And there are various analyses, like in
14 training, when the operators are trained in the
15 simulators they -- they have to deal with LOCA events
16 or loss of offsite power events.

17 So there are very well pre-set scenario
18 set out, and there is a very detailed data collection
19 in terms that are video cameras that are observing,
20 there are experts that are observing human
21 performance, as well as there are debriefing protocols
22 that help identify, if operators did a mistake, why
23 they did it. And that's a very crucial aspect for
24 human reliability perspective.

25 MEMBER APOSTOLAKIS: But what they measure

1 -- what they measure is the response time. That's
2 what they measure.

3 MR. BANERJEE: That's the key -- time.

4 MEMBER APOSTOLAKIS: The time.

5 MR. BANERJEE: Okay.

6 MEMBER APOSTOLAKIS: So what they do in
7 some of the experiments, they change the conditions,
8 for example.

9 Okay. There is a LOCA in the simulator,
10 things are going as expected, and they will see how
11 they respond. Then, they create a diversion that the
12 staff now -- the crew has to take care of something
13 else while the LOCA is occurring. What is the new
14 response time? Okay? And they do things like that.
15 I mean, they are very well thought out experiments,
16 and they produce --

17 MS. LOIS: But we have helped them to get
18 away a little bit away from the -- that's what they
19 were doing in the past for -- called human factors
20 applications. But we -- for human reliability, we
21 believe that you should allow the crews to take the
22 time and see actually what happens if they have a
23 little bit more time.

24 And, therefore, there is -- those
25 scenarios are set out to -- for an hour, an hour and

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1 a half, so it's not just if you didn't perform within
2 10 minutes or you failed, if you didn't perform -- I
3 mean, we have observations that actually crews meets
4 to perform the action, and probably started doing
5 something which was entirely different than what they
6 were supposed to do.

7 MEMBER APOSTOLAKIS: Well, yes, there were
8 variations. There are variations, and so on.

9 CHAIRMAN WALLIS: Well, that must be a
10 variable. Did they do the right thing? That must
11 be --

12 MEMBER APOSTOLAKIS: Yes.

13 CHAIRMAN WALLIS: The time is one of the
14 drivers.

15 MS. LOIS: It isn't a response time
16 related -- only that. I mean, that's one aspect of
17 it.

18 MEMBER APOSTOLAKIS: But that's a key
19 aspect, though, is that not? It is a key aspect,
20 because the thermal hydraulics controls that. You
21 have certain time for response.

22 DR. COOPER: Unless it's an error of
23 commission.

24 MEMBER APOSTOLAKIS: Unless it's an error
25 of commission.

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1 MEMBER BONACA: Unless you have an error.
2 I mean, Halden was quite interesting. I mean, what
3 they showed here. And, again, it was complicated,
4 too, in the sense that some crews were very effective
5 in one way, and then they were ineffective in other
6 ways.

7 MEMBER APOSTOLAKIS: Yes. And the EPRI
8 exercises of 15 years ago or something. There were
9 also simulator exercises. In fact, they produced
10 curves using the results from the simulators, and they
11 had certain hypotheses that they tested, you know,
12 that the operator response time behaves this way, they
13 got the test of it, sometimes it failed, sometimes it
14 worked. So there were significant efforts.

15 MR. BANERJEE: Maybe that's why EPRI
16 focuses on time.

17 MEMBER APOSTOLAKIS: They focus on time.
18 There is also a point of view. I mean, they really
19 want to develop a method. That's why they have this
20 calculator, which is software based. They claim that
21 we should have a method that a good engineer can use
22 without being an expert on HRA. I mean, he should --
23 he or she should know something about it. I mean,
24 it's not like you go blindly or apply it, but they try
25 to proceduralize it as much as they can.

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1 MS. LOIS: Which we object.

2 DR. COOPER: Yes, we do.

3 MEMBER APOSTOLAKIS: Okay. Well --

4 MS. LOIS: This is our fundamental
5 objection with this methodology, the fact that you
6 have a capability. My thermal hydraulics tells me I
7 have half an hour. I put in half an hour. Here is my
8 probability. It's -- you can become blind as to what
9 are your potential drivers of human error, and why
10 half an hour was not -- was not enough, etcetera. So
11 that mechanistic approach to human reliability is
12 the --

13 CHAIRMAN WALLIS: Something is missing
14 from this. The output of this must be a probability
15 you put in a PRA or something.

16 MEMBER APOSTOLAKIS: That's correct.

17 DR. COOPER: That's the result.

18 MEMBER APOSTOLAKIS: An output. I mean,
19 the question is: how do you arrive at that output?
20 And time presumably is a means to an end. You've got
21 to do something with that time when you get it.

22 CHAIRMAN WALLIS: Right.

23 MEMBER APOSTOLAKIS: So I haven't heard
24 that mentioned yet.

25 MEMBER ARMIJO: I have a question. This

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1 has been going on for --

2 MEMBER APOSTOLAKIS: A long time.

3 MEMBER ARMIJO: -- 20, 30 years. I know
4 in Halden, NRC has been a member forever. I believe
5 EPRI has been a member forever. It's surprising it
6 hasn't converged to a point where there is maybe two
7 major competing models, and the issues are well
8 defined, and now you're going to set up some sort of
9 method to resolve those issues. Is that where we are?

10 MS. LOIS: Halden has been involved in
11 human reliability-related research the last three
12 years or four years.

13 MEMBER ARMIJO: Before that it was called
14 human factors.

15 MS. LOIS: It was human factors.

16 MEMBER ARMIJO: Not the same thing?

17 MS. LOIS: It is not the same thing.

18 MEMBER ARMIJO: Okay.

19 MEMBER BONACA: But, you know, I mean, the
20 one big issue -- question is always, how
21 representative is this of what takes place in the
22 powerplant? Because the powerplant has certainly a
23 huge edge in the sense that they have the procedures.
24 The operators are trained continuously on those
25 procedures. The simulator puts in front of them

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1 problems which have to do with their own specific
2 console, controls, procedures.

3 So they operate now -- that may set also
4 a stage for some trap for them, because they are so
5 used to certain circumstances. Something can happen
6 that throws them off. But this is different from what
7 takes place at Halden, for example, where you have
8 these people going in, and I don't know how trained
9 they are in specific procedures for the powerplant.

10 MS. LOIS: They are actual --

11 MEMBER APOSTOLAKIS: They are.

12 MEMBER BONACA: They are. But, you know,
13 I don't know how it compares to crews that live at the
14 plant for years and years.

15 MEMBER APOSTOLAKIS: Let's pursue this a
16 little bit, what Erasmia mentioned. I said that the
17 EPRI guys tried to proceduralize, produce curves, and
18 so on. On the other side, ATHEANA -- both methods
19 have a very detailed evaluation of the context. EPRI
20 doesn't call it context, but essentially they are also
21 looking at the performance-shaping factors, what is
22 the accident sequence, and so on. This is the shop
23 framework. So there is a commonality there.

24 Then, when it comes to producing
25 probabilities, ATHEANA says essentially that you

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1 should assemble a group of experts who will evaluate
2 all these factors and the context, and so on, and will
3 develop a probability distribution for the human
4 error.

5 The other side is the EPRI guys, which
6 Erasmia said they were objecting, that has
7 proceduralized that. It has curves, and so on, and
8 there is some flexibility, but essentially you have to
9 follow what they are telling you.

10 And one question, for example, that I
11 think we should try to address as an agency is: can
12 we merge these two? Is it possible to bring some of
13 the EPRI approach into ATHEANA and some of the ATHEANA
14 approach into EPRI, and come up -- because, you know,
15 when you tell people who are doing a PRA, for example,
16 that they have to have a group of experts to do this,
17 that's a very expensive proposition.

18 So there are advantages and disadvantages.
19 It probably is a more thoughtful and detailed
20 evaluation of the context if you have experts that are
21 doing it, and perhaps you should do that for one or
22 two or three events or human errors that are of
23 extreme importance to the plant. But should you be
24 doing it for all of them?

25 CHAIRMAN WALLIS: George, can I ask you

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1 something? When anything matures as an engineering
2 discipline, people can teach it. And if I were to
3 teach students this, I'd want to teach them how to do
4 it. I'd want to have some way of testing whether they
5 did it well. All those things that we do in every
6 other discipline -- this doesn't exist in this area at
7 all?

8 MEMBER APOSTOLAKIS: Well, I think,
9 Graham, you can only take the analogy from the
10 sciences, the hard sciences so far here. I mean, yes,
11 it would be nice to have experiments that would
12 validate and --

13 CHAIRMAN WALLIS: Oh, right. If I had to
14 teach --

15 MEMBER APOSTOLAKIS: -- how you --

16 CHAIRMAN WALLIS: -- what would I say?

17 MS. LOIS: We are going to do it, to the
18 degree that we can.

19 MEMBER APOSTOLAKIS: What do you mean?
20 You will present these models and tell them how to do
21 that.

22 CHAIRMAN WALLIS: By saying the way you do
23 it is hire a group of experts?

24 MEMBER APOSTOLAKIS: Well --

25 CHAIRMAN WALLIS: You said homework on

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1 that basis.

2 DR. COOPER: No. But for this particular
3 case you need experts. At least, in the ATHEANA case,
4 it would be trainers from nuclear powerplants. And so
5 we present to them the context, which could include
6 time and does often include time as a factor. And
7 have them evaluate for their own plant and their
8 crews, what their judgment is so far as whether or not
9 those crews would fail in that particular situation.

10 So, and the purpose of having the experts
11 together and not just one person is so that, in fact,
12 you can have discussion about that context, because
13 one of the things that was found in the old, old
14 benchmarking study is that many of the differences had
15 to do with the fact that people were studying the
16 different problem.

17 They were thinking -- they had to make
18 assumptions. In other words, it wasn't a completely
19 defined problem, and they had to make assumptions
20 about what the context was. And so, in fact, they
21 were actually analyzing different things.

22 So if you get people in the same room and
23 they -- you know, you describe the context in a
24 certain way, which may include time, and ask them to
25 -- okay, so this is the situation, what is your

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1 opinion, which is an expert opinion, because they've
2 been watching their crews going through the
3 simulators, and probably they've even done some work
4 for this particular analysis, what's your
5 opinion/judgment on whether or not they'd be
6 successful in this particular case?

7 And you might find out in the discussion
8 that somebody says, okay, I think -- I think it's
9 this, and I think this is a really important factor
10 and we haven't considered it yet. And then, maybe
11 you, you know, change the context or you define two
12 different events, and, you know, the idea is to reach
13 some consensus but also a common understanding of what
14 that context is.

15 Now, it's our opinion that, although we do
16 believe that time is important, but for a long time
17 now, even back in the '90s, there was discussion in
18 the HRA community that to be too focused on time can
19 get you in trouble.

20 I mean, you plug in 30 minutes for this
21 event, you plug in 30 minutes for this particular
22 human failure event, and the conditions are very
23 different. In some cases, it could be very close.
24 You may not be successful. In another it's plenty of
25 time. But you've got the same time.

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1 CHAIRMAN WALLIS: But the question I have
2 is: how does it work? I mean, the agency has to
3 evaluate something submitted by some utility or
4 something. They say, "We hired a group of experts,
5 and the experts said that the probability of doing
6 this right is point one." Now, how does the agency
7 evaluate whether that's a reasonable number or not?

8 DR. COOPER: Maybe we ought to let
9 Gareth --

10 CHAIRMAN WALLIS: They must have some way.

11 MR. PERRY: Yes, this is Gareth Perry from
12 NRR. I've been trying to sit in my seat without
13 jumping up too much, because I've heard a lot of
14 things I disagree with here.

15 CHAIRMAN WALLIS: What, with the questions
16 or the answers?

17 (Laughter.)

