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# OFFICIAL TRANSCRIPT OF PROCEEDINGS
# NUCLEAR REGULATORY COMMISSION

## ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

**Title:** MEETING: 471ST ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

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**Work Order No.:** ASB-300-1215

**LOCATION:** Rockville, MD

**DATE:** Wednesday, April ~~4~~ 5, 2000

**PAGES:** 1 - 301

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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

APRIL 5, 2000

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on April 5, 2000, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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

1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

3 ***

4 471ST ADVISORY COMMITTEE ON

5 REACTOR SAFEGUARDS (ACRS)

6

7 Conference 2B3

8 Two White Flint North

9 11545 Rockville Pike

10 Rockville, Maryland

11 Wednesday, April 5, 2000

12

13 The Committee met, pursuant to notice, at 8:30

14 a.m.

15 MEMBERS PRESENT:

16 DANA A. POWERS, Chairman, ACRS

17 GEORGE APOSTOLAKIS, Vice-Chairman, ACRS

18 THOMAS KRESS, ACRS Member

19 JOHN D. SIEBER, ACRS Member

20 GRAHAM B. WALLIS, ACRS Member

21 ROBERT L. SEALE, ACRS Member

22 WILLIAM J. SHACK, ACRS Member

23 ROBERT E. UHRIG, ACRS Member

24 JOHN J. BARTON, ACRS Members

25 MARIO V. BONACA, ACRS Member

1 PARTICIPANTS:

2 JOHN LARKINS, Executive Director, ACRS

3 MARK RUBIN, NRR

4 GLENN KELLY, NRR

5 MEDHAT EL-ZEFTAWY, ACRS Staff

6 PAUL A. BOEHNERT, ACRS Staff

7 MIKE CHEOK, NRR

8 GARETH PARRY, NRR

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

2 [8:31 a.m.]

3 DR. POWERS: The meeting will now come to order.
4 This is the first day of the 471st meeting of the Advisory
5 Committee on Reactor Safeguards.

6 During today's meeting, the committee will
7 consider the following; spent fuel pool accident risk for
8 decommissioning plants, proposed research plan for digital
9 instrumentation and control, proposed white paper on
10 risk-based performance indicators, human performance
11 program, proposed ACRS reports.

12 The meeting is being conducted in accordance with
13 the provisions of the Federal Advisory Committee Act. Dr.
14 John T. Larkins is the designated Federal official for the
15 initial portion of the meeting.

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

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

23 I will begin with some items of current interest.
24 First, I would like to note there has been a change in the
25 agenda for Thursday's meeting. The briefing we have

1 scheduled on the reactor trip on loss of AC power at Indian
2 Point Unit 2 scheduled between 10:00 and 11:15 a.m. on
3 Thursday, April 6, 2000 has been postponed to the June ACRS
4 meeting, at the request of the NRC staff. Quite frankly,
5 there is enough going on there, it would be an imposition on
6 the staff to ask them to prepare a presentation and come
7 talk to us.
8 MR. BARTON: In June, will we hear both events?
9 DR. POWERS: I think we'll hear soup-to-nuts, at
10 least as much of the nuts as we can understand at that time.
11 MR. BARTON: Thank you.
12 DR. POWERS: I would also like to introduce to the
13 committee Barbara Jordan. She is working in Sam's office on
14 a rotational assignment from RES and -- how long, three
15 months, six months?
16 MS. JORDAN: Six months.
17 DR. POWERS: Six months you'll be with us.
18 Welcome aboard, Barbara.
19 MS. JORDAN: Thank you.
20 DR. POWERS: I will remind members that the rights
21 of spring are upon us and it's time to have ethics training
22 and we all know we need that. So tomorrow at noon we will
23 be having ethics training. We've generously offered an
24 additional 15 minutes for you to get lunch and come back up
25 here and get your training and you will all be ethical

1 thereafter.

2 I do have three items of interest in your package,
3 labeled items of interest. You do have a copy of
4 Commissioner Merrifield's speech at the Regulatory
5 Information Conference. I think Commissioner Merrifield
6 laid out an explicit program of areas that he thinks are
7 high priority for the coming year, and it's interesting
8 reading.

9 Another item of interest or maybe it's interest,
10 you can judge for yourself, is an extraordinary interview
11 with the Vice Chairman. I have this with two stars on it,
12 but I'm taking one away because he failed to mention the
13 triplet in his interview.

14 Finally, I will note that there is, in the package
15 of items of interest, registration forms for an ANS meeting
16 that you might be interested in attending.

17 I will also note this blue document is the joint
18 letter from the ACRS and the ACNW on defense-in-depth and
19 risk-informed regulatory process. I'd encourage the members
20 to examine this over the course of the day. This is a joint
21 committee letter. So we are constrained to approve it,
22 disapprove it, or approve it with additional comments, but
23 not to edit it.

24 With that, I will ask if members have any comments
25 they want to make in the opening statements.

1 [No response.]

2 DR. POWERS: Seeing none, I will turn to the first
3 item of business, which is the spent fuel pool accident risk
4 for decommissioning plants. Dr. Kress, I believe you're
5 going to lead us through this.

6 DR. KRESS: I'll get us started.

7 DR. POWERS: You'll get us started. I personally
8 have a large number of questions about how to look upon this
9 study. My first reaction to it was to look upon it as
10 something like the WASH-1400 for decommissioning plants.

11 Upon looking at it in more detail, I'm not sure I
12 want to look at it in that august of terms. But if you
13 could give me some guidance on this matter, I would
14 appreciate it.

15 DR. KRESS: Okay. The information is listed under
16 tab 2 in your book. We know that when a plant goes into
17 decommissioning, it's still pretty much constrained to
18 follow most of the regulations that are in place for
19 operating plants, even though, surely, as time goes by and
20 decay takes effect on fission products, that the risk is
21 going down with time.

22 So as a result, quite often the staff is faced
23 with a number of exemption requests to the regulations and
24 they have a number of diverse activities related to
25 decommissioning rulemaking that they would like to

1 consolidate and put under one package in an integrated
2 rulemaking and recognize the fact that the risk is
3 decreasing with time and see if they can come up with a
4 rulemaking package that would be risk-informed and
5 appropriate for decommissioning plants.
6 I guess that's all the introduction I need to
7 make, because we'll hear the details of the technical
8 analysis that back up, that they've made to back up this
9 rulemaking activity.
10 With that, I guess I'll turn it over to Mark
11 Rubin.
12 MR. RUBIN: Good morning, Dr. Kress and committee
13 members. I'm Mark Rubin. I am acting Branch Chief for the
14 day for the PRA Branch in NRR. We're here this morning to
15 discuss the draft report which was issued for public comment
16 on the spent fuel pool safety assessment for decommissioning
17 plants.
18 This was the follow-on work from the preliminary
19 draft report which was issued last June, after a very quick
20 sort of insight scoping assessment to help us focus on where
21 the more significant risks might appear from a spent fuel
22 pool in a decommissioned plant.
23 This report, as I said, is out for public comment
24 right now. The public comment period closes, I believe,
25 this Friday. We've gotten a few comments which we're

1 looking at, but we may receive some more.

2 Mr. Kelly coordinated the risk portion of the PRA
3 assessment. There's a large number of technical
4 contributors in both risk areas, as well as other
5 engineering disciplines, and we have most of the technical
6 contributors or at least many of them here today to answer
7 any questions you or any other committee members may have.

8 With that, I will let Mr. Kelly go through a high
9 level presentation on the draft report and also including
10 highlighting a few differences where this report evolved
11 from the very preliminary study done last year.

12 DR. POWERS: In the course of the presentation,
13 will I get some understanding of -- at least when I look at
14 the documentation associated with this, I get the impression
15 that this is an important technical basis of what you're
16 going to try to do and with respect to decommissioning
17 plants.

18 And so that it is not just an interim study, it is
19 going to be a very definitive technical basis for
20 regulation. Is that a correct understanding?

21 MR. RUBIN: The final study, yes, will be a
22 technical basis, proposed as a technical basis for future
23 rulemaking in the area of decommissioning.

24 MR. KELLY: This is Glenn Kelly. It will also be
25 used as the technical basis for exemption requests during

1 the period while the rulemaking is in process.

2 I'm Glenn Kelly, with the Probabilistic Safety

3 Assessment Branch in NRR. I was the coordinator of the risk

4 assessment portion of the analysis that we did on spent fuel

5 pool reactors.

6 As Mark Rubin mentioned, we had a large number of

7 technical contributors and I think that you may notice a

8 number of them. We believe they're a very high quality

9 group.