18 MR. PERRY: Everything.

19 CHAIRMAN WALLIS: The questions are hard
20 to disagree with.

21 (Laughter.)

22 MR. PERRY: One of the problems that I --
23 I'm not sure that you're tackling the right problem.
24 I don't think we need a one size fits all method for
25 every application. For example -- let me give you --

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1 we use, for the SDP, the significance determination
2 program, we use the SPAR-H model. The question we
3 should be asking is: is that good enough for that
4 purpose? Because certainly any proposal to use
5 ATHEANA for SDP is like using a sledgehammer to crack
6 a nut.

7 So I think the things we have to
8 understand is where the applicability of these models
9 is, and that I think is what the comparison of the
10 good practices -- comparison of the methods against
11 the good practices provides a good basis for this
12 document.

13 Now, another thing, I want to raise an
14 objection to Erasmia's objection that you can't have
15 a method that you could proceduralize that could be
16 used by non-experts. I think that was one of the
17 bases of many of the EPRI methods, particularly the
18 CBDT method, which is the decision tree approach.

19 And the idea behind that is is you bring
20 in the knowledge that you have about the aspects of
21 human performance, put that in the model, and then
22 train the person to recognize which of those factors
23 are relevant for the particular sequence that he's
24 dealing with.

25 CHAIRMAN WALLIS: Well, you're teaching

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1 someone to do something.

2 MR. PERRY: Well, that's the idea, to try
3 and -- at least to embed it in the structure of the
4 model, so that you can do that. And personally, I
5 think that's a very useful thing for people in NRR who
6 are reviewing licensee's applications.

7 MEMBER APOSTOLAKIS: But let me disagree
8 with you now. It's one thing to say we need a model
9 for this particular application that's appropriate for
10 it, and quite another to actually look at what the
11 model does.

12 Let me give you an example of reactor
13 physics -- obey the Boltzmann question, period.
14 That's how they move in a reactor. It's also -- you
15 can solve it that way.

16 CHAIRMAN WALLIS: Wait, wait.

17 MEMBER APOSTOLAKIS: You can solve it.
18 You can solve it. You can solve the equation. There
19 are methods for different applications. In a time-
20 dependent situation, the simplest one is the point
21 kinetics. For certain application, it's hard. For
22 other applications you go to multi-group --

23 CHAIRMAN WALLIS: You can test it, George.

24 MEMBER APOSTOLAKIS: -- you go to -- well,
25 wait a minute. You go to multi-group diffusion

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1 equations, and you solve those using sophisticated
2 methods. Okay? Sledgehammer and all of that.

3 But all of these methods are produced from
4 the Boltzmann equation, making approximations. I've
5 done it many times, Graham.

6 CHAIRMAN WALLIS: But you don't have to do
7 it that way.

8 MEMBER APOSTOLAKIS: But we -- my point is
9 that they are all based on the same -- on the same
10 physical processes, and then you make approximations.
11 SPAR-H used different assumptions from ATHEANA.
12 That's my problem. I don't mind having a simple way
13 of handling routine regulatory applications, but it
14 should not really be different --

15 CHAIRMAN WALLIS: But, George --

16 MEMBER APOSTOLAKIS: -- it's not entirely
17 different, but it --

18 CHAIRMAN WALLIS: But, George, it's
19 hopeless, because you say, first, I believe the
20 Boltzmann equation, and then I deduce everything. In
21 this area there's nothing you can believe as the
22 fundamental equation, deduce things.

23 MEMBER APOSTOLAKIS: But give me the
24 benefit of the --

25 MEMBER POWERS: Graham, come on.

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1 MEMBER APOSTOLAKIS: I mean, if ATHEANA
2 believes that certain assumptions are very important,
3 and these assumptions are not in SPAR-H, you're going
4 to have a problem.

5 MR. BANERJEE: Well, the Boltzmann
6 equation is a model, albeit not very exact, for some
7 types of behavior. So is there an equivalent, however
8 approximate, model for human behavior? If there is
9 not, you don't have the equivalent to it.

10 MEMBER APOSTOLAKIS: Well, wait, wait,
11 wait. I think my point is that even in cases where
12 you have the fundamental equation, you have to develop
13 models like Gareth says that are applicable to
14 different situations and have different degrees of
15 flexibility and accuracy, point kinetics being the
16 crudest.

17 But all these models have these
18 fundamental -- this fundamental process under them.
19 Okay? They are approximations and can show how you
20 produce them. Here you don't have that. You don't
21 have that. But that doesn't mean that you can make
22 any kind of assumption you want to develop your own
23 model.

24 At some point you have to compare them.
25 You have to compare them and say, "When SPAR-H gives

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1 me six or seven levels of stress and puts a factor of
2 ten here and a factor of five there, how does that
3 compare with something that ATHEANA does in a similar
4 situation?"

5 MR. BANERJEE: Sounds like biology.

6 MEMBER APOSTOLAKIS: Well, it could be.

7 MS. LOIS: But the history of human
8 reliability, I don't think we can take it back. It
9 was -- this is the evolution of these methodologies
10 and we do believe --

11 MEMBER APOSTOLAKIS: And nobody disagrees
12 with that.

13 MS. LOIS: -- that the -- through these
14 benchmarking exercises we will be able to address
15 exactly those questions, in the sense that we are
16 going to test the underlying assumptions of SPAR-H an
17 ATHENA and THERP -- that has been still used -- and
18 through that exercise we'll be able to compare, to see
19 the differences, and then also determine the
20 applicability of the method or how we can improve the
21 method.

22 MEMBER APOSTOLAKIS: Well, then you are on
23 the way of doing what I want. But what I would like
24 to see first is a comparison on a table with columns.
25 Before you do any benchmark exercises, you say, okay,

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1 this guy does this, this other guy does that, how do
2 these two compare?

3 MS. LOIS: But we've done that in 1842.

4 MEMBER APOSTOLAKIS: No.

5 MS. LOIS: We have tables where we
6 compared -- I mean, we do not compare it, but we
7 identify the basic assumptions in these methods.

8 MEMBER APOSTOLAKIS: No, you haven't done
9 it the way I want it. I want you to go to SPAR-H when
10 they have any questions for the dependency and beat
11 the hell out of it, and say, "Why is this true? How
12 do other models handle this?" There are some
13 equations there that come out of the sky and you're a
14 -- I'm scratching my head to why this is true and
15 nobody questions it.

16 MS. LOIS: That can be done only through
17 collection of data and -- because we are not going --
18 in the benchmarking exercise, we are not going to
19 compare methods. What we are going to do is we're
20 going to evaluate, if you wish, every individual
21 method in its merit.

22 So the plan is, and probably I have that
23 in my backup slides --

24 CHAIRMAN WALLIS: I'm wondering, what do
25 we expect the committee to do with this? I'm sort of

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1 struggling with this, and --

2 MEMBER APOSTOLAKIS: Well, the first
3 question, is the committee happy with having three NRC
4 models and one industry model?

5 CHAIRMAN WALLIS: Well, three codes for
6 thermal hydraulics.

7 MEMBER POWERS: George, I think there is
8 no inherent reason that you wouldn't have three
9 models. Now, to have them on a different
10 philosophical and technical bases is a little more
11 distressing. But there is nothing inherently wrong
12 with having three models.

13 MEMBER APOSTOLAKIS: Oh, no. No, I think
14 it's --

15 MEMBER POWERS: And I don't think you
16 think that either.

17 MEMBER APOSTOLAKIS: That's not what I
18 mean, no.

19 MEMBER POWERS: But I don't -- I don't
20 quibble any with your objectives here. I a little bit
21 quibble with educating the members at the table. I
22 think it would be useful to go through the
23 presentation. Paging through it, it looked like it
24 was a useful exposition on what the research program
25 is.

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1 I would like to explore further what's
2 meant by benchmarking, and I think they'll get to it.
3 And, of course, I'm very interested in how they use
4 maybe flight distributions.

5 MEMBER BONACA: The only place where I
6 would have a major problem with the three different
7 models would be if for the same scenario people not
8 familiar necessarily with all of them will come up
9 with very significant differences. That would be
10 troublesome, because then, how do I judge that, you
11 know, for the SDP it -- is it proper to use SPAR-H?
12 I mean, do we know that?

13 MEMBER APOSTOLAKIS: I really think it is
14 inappropriate -- is for us to accept results from the
15 EPRI calculator without a review of the model.

16 MEMBER MAYNARD: I believe that it's
17 worthwhile to continue to try to come closer together
18 on these things, but I'm not sure you're ever going to
19 get to one method. And I know that from experience
20 when the industry has an issue or a model, the NRC
21 will use their models, and where there's a difference
22 then they get together.

23 And it's up to the industry to then prove
24 that -- you know, if the industry is coming up with
25 better numbers or so to speak, that -- you know, the

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1 NRC number prevails unless the industry can convince
2 them that, you know, their model doesn't account for
3 everything.

4 And the industry -- there's a lot of
5 information out there. There's a lot of things that
6 are being done in the simulators. There are exercises
7 going on all the time that toss in a lot of just
8 things that distract you and different things like
9 that. So I think we're getting more and more data
10 that -- it's not just an opinion by somebody as to
11 what or may not happen. There's a lot of data to back
12 up the performance.

13 MEMBER BONACA: But again, I mean -- but
14 again, however, you should have some consistency.
15 What I mean is that -- take a critical scenario that
16 everybody is taking credit for in PWRs -- bleed and
17 feed. Now that's a fundamental scenario for some type
18 of plants. For example, the C plants or the early
19 design, there is a very narrow window for being
20 successful.

21 If you do it too late, you're not going to
22 succeed. It will be interesting to know, given the
23 scenario with some complications or whatever they may
24 be, if you get very different results that says with
25 this model you are never going to make it, with this

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1 model you'll make it with success, and then I would
2 like to understand, you know -- that's really what I
3 would have --

4 MS. LOIS: Well, exactly that's what we
5 are going to try and hold it, to set up scenarios that
6 probably pertain to some --

7 MEMBER BONACA: Okay. Good.

8 MS. LOIS: -- very important human
9 actions.

10 MEMBER BONACA: Yes.

11 MS. LOIS: And the analysts, the experts,
12 ahead of time they will do their predictions. Given
13 that scenario, that specific plan characteristic, you
14 know, get all the collection and collect all the
15 information you would have when you -- in HRA by
16 yourself. And you would do your predictions.

17 And then, afterwards, we are going to see
18 what --

19 MEMBER BONACA: Yes. No, I understand.

20 MS. LOIS: -- how well and why if you
21 didn't predict well, why -- and if you did predict
22 well, why. And we are going to compare all of that.

23 MEMBER BONACA: Okay. So you'd use three
24 different methods of -- all different ones.

25 CHAIRMAN WALLIS: The thing is, if I read

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1 -- I mean, I read the Halden report, the previous
2 report. What I would like to see in the future, for
3 example, from a similar report is to say, okay, we
4 have this scenario. If I take SPAR-H, this is what
5 I'm supposed to do to calculate some probability. And
6 this is what the simulation will be to test whether
7 these guys are doing the right thing.

8 Now, ATHEANA will do something else. So
9 this is how we're going to test ATHEANA. Rather than
10 have those guys run their scenarios and do whatever --

11 MS. LOIS: Exactly. That's what we tried
12 to do. Here is -- define the measure --

13 MEMBER APOSTOLAKIS: Which is sort of --

14 CHAIRMAN WALLIS: We're supposed to write
15 a letter on this research program, and I don't have a
16 clue what it is yet. So how can I write a letter on
17 it? I mean --

18 MEMBER APOSTOLAKIS: Well, no, we are not
19 writing a letter on the research program.

20 CHAIRMAN WALLIS: We seem to be going into
21 all sorts of stuff, which is very interesting, but
22 what is the program we're reviewing?

23 MEMBER APOSTOLAKIS: This is not a letter
24 on the research program. We have already done that.

25 CHAIRMAN WALLIS: It says it's a

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1 presentation on the HRA research program.

2 MEMBER APOSTOLAKIS: Well, no, it was on
3 this -- the fundamental question in my mind that
4 triggered this meeting is, is it appropriate for the
5 NRC to have three different models based on three
6 different assumptions? Not completely different -- I
7 mean, they share a lot.

8 If, for example, SPAR-H was presented and
9 developed as an approximation to ATHEANA, then I
10 wouldn't have any problem, but that's not how it was
11 developed.

12 CHAIRMAN WALLIS: How can you approximate
13 an expert elicitation? I mean --

14 MEMBER APOSTOLAKIS: If it was presented
15 that way, there would be no problem. The other thing
16 that bothers me is that in the regulatory arena we are
17 accepting results from a model that there are answers
18 that have not been reviewed officially. I would like
19 that --

20 VICE CHAIRMAN SHACK: But they reviewed
21 the results, George.

22 MR. PERRY: I'm not sure that we
23 necessarily accept those results. We just don't find
24 them unacceptable, but it's not that we're endorsing
25 those results. And, no, that's -- there's a

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1 difference in that statement. Personally, I don't
2 believe that for most of these power uprates that you
3 need to use these time reliability curves, because I
4 don't think -- I don't believe, from my understanding
5 of the procedures, that the shift in time from 25
6 minutes to 20 minutes makes much of an impact on the
7 way the operators are --

8 MEMBER APOSTOLAKIS: There was a case of
9 eight to six. There was a case of eight minutes to
10 six minutes. Any time we use a model, we have to make
11 sure we review it and we understand it. And that's
12 not in this case. I don't know. Is this a different
13 field where we don't apply these --

14 MS. LOIS: This activity is going to give
15 us that opportunity.

16 MEMBER APOSTOLAKIS: Okay. Great. If it
17 does, it does.

18 MS. LOIS: And I'm sure that Jeff Julius
19 is on the telephone. But the assumption is that
20 every --

21 MEMBER APOSTOLAKIS: So tell us what -- I
22 mean, we interrupted you. What are you planning to
23 do? Maybe that's what's missing from this discussion.

24 MS. LOIS: Okay.

25 MR. JULIUS: I'm online.

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1 MS. LOIS: Hello, Jeff.

2 MR. JULIUS: Hi.

3 MS. LOIS: Do you want to speak out for --

4 MEMBER APOSTOLAKIS: It's very early for
5 him, by the way. He's on the west coast.

6 MS. LOIS: Yes. For your participation in
7 the benchmarking exercise.

8 MR. JULIUS: Yes. I guess the statement
9 I wanted to make was that where we are converging is
10 on these performance-shaping factors. If you look at
11 the basis for the SPAR-H performance-shaping factors,
12 and the SPAR-H -- and the EPRI HR calculator to
13 perform the shaping factors, and this is the same
14 performance-shaping factors I believe are used in the
15 ATHEANA -- the baseline quantification or as part of
16 the ATHEANA process to look for deviations from the
17 baseline quantification.

18 We have converged on those, and those are
19 what are published and being collected in the NUREG on
20 HERA. And then, the question is now, are we looking
21 at the -- how these are wired up or what -- the
22 impacts of these performance-shaping factors. So we
23 have I guess reached beyond the methods, and agreed at
24 least upon a baseline set of performance-shaping
25 factors that we're looking at.

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1 MS. LOIS: But, however, in terms of
2 participating in the benchmarking exercise, that would
3 allow us to compare notes in a much more detailed
4 manner. It appears that it's a guess, right?

5 MEMBER APOSTOLAKIS: Is EPRI
6 participating?

7 MS. LOIS: I assume so. Jeff?

8 MR. JULIUS: Yes. Yes, EPRI is.

9 MEMBER APOSTOLAKIS: The thing is this:
10 if you look at the methods, they share a lot of common
11 elements. They do. It's not that they are completely
12 in different directions, but they also have
13 differences. And the simple question I'm asking is:
14 has anybody sat down, looked at them critically, and
15 said, "This is where they really differ, this is where
16 they are doing the same thing," and perhaps by doing
17 so start creating the basis of a more unified
18 approach. It's a very simple question.

19 Because I don't -- I repeat: the purpose
20 of this is not to blame anybody. I agree with Erasmia
21 that historically that's how methods evolve in a new
22 field. Okay? People develop what they believe is the
23 appropriate way to approach it, but at some point --

24 CHAIRMAN WALLIS: Let's see the plan for
25 evolution, then. I mean --

1 MEMBER APOSTOLAKIS: That's exactly what
2 the letter is going to say. That's what the letter
3 says.

4 CHAIRMAN WALLIS: Well, I was hoping I was
5 going to see. It was sort of --

6 MEMBER APOSTOLAKIS: That's what the
7 letter says.

8 CHAIRMAN WALLIS: I understand people are
9 converging on performance-shaping factors. That's a
10 step forward. Now, how do they shape performance? Is
11 the next question perhaps, the performance-shaping
12 factors and how they're being addressed.

13 MEMBER BONACA: I would like to say, I
14 mean, on behalf of what George is trying to do, I
15 mean, the issue of human reliability is very
16 important. When the IPEs were submitted originally,
17 or at least -- you know, the estimations from plant to
18 plant, they were all over the place. I mean, they
19 were wild. There were order of magnitude estimation
20 differences between different plants, etcetera.

21 So how can you believe the results of PRAs
22 that we, you know, base our judgment so much when you
23 have embedded in those these wide variations?

24 Now, if something has been done, but still
25 now there are big variations between the reliability

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1 of human action in different PRAs, and that skews the
2 results. That's the fundamental reason why I've
3 always believed the SPAR program is so fundamental for
4 the agency, because it's one model and hopefully also
5 in the HRA is going to be some consistency there, so
6 that you have some consistent approach.

7 So if you have the type of plant, you
8 know, there are five or six of those plants, you will
9 have certain expectations if the -- this proper
10 training is also -- so that's a very important issue,
11 because --

12 MEMBER APOSTOLAKIS: And the --

13 CHAIRMAN WALLIS: George, I'm going to
14 assert some authority here. I mean, it seems to me
15 we're asked to decide to comment on what the staff is
16 doing, and we have to know what it is. And we just
17 keep talking around this thing. Can we sort of agree
18 that they have 20 minutes or something to tell us what
19 they're doing?

20 MEMBER APOSTOLAKIS: Yes.

21 CHAIRMAN WALLIS: Can we agree that?
22 Because we just -- they never get going on anything
23 here. Can we agree that?

24 MS. LOIS: I guess at this time we have
25 kind of exhausted our presentation. The only thing I

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1 can -- the only discussion, only topic, and we would
2 like to really --

3 VICE CHAIRMAN SHACK: Let me ask a
4 question about the benchmarking studies.

5 MEMBER APOSTOLAKIS: That's why we don't
6 do that.

7 VICE CHAIRMAN SHACK: When you have
8 something that has a relatively low air probability,
9 just how are these experiments done? I mean, I
10 presume that these people don't fail all that often.
11 You can't run the same experiment over and over again.
12 How is it actually done?

13 MS. LOIS: It's what Dr. Apostolakis
14 explained before. You start out with a -- it's been
15 called basic scenario, which is a well-trained
16 scenario, and you have the capability to observe --

17 CHAIRMAN WALLIS: Can I establish
18 something? Erasmia, you said you didn't want to
19 follow my process. You don't have enough to present.
20 You'd rather have a conversation with the committee,
21 is that okay?

22 MS. LOIS: Yes.

23 CHAIRMAN WALLIS: That's okay. All right.

24 MS. LOIS: I would like to finish with --

25 VICE CHAIRMAN SHACK: I have to understand

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1 what it is they're doing.

2 MEMBER APOSTOLAKIS: Well, let her finish
3 first, and then -- why don't you finish, Erasmia, and
4 then we'll --

5 MS. LOIS: Okay. I will answer your
6 question. The only thing I would like to add here is
7 that we are not quite sure how we are going to
8 determine success in the benchmarking exercise. It's
9 a very early process. I would like to, you know,
10 personally express appreciation for what the committee
11 is doing. It helped -- you are helping us on that.
12 It's not -- I think we are in full agreement here.

13 It's not that we know how to do it, but --
14 and we both recognize that the variability in the
15 bottom line number among methods is an issue that we
16 have to address. We believe that this benchmarking
17 exercise -- I don't know if the right word
18 "benchmarking" -- but this exercise, by observing
19 simulator crews to perform, and then collecting the
20 data, having the experts have -- ahead of time to have
21 predicted -- predict what are the potential failures
22 and to what degree --

23 VICE CHAIRMAN SHACK: But suppose he
24 predicts an error rate of .01, how do you -- how do
25 you measure that in the experiment?

1 MEMBER APOSTOLAKIS: You don't.

2 VICE CHAIRMAN SHACK: You don't. Okay.

3 MEMBER APOSTOLAKIS: That's a straight
4 answer. You don't. The simulator exercises will not
5 produce Monte Carlo simulations where you calculate
6 the probability. They are evaluating assumptions in
7 performance-shaping factors. Like, you know, one of
8 the results, as I remember, they tested four crews or
9 five. Four of them did something within five and a
10 half to six minutes. One of them was 11 minutes. And
11 then, they asked, what? What happened? What was the
12 factor that affected them? This is the kind of
13 fundamental insight you are going to get from this.

14 MR. BANERJEE: And what was the factor?
15 I mean, can we have something concrete to -- as
16 examples?

17 MEMBER APOSTOLAKIS: It's in the report.
18 I don't remember.

19 MS. LOIS: The main factor in that
20 specific case was communications among the crews.

21 MEMBER APOSTOLAKIS: Yes.

22 MS. LOIS: How the SDA was not -- the way
23 they were doing their work, people were totally not
24 communicating about what they had to do. So we really
25 find some very important things. And to answer your

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1 question here, you do not have the capability to run
2 a thousand experiments of the same, but you do have
3 the capability in the simulator to have -- to make
4 scenarios a little bit more difficult. And then, you
5 are observing some failures, and you understand why
6 the --

7 VICE CHAIRMAN SHACK: But you'll still
8 have to make a judgment, then, to get your
9 probabilities.

10 MEMBER APOSTOLAKIS: Exactly. Exactly.

11 VICE CHAIRMAN SHACK: It will just be a
12 more informed judgment.

13 MS. LOIS: That's the method, the
14 judgment --

15 MEMBER APOSTOLAKIS: Yes.

16 MEMBER CORRADINI: Can I repeat what I've
17 heard, since we're -- you have -- there is a few -- I
18 heard you agree to a few ground rules, which surprised
19 me but it's great, which is the presentation is kind
20 of over, conversation is okay. So as part of the
21 conversation, I want to repeat some things so I get it
22 right.

23 One is, there is three NRC models, that
24 you do agree with what George's hypothesis -- or
25 thesis was, and Dana restated it, but it -- it struck

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1 me as interesting, which is they do have fundamentally
2 different assumptions. They're not --

3 MEMBER APOSTOLAKIS: Some.

4 MEMBER CORRADINI: Some. They're not
5 like, you know, Model X, and then Model Y is just a
6 more detailed Model X, and Model Z, which is just a
7 deterministic, less detailed, or a different branch of
8 Model X. There are literally three models with
9 potentially three different sets of some -- some of
10 the assumptions were fundamentally different. I heard
11 you kind of agree to that. Is that true?