10 The members who were there, most of them were

11 members of what we call the spent fuel pool technical

12 working group.

13 Just a little background on how we got here. In

14 June of 1999, we put out for public comment what I would

15 consider a pretty high quality draft report identifying the

16 potential problem areas that you might find at a

17 decommissioning reactor. We put this out very early in

18 order to give stakeholders an opportunity to comment on our

19 early ideas and to get people involved in the process as

20 quickly as possible.

21 The June report concluded that zirconium fires can

22 occur during the first several years after shutdown of the

23 reactor, that the off-site consequences in the event of a

24 zirconium fire would be very high, and it concluded that the

25 frequency of a zirconium fire would be about

1 two-times-ten-to-the-minus-five per year. This was
2 dominated by human error.
3 The June report, as you know, received lots of
4 comments from stakeholders and the ACRS. At the same time,
5 the NRC sponsored a technical review by the Idaho National
6 Engineering and Environmental Laboratory to take a look at
7 the report, to determine whether or not we had missed any
8 significant initiators or to help us with also looking at
9 the human reliability aspects of the report, because
10 probably more than any other major PRA, this one really came
11 down to looking at a new area of human reliability.
12 That is, what happens, how do operators act over
13 long periods. We're looking at events that take days to
14 weeks versus normally a reactor, operating reactor events
15 that occur very, very quickly.
16 Subsequent to the issuance of the report, the
17 industry made a series of commitments which we've documented
18 in our report, in our current draft report, and they
19 proposed a seismic checklist. The risk of operation of
20 spent fuel pools was re-quantified and on February 15, we
21 put out for public comment our current draft.
22 So what are the major technical results coming from our
23 re-quantification? In the current draft report, the risk is
24 significantly reduced and this is primarily due to the
25 industry's commitments that they made. The human

1 error-driven sequences which dominated our June draft report
2 were reduced to about two-times-ten-to-the-minus-seven per
3 year.
4 DR. KRESS: Now, this is not just an assessed
5 reduction. It's a real risk reduction because of
6 commitments that --
7 MR. KELLY: That is correct.
8 DR. KRESS: -- the industry are making to do
9 things during decommissioning.
10 MR. KELLY: That's correct. I have a backup slide
11 that I can use to talk to you a little bit about where those
12 human error reductions actually came from.
13 The NEI commitments that we received made a
14 significant difference in the report. They reduced the
15 absolute value to dependencies among the human error
16 probabilities. The frequency of loss of inventory events,
17 which was also significant, was reduced due to NEI
18 commitments. And we also found that by taking a look at
19 some other numbers that we had in recovery of off-site
20 power, that we could make some improvements there.
21 DR. POWERS: I guess I was unaware that NEI had
22 any spent fuel pools.
23 MR. KELLY: Not the last time we checked, but as
24 representative of the industry, what they did is they
25 proposed to us a series of commitments for the industry

1 which they believe the industry would be willing to follow,
2 based on, I understand, their discussions with industry
3 leaders.
4 MR. RUBIN: If I could add. The specific
5 commitments that were relied upon in the enhanced modeling
6 and generally the sensitivity of the result to them are
7 specifically called out in the report to be captured during
8 the rulemaking or the exemption process later on.
9 So you're correct, NEI can't legally commit a
10 plant, but the commitments, quote, are highlighted so they
11 can be captured and carried through to completion.
12 DR. KRESS: So they will be part of the rule
13 itself.
14 MR. RUBIN: I can't speak for the rules myself,
15 but, yes, that's certainly the intent.
16 DR. KRESS: They could be. Okay.
17 DR. APOSTOLAKIS: Now, can you tell us a little
18 bit how the absolute value of the dependencies among human
19 error is reduced due to some commitment?
20 MR. KELLY: George, did you want a detailed
21 explanation of how we reduced it or --
22 DR. APOSTOLAKIS: We want the details here.
23 MR. KELLY: The high level answer is that the
24 commitments allowed us to do things such as assume that we
25 would be getting independent shift turnovers where each

1 shift would be looking at the plant in an independent
2 manner.
3 This made a big difference in our overall
4 dependency amongst the human error probabilities. If you'd
5 like significant details, we have Mike Cheok and Gareth
6 Parry here, who can --
7 DR. APOSTOLAKIS: Can you give us a short summary,
8 Gareth?
9 DR. POWERS: Including why you believe the numbers
10 are true.
11 MR. RUBIN: We'll let Gary and/or Mike Cheok, who
12 completed the assessment, talk.
13 DR. APOSTOLAKIS: Why don't you come up here,
14 Gareth? It's easier to shoot at you. Maybe you can give us
15 a little bit of background. What were the significant
16 dependencies and how --
17 MR. PARRY: Actually, I'm not really -- I wouldn't
18 necessarily characterize it specifically as pulling on the
19 dependencies. I think what we -- what we did was we tried
20 to establish what would be needed in terms of management
21 directives, operator practices to establish low human error
22 probabilities.
23 These included things like making sure that there
24 was good instrumentation, that there would also back up to
25 the instrumentation in terms of things like walk-downs that

1 would be done by the plant staff, so that there were -- in
2 this sense, this does get over into the dependency issue.
3 That there would be independent means of identifying that
4 there were problems at the plant, in sufficient time that
5 corrective action could be taken.
6 So to a certain extent, we did introduce a
7 redundant and diverse means of identifying problems, and I
8 guess that, in a way, is what Glenn was referring to as a
9 reduction in the dependency.
10 DR. KRESS: What was the instrumentation you
11 referred to?
12 MR. PARRY: Well, what we were saying is that you
13 would need to have -- and I think this is one of the NEI
14 commitments, that there would be instrumentation that would
15 refer to the pool temperature, there would be level
16 measurements that would be indicated in the control room to
17 give you the first line of defense, if you like, and then at
18 a second level, there would also be local instrumentation
19 that the people doing the walk-downs would be able to read,
20 which would be not necessarily powered from the same power
21 source and something that would just be visual.
22 DR. KRESS: Primarily pool temperature and level.
23 MR. PARRY: Temperature and level primarily yes,
24 but also radiation could be part of it. We were not that
25 specific in the sense that what we needed was an indication

1 that there was a problem.

2 MR. KELLY: The reason for that is that the

3 thermal margins associated with fuel heat-up and the large

4 volume of water in the pool are such that it primarily just

5 requires the fuel handlers who are going into the building

6 to make sure that they notice that there is a problem.

7 That's the major thing that we need to make sure happens.

8 MR. PARRY: I think, if I remember correctly, in

9 the original study, one of the contentions was that -- one

10 of the comments from many of the commenters was that we were

11 not giving enough credit for the identification that the

12 problems existed, rather than -- not so much that they

13 couldn't respond, but that we weren't giving enough credit

14 for recognition that there were problems, and I think that's

15 fair enough.

16 And with these commitments in place, I think it

17 makes it pretty difficult to miss something going on.

18 DR. POWERS: When I examined the document, I see

19 that in evaluating these human errors, that you reference

20 THERP, which is fairly well known; geriatric, but well known

21 process for estimating human errors.

22 MR. PARRY: Right.

23 DR. POWERS: You also cite something called, if I

24 can get it all right, the SARP human reliability estimation

25 technique, but you don't provide me a reference there.

1 Where do I find out about this technique?

2 MR. PARRY: This is the ASP one, right?

3 DR. POWERS: It says SARP.

4 DR. KRESS: I think it is the one that the ASP

5 people use.

6 MR. PARRY: It's the one that the ASP people use.

7 It was a --

8 DR. APOSTOLAKIS: Is it the SPAR?

9 DR. POWERS: Maybe it's SPAR. Yes. I'm sorry.

10 It's SPAR.

11 MR. PARRY: It's the one that INEL has designed

12 for use with the SPAR models.

13 DR. POWERS: And this is the one that --

14 MR. PARRY: Harold Blackman has done it.

15 DR. POWERS: There's nothing in the reference list

16 that leads me to SPAR HRE methodology. I do notice that

17 some of your critics felt uninformed about that technology,

18 if that's the right one, something invented by Idaho and not

19 exposed to the kinds of peer review and technical review

20 that some of the other HR, human reliability models have.

21 MR. PARRY: Yes. Actually, there is a reference

22 to it, it's reference nine in the report.

23 DR. POWERS: There is?

24 MR. PARRY: Yes.

25 DR. POWERS: Tell me what page to hit.

1 MR. KELLY: Appendix 2-A, page 66. It's Appendix
2 2-A. Under Appendix 2, it's the first sub-appendix under
3 Appendix 2.
4 DR. POWERS: There it is. Which reference is it?
5 MR. PARRY: Number nine, bias.
6 DR. POWERS: Okay. So it's a draft document.
7 MR. PARRY: Right.
8 DR. POWERS: And the acronym used in the text is
9 SPAR and here it's ASP. It's a dialectic model or something
10 like that.
11 MR. PARRY: Dialectic.
12 DR. APOSTOLAKIS: Is it different from THERP?
13 MR. PARRY: Yes. It's effectively a -- it's set
14 up in terms of looking at performance shaping factors and
15 how they impact basic error probability. It's different
16 from THERP in the sense that in THERP, you build a logic
17 model of the process and you identify all the different
18 error.
19 DR. APOSTOLAKIS: When we say THERP, we're
20 referring to the human reliability handbook.
21 MR. PARRY: Yes. It's Wayne's method, right.
22 DR. APOSTOLAKIS: Okay. Now, the human
23 reliability handbook does include performance shaping
24 factors.
25 MR. PARRY: It does. It does.

1 DR. APOSTOLAKIS: There is a long discussion.
2 MR. PARRY: But it also requires you to build
3 human reliability fault tree models for each of the --
4 DR. APOSTOLAKIS: If necessary.
5 MR. PARRY: If necessary, right. In this case, I
6 think this SPAR approach is more akin to something like
7 HART, if you're familiar with that, George.
8 DR. APOSTOLAKIS: Say it again.
9 MR. PARRY: It's more like HART.
10 DR. APOSTOLAKIS: Which really excited us last
11 time we looked at it, right? When we looked at the ATHENA.
12 MR. PARRY: Right. But, again, it splits things
13 up into two different portions, the cognitive part and the
14 execution part, and it deals with them separately.
15 DR. APOSTOLAKIS: I think you are giving me now
16 some thoughts to put in the letter on the human performance
17 program. I agree with Dr. Powers that we can't really
18 develop new models all the time.
19 MR. PARRY: Right.
20 DR. APOSTOLAKIS: And say, you know, in the SPAR,
21 we're going to use this and in other situations we're going
22 to use the reliability handbook, and then in other
23 situations we're going to use ATHENA.
24 I think the issue of peer review is really very
25 important.

1 MR. PARRY: Right. But to give you an indication
2 of why we chose to go down this path, there are some things
3 for which -- there are some elements of this analysis for
4 which we think THERP are appropriate. For example, the
5 response to alarms, that's a classic case where THERP is
6 used and is appropriate.
7 Other areas which are things like the performance
8 of administrative procedures, which is like during the
9 walk-downs and making sure that they're doing, things like
10 that, again, THERP fits nicely into that.
11 Where we use this ASP model is in the response
12 areas, which --
13 DR. APOSTOLAKIS: But that's ATHENA now. If it's
14 in the response area, we're getting into ATHENA.
15 MR. PARRY: Yes. But ATHENA, as you know, is not
16 a fully operational HRA method yet. And besides, I think to
17 -- really, if you than about ATHENA, ATHENA, you need a lot
18 more information than we have available typically. ATHENA
19 is meant to be a process whereby you're looking at very
20 detailed accident sequences to look for opportunities for
21 errors of commission, primarily.
22 DR. APOSTOLAKIS: But in this case, clearly, one could
23 define an error forcing context and you don't necessarily
24 have to go to ATHEANA's detailed analysis of that and say
25 the error forcing context here is perhaps they don't see the

1 level indication. Right?

2 MR. PARRY: Yes. At that level, I think we're

3 consistent with the ATHENA type of concept and, in fact, I

4 think we've designed it that way. But in terms of the

5 quantification model, which is really where we're heading to

6 now, as you know, ATHENA does not really have a

7 quantification model.

8 DR. APOSTOLAKIS: That's true.

9 DR. POWERS: I was most interested in this human

10 reliability model because it produces truly remarkable

11 results. They must be accurate -- unbelievable numbers of

12 digits, because there is no error bound put on these

13 estimates. There's no range given at all.

14 MR. PARRY: I understand that criticism. However,

15 I think the intent of this human reliability analysis was

16 really to illustrate the fact that if you have certain

17 commitments in place, the error probabilities are going to

18 be low, because you have the right defenses in place.

19 DR. APOSTOLAKIS: I think that's a valid argument,

20 because no matter what model you use, I think commitments

21 like the ones you mentioned do help you reduce the numbers.

22 The thing that worries me a little bit here is the

23 proliferation of HRA models and we're supposed to have a

24 program on human performance that coordinates these things

25 and if the agency is investing all this money into ATHENA,

1 one would think that that would be a model that people would
2 use, as appropriate.
3 MR. BARTON: But ATHENA is not applicable to all
4 situations, George.
5 DR. APOSTOLAKIS: But the ideas are. That doesn't
6 mean I can sit down and develop my own. If ATHENA hasn't
7 done it after all these millions of dollars, can I do it on
8 my own?
9 MR. PARRY: I think Mr. Barton has a very good
10 point, though, that ATHENA is primarily designed to, at
11 least the current way it's structured, is for between the
12 ears problems of an operating crew responding to an
13 accident. The situation here, I think, is a lot different.
14 We're talking really about organizational failures, because
15 the time scales that we're talking about are on the orders
16 typically of several shifts.
17 So we're not talking about the mindset of a
18 particular operator as he is responding to a situation.
19 We're talking about the mindset of an organization that is
20 coping with a deteriorating situation.
21 So I think the models are different for good
22 reasons in that they are dealing with different types of
23 situations.
24 DR. APOSTOLAKIS: Okay. I mean, if I look at the
25 human performance program, I don't recall an item that says

1 SPAR models, unless I missed it somewhere. It should be
2 coordinated better. We have a presentation later today on
3 that and maybe we can raise the issue then.
4 MR. PARRY: The SPAR model is not meant, I don't
5 think anyway, as a substitute for a really detailed HRA
6 model. It's meant to be more of an indicative one, I think,
7 for use with the ASP program and in a sense, I think that's
8 what we're doing here. We're making more indicative
9 analyses than definitive HRA analyses.
10 As long as we cover the points that -- as long as
11 we address the issues that we're trying to do, which is to
12 look at the defenses and see what they buy you, I think this
13 relatively more crude approach is appropriate.
14 DR. APOSTOLAKIS: But if the -- what is the new
15 total frequency of --
16 MR. KELLY: For HRA or for --
17 DR. APOSTOLAKIS: For the whole thing.
18 MR. KELLY: It's less than
19 three-times-ten-to-the-minus-six per year.
20 DR. APOSTOLAKIS: And what is the upper bound,
21 95th percentile?
22 MR. KELLY: We don't have those type of
23 percentiles, because we don't have distributions. In most
24 cases, we have extremely limited data.
25 DR. APOSTOLAKIS: These distributions in human

1 error were never based on data anyway. They were really the
2 judgments of experts.
3 MR. KELLY: Right.
4 DR. POWERS: The idea that I have very little
5 data, therefore, I won't do an uncertainty analysis strikes
6 me as unusual.
7 DR. APOSTOLAKIS: Yes.
8 MR. PARRY: I think one thing that Glenn didn't
9 say, though, is that that three-times-ten-to-the-minus-six
10 figure he's talking about, most of that comes from seismic.
11 I think that that is, in a sense, a bounding assessment.
12 DR. APOSTOLAKIS: Okay. Let's focus then on the
13 human error driven sequences, which are
14 two-ten-to-the-minus-seven. Could this be
15 ten-to-the-minus-five?
16 MR. PARRY: I wouldn't think so.
17 DR. APOSTOLAKIS: In which case I'm back to the
18 earlier estimate. I mean, shouldn't there be some
19 uncertainty evaluation here? Here they are. Okay. Where
20 are the human --
21 MR. KELLY: This shows how the numbers dropped
22 from our June 1999 report to our current report. For loss
23 of off-site power, fire, loss of pool cooling, loss of
24 inventory, these were primarily due to -- the changes were
25 due primarily to commitments made by the industry and by the

1 areas of clarification that the NRC came up with that they
2 believe need to be done in order to get these numbers down
3 there.
4 DR. POWERS: If you look at these numbers and you
5 say, gee, this is something less than the probability that
6 the vessel in an operating plant is going to break open, and
7 so your tendency is why do I worry about this, it's a very
8 low probability sort of event.
9 But then you're reminded that these numbers are
10 after we've done a bunch of things.
11 MR. KELLY: I'm sorry, they're?
12 DR. POWERS: They're after we have done -- they're
13 for situations after we've done a bunch of things.
14 MR. KELLY: That's correct.
15 DR. POWERS: Okay. What I'm wondering is, was
16 there a connection between the estimates before we did
17 things and what was decided to do or what you decided to do
18 is just kind of in an ad hoc way and you recalculated it and
19 found the numbers were very low.
20 MR. KELLY: The commitments that were made by the
21 industry were directly tied to the areas that we had
22 identified as being ones that we felt were important to be
23 clarified so that we could more -- we could take advantage
24 of the things we thought industry probably would be doing,
25 but there were no commitments or requirements for them to

1 do.