12 MS. LOIS: That is true.

13 MEMBER CORRADINI: Okay. All right. So
14 that's one.

15 Two, that the Halden exercise, as you've
16 been trying to explain it -- I'm still not sure
17 exactly what it is, but it's the equivalent of I went
18 to Kewaunee, and I watched them run essentially a
19 small break LOCA in their simulator, watched the crews
20 respond to it, except that you run it with five or six
21 different crews, and then you threw curves at them in
22 terms of what should be the standard operating
23 procedure to address a small break and try to give
24 them deviations and things that will try to knock them
25 off and see if they either succeed or don't succeed.

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1 Did I hear that right?

2 MEMBER APOSTOLAKIS: That's also correct.

3 MS. LOIS: Yes. But ahead of time, you
4 are -- now your expert -- your HRA expert would know
5 that Kewaunee has a -- had a small break --

6 MEMBER CORRADINI: Yes.

7 MS. LOIS: -- and these the correct --

8 MEMBER CORRADINI: So the three models of
9 the four models were predicted.

10 MS. LOIS: Use your numbers --

11 MEMBER CORRADINI: Okay.

12 MS. LOIS: -- for those situations, and
13 then you observe what happens.

14 MEMBER CORRADINI: But then you said
15 something that really got me, which is after you did
16 that you said you're still not sure how to evaluate
17 the results of the experiment relative to the
18 predictions. Did I mishear that?

19 MS. LOIS: No, no. I said it will give us
20 the capability to evaluate.

21 MEMBER CORRADINI: And so now, like an
22 experiment that I do in my lab, or somebody does for
23 me in my lab, since I don't do that anymore, is so do
24 you have the attributes and the procedure to do the
25 comparison, or are you going to do the comparison

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1 procedures on the fly?

2 MS. LOIS: Okay. So then, we are
3 determining the -- we are determining the -- what we
4 call "experimental design." We have to -- to define
5 what we call "success," at what point we would be able
6 to say that, yes, SPAR-H successfully predicted, to
7 come up with the number it's -- you know, given the
8 small number of experiments, it's very unlikely.

9 But if, for example, we see that workload
10 is a big issue in this specific example, and SPAR-H
11 identified workload as the driver of the human
12 failure, we believe that this is really good.

13 MEMBER APOSTOLAKIS: In the experimental
14 design, though, you will bring all four models.

15 MS. LOIS: Yes.

16 MEMBER APOSTOLAKIS: Okay.

17 MS. LOIS: We are going to bring every --
18 I believe -- correct me if I'm wrong -- ACRO and CBDT.

19 MEMBER APOSTOLAKIS: Okay.

20 MS. LOIS: And the NRC and I guess -- NRC
21 and EPRI is going to benchmark or to test PIRT, and
22 then we have ATHEANA and SPAR-H.

23 MEMBER APOSTOLAKIS: That's very good.
24 That's very good. Now -- I forgot what I was going to
25 say.

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1 MR. BANERJEE: What's even more important,
2 something that you said, was you tried to understand
3 the reasons why these models don't agree. And I don't
4 know if such a small set of experiments can actually
5 shed light on what is right or wrong, but it's
6 worthwhile finding out at least what the reasons are,
7 you know?

8 MEMBER CORRADINI: So that actually leads
9 me to another question, which INPO, for their training
10 and their reaccreditation of all the plants, part of
11 the observations are always these crew observations.
12 Is there just a disconnect on -- or is it
13 inappropriate to understand from all of the simulator
14 training and all of the various events at all the
15 plants, to try to extract something that you can use
16 as a comparison to these models? It just seems to me
17 they are doing this again and again and again at all
18 the plants, at least when I was at Kewaunee watching
19 this

20 MEMBER BONACA: Yes, but they don't --
21 they don't put in the monkey wrench that they do at --

22 MEMBER CORRADINI: Well, yes, they do, and
23 the simulator training is --

24 MEMBER BONACA: Yes, you do some
25 variations, but I'm saying that when you are looking

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1 at the center-oriented procedures to see if they --
2 they seem to fall back on the center oriented. But
3 this is something -- something different.

4 MEMBER APOSTOLAKIS: It is different.

5 MEMBER CORRADINI: So it's a more
6 controlled environment.

7 MEMBER APOSTOLAKIS: I would like -- IU
8 mean, this is great. But what I also would like to
9 see is, before that or in parallel with this, to see
10 a critical evaluation of the details of the models by
11 people like you. What do I mean by that?

12 You mentioned the two reports, the NUREGs
13 that looked at model's best -- good practices, and so
14 on. They are -- as I recall the good practices
15 report, it said you had a number of steps that you
16 thought were the good -- a good thing to do, and then
17 you searched to see whether each model -- how each
18 model addressed these steps.

19 And it was at a certain level that said,
20 yes, this model does do this. Okay? This model does
21 it peripherally, but not in detail. What I'm saying
22 is -- what I mean by "critical evaluation" is to go a
23 couple of levels down and say, yes, this model does
24 it. They account for dependencies, they account this
25 way, and we think that's not right for such-and-such

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1 a reason.

2 In other words, evaluate the way they do
3 it, not just the fact that they do it. And I think
4 that will be a great thing to have in addition to the
5 experiments, and then I think everybody will be --
6 will begin to -- first of all, another thing that I
7 have noticed, and maybe you disagree, but as you know
8 I had an opportunity to look at the EPRI model and the
9 ATHEANA model in more detail, and I must say I was
10 surprised by how much -- how similar they are in many
11 respects.

12 I thought that, you know, the EPRI model
13 they -- and I hope Jeff will forgive me. I thought it
14 was on a much shakier ground than it turned out to be.
15 And we had access to somebody from a utility who is
16 actually using the model, and his response to a lot of
17 questions -- of our questions were very reasonable.
18 In fact, they were doing many of the things that
19 ATHEANA does.

20 So my -- the thought in my mind is: why,
21 then, not try to blend them?

22 MS. LOIS: Okay. I think there are two
23 things.

24 MEMBER MAYNARD: At least approve it. You
25 would approve --

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1 MS. LOIS: Two different things. One is
2 what we call good practices. And this is the SHARP-1
3 framework that EPRI created at the beginning of HRA,
4 and then the good practices that we lately documented.
5 Those guidance documents tell you how to create your
6 HRA model as interaction with the PRA.

7 I believe that the calculator has been
8 improved tremendously after the good practices
9 computation. And, therefore, a lot of the
10 fundamentals that -- if this was derived from the
11 ATHEANA development and from reviewing the IPEs and
12 really developing an experience of what's going wrong,
13 you know, why results in human reliability are so
14 different, have addressed through those guidance
15 documents.

16 And we believe that the calculators
17 probably will be a very good tool to do --

18 CHAIRMAN WALLIS: Erasmia, can --

19 MS. LOIS: We do not object to that.

20 CHAIRMAN WALLIS: -- can I now begin the
21 conversation? I see you've got a slide up here. I'd
22 like to address that. I mean, you have a plan. Now,
23 when you have a plan, I first like to see what's the
24 objective. And the objective, I gather, is to assess
25 the validity of several models. If it's not, then

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1 tell me something else.

2 MS. LOIS: Yes.

3 CHAIRMAN WALLIS: Then, you're going to
4 run some experiments and collect data. So where we
5 might be able to help would be if you could tell us
6 why these particular experiments measure the key
7 things which enable you to evaluate the models, and
8 what kind of data you need to collect, you know, maybe
9 how many you need to collect.

10 You know, all those kind of -- are you
11 just exploring the kinds of things which might
12 influence behavior, or are you actually assessing and
13 validating some models, which seems to be part of the
14 discussion? In that case, the plan has to address
15 that in some specific way.

16 MS. LOIS: So we'll be happy to come back
17 in January and address that.

18 MR. BANERJEE: Is this a major facet of
19 your verification and validation program for these
20 models, these experiments?

21 MS. LOIS: I believe it is.

22 MR. BANERJEE: So, then, it would be nice
23 to see the experimental plan and how they're
24 addressing each issue with regard --

25 MEMBER APOSTOLAKIS: Yes.

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1 MR. BANERJEE: What are the issues with
2 regard to the models? How are these experiments
3 addressing that? What do you expect to get out of
4 them at the end of the day?

5 MEMBER APOSTOLAKIS: Well, let me ask you
6 another question, because we keep talking about
7 agreements, and so on. Where do you think, Erasmia,
8 that there is a disagreement around the table? Is
9 there a disagreement anywhere, or are we just
10 violently agreeing?

11 MS. LOIS: I think we agree. I believe we
12 agree.

13 MEMBER APOSTOLAKIS: You are focusing --
14 let me, then, see if I -- if we -- do we -- I mean,
15 the experimental design, I agree with what Professor
16 Banerjee just said, and it will be great. We can meet
17 with the subcommittee if you'd like to discuss it.

18 But I still think that before we jump into
19 it, maybe in parallel or a little bit ahead, you
20 should produce a document like the good practices that
21 goes with a different name, goes deeper into the
22 models, and evaluate -- and say the fundamental
23 premise of this model is this -- the fundamental
24 premises. I mean, there are a number. And then,
25 start comparing them, and then of course you will need

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1 to collaborate with Jeff or other representatives of
2 EPRI to make sure that you get the right perspective
3 from their side.

4 MS. LOIS: Can I ask Alan Kolokzcowski to
5 answer this question?

6 MEMBER APOSTOLAKIS: Oh, absolutely.

7 CHAIRMAN WALLIS: Well, I think what
8 you're saying, George, is what we're saying, too --
9 find out the differences between the models, find out
10 the way to run the experiment to tell which one is
11 right or how -- if they're both wrong or something,
12 how good they are --

13 MEMBER APOSTOLAKIS: But I don't want to
14 do only -- yes, there needs to be something about the
15 dependence between human errors and the models do it.
16 I wanted to go down to how they do it and whether the
17 analysts agree. And, again, the objective here is not
18 to blame anybody.

19 The objective is not to say, "You are bad
20 and I'm good." The objective is, you know, after 20,
21 25 years of working in this field it's time to listen
22 to the other guy, and it's time to try to see where we
23 agree and where we disagree at the detailed level.
24 That's my objective here.

25 MS. LOIS: We totally agree with you, but

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1 we believe -- and that's why I would like to have
2 either John Forester or Alan Kolokzcowski do -- answer
3 that. We believe that in the methods evaluation, with
4 respect to good practices, although that's -- we
5 naturally -- we went beneath that and we identified
6 the characteristics and the basic assumptions of these
7 models, and we tabulated it.

8 And we characterize them in terms of, you
9 know, goodness or a lack of goodness, whatever that
10 is. We didn't do it in a -- the level of detail that
11 you probably asked to do.

12 MEMBER APOSTOLAKIS: Well, then it will be
13 very easy for you to do what I want.

14 MS. LOIS: But I don't know if it's
15 possible. Is it? We can do these things?

16 MEMBER APOSTOLAKIS: It's possible.

17 DR. COOPER: It's very context-specific,
18 and that's one of the reasons why there was first a
19 good practices, and then a methods evaluation with
20 respect to the good practices. As Erasmia explained,
21 good practices addresses really how you do an HRA, the
22 various steps of an HRA process overall, whereas many
23 of them -- the HRA methods in fact only address
24 quantification.

25 So many of those process steps are really

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1 sort of outside of a specific quantification method,
2 and they really rely on how they do things. So those
3 good practices were laid out, and then we -- the
4 methods evaluation, then, we're supposed to look at,
5 then not just -- those methods, how they matched up to
6 good practices, but also something with respect to
7 implementation.

8 But the challenge all along is: how do
9 you make that generic? Because for one application --
10 let's say for at power -- it's different than it is
11 for shutdown or for fire, because you have -- you need
12 different capabilities. So what may be good for at
13 power may not be -- it may not be good enough for
14 fire.