2 DR. POWERS: Okay.

3 MR. KELLY: And as a matter of fact, Gareth had
4 done some draft work that had been transmitted to the
5 industry and to the stakeholders, where people had an
6 opportunity to take a look at what were the type of things
7 that we thought were important in order to come up with the
8 human error failure probabilities.

9 DR. KRESS: What does seismic do to you? Does it
10 break a pipe and drain the pool?

11 MR. KELLY: No. This is catastrophic failure of
12 the pool itself.

13 DR. KRESS: The pool itself.

14 MR. KELLY: These numbers, seismic numbers are
15 about three times the SSE.

16 DR. KRESS: Is that the reason you say they're
17 bounding, because they're about three times the SSE?

18 MR. KELLY: The numbers are bounding because of
19 the -- these are based on looking at generic -- I shouldn't
20 say generic, but numbers across the industry. So for some
21 sites, these numbers are clearly very bounding. For others,
22 they may be closer, they're not as bounding, but we have Dr.
23 Kennedy here in the audience who can give you the details of
24 his estimates that he did and how he came up with the number
25 of three-times-ten-to-the-minus-six, if you'd like to have

1 him speak on that.

2 DR. KRESS: I think we would. I would, because

3 clearly it's the dominant sequence.

4 MR. KELLY: Dr. Kennedy is here ready to enlighten

5 you.

6 DR. KENNEDY: Should I go up there or sit back

7 here?

8 DR. KRESS: Up there would be better, if you

9 could.

10 DR. KENNEDY: Okay. Bob Kennedy speaking. What

11 industry committed to is to agree to do a set of screening

12 criteria on their spent fuel pools. This screening

13 criteria, if the plant passes it, would give high confidence

14 of a low probability of failure, essentially about a -- on a

15 mean one percent conditional probability of failure at

16 ground motions in the neighborhood of 1.2g spectral

17 acceleration or a half g peak ground acceleration.

18 So what I did is start with the assumption that

19 the plant would pass the screening criteria, but would

20 barely pass it. Now, some of the plants may pass it by

21 quite a bit and we're assuming they just barely pass the

22 screening criteria, but we are assuming they do pass. If

23 they don't pass, they would have to do something else.

24 With that set of assumptions, evolving a seismic fragility

25 curve that's based on that set of assumptions with seismic

1 hazard curves, we found for the 69 central and eastern U.S.
2 sites that Livermore hazard curves were developed at, that
3 only eight of the 69 sites had annual frequencies of failure
4 in excess of three-times-ten-to-the-minus-six. That's based
5 on a Livermore hazard study.
6 If, instead, EPRI hazard curves were used, only
7 four of the sites, if my memory is right, they studied 60 of
8 the 69 central and eastern U.S. sites, only four of those
9 sites would exceed .5-times-ten-to-the-minus six. So the
10 three-times-ten-to-the-minus-six number, there are eight
11 sites that would exceed it and pass the screening criteria,
12 if you use Livermore hazard study. If you use EPRI hazard
13 study, none of the sites will exceed this. In fact, only
14 one site exceeds one-times-ten-to-the-minus-six and only
15 four sites exceed .5-times-ten-to-the-minus-six.
16 So we're operating in an area where there is
17 significant uncertainty induced by just simply the
18 difference in the seismic hazard estimates in the east and
19 these two studies represent both very high quality studies.
20 They're in reasonable agreement with each other at the
21 ten-to-the-minus-four level, but by the time they get down
22 into the ten-to-the-minus-six level, they're producing
23 estimates of ground motion that are very dissimilar from
24 each other.
25 DR. POWERS: I thought we had a unification of

1 those two. I thought we had done a study that got rid of
2 this business of using two different --
3 DR. KENNEDY: The difference was gotten rid of in
4 about the ten-to-the-minus-four level, but the difference
5 still exists -- I mean, typically, it's
6 ten-to-the-minus-four, ten-to-the-minus-five level on the
7 hazard curves that are most interesting, from the
8 traditional seismic PRAs that looked at seismic-induced core
9 damage.
10 But now, as you try to go down to the
11 ten-to-the-minus-six level, these differences are still very
12 dramatic.
13 DR. APOSTOLAKIS: So let me understand this, Bob.
14 You say six sites would exceed three-ten-to-the-minus-six.
15 DR. KENNEDY: If we use the Livermore hazard
16 study, eight sites exceed, eight central and eastern sites,
17 and, of course, the western sites would exceed, under this
18 assumption that they barely meet a HCLPF capacity of .5 g.
19 DR. APOSTOLAKIS: Now, what's magical about
20 three-ten-to-the-minus-six? Why do we worry about whether
21 we exceed it or not?
22 MR. KELLY: We didn't.
23 Three-times-ten-to-the-minus six is not magical. It's where
24 the numbers turn out and that was the number assuming that
25 .5 g is the appropriate number for determining the capacity

1 of the pool.

2 DR. APOSTOLAKIS: But, I mean, why do I care that

3 eight sites exceed it? What's so special about it?

4 MR. KELLY: What we said is --

5 DR. APOSTOLAKIS: And by the way, Bob, do you

6 remember by how much? They would be what?

7 DR. KENNEDY: Yes, I do. If you'll give me a

8 second, I brought my report with me. One site, if you use

9 Livermore hazard curve and you, again, assume that the HCLPF

10 capacity is .5 g and use a fragility curve based on that,

11 one site, the highest site with the Livermore hazard curve

12 is basically 14-times-ten-to-the-minus-six.

13 DR. APOSTOLAKIS: So we are moving into a

14 ten-to-the-minus-five.

15 DR. KENNEDY: One site. A second highest site by

16 that particular -- now, the site that is

17 14-times-ten-to-the-minus-six by Livermore hazard curve is

18 .14-times-ten-to-the-minus-six by EPRI hazard curve. So do

19 keep in mind there is a big difference in these two hazard

20 curves at this level.

21 DR. KRESS: When you say site, could there be

22 multiple plants on those sites? Are we talking about

23 individual plants?

24 MR. KELLY: There could be multiple plants.

25 DR. KENNEDY: There could be more than one unit.

1 But that's the highest. The next highest is 8.3 and by EPRI
2 that one is two-times-ten-to-the-minus-six.
3 DR. APOSTOLAKIS: So the highest then we have is
4 1.4-ten-to-the-minus-five and that's intended to be, what, a
5 mean value?
6 DR. KENNEDY: That's a mean estimate.
7 DR. APOSTOLAKIS: The mean using the Livermore
8 curves.
9 DR. KENNEDY: Using the Livermore curves.
10 DR. APOSTOLAKIS: So there is model uncertainty
11 here in the sense of the whole bunch of curves could move to
12 lower values if one used EPRI.
13 DR. KENNEDY: Yes.
14 DR. APOSTOLAKIS: Okay. Why isn't that good
15 enough?
16 MR. KELLY: We haven't said that the numbers
17 weren't good enough. We just said that --
18 DR. APOSTOLAKIS: But I think you are giving the
19 wrong impression by comparing with the
20 three-ten-to-the-minus-six and say, well, gee, certain sites
21 are above and below. There is nothing about
22 three-ten-to-the-minus-six that's special and
23 1.4-ten-to-the-minus-five may very well be an acceptable
24 number.
25 MR. KELLY: It might be, yes.

1 DR. APOSTOLAKIS: Who is going to determine that?
2 MR. KELLY: Well, if they come in on a
3 plant-specific basis, we would say that they could -- I
4 mean, we have no -- there's no number out there for either
5 core damage frequency or for risk that is the number that a
6 plant has to meet. What we have here is we have looked at
7 numbers based on -- and I was going to get into that later
8 -- based on the Reg Guide 1.174 thought process of large
9 early releases at the level of
10 one-times-ten-to-the-minus-five per year being a level at
11 which we would allow a licensee to come in and make a --
12 below that, if your LERF was below that level, you'd be able
13 to make small increases in your LERF.
14 So we just used that number of
15 one-times-ten-to-the-minus five in our report as a surrogate
16 to allow us to judge what was appropriate and as a matter of
17 fact, the ACRS had suggested to us previously that that was
18 a good way to go.
19 DR. APOSTOLAKIS: But let's see now. These are --
20 but you can't really view this as being changes in the
21 licensing basis, is it? Are they changes?
22 MR. KELLY: No, this is not.
23 MR. RUBIN: This is Mark Rubin, again. Dr.
24 Apostolakis, if you look at the draft report, we evolved a
25 proposed, a suggested pool performance frequency guideline

1 of 1E-to-the-minus-five based on the logic processes in
2 1.174, which I think we discussed with you at the previous
3 and you endorsed.
4 So you're correct. Even the outlier plants would
5 essentially -- using the higher Livermore curve, would
6 essentially meet the total screening guideline we suggested,
7 as appropriate, 1E-to-the-minus-five. So, yes, there is
8 nothing at all magical about that.
9 DR. APOSTOLAKIS: But the existing numbers can be
10 greater than ten-to-the-minus-five and you can't force the
11 licensee to do anything about it.
12 MR. RUBIN: That's correct.
13 DR. APOSTOLAKIS: Right.
14 MR. RUBIN: Right.
15 DR. APOSTOLAKIS: So it's only where they're
16 requesting changes that these numbers become important.
17 MR. KELLY: This is in the context of licensees
18 asking for exemptions to essentially operating reactor
19 regulations.
20 DR. APOSTOLAKIS: To change them.
21 MR. RUBIN: Yes, sir.
22 DR. POWERS: Now, I would say the following. This
23 is how I would argue this. It's 1.4-ten-to-the-minus-five.
24 So you are really on the boundary there. Remember the
25 footnote in the pictures. Increased management attention,

1 right? That's really where we are now. And then Dr.
2 Kennedy is telling us this number is a result of one
3 approach and there is another approach that produces a
4 number that is lower.
5 So I'm not even sure that
6 1.4-ten-to-the-minus-five is the number to use. Chances are
7 I'm below the line, right?
8 MR. KELLY: That's correct. What we wanted --
9 again, it's still a draft, and so these comments are very
10 welcome. We want to identify sort of a high confidence
11 bound for a large group of plants where the evaluation here
12 would be generally representative, that could be used in
13 looking at exemptions and looking at rulemaking.
14 As we started going into the analysis, we weren't
15 trying to draw very fine lines to try to say, well, everyone
16 is pretty much okay. There were some -- there was enough
17 variation that we went with this high confidence group,
18 which we generally covered by the evaluation here, and then
19 the plants that fell perhaps a little outside, perhaps not,
20 we'd look at a little closer.
21 That's the increased management attention aspect.
22 DR. APOSTOLAKIS: So what it comes down to is that
23 senior management at the NRC will ultimately have to pass
24 judgment here in these cases, because you are in that region
25 that is dark.

1 DR. KRESS: While we're on the subject of these
2 regions and the darkness and the increased management
3 attention, I recognize that the ACRS might have said that
4 one-times-ten-to-the-minus-five might be a good criterion to
5 use as an acceptance criterion, but I would like to raise
6 some questions about that.
7 In the first place, it was -- in 1.174, that was a
8 surrogate for prompt fatalities and it was an acceptance
9 criteria for reactors, of which there might be 100 or so out
10 there operating for 40 or 60 years.
11 Then we have decommissioning plants, not reactors,
12 although there are some similarities, but very few, there's
13 not that many of them. They're only at risk for a short
14 time, like five years or so, at any risk. And not only
15 that, the 1.174 surrogate for prompt fatalities was based on
16 a source term that was driven by steam oxidation of the
17 core.
18 Here we have a situation where the source term is
19 driven by air oxidation of spent fuel, which gives you an
20 entirely -- possibly gives you an entirely different mix of
21 fission products, which puts into question the back
22 derivation of one-times-ten-to-the-minus-five from a prompt
23 fatality.
24 So I don't think I see a proper thinking out of
25 this acceptance criteria. It doesn't seem to me like it's a

1 defendable acceptance criteria because it's so different
2 from 1.174, and I don't see the connection to 1.174 here.
3 MR. RUBIN: Dr. Kress, there's quite likely a lot
4 of validity in the general comments that you made. It's not
5 a one-to-one mapping certainly. There are a number of
6 differences here.
7 We tried, though, to at least make those
8 differences transparent in the draft report to lay out what
9 our thought processes were that let us sort of meander
10 around from 1.174 numbers into this proposed guideline.
11 Very briefly, certainly, the guideline could be
12 even higher because of the differences in the source term,
13 some might argue even lower because there possibly are some
14 lower levels of defense-in-depth for pool versus reactor.
15 I think what we tried to do was establish some
16 balance between the thought processes that might lead you up
17 and might lead you down, and basically what we did was based
18 on some very good work from the Office of Research in
19 looking at the source terms and the consequences.
20 It was pretty clear that this was a highly
21 undesirable event. Whether it would be precisely the same
22 as a large early release in a reactor, most probably not.
23 There would be fewer prompt fatalities. There would still
24 be a very large release, though, a significant number of
25 latent fatalities.

1 DR. KRESS: Let me ask you about this.

2 MR. RUBIN: Certainly.

3 DR. KRESS: That study was based on a reactor

4 source term, a reactor like source term.

5 MR. KELLY: No, it wasn't. It was based -- the

6 one that we did, the first one that we showed in the June

7 report, actually the June report didn't have it, but our

8 June report was based on knowledge that we had at the time

9 of using source terms that came out of a Brookhaven report

10 that were supposed to be for --

11 MR. RUBIN: Glenn, excuse me. Why don't we let

12 Jason Schaperow, from Office of Research, who did the

13 evaluation, provide details to the committee.

14 DR. APOSTOLAKIS: One last question before Dr.

15 Kennedy leaves. Did you also do an uncertainty analysis

16 given, say, Livermore curves?

17 DR. KENNEDY: No, I did not. But typically

18 there's large uncertainty. Typically, with Livermore hazard

19 curves, the median value, for instance, is typically about a

20 factor of ten less than the mean value. That is some

21 indication of the uncertainty.

22 With the EPRI hazard curves, there is somewhat

23 less uncertainty claimed by EPRI in their hazard curves. So

24 you could get large uncertainties on these numbers.

25 DR. APOSTOLAKIS: So that

1 1.4-ten-to-the-minus-five could be close to
2 ten-to-the-minus-four, if one accepted the Livermore curves.
3 DR. KENNEDY: I don't think it could get as high
4 as -- I tried to -- the numbers I gave are based upon the
5 mean hazard curve, which tends to be up around the 85th
6 percent non-exceedance probability on Livermore hazard
7 curves.
8 The median number, of which 50 percent above, 50
9 percent below, would be typically a factor of ten lower. So
10 the 1.4-times-ten-to-the-minus-five mean would typically be
11 in the neighborhood of 1.4-times-ten-to-the-minus-six
12 median.
13 MR. PARRY: Can I also remind you that the
14 acceptance guidelines, if we use them, from Reg Guide 1.174
15 are intended to be compared with mean values.
16 DR. POWERS: That's right, and I don't know how to
17 do that. I mean, I don't know how to compare these numbers
18 to means and subsequently to 1.174. I mean, how do I do
19 that? I don't know what the statistical significance of
20 these numbers is.
21 DR. APOSTOLAKIS: So the first point is that there
22 is no rigorous uncertainty analysis here. But the second
23 point is that even though the guide says use mean values, as
24 you approach the forbidden area and you have increased
25 management attention, then it seems to me input like the one

1 Dr. Kennedy just gave us, because important to management to
2 have an idea what they're talking about, because the mean
3 values is a convenient way to act, but I would act
4 differently if I were senior management if an expert told me
5 the mean -- the 95th percentile could be a factor of five
6 above or whatever, or it could be a factor of two.
7 These are important inputs to the deliberation,
8 even though the guide says use the mean value.
9 MR. PARRY: I agree. I think perhaps one of the
10 more important inputs, though, is the fact that there is
11 such a big difference between the Livermore curves and the
12 EPRI curves.
13 DR. APOSTOLAKIS: Of course, there is, and that's
14 also important.
15 MR. PARRY: And that's also part of the --
16 DR. APOSTOLAKIS: Of course. That's why I keep
17 saying if one accepts the Livermore curves. There is no
18 question about it.
19 DR. POWERS: I guess I don't understand. You say
20 the bigger thing is the difference between the --
21 MR. PARRY: Well, the modeling uncertainties.
22 DR. POWERS: Between Livermore and EPRI is at this
23 range, but at least the numbers quoted to me sounded like
24 they were like the difference between the median and the
25 mean for a given curve.