15 You know, the set of performance-shaping
16 factors that you want for at power may be different
17 for fire. Maybe they should be. So that's the -- to
18 be able to do something, you know, very detailed
19 about, you know, evaluating some aspect of their
20 model, really has to be within the context of what
21 specific application you're trying to use HRA for.

22 MEMBER BONACA: When -- go ahead.

23 MEMBER SIEBER: I don't think you can
24 successfully benchmark these models either. There is
25 a lot of aleatory uncertainty involved in human

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1 performance, and it's not like you're measuring some
2 engineering property and writing an algorithm that
3 will predict some engineering performance.

4 I think it's much more difficult in the
5 human performance area, and probably the best you can
6 do is evaluate these qualitatively to decide whether
7 the right factors are there and properly treated,
8 rather than put in your mind in advance that you want
9 to reduce the number of models that you have. I think
10 that's --

11 MEMBER BONACA: That's why for major
12 actions in PRA the licensees depend heavily on the
13 simulator observation.

14 MEMBER APOSTOLAKIS: If you look at SPAR-
15 H, it says somewhere there, here are the various
16 levels of stress. And if the stress level is at this
17 level -- if the stress is at this level, multiply the
18 human error probability, the nominal probability, by
19 eight. And I'm sitting there and I'm saying, "Why?"
20 Is that consistent with what ATHEANA says you should
21 do? Why 8 and not 15?

22 See, this is the question that I think
23 somebody has to address.

24 MS. LOIS: You have to have data, and we
25 are creating the HERA database, which will help us

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1 to --

2 MEMBER APOSTOLAKIS: No.

3 MS. LOIS: -- potentially address some of
4 these questions, and we are going to do simulator --

5 MEMBER APOSTOLAKIS: My point is that
6 first you have to ask the question, and I'd like to
7 see a document that says, "Here is what they do," and
8 it's maybe open to question whether these are the
9 appropriate levels, maybe the factors are up in the
10 air and they have to be validated. That's what I
11 don't see.

12 MR. FORESTER: George, this is John
13 Forester. I'd just like to comment on that. In terms
14 of the HRA reviews, there is a discussion section in
15 each of the method reviews where we do address the
16 underlying assumptions of the method and try and
17 address, you know, what are the problems with the
18 matters, what are the advantages and disadvantages,
19 and really what are the weaknesses and strengths in
20 terms of their assumptions, and so forth.

21 It is a bit buried in there, but I do
22 believe there is a fairly sound discussion that gets
23 at the strengths and weaknesses of the methods. Now,
24 that could be extracted out, but I think there is some
25 fairly good information in there on that.

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1 CHAIRMAN WALLIS: Guys, when you design
2 something, you have a customer, and you are producing
3 these methods for someone to use. And, really, the
4 only question is: when you tell the customer
5 something, how good is it? How -- what are you going
6 to tell the customer this is good for? That's what
7 matters eventually.

8 MEMBER APOSTOLAKIS: That's right.

9 MEMBER KRESS: So why not think very hard
10 about how can one determine the uncertainty in the
11 models.

12 MEMBER APOSTOLAKIS: Yes. I mean --

13 MEMBER KRESS: That looks like a tough
14 chore to me. You can't just look at the model and do
15 a Monte Carlo uncertainty.

16 MEMBER APOSTOLAKIS: No.

17 MEMBER KRESS: You just don't have the
18 information. So it seems like you need to think about
19 how to conduct the benchmark tests to arrive at some
20 uncertainty in the predictions.

21 MS. LOIS: And we could potentially have
22 to go back and do exactly what Dr. Apostolakis says,
23 in the sense in order to ask the right questions for
24 each one of the models, we'll have to go deeper as to
25 what the models are assuming.

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1 MEMBER APOSTOLAKIS: That's what I'm
2 saying.

3 MS. LOIS: Yes.

4 MEMBER APOSTOLAKIS: And you have done
5 already a lot of it. I'm not denying that.

6 MS. LOIS: Gareth, do you want to --

7 MR. PERRY: This is Gareth Perry again.
8 I do think that it would be useful to do some of these
9 simulator exercises at Halden, but I think we have to
10 be realistic. Really, if you think about it, I can't
11 remember how many PSFs SPAR-H has. Eight? Okay.
12 ATHEANA has 60 or something. CBDT has several.

13 There's no way that you're going to be
14 able to conduct experiments that will enable you to
15 calculate the impact of changing PSFs on human error
16 probabilities for sure. So, for example, asking
17 whether the stress changes by a factor of five,
18 because it increased the -- sorry, a high stress
19 increases the failure probability by five is not
20 something we're going to be able to answer with these
21 issues.

22 MEMBER APOSTOLAKIS: That's why I want
23 this evaluation separate.

24 CHAIRMAN WALLIS: That's the kind of
25 information I like to hear. I mean, that's useless to

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1 me. If you've got 60 parameters in the model, and
2 you're going to try and run experiments, that's an
3 awful lot.

4 MEMBER POWERS: Well, that's a question I
5 think that -- I don't know if this -- these
6 benchmarking --

7 CHAIRMAN WALLIS: Well, I would say right
8 up front, that's a useless model. If it has 60
9 parameters, which you're going to adjust to get an
10 answer, that's absolutely useless.

11 MEMBER ARMIJO: Yes. You know, I'm not in
12 -- from this area, but I would -- I would look for
13 something -- a ranking of what you currently believe
14 are the most important --

15 CHAIRMAN WALLIS: Yes.

16 MEMBER ARMIJO: -- shaping factors, and
17 then separate effects tests in some way, maybe in the
18 laboratory environment like Halden, to really see if
19 these stress or operator fatigue or some other factor
20 really does have that much of an effect.

21 MEMBER SIEBER: But you aren't going to be
22 able to tell.

23 MEMBER ARMIJO: Well, I'm just saying, I
24 don't know how to do this sort of stuff, but it seems
25 to me when you have that many variables operating

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1 simultaneously, I don't know how you --

2 MEMBER APOSTOLAKIS: It's precisely for
3 that reason that I don't think we should rely only on
4 the experiments. That's why I think we need the
5 experts in the field to create this comparative
6 evaluation and raise questions. Maybe you don't want
7 to say that this is wrong, but at least ask the
8 question, because it's true what Gareth said. You
9 cannot test all these things here.

10 MR. BANERJEE: No. But what they were
11 saying, if I understood it correctly, was that they
12 would be pre-predictions of this --

13 MEMBER APOSTOLAKIS: Of importance.

14 MR. BANERJEE: Yes, of --

15 MEMBER APOSTOLAKIS: Importance of the
16 factors.

17 MR. BANERJEE: -- of these, let's say,
18 benchmarking exercises. And these pre-predictions may
19 or may not be right. But if they were not right, they
20 would try to understand why.

21 MEMBER APOSTOLAKIS: That's right.

22 MR. BANERJEE: I mean, I think this field
23 is going to be open to qualitative attacks for a long,
24 long time. I mean, you're not going to have
25 quantitative --

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1 MEMBER APOSTOLAKIS: Yes.

2 MR. BANERJEE: But even if you look at,
3 say, the so-called predictive methods for good
4 mechanics of something, these codes have hundreds of
5 parameters in them which are adjustable. And the
6 number of experiments that can be done are very
7 limited.

8 So the situation isn't all that different.
9 I mean, we don't test every parameter. We may choose
10 five or six which we think are really important, and
11 that's our judgment call. In some, you know, exercise
12 of the models we find out where the main uncertainties
13 lie. I'm sure you guys do the same thing in some way.
14 You try to figure out, what are the most important
15 factors in these models? And see how they are
16 affected in an exercise like this.

17 But I think we should encourage this and
18 get back to really seeing what the results are. It
19 would be very interesting.

20 MEMBER APOSTOLAKIS: Yes, we are not
21 discouraging it.

22 MR. BANERJEE: And I'm just really
23 wondering whether there is more data around from even
24 the day-to-day simulator training exercises and all,
25 which must be somehow put into these models, right?

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1 I mean, you are extracting and inducing data every
2 day, I would think, from all these training exercises.

3 MS. LOIS: So we have this activity on
4 collecting data, which is very resourceful. Actually,
5 it requires a lot of resources to take an event and
6 evaluate it from a human reliability perspective, and
7 then put it in the database.

8 And the activity that starts out with
9 LERs, more are looking at events that are -- have had
10 some kind of precursor analysis, etcetera. So it's
11 one activity that we're pursuing, and we hope two or
12 three years from now to be able to do -- to use this
13 data as objective measures of the -- to test the
14 underlying hypothesis or predictability of the HRA
15 methods.

16 That's a long-term activity, which we
17 have, but this one -- the Halden experiments give us
18 a controlled environment to do experiments, which I --
19 we believe that will help us to expedite our process
20 for understanding the methods.

21 MR. BANERJEE: Well, I like the pre-
22 prediction --

23 MEMBER APOSTOLAKIS: To summarize now --
24 we have to summarize. To summarize, it seems to me if
25 there is a disagreement it is -- it is the degree to

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1 which you rely on the experiments. I would like to
2 see -- and I'm willing to say, fine, you've done some
3 of it already in the good practices, but I'd like to
4 see a critical evaluation of these models and their
5 assumptions in parallel with this activity, which I
6 believe is very important, but I wouldn't rely only on
7 this activity.

8 And I think if you have a group of experts
9 who are familiar with these methods, have used them,
10 you certainly have people that have used SPAR-H,
11 ATHEANA obviously, but maybe get Jeff or somebody who
12 is experienced with the EPRI model who can go a little
13 deeper than what we have done. I think that would be
14 extremely valuable to everybody, and then we'll see
15 what happens. Then we'll see what happens, but it --

16 CHAIRMAN WALLIS: George, how do you
17 critically evaluate without an experiment? Unless you
18 -- I can evaluate whether it's mathematically
19 consistent or something, but that's not the question
20 here. The question is: are these hypotheses valid?
21 Isn't that the thing?

22 And then, if they are valid, how do you
23 quantify them in some way?

24 MEMBER APOSTOLAKIS: But, first, I want to
25 have an identification of these hypotheses. I want

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1 them to raise the questions first.

2 CHAIRMAN WALLIS: So you want a logical
3 evaluation of the hypotheses.

4 MEMBER APOSTOLAKIS: Yes.

5 MR. BANERJEE: But there was -- and
6 somebody said --

7 MEMBER APOSTOLAKIS: And there is -- these
8 people are very experienced, right?

9 MR. BANERJEE: -- that there was an
10 evaluation done.

11 MEMBER APOSTOLAKIS: Sorry?

12 MR. BANERJEE: Somebody said on the phone
13 that the evaluation is buried in --

14 MEMBER APOSTOLAKIS: No, to some extent
15 it's done. And what I'm saying is, great, build on
16 that and go a couple of levels deeper to actually look
17 at how each model is doing certain things and raise
18 questions, compare with what -- it's a comparative
19 evaluation, really. ATHEANA does this in this area,
20 this other model does that, and maybe there are some
21 questions.

22 CHAIRMAN WALLIS: Now, can we ask Erasmia
23 to summarize at this time?

24 MEMBER APOSTOLAKIS: I'm done. Do you
25 have any summary responses?

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1 CHAIRMAN WALLIS: What do you want us to
2 take away from this?

3 MEMBER APOSTOLAKIS: What I'm really
4 struggling for is: how do we add any value in a
5 letter? I mean, we discussed all kinds of stuff, and
6 I don't see there's any sort of real focus on what we
7 need to say.

8 MR. BANERJEE: It's very important.

9 CHAIRMAN WALLIS: George, can you tell us
10 what you want us to say, and then maybe we can say it
11 -- we can see if that's appropriate? What would you
12 like us to say? I had to ask Gareth to -- are you the
13 customer, Gareth, for this work?

14 MR. PERRY: Sort of, yes.

15 CHAIRMAN WALLIS: Yes, I think it would be
16 nice to hear from the customer, too. So can you both
17 summarize your --

18 MEMBER APOSTOLAKIS: Can I also tell you
19 what I would say?

20 CHAIRMAN WALLIS: No, no, George. You're
21 not allowed to say anything.

22 (Laughter.)

23 MEMBER APOSTOLAKIS: No. Because I want
24 them to react to it.

25 CHAIRMAN WALLIS: I want them to tell us

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1 what would be most useful for us to say in a letter to
2 help them. Now, can you tell us --

3 MS. LOIS: I would ask John Monninger to
4 do the --

5 CHAIRMAN WALLIS: Your manager?

6 MS. LOIS: John Monninger.

7 CHAIRMAN WALLIS: Okay. Ask the manager,
8 then. You have any opportunity now to tell us what
9 you'd like to -- like us to say in our letter.

10 MEMBER APOSTOLAKIS: What is it that you
11 would like?

12 MS. LOIS: John, do you want to make --

13 MR. MONNINGER: This is John Monninger
14 from the Office of Research. I guess first off, you
15 know, we weren't explicitly requesting a letter. But
16 if a letter was to come, you know, from the ACRS, one
17 thing we think is important to recognize, the
18 advancements or the contributions, or the work that
19 has been done to date in, you know, the establishment
20 of the good practices and the evaluation of the
21 methods against the good practices.

22 CHAIRMAN WALLIS: Didn't we send you a
23 letter on that already?

24 MEMBER APOSTOLAKIS: Yes, we did.

25 MR. MONNINGER: Yes. Yes, you did. The

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1 second thing with regard to the planned experiments
2 with Halden, we are still, you know, in the planning
3 phases with them. The kickoff meeting is later I
4 guess in the beginning part of December.

5 I think, you know, something along the
6 lines of, you know, a qualitative endorsement of the
7 proposal to go forward with the program, but with, you
8 know, some type of caveats to the extent that the
9 committee would like to be informed of the objectives,
10 the approach, etcetera. You know, further briefings,
11 interactions on the program would be, you know,
12 helpful.

13 You know, the motion with regards to the
14 critical evaluation of the HRA methods, I guess one
15 question comes to my mind, you know, do you do that,
16 you know, if we were to do that, or, you know, if we
17 had the resources to do that? Would you do that in
18 parallel, or would you proceed first with the -- you
19 know, the benchmarking exercises? And then, you know,
20 see what the results of that are, and then, you know,
21 go a step below into the critical evaluation of the
22 methods and models. So --

23 MR. THORNSBERRY: Dr. Wallis, I'd like to
24 also -- the staff is here on our request. This falls
25 under the category of an ACRS initiative. So like

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1 John said, they weren't specifically coming to us to
2 ask for a letter. It was our initiative led by Dr.
3 Apostolakis.

4 MEMBER APOSTOLAKIS: They'd rather be left
5 alone.

6 MR. THORNSBERRY: And it fell out of our
7 subcommittee meeting in the summer. So it's really
8 kind of our initiative is why they're here, to set the
9 stage and tell us what they've been doing. But the
10 things that came out of the subcommittee led us to
11 this, so that we could give some additional guidance
12 beyond what they're already doing.

13 CHAIRMAN WALLIS: Do you have anything to
14 say, Gareth?

15 MR. PERRY: Actually, I think a lot of
16 what we need is probably being done in 1842, to the
17 extent that there is a review of the models that
18 explains what the models can and what they can't do.
19 It probably would help to have maybe a little more
20 confidence in some of the models that we use, such as
21 SPAR-H. But I think certainly an attachment of
22 whether it's good enough for the purposes for which we
23 use it is -- certainly would be helpful.

24 Personally, I'm interested in the results
25 of these experiments, particularly if they -- if they

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1 -- what they can do is to highlight for us what are
2 the most important performance-shaping factors. And
3 I would prefer them to be performance-shaping factors
4 that somehow you can measure as opposed to something
5 like stress, which is something you have to -- you
6 have to think about what it means.

7 But I think -- I think certainly I'm very
8 happy with the 1842 document. I think that was really
9 helpful to us.

10 CHAIRMAN WALLIS: This is the one that we
11 reviewed before.

12 MR. PERRY: Yes, this is the one you
13 reviewed before.

14 CHAIRMAN WALLIS: We've written a letter
15 on that already.

16 MR. PERRY: Yes, yes.

17 MEMBER BONACA: I have a question for
18 Gareth. Right now, since the SPAR-H is being used to
19 model different plants out there for which there are
20 already PRAs, I'm sure there are many instances the
21 staff reviews HRA assumptions in this -- in this
22 report against what you're predicting yourself. I
23 mean, do you find some convergence there taking place?
24 I mean, with respect to what you used in the past, or
25 do you find wide differences still?

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1 MR. PERRY: Actually, that's hard for me
2 to say, since I don't get involved with the reviews
3 myself.

4 MEMBER BONACA: I understand.

5 MR. PERRY: But let me tell you one of the
6 things that we do have problems with, and particularly
7 in things like the significance determination process.
8 It's not the routine human error probabilities like
9 failure to depressurize, for example. We don't --
10 there seems to be general agreement that it's within
11 a certain band.

12 But it's the -- it's the unusual things
13 like the recovery actions that our licensees claim
14 that they can do in a certain time to demonstrate that
15 this particular event was not a high-risk event. And
16 I think a lot of those things are actually not even
17 addressed by many of the models. The models just
18 don't apply in those situations.

19 CHAIRMAN WALLIS: Okay. George, was it --

20 MEMBER APOSTOLAKIS: Well, let me tell you
21 what I think.

22 MR. BANERJEE: Excuse me. Why don't the
23 models apply in those regions?

24 MR. PERRY: Because the majority of the
25 models have been developed to address control room

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1 responses to procedures, I think, in the main. I
2 mean, yes, you can adapt ATHEANA probably to go beyond
3 that. But ATHEANA isn't the method that is widely
4 used by industry, for example.

5 MR. BANERJEE: But wouldn't that be an
6 important initiative on the part of Research, to try
7 to collect this information that through the
8 significance evaluation process is being really
9 developed and used, and to gather an understanding of
10 what is happening out there insofar as -- I mean,
11 there's a wealth of information being generated there
12 at the working level on -- in the field.

13 MR. PERRY: Yes.

14 MR. BANERJEE: And I think that that's
15 something that could be mined.

16 MR. PERRY: Yes, and I think probably that
17 could go into here, probably is where that -- that
18 would be useful input to HERA I think.

19 MR. BANERJEE: But coming back to -- you
20 said that one of the major areas where you have a need
21 currently -- recovery actions or whatever 00 which are
22 not necessarily control room oriented, how do you
23 handle these right now?

24 MR. PERRY: Typically, we handle them
25 through discussion with the licensee. They'll tell us

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1 what they think is the case, and we will inquire --
2 typically, what we look at actually is the -- is what
3 ATHEANA could call the context, and make a decision on
4 that basis whether we think the action is feasible,
5 and then we either reach agreement or disagreement
6 with the licensee on whether we think it's a feasible
7 action.

8 MR. BANERJEE: But would you like to have
9 something a little more -- or is this a satisfactory
10 situation?

11 MR. PERRY: You know, for what we're
12 dealing with, this -- I'm not sure if you're familiar
13 with the significance determination process, but it's
14 really meant to be a quick evaluation to determine the
15 extent of the additional inspection that we give to
16 plants. I don't think we need a major new tool to do
17 that. I think we can -- we should be able to deal
18 with it.

19 But I think what we do need, though, is a
20 little bit more basis perhaps on what are the
21 important factors that decide whether an action is
22 feasible or not.

23 MEMBER APOSTOLAKIS: Yes, let me -- I'd
24 like to read the three lines that they have here for
25 recommendations.

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1 MR. BANERJEE: Well, just one thing I
2 wanted to ask you, because this hasn't really -- I
3 haven't got to the end of this. We hear about people
4 having to switch from hot leg injection to cold leg
5 injection, or cold leg injection to hot leg injection,
6 a variety of stuff that people have to do in various
7 accidents.

8 Is that covered by these models, or is
9 that falling under what is --

10 MR. PERRY: No, that would be covered by
11 the models.

12 MR. BANERJEE: That will be covered.

13 MR. PERRY: Because those are
14 proceduralized actions.

15 MR. BANERJEE: Okay.

16 CHAIRMAN WALLIS: Okay. Are we --

17 MEMBER APOSTOLAKIS: So what -- I'd like
18 to know in the next minute the reaction of the staff
19 -- this is important -- if the recommendation was
20 this. The staff should evaluate the agency's human
21 reliability models and the models included in the EPRI
22 HRA calculator and create a plan for the development
23 of either a single model for the agency to use or an
24 integrated suite of models to be used in specific
25 circumstances. Would that be something that would

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1 cause a heartburn?

2 CHAIRMAN WALLIS: Yes, you should create
3 a model which can be used for the purposes of --

4 MS. LOIS: A model or a suite of models.

5 MEMBER APOSTOLAKIS: Yes, or a suite of
6 models. But right now we're asking for a plan.

7 CHAIRMAN WALLIS: Aren't they doing that
8 already? I mean, I hope they're doing that already.

9 MR. MONNINGER: It sounds very broad and
10 open. I mean, it sounds very feasible. I mean,
11 you're saying either a single one or a suite of
12 models, that would be appropriate for the
13 circumstances.

14 MEMBER APOSTOLAKIS: But I would like to
15 see a plan that says by this time we are comparing
16 these, we are hoping to get these conclusions. Then,
17 we do these experiments. This is the objective. This
18 is what we are getting by this time. Then, by that
19 time we're going to do something else. Having in mind
20 this ultimate goal of either one model or a suite of
21 models that are not developed independently for
22 specific applications. So, yes, it's broad.

23 CHAIRMAN WALLIS: I guess what we're
24 saying, though, is that the plan should be more
25 structured.

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1 MEMBER APOSTOLAKIS: Right.

2 CHAIRMAN WALLIS: And there should be some
3 logical threads which we can look at, and so on.
4 That's --

5 MEMBER APOSTOLAKIS: So what would be
6 something that --

7 CHAIRMAN WALLIS: But I don't think they
8 asked them to develop a plan. They already have a
9 plan, so we are commenting on it, aren't we? George?

10 MEMBER APOSTOLAKIS: Well, they have a
11 plan, and I'm asking for a new plan. I don't know.
12 A sub-plan. So the plan that they presented to us is
13 much broader. It's a human factors, human -- this is
14 specifically human reliability, a plan to achieve a
15 specific goal, either a single model or a suite of
16 models, an integrated --

17 CHAIRMAN WALLIS: Well, we don't quite
18 know which is appropriate yet, until we look at the
19 context of this, do we?

20 MEMBER APOSTOLAKIS: What?

21 CHAIRMAN WALLIS: It may be that the use
22 requires several models. I don't know.

23 MEMBER APOSTOLAKIS: But that's what it
24 says, or an integrated suite of models.

25 CHAIRMAN WALLIS: So a plan -- you're

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1 looking for a logical plan is what you're --

2 MEMBER APOSTOLAKIS: Yes. And I don't
3 hear any objection.

4 CHAIRMAN WALLIS: But that's what anybody
5 would do, isn't it? I mean, it's almost like saying
6 that they're having an illogical plan now. Therefore,
7 they need a logical one. Is that --

8 MEMBER APOSTOLAKIS: Well, it's a matter
9 of focus and direction, and I'm sure a lot of it they
10 are already doing, but now --

11 CHAIRMAN WALLIS: Do we want to change --

12 MEMBER APOSTOLAKIS: -- it's going to be
13 specific: this is where we want to go, and this is
14 how we're going to get there.