1 MR. PARRY: In one case, maybe.

2 DR. KENNEDY: In the case that had the highest
3 value from Livermore, and the difference between Livermore
4 and EPRI varies from site to site, and that happens to be
5 one of the sites where it's one of the bigger differences.
6 In that particular case, the numbers based upon a mean
7 Livermore hazard curve were 14-times-ten-to-the-minus-six,
8 based on a mean EPRI hazard curve were
9 .14-times-ten-to-the-minus-six, a factor of 100 difference.

10 I didn't do this study doing convolution of the
11 uncertainties, but I've done that in many other cases, and
12 typically the difference from Livermore hazard curves
13 between the mean and the median values are about a factor of
14 ten.

15 So if that held true for this site, and I can't
16 confirm that, but if it did hold true for this site, the
17 median numbers from Livermore would be a factor of ten less
18 than the mean numbers, but the mean EPRI number is a factor
19 of a 100 less.

20 So there is -- basically, the two sets of hazard
21 curves, at ten-to-the-minus-six, do not overlap.

22 DR. APOSTOLAKIS: Now, you also mentioned in
23 passing earlier something about the west. What happens in
24 the west?

25 DR. KENNEDY: Western sites would have to do

1 something beyond this screen. This screening criteria that
2 NEI put out, that I happen to agree with as being a good
3 screening criteria, is aimed at some fairly simplified
4 reviews that the plant can do and if they pass those
5 reviews, demonstrate that they have a high confidence low
6 probability of failure capacity greater than .5 g, such a
7 capacity is not adequately high for some of the western
8 sites.
9 So they would not be able to use this same
10 screening criteria to demonstrate adequate seismic
11 ruggedness. They would have to do further review.
12 MR. BAGCHI: Can I say something? This is Goutam
13 Bagchi. I'm a senior level advisor in Division of
14 Engineering. The biggest difference between east and west
15 is the hazard curve itself. In the west, the hazard is well
16 known and driven by some well known seismogenic sources.
17 The hazard curve, therefore, instead of being
18 asymptotic, becomes almost vertical and that kind of
19 uncertainty at the high level, at the low probability level
20 is just not there.
21 So we have chosen a ground motion level which is
22 two times this, as in the report, for the western sites and
23 we think that's quite adequate. And what has not been said
24 all this time is that in our preliminary report, many of our
25 staff members, particularly geophysicists, and I myself

1 agree with that, that three times the SSE for the eastern
2 United States, that's the threshold of credible ground
3 motion.
4 It is extremely high ground motion. If you can
5 show a HCLPF level at that kind of ground motion, I don't
6 think there is any uncertainty, I mean very little
7 uncertainty beyond that that there will be a catastrophic
8 failure of these pool structures.
9 You have to understand how robust and rugged the
10 pool structures are.
11 DR. APOSTOLAKIS: Now, three times the SSE is how much?
12 MR. BAGCHI: Three times the SSE for the eastern
13 United States at the highest level would be .75 g. There is
14 no known seismotectonic behavior that could lead to that
15 kind of a ground motion.
16 DR. APOSTOLAKIS: How does that fit into what Dr.
17 Kennedy does?
18 MR. BAGCHI: It does not. This is a deterministic
19 consideration and we're saying to you that the hazard curves
20 that were compared, EPRI versus Livermore, back in 1993
21 study, were only looked at up to the SSE level. So when you
22 go beyond the something-times-ten-to-the-minus-four to the
23 level of something like ten-to-the-minus-five and minus-six,
24 then the uncertainty zooms out and there has been no direct
25 correlation or methodological understanding of why those

1 differences exist.

2 DR. KENNEDY: I think if you look at the Livermore
3 hazard curves at the ten-to-the-minus-six level, you get to
4 ground motions that a number of people in the seismological
5 community do not feel are really very credible ground
6 motions in the east.

7 The EPRI hazard curves tend to curve over and
8 truncate and it's the difference that Goutam just mentioned
9 is really the source of difference between the Livermore and
10 the EPRI hazard curves. The EPRI hazard curves would tend
11 to follow the approach that many seismologists would agree
12 with that there is some limits to what this ground motion
13 might be in the east at reasonably annual frequencies.

14 Well, I'm not sure ten-to-the-minus-six is
15 reasonable annual frequencies, but at ten-to-the-minus-six
16 annual frequencies, there are other seismologists who don't
17 agree that those limits apply. Livermore hazard curves tend
18 to -- in their mean, tend to weight that evidence -- not
19 evidence, but those suppositions stronger than the EPRI ones
20 do.

21 At ten-to-the-minus-six ground motions, I think
22 it's a wild guess what the ground motion might be in the
23 east at ten-to-the-minus-six annual frequencies, and that
24 shows up in these hazard curves.

25 DR. KRESS: Okay. Can we hear from Jason now on

1 the source term?

2 MR. SCHAPEROW: I am Jason Schaperow, from the

3 Office of Research. I have put together a short

4 presentation on our consequence assessment, including some

5 work done after the draft report was issued in response to

6 ACRS comments.

7 The object of our consequence evaluation was to

8 assess the effect of one year of decay on off-site

9 consequences. We also assess the effect of early versus

10 late evacuation.

11 DR. KRESS: Why did you choose one year, Jason?

12 MR. SCHAPEROW: One year was chosen as the point

13 where NRR was going to start considering reductions in

14 emergency planning.

15 DR. KRESS: You had an idea that that might be

16 about the timeframe for the risk as reduced to a level you

17 could live with.

18 MR. RUBIN: If I could add, Dr. Kress. This is

19 Mark Rubin, again. Yes. Obviously, you have a decreasing

20 heat load. The key was increasing time for operator

21 response, because so many of these sequences were operator

22 response driven, at least at the very beginning. So one

23 year was a convenient time when we thought we'd probably

24 have enough time to get pretty robust remedial actions

25 taken, and that was where the calc was done.

1 MR. SCHAPEROW: Our evaluation was an extension of
2 a previous evaluation performed by Brookhaven on operating
3 reactor spent fuel pool accidents performed in support of
4 resolution of Generic Safety Issue 82, and the Brookhaven
5 work was done for 30 days after shutdown.
6 DR. KRESS: My comment, Jason, that this was an
7 operating reactor source term had to do with the release
8 fractions.
9 MR. SCHAPEROW: Yes, I'll get to that.
10 DR. KRESS: Not to decay or the inventory. But am
11 I correct that you use release fractions that would have
12 been appropriate for operating reactors?
13 MR. SCHAPEROW: As I will discuss here in the
14 second and third slides, we used the operating reactor type
15 source term and then we took a look at it in light of the
16 possibility of air ingression. For example, for a seismic
17 event, where the bottom falls off the pool, the air can come
18 up inside and --
19 DR. KRESS: But that air ingression wasn't part of
20 the original document.
21 MR. SCHAPEROW: That's correct. You read it
22 correctly. There's no discussion of air ingression or
23 ruthenium in there.
24 To perform our evaluation, we performed in-house
25 MAACS calculations with fission product inventories for 30

1 days and one year after final shutdown.

2 DR. POWERS: When you used the MAACS code, did you

3 -- how did you model the plumes coming out?

4 MR. SCHAPEROW: We modeled it as an early release

5 from a reactor accident. We used the Surry modeling.

6 DR. POWERS: Do you use the default parameters for

7 plumes in MAACS?

8 MR. SCHAPEROW: Yes, I believe so.

9 DR. POWERS: The NRC, in cooperation with the

10 Europeans, has done quite a little uncertainty study on

11 those plumes and when the default parameters appeared

12 against the expert elicitations, there's quite a discrepancy

13 between the two, isn't there?

14 MR. SCHAPEROW: Is that a draft study? I think I

15 looked at that recently.

16 DR. POWERS: It's fully published.

17 MR. SCHAPEROW: Okay. I guess I'm not aware of

18 the study then.

19 DR. POWERS: I think before you use the MAACS

20 code, you need to look at this expert elicitation. It's

21 quite a fine expert elicitation, quite a fine piece of work.