15 CHAIRMAN WALLIS: Okay.

16 MEMBER APOSTOLAKIS: Okay. And with that
17 happy thought, I'll turn to back to you, unless --
18 Dana?

19 MEMBER POWERS: I have a variety of
20 questions to ask.

21 MEMBER APOSTOLAKIS: Do you want to ask
22 them now or during the -- oh, okay.

23 MEMBER POWERS: I don't want to ask them
24 during the break, no.

25 (Laughter.)

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1 MEMBER APOSTOLAKIS: You don't. Okay. Go
2 ahead, then.

3 MEMBER POWERS: If we could turn to page 3
4 on the viewgraphs. It indicates that you're
5 collaborating international entities. I'm wondering
6 what those entities were. Is that just Halden? I see
7 later on you'd interact with IRSN.

8 MS. LOIS: In actuality, the plan -- and
9 probably I should use my backup slides. Let's do
10 that. To have -- to have a steering committee which
11 would be two members from the U.S., and that would be
12 EPRI and NRC, and then have representatives from other
13 countries. So far, India has expressed an interest,
14 and, of course, WG risk, IAEA, would be -- no, I'm
15 sorry, the OECD facilities.

16 And, of course, the have expressed an
17 interest to participate, so what we plan is to have a
18 steering committee which would kind of do this thought
19 process, come up with a plan, come up with an
20 experimental design, and communicate that with those
21 organizations signatory to Halden that would like to
22 participate, and then hopefully have an agreed-upon
23 plan and design for the experiments that everybody
24 would agree, and then try to do the experiment.

25 Now, there are many intermediate steps for

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1 that. For example, right now at Halden there are
2 about 16 crews are running experiments, and we are
3 going to have a crew. A few of us will go there to
4 observe and see how the experiments are run, so that
5 we understand what it takes to come up with a design.

6 It will be hopefully a meeting in January
7 with prospectives and other signatory countries, and
8 debate what it will take. Everybody has its own
9 method they would like to test, its method or methods.
10 So it's -- there is going to be many, many steps in
11 between in order to come up with the plan and the
12 design of the experiment.

13 MEMBER POWERS: Very helpful. Not
14 apparent from the soliloquy that was conducted here.

15 MS. LOIS: I'm sorry. The presentation
16 was not on the benchmarking, and probably I should
17 have done that.

18 MEMBER POWERS: Will you turn to page 4?
19 You indicate that you're putting operational data into
20 HERA. Could you just give me a thumbnail sketch of
21 what that data are?

22 MS. LOIS: They are -- right now it's LER
23 data.

24 MEMBER POWERS: LER data. That's enough
25 for me. Thank you.

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1 If I could turn to page 8. You indicate
2 you're working in the SOARCA program. I understand
3 there is some debate within SOARCA on how much HRA
4 help they need. Would you elaborate?

5 DR. COOPER: Susan Cooper. They are
6 getting HRA help. I'm the HRA representative within
7 NRC. We have Sandia and subcontractor SAIC. I don't
8 know if John and Alan are still on the line, but
9 they're helping out.

10 But in any case, we are getting HRA
11 support. I would say that the principal uncertainties
12 with regard to HRA support right now have to do with
13 how the overall project is going to proceed. But it
14 is the expectation of everyone involved at this point
15 in time that HRA will be an important factor in how
16 scenarios are refined and developed for developing
17 MALCOR inputs. But, you know, this -- may of the
18 specifics have not been decided, and we're very early
19 on in the process.

20 MEMBER POWERS: Okay. So you think you're
21 going to be looking at interfered accidents and not
22 just hands-off accidents.

23 DR. COOPER: That's -- yes, we will be
24 looking at accidents that involve operator actions.

25 MEMBER POWERS: Okay. Thank you.

1 On page 9, you indicate ATHEANA. And you
2 say "trial applications" under there. And I thought
3 we had gone through about a year of trial
4 applications, so I was trying to understand what -- it
5 doesn't say what trial applications, so I --

6 MS. LOIS: What I'm talking about here is
7 the ATHEANA user's guide, which is an addendum to the
8 existing ATHEANA NUREG, NUREG-1624 I believe. And the
9 question is how good the user's guide would be. Could
10 an HRA expert pick the user's guide and apply ATHEANA,
11 given that he's an expert? So --

12 MEMBER POWERS: So it's --

13 MS. LOIS: -- we are going to do some of
14 those, or we hope we will.

15 MEMBER POWERS: It's a novice HRA
16 professional, not a novice ACRS member.

17 MS. LOIS: Correct.

18 MEMBER POWERS: Which we have several.
19 Thank you.

20 Let's see, if we come down to page 10, it
21 says, "HRA have implications on burnup credit for
22 spent fuel pools." I found that surprising. I
23 wondered what you meant by that.

24 DR. COOPER: This is a preliminary
25 suggestion or indication of where we might help.

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1 There is a user need in draft from NMSS, and we have
2 been doing some development and demonstration of HRA
3 capability for them in the area of spent fuel misloads
4 and cask drops. And because of that, we're -- they
5 see the potential usefulness of HRA in answering the
6 questions, so far as allowing burnup credit.

7 MEMBER POWERS: So it's really a question
8 of spent fuel pool operations and not so much about
9 what the actual neutron count is going to be.

10 DR. COOPER: That's correct.

11 MEMBER POWERS: Okay. If we could come to
12 page 12, and, boy, do I have trepidation here. You're
13 talking here about benchmarking, and I'm a little
14 unclear what you mean by "benchmarking." And I note
15 that during your -- the free-form discussion that was
16 held that you said it may not be quite the right word.
17 I wonder if you could give me two sentences on what
18 you mean by "benchmarking."

19 MS. LOIS: Well, in the engineering
20 sciences, I believe that "benchmarking" has a very
21 concrete definition. In here, in human reliability,
22 given that the environment will not allow benchmarking
23 exercise in a very consistent way, we are not quite
24 sure if that's the right word.

25 However, what we tried to do there is to

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1 -- to do a testing or a determination of each method
2 capability to predict on its own. And then, given
3 that all those methods will be tested out, then we'll
4 have the capability to compare the methods.

5 MEMBER POWERS: I see. In other words,
6 you're using "benchmark" much as it would be used for
7 any deterministic code. How does that code work on
8 this problem by itself? Thank you.

9 MS. LOIS: I'm happy to hear that.

10 MEMBER POWERS: Let's see if I can come
11 back to page 10. You used the word "modality," and
12 I'm not sure what you meant by that.

13 DR. COOPER: "Modality" is a term used by
14 those folks involved in evaluating medical
15 applications of radioactive material. That could be
16 brachytherapy, it could be gamma knife, could be --
17 there are any number of different treatments --

18 MEMBER POWERS: So it's what's being done.

19 DR. COOPER: Exactly, what's being done
20 and how it's -- you know, what vehicle by which it's
21 being done. It's a -- the work is being focused on
22 gamma knife right now, and so that's why I say "other
23 modalities." It could be extended.

24 MEMBER POWERS: You will quickly learn in
25 front of this committee the less you say, the less

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1 likely you are to get in trouble.

2 (Laughter.)

3 Thank you.

4 Now, let me ask you about one question
5 that the committee has wrestled with a couple of
6 times, and that has been in the power uprates for
7 boiling water reactors. Especially when we are
8 working with BWR-4s, we have a short period of time
9 for the operators to respond to indications of core
10 instability.

11 And in that discussion with the applicants
12 for the power uprates, they consistently came in and
13 used THERP to estimate the reduction in operator
14 reliability. But they indicated to us that this
15 particular evolution is practiced regularly by each
16 crew, each year, operates this.

17 And, for instance, one of our applicants
18 indicated they had 50 data points with no failures,
19 yet he took a -- there was an increase in operator and
20 reliability of .01. Okay? How do you respond to
21 that? And can you -- is there anything that's going
22 to be able to help us on that question in the future?

23 MS. LOIS: I'll try -- I'll answer that
24 question from a high level and then probably go to --

25 (Laughter.)

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1 I believe because, as Dr. Apostolakis
2 mentioned before, the Halden experience -- experiments
3 can be time-driven. I believe that we could set --
4 and I'm not quite sure if this is the time, this --
5 this time around is going to be the time. but we
6 could potentially set up experiments with various time
7 intervals allowed for the operators and observe their
8 capability on well-trained actions and observe their
9 capability to do the action as reliably as before.

10 Now, I would like to note that even in
11 those well-trained scenarios that we have observations
12 so far, you do see a crew that was a little bit
13 delayed to complete the action, even for a well-
14 trained scenario. Now, that's an indication that not
15 all crews may complete the action as reliably, but I
16 guess it's within the variability of human performance
17 that one expects.

18 MEMBER POWERS: Okay. Finally, I'd like
19 to ask a question on -- in the course of looking at
20 some NUREG guides on hazardous materials around
21 nuclear powerplants, we several times have had
22 licensees tell us that they equip their control rooms
23 with self-contained breathing apparati, so that should
24 some noxious material come into the control room that
25 operators could stay on station and continue to work

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1 there.

2 But when we've asked them, do they ever
3 train on that, in the simulators, I have yet to have
4 any of them say yes. Now, I cannot claim to have done
5 a complete survey, but I've asked the question at
6 every place I go. How would ATHEANA or any of these
7 human reliability models handle operations under --
8 with self-contained breathing apparatus and any
9 degradation in reliability that would come from that?
10 And wouldn't the agency be interested in that kind of
11 information?

12 DR. COOPER: I can't answer the last
13 question. Maybe you folks can direct us to that. I
14 can say that with respect to the first question that
15 there are some methods that would at least identify
16 that as being a potentially important aspect to be
17 considered as an influence on human performance.

18 That's only one piece of it -- an
19 important piece to know that you actually ought to
20 address it. The other part is, so how does it
21 influence human performance? And that question I
22 can't answer. I mean, we have not tried to analyze
23 something like that.

24 Right now, I don't know if there's any
25 information out there right now. It's not -- that

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1 kind of knowledge, if you will, is not contained in
2 any HRA method that we have right now, just as there
3 isn't any knowledge in any HRA method right now so far
4 as the effect of smoke on human performance.

5 Now, whether or not there is information
6 more broadly across the U.S. and other industries or
7 in psychological data, I don't know. But if you were
8 to try to address that, that would be my first step.
9 But it's not in any HRA method right now.

10 MEMBER POWERS: I use it -- something is
11 a stocking horse, because I've been interested in it.
12 But we have had challenges in the agency with control
13 room habitability issues, and there's quite a lot
14 assumed and argued in connection with control room
15 habitability.

16 And I might suggest that because of the
17 central role of the control room that you might want
18 to look at some of those FSARs to identify areas of
19 human reliability that need to be explored as you
20 develop those models. That completes my questions.

21 CHAIRMAN WALLIS: George, are you through?

22 MEMBER APOSTOLAKIS: I'm through.

23 CHAIRMAN WALLIS: So it's back to me?

24 MEMBER APOSTOLAKIS: Back to you.

25 CHAIRMAN WALLIS: Well, my first comment

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1 was that the sort of questions that my colleague Dr.
2 Power has asked are the sort of thing -- one of the
3 sort of things I thought we were going to be doing
4 here.

5 I thought we were going to be looking at
6 your slides and your plan and your activities, and I
7 was sort of pleased when your answer to the first of
8 his questions, you actually showed us a plan. I mean,
9 he said, "What's your plan for international work?"
10 and it turned out you did have a plan, which we didn't
11 know, you know?

12 So, you know, I think the -- when folks
13 come before this committee, you have to have a plan.
14 You have to say, "I want this committee to look at our
15 plan or look at our list of activities," or something
16 specific, and then we can respond to that. So that --

17 MEMBER APOSTOLAKIS: I think it's --

18 CHAIRMAN WALLIS: -- off track, I wasn't
19 sure what you were asking us to do, and we got into
20 this discussion and again it wasn't clear to me what
21 you were asking us to do. So --

22 MEMBER APOSTOLAKIS: I think one of the
23 things we have to do, Graham, is we -- we saw today
24 what we saw also a little bit yesterday. We have too
25 many new members.

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1 CHAIRMAN WALLIS: That's not the problem,
2 George.

3 MEMBER APOSTOLAKIS: It is a problem,
4 because there were questions -- there were
5 questions --

6 CHAIRMAN WALLIS: The question is: is the
7 staff controlling their own presentation and being
8 allowed to do so?

9 MEMBER APOSTOLAKIS: There were questions
10 that the staff assumed had been answered in many
11 meetings in the past, and it was true.

12 CHAIRMAN WALLIS: Well, how do you know
13 what they assumed? George, I'm not going to get into
14 this conversation. I'm going to stop this now.

15 MEMBER APOSTOLAKIS: They assume we know
16 what ATHEANA is, for example.

17 CHAIRMAN WALLIS: I think we need --

18 MS. LOIS: One clarification is that we
19 believe that this is more the committee's meeting, I
20 suppose, and we had to prepare something --

21 CHAIRMAN WALLIS: But if there is a -- I
22 think staff has to come to the committee saying, "This
23 is what we're going to present to you, this is our --
24 this is our" -- you know, you, it's your presentation.
25 These are the kind of issues where you think that we

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1 can contribute. Of course, we'll jump into all kinds
2 of things, but if we let it go everywhere it's going
3 to go everywhere, and you have to bring it back again.

4 So on that note, I'd like to stop, if the
5 committee is happy to stop now. And we'll take a
6 break until quarter to 11:00, and then we will do the
7 P&P and a few sort of administrative matters, and then
8 we'll go to letter writing. We don't need the Court
9 Reporter anymore. Thank you.

10 (Whereupon, at 10:31 a.m., the
11 proceedings in the foregoing matter went
12 off the record.)

CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on
Reactor Safeguards
537th Meeting

Docket Number: n/a

Location: Rockville, MD

were held as herein appears, and that this is the original transcript thereof for the file of the United States Nuclear Regulatory Commission taken by me and, thereafter reduced to typewriting by me or under the direction of the court reporting company, and that the transcript is a true and accurate record of the foregoing proceedings.



Charles Morrison
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*Office of Nuclear Regulatory Research
United States Nuclear Regulatory Commission*

Status Report on Human Reliability Analysis Research Program

John Monninger, Erasmia Lois, and Susan Cooper
Directorate of Probabilistic Risk and Applications
Division of Risk Assessment and Special Projects

*Presented to
Full Advisory Committee on Reactor Safeguards*

November 2, 2006

Briefing Objectives

- Summarize recent Human Reliability Analysis (HRA) Research Program activities
 - Focus on reactor applications
- Outline preliminary plans for the next four years, and obtain ACRS feedback
- Discuss HRA issues identified by the ACRS

HRA Research Program Objectives

- Support risk-informed regulatory activities
 - Improve HRA quality
 - Develop guidance for performing/reviewing HRAs
 - Address outstanding technical issues
 - Perform technology transfer
 - Support resolution of specific regulatory issues
 - Address emerging needs
- Collaborate with domestic and international entities for efficiency and effectiveness

Accomplishments (2001-2006)

HRA Quality & Outstanding Issues

- HRA Guidance--supports RG 1.200, *An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment for Risk-Informed Activities*, Feb. 2004
 - NUREG-1792--*HRA Good Practices*, April 2005
 - NUREG-1842, *Methods Evaluation Against the Good Practices*, Sept. 2006
- Outstanding technical issues--supports the PRA Action Plan (SECY-04-0068)
 - Develop data
 - NUREG/CR-6903, *Human Event Repository and Analysis (HERA), Overview*, August 2006
 - Loading operational experience data in HERA
 - Develop quantification tools to use the data
 - Draft report on the use of Bayesian-type techniques in HRA in peer review

Accomplishments 2001-2006

Support Resolution of Specific Regulatory Issues

- HRA for the PTS PRAs, NUREG-1806, *Technical Basis for Revision of Pressurized Thermal shock (PTS) Screening Limit in the PTS rule (10 CFR 50.61): Summary Report*
 - Supports the revision of Part 50.61
- Screening analysis for the *EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities*, NUREG/CR-6850/EPRI1011989,
 - Supports implementation of NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*
- NUREG-1852, *Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire*, in public comment, final April 07
 - Will be referenced in the revised Staff Review Plan, NUREG-0800, Section 9.5.1

Accomplishments 2001-2006

Technology Transfer and Collaboration

■ Technology transfer

- Develop "ATHEANA User's Guide," Addendum to NUREG-1624, to be finalized in April of 07
- HRA technology transfer to Halden Reactor Project thru close interactions (including staff exchanges)

■ Domestic and International collaboration

- Close interactions with industry
- Close interactions and direct contribution to international programs
 - Halden Reactor Project
 - WGRisk--Task on sharing data for HRA

Accomplishments 2001-2006

Emerging Needs

- **New and advanced reactors**
 - Draft plan outlining issues to be addressed
- **NMSS needs**
 - Medical applications (e.g., review of licensee applications)
 - HRA-informed job aid & associated training
 - Fuel handling (e.g., misloads & cask drops)
 - Development & demonstration of appropriate HRA methods, tools, & data
 - Yucca Mountain
 - Public meetings, pre-licensing interactions with DOE

Draft HRA Research Plan 2007-2010

- HRA guidance
 - Benchmark HRA methods using simulator experiments
 - Revise NUREG-1842, if needed
 - Develop a handbook on the use of empirical data for HRA
- Specific regulatory issues
 - NRC/EPRI collaboration on detailed HRA methodology for fire PRAs (NFPA 805)
 - Support to State-of-the-Art Reactor Consequence Analyses (SOARCA) (e.g., refinement of selected scenarios, credit for operator mitigation beyond EOPs)

Draft HRA Research Plan 2007-2010 (cont)

- Technical issues
 - Incorporate into HERA data from other sources (e.g., simulator, literature, aviation)
 - Update treatment of pre-initiator failures (e.g., collaborate with IRSN on expansion of ATHEANA & MERMOS)
 - Finalize Bayesian report, May 2007
 - Perform trial applications
 - Publish the ATHEANA User's Guide, April 07
 - Perform trial applications
 - Benchmarking of HRA methods using empirical

Draft HRA Research Plan 2007-2010 (cont)

■ NMSS support

■ Medical applications

- Roll-out of HRA-informed job aid & training for gamma knife (e.g., Regions)
- Extension to other modalities & industrial applications

■ Fuel handling

- HRA methods development & demonstration (especially, quantification)
- Address regulatory needs (e.g., implications of credit for burnup in spent fuel pools)

■ Yucca Mountain

- Pre-licensing interactions with DOE
- Development of staff review guidance
- General support to staff in reviewing DOE's application
- Public meetings, hearings, etc.

HRA Issues Identified by the ACRS

- Comparison of fundamental assumptions behind NRC models (ATHEANA, SPAR-H, time margins in operator actions in response to fire)
 - Treatment of time in NUREG-1852 vs. HRA methods
 - Comparison of fundamental assumptions in ATHEANA, SPAR-H
- Comparison of NRC methods with the EPRI HCR/ORE and CDBT
- Will the NRC have one model for all of its applications?
- Will both Industry and NRC have one model for all HRA applications?

Addressing ACRS HRA issues

- We believe that we have answers for some of the questions
- We have initiated a "*HRA Methods Benchmarking Using Simulator Data*" effort, which we believe will help address additional ACRS questions
- First will discuss answers that we believe we have
- Second will discuss the benchmarking activity

Treatment of Time

- The concept of "Time Margin" in NUREG-1852, and the treatment of time in HRA methods (ATHEANA) are **not** inherently **inconsistent** in their underlying assumptions, but
 - The time margin is a deterministic approach
 - HRA methods are probabilistic
 - This leads to differences in the ways they are implemented and how uncertainties are addressed
- In the deterministic analysis, as long as a defined set of criteria is adequately met, *success is assumed to be very likely*. Otherwise, the action is assumed to be *unreliable and therefore likely to fail frequently*
- In the probabilistic approach, the same (or similar) factors relevant to performance are addressed (including time), however, a *probability of failure is estimated* with an uncertainty distribution

Treatment of Time (cont)

- Current HRA methods generally treat all factors (of which time is just one factor) to *directly estimate the probability of failure to perform the action* including an uncertainty distribution
- Potentially, an alternate (better?) “model” may be to treat time more explicitly, by considering all the other factors, except time, as a means to *estimate the time to perform the action* (with uncertainty) and then compare this to the time available to take the action to derive the probability of failure

Treatment of Time (cont)

- The EPRI HCR/ORE model is an example of this alternate type of model, *assuming that adequate simulator runs are performed for each human action needed under various conditions*
 - However, typically limited simulator runs are performed, therefore variability in conditions and crews are not adequately covered.
 - The applicability of generic values is questionable
 - Additional effort required to explicitly understand the drivers of behavior
- The benchmarking work will hopefully help address the treatment of time in HRA

Comparison of Fundamental Assumptions

- Comparison of fundamental assumptions behind (a) NRC models (ATHEANA, SPAR-H,) and (b) among the NRC methods and the EPRI HCR/ORE, and CBDT
 - NUREG-1842, "Methods Evaluation Against the Good Practices," identified the basic assumptions and characteristics of these methods
 - Although direct comparisons were not made in all cases, the NUREG identified
 - Some basic differences between ATHEANA and SPAR-H that could impact the results
 - Some basic differences between the NRC's methods and the EPRI methods HRC/ORE, CBDT
- Therefore, we believe that we understand the basic differences of these methods

Comparison of Fundamental Assumptions (cont)

- In order to better understand the impact of these differences, the need to benchmark the methods with data became apparent
 - The NRC initiated (in collaboration of the Halden Reactor Project) a ***HRA method benchmarking activity***
 - The activity is pursued as a collaborative effort with EPRI and other signatory members of Halden
- The NRC's methods THERP, SPAR-H, and ATHEANA will be used in the benchmarking
- To the extent that the EPRI methods are used in benchmarking studies, we will also understand these methods

Comparison of Fundamental Assumptions

(cont)

- The results of the benchmarking studies should provide a basis to better characterize
 - The capability of a method to identify/predict human failure events (HFEs) and associated failure causes/drivers
 - **We are currently defining what these measures will be**
 - The conditions under which methods should or should not be used
 - Ways to make some methods better
- Analysis of the data should result in *better understanding of the treatment of time in HRA methods and potentially the need for a more explicit treatment*

Is there a possibility for "one" HRA model?

- Will the NRC have one model for all of its applications?
Will both Industry and NRC have one model for all HRA applications?
 - The answer is "***probably not.***"
- NUREG-1842 recognizes the need for a "tool box"
 - High level screening-type vs. detailed analysis
 - Regulatory needs should drive the decision as to which method should be employed (NUREG-1842)
 - Tools in the "tool box" will be improved and probably new tools will be invented after the benchmarking exercise
 - NRC and industry will have a better basis for choosing HRA method(s) for regulatory applications following the benchmarking exercise

Summary

- We believe that our plans are addressing the ACRS concerns
- We will continually and actively interact with the ACRS
 - Briefing on progress and incorporate feedback
- We look forward in today's discussion for input
- We would like to express our appreciation for the ACRS interest in and support of the HRA research plan and activities