22 One of the things that I find most striking about

23 it is how it describes -- how the experts describe plumes as

24 opposed to how it's done by default parameters within the

25 MAACS code.

1 In particular, the experts said, gee, these plumes
2 spread more rapidly than described by the default
3 parameters. Now, they had quite a range on their -- it's a
4 b parameter, I think, that they used to describe the spread
5 of the plumes.
6 But I think in all cases, the spreading was a good
7 deal higher than what you would ordinarily get if you just
8 sat down and ran the MAACS code. If that's the case, first
9 of all, there's a substantial uncertainty in your results.
10 Second of all, you may over-estimate prompt fatalities and
11 under-estimate the number of latents and the amount of land
12 contamination associated with these plumes.
13 MR. SCHAPEROW: As I said, I am not familiar with
14 that, but we can go back and take a look at that.
15 DR. KRESS: Did your default parameters include an
16 energy of the plume release so that you can get the extended
17 elevation?
18 MR. SCHAPEROW: That's correct. That's correct.
19 We used the same as an early release in the Surry deck.
20 DR. KRESS: So it would be release from a
21 containment.
22 MR. SCHAPEROW: We used the large early release
23 for Surry for NUREG-1150.
24 DR. KRESS: It had the same energy.
25 MR. SCHAPEROW: Correct.

1 DR. KRESS: As opposed to a fire release.

2 DR. POWERS: I don't think that helps me. I think

3 it makes it even worse.

4 DR. KRESS: I think it makes it worse, because a

5 fire driven release would go higher. It has more energy in

6 it and it would spread out more and do more of the land

7 contamination and the latent fatalities that you talked

8 about. It might help the early fatalities.

9 DR. POWERS: I think what is most at risk here is estimates

10 of the prompts and as you know, you and I disagree on the

11 role of the prompts versus the latents.

12 DR. KRESS: Maybe not in this case.

13 DR. POWERS: But maybe not in this case, yes.

14 Maybe we've found grounds for agreement here. But I think

15 the issue really boils down to we're doing calculations in

16 an uncertain area and we're doing them as point values and

17 maybe sensitivity studies, and then we're being asked to

18 compare the results against criteria that were developed

19 that explicitly call out the mean, and I just can't find the

20 means. I just don't know what they are.

21 MR. RUBIN: If I could share a perspective with

22 the committee. Your point certainly we will follow up on.

23 As far as the actual consequence calculations, results of

24 the analysis, mean values or even point estimates weren't

25 used in our actual decision-making process. The results

1 were used to give us a perspective on the general
2 characteristics of a spent fuel pool fire consequences.
3 We wanted to get an appreciation --
4 DR. POWERS: If I can interrupt you.
5 MR. RUBIN: Yes, sir.
6 DR. POWERS: And say you're not helping. When you
7 tell me that I didn't do the uncertainty study, and so I
8 didn't have that information to help me make my decision,
9 I'm not sure that helps.
10 DR. KRESS: What he's also telling me is that
11 these consequence analyses were interesting, but weren't
12 used anywhere in the assessment or the results of the study,
13 because what they did is just said, all right, we'll just
14 back off to the one-times-ten-to-the-minus-five LERF and not
15 use these anyway.
16 DR. POWERS: Your point is that maybe this is a
17 higher risk than --
18 DR. KRESS: Maybe this risk is higher than the
19 1.1-times-ten-to-the-minus-five or maybe the LERF, the
20 surrogate LERF ought to be higher based on the fact that --
21 MR. KELLY: What we looked at in doing this is
22 that we did the risk -- we asked Research to do the
23 consequence analysis because we wanted to find out and
24 confirm what we expected, that the consequences were going
25 to be very, very significant, and it would be a type of

1 thing that we wanted to make sure that the frequency of it
2 occurring would be relatively low and we were not worried
3 about getting an exact number.
4 We were interested in confirming that the
5 consequences were significant or perhaps being surprised and
6 finding out they weren't significant. But the bottom line
7 is when we came out, they were very significant, done
8 several different ways, they keep turning up to be very
9 high.
10 DR. KRESS: But I think the point is that they may
11 be more significant than the reactor accident.
12 MR. KELLY: The potential is there, particularly
13 when you have multiple cores available.
14 DR. KRESS: That's what is concerning us, yes.
15 DR. POWERS: I guess there is this intuition that
16 says, gee, you've decayed out for a long time, how much can
17 you possibly release, and what should come back is maybe a
18 lot.
19 MR. SCHAPEROW: Our evaluation, which was
20 described in the report, which did not include large
21 ruthenium releases, showed the short-term consequences, the
22 early fatalities were reduced by a factor of two in going
23 from 30 days to one year.
24 It also showed that early evacuation reduces early
25 fatalities by up to a factor of 100. Long-term

1 consequences, the cancer fatalities and the societal dose,
2 were less affected by the additional decay and early
3 evacuation.
4 Here is a summary of our calculated results. We
5 did do a lot of MAACS calculations. We performed over three
6 dozen MAACS calculations, which included variations in the
7 radionuclide inventory, evacuation start time and population
8 density. The results shown here are for the Surry
9 population density.
10 Again, our results show about a factor of two
11 reduction in early fatalities and going from 30 days to one
12 year. Cesium, with it's long half-life of 30 years, is
13 responsible for limiting the reduction. For populations
14 within 100 miles of the site, 97 percent of the societal
15 dose was from cesium.
16 Our results also show a large reduction in early
17 fatalities when evacuation takes place before the release.
18 MR. KELLY: I just wanted to comment that these
19 results that are up there are the ones that represent those
20 that were reported in our draft report.
21 MR. SCHAPEROW: Now, I'd like to discuss the
22 effect of ruthenium, which is an important issue which was
23 identified by the committee. We spoke with Canadian
24 research staff responsible for experimentally determining or
25 investigating air ingression to better understand their

1 experimental research.

2 We also performed MAACS calculations using a 100

3 percent ruthenium release.

4 DR. KRESS: From how many spent fuel cores?

5 MR. SCHAPEROW: About three-and-a-half cores.

6 Basically, the whole pool. Assuming the whole pool heated

7 up to high temperatures under air conditions and released

8 all of its ruthenium.

9 And our calculations show that release of all

10 ruthenium increases early fatalities by up to a factor of

11 100 because of the assumed form ruthenium oxide has a large

12 dose per curie inhaled, due to its long clearance time from

13 the lung to the blood.

14 DR. KRESS: Which would say that the LERF value

15 might ought to be increased by a factor of 100. Instead of

16 one-times-ten-to-the-minus-five, it ought to be --

17 MR. SCHAPEROW: Ruthenium does have a very large

18 impact.

19 DR. KRESS: The other way around.

20 MR. SCHAPEROW: And we did identify a couple of

21 mitigating factors. While the effect of ruthenium is, as

22 you say, potentially quite large, as our calculations show,

23 there are a couple of mitigating factors.

24 Rubbling of the fuel may limit air ingression and

25 reduce the release fraction.

1 DR. KRESS: Maybe.

2 DR. POWERS: I can't resist but jump in and just
3 point out that when we looked at the substantial ruthenium
4 releases that occurred from Chernobyl, that by and large,
5 the particles, we believe, were released in the oxide form,
6 but they promptly converted to the metallic form at some
7 point in their transport, because we only collect them after
8 they've gone quite a little ways.

9 And I don't know why they were reduced to the
10 metallic form, but I do know it does appear that most of
11 them are back into the metallic form. That will change the
12 clearance.

13 DR. KRESS: That will change the consequence, yes.

14 DR. POWERS: Their capability and their dose
15 effectiveness. It may change them only in the organ that's
16 affected rather than the --

17 DR. KRESS: It would have some effect on the
18 analysis.

19 DR. POWERS: It will have some effect on the
20 analysis, nor do I have any confidence that what was
21 observed at Chernobyl would be observed at any other
22 accident.

23 DR. KRESS: The other thing is ruthenium, a
24 one-year half-life, will be a significant effect on latent
25 cancers and land contamination, also.

1 MR. SCHAPEROW: That's correct.
2 DR. KRESS: You don't mention it here, but --
3 MR. SCHAPEROW: That's correct, and that's --
4 DR. KRESS: -- it would increase those
5 considerably.
6 MR. SCHAPEROW: The next slide indicates that.
7 DR. KRESS: I'm sorry.
8 MR. SCHAPEROW: Also, with regard to the
9 mitigating effect of the one-year half-life of ruthenium is
10 the fuel is going to be in spent fuel pools for at least
11 five years. That's what the casks are -- the dry casks are
12 not now approved for less than five years.
13 So with a one-year half-life, this is going to --
14 you're going to see a big fall-off in the early fatalities
15 as you get further out in time.
16 Finally, I would like to note that a PHEBUS test
17 is planned to examine the effect of air ingression on a
18 larger scale in an integral facility. We believe that this
19 test is a good opportunity to get integral data on ruthenium
20 releases.
21 DR. POWERS: Since you mentioned ruthenium, my
22 recollection of the work done at Oak Ridge back in the '60s
23 as they saw enhanced release of other radionuclides. Did
24 you look at anything else?
25 MR. SCHAPEROW: No, we did not. I think generally

1 you will find that those nuclides have very short
2 half-lives, is my suspicion. If there are any that you're
3 aware of, I will certainly be happy to look into them.
4 DR. POWERS: What I suspect is that everything
5 gets dominated by the ruthenium and it really didn't matter
6 what else you release, just because of its peculiarity.
7 Ruthenium is a most intriguing radionuclide from a
8 radiological point of view.
9 MR. SCHAPEROW: My last side provides a summary of
10 our calculated dose for the ruthenium issue. The first two
11 cases are for late evacuation. The first case only uses a
12 small ruthenium release, and that's our -- we had a very
13 small number of early fatalities, that's one.
14 The second case uses a 100 percent ruthenium
15 release, which results in a very large increase in early
16 fatalities. In the third case, which is for early
17 evacuation, the prompt fatalities drop back down.
18 As a result of our calculations, we conclude that
19 the effect of ruthenium can be very significant, but can be
20 offset by early evacuation.
21 Those are my prepared remarks to address the ACRS
22 issue.
23 DR. KRESS: Well, if you only focused on prompt
24 fatalities, but evacuation is not going to help the land
25 contamination. It's not going to help the latent fatalities

1 too much.

2 MR. SCHAPEROW: That's correct. Those numbers do

3 go up some, as you can see.

4 DR. KRESS: So I'm not sure which is the

5 controlling regulatory objective here, right? I don't know

6 whether without the -- we think whether prompt fatalities is

7 what we are -- just as Davis says, maybe we should look at a

8 risk acceptance criteria on land contamination or on total

9 deaths or latent cancers and see if you get a different

10 worth.

11 MR. SCHAPEROW: That's true.

12 DR. KRESS: It wouldn't be the same LERF and it

13 wouldn't even be called a LERF. It would be called

14 something else.

15 MR. SCHAPEROW: The societal dose and the cancer

16 fatalities are affected by the relocation criteria, the

17 relocation criteria of 25 rem for distances beyond ten

18 miles. So we can do something to reduce some of those

19 consequence numbers.

20 DR. APOSTOLAKIS: Why do you have to assume that

21 100 percent of the ruthenium is released?

22 DR. KRESS: You can't get more than that.

23 DR. POWERS: Conservative, George.

24 DR. APOSTOLAKIS: When you say mean consequences

25 not to do things like that.

1 DR. POWERS: Unfortunately, George, that may well
2 be the mean. The Canadian studies that Mr. Schaperow
3 referred to sees astronomical releases, fractions, that get
4 up to 100 percent when fuel is exposed to air at relatively
5 modest temperatures, around, what, 1,800 degrees -- I don't
6 even remember -- 1,800 degrees Centigrade, I think they were
7 getting 100 percent releases.
8 MR. SCHAPEROW: That sounds like the right
9 ballpark to me.
10 DR. POWERS: And that some work done back in the
11 '60s at Oak Ridge where they put chunks of fuel into the
12 air, they were seeing like 100 percent releases at about
13 1,100 degrees Centigrade.
14 Now, I would hasten to add, as Mr. Schaperow has,
15 that if we put this stuff in a big pile, it's going to be
16 different than these small tests that they've done and maybe
17 don't get to 100 percent release, but I'm not sure there's a
18 big difference between 80 and 90.
19 DR. KRESS: Now, we're pointing to the ruthenium
20 possibly changing our perspective on what the 1.174 risk
21 acceptance criteria. I would like to repeat something I
22 said earlier, to be sure it got in. Those acceptance
23 criteria were for reactors, of which there are about 100,
24 that are going to operate for 40 to 60 years or at least
25 operate the remaining lifetime.

1 Here we're talking about a small number of
2 decommissioned plants that are only at risk for a short
3 time, like five years or so, and that thinking ought to
4 enter into your acceptance criteria. This will bring it
5 down the other way.
6 It's going to allow -- I mean, it's going to allow
7 you to have a higher risk acceptance criteria than the
8 one-times-ten-to-the-minus-five. So that is a mediating
9 concept that you should have in your thinking about this,
10 even though we're saying that the ruthenium puts into doubt
11 the value in the other direction, these other things put it
12 into doubt in the other direction.
13 So this might offset things. I think what we need
14 to do is re-think what is our acceptance criteria and get
15 the right factors in there, rather than just pick the value
16 out of 1.174.
17 DR. APOSTOLAKIS: Is it really reasonable to ask
18 --
19 DR. KRESS: If you're going to have a
20 risk-informed regulation, which is what we're talking about,
21 we're talking about making a rule on decommissioning and
22 making it risk-informed.
23 If you're going to do that, the first place you
24 have to start, according to one of the ACRS letters, is that
25 you have to have risk acceptance criteria.

1 DR. APOSTOLAKIS: Yes.

2 DR. KRESS: And these may be prompt fatalities,
3 they may be latent fatalities, they may be land
4 contamination, they may be lots of things. You ought to
5 decide what they are before you even start a risk-informed
6 regulation.

7 DR. APOSTOLAKIS: My question is really whether
8 this particular project should think about it or the other
9 one where --

10 DR. KRESS: I think this would be a great place
11 because it's the one place that looks like land
12 contamination or latent fatalities may be the controller and
13 it may be a place where you don't want to think prompt
14 fatalities.

15 DR. APOSTOLAKIS: But there is another project
16 that is thinking about revising.

17 DR. KRESS: I don't know. I don't like to think
18 of NRC being fractured into different parts. They ought to
19 get their act together. But my point is that risk
20 acceptance criteria ought to involve other things, like how
21 many things are at risk, how many things are we talking
22 about, and how long are they at risk, and those don't seem
23 to be showing up here properly and both of those show up --
24 all of those show up in this particular place.

25 It's a good place to re-think how we do our risk

1 acceptance criteria.

2 DR. APOSTOLAKIS: I agree.

3 MR. KELLY: Some time ago, we were talking about
4 changes, the technical results we had gotten, and we talked
5 about human errors, reduction in human errors. The other
6 significant reduction from the June report to our current
7 report was the heavy load sequences, reduced to about
8 two-times-ten-to-the-minus-seven per year.

9 This frequency reduction was primarily based on
10 use of better statistics on our part. We didn't get
11 significantly more information, but when we went to a
12 statistician to help us with our uncertainties, we came up
13 with, we believe, better numbers.

14 We have already talked about the seismic failures
15 and the overall frequency was reduced by about an order of
16 magnitude between the June report and our current report
17 today.

18 DR. APOSTOLAKIS: This first bullet is a little
19 bit of a mystery. First of all, Dr. Kennedy told us that
20 they are not bounded, but there are eight sites. So why use
21 the word bounded?

22 MR. KELLY: In the report, it is bounded for all
23 but those eight sites and we indicate in the report that
24 there are eight sites where this doesn't apply, plus the
25 western sites, and in those cases, we have slightly

1 different criteria.

2 Again, we're -- I'm trying to give you a high

3 overview and there's little asterisks associated with a lot

4 of these things.

5 DR. APOSTOLAKIS: But then, again, I ask you

6 what's so magical about the ten-to-the-minus-six, and you

7 said nothing. So you could have said here seismic failure

8 frequency bounded by four-ten-to-the-minus-six, but eight

9 sites are greater.

10 I'm trying to understand what is the purpose of

11 this bullet.

12 DR. KRESS: It's a result of the calculation,

13 George.

14 DR. APOSTOLAKIS: But I could have picked another

15 number and said seismic failure frequency bounded by

16 ten-to-the-minus-six, but nine sites are above it.

17 MR. RUBIN: This is Mark Rubin, again. I should

18 let someone who knows something about this, rather than I,

19 speak out, but it wasn't back calculated from

20 3E-to-the-minus-six and these are the plants that meet it.

21 Rather, there were -- originally, there were some simplified

22 seismic techniques that were used, two times, three times

23 SSE for some sites, that were felt to be appropriate for

24 initial evaluation and then this was refined by Dr. Kennedy.

25 When that was done, a calculation came out of

1 3E-to-the-minus-six for those assumptions. Well, those
2 assumptions didn't apply to these eight sites. So it went
3 the other direction and indeed another number could be
4 chosen and then different sites could be defined as meeting
5 it or not meeting it. But it fell out of some early
6 assumptions that went into the calculation.
7 DR. APOSTOLAKIS: So there is then some
8 significance to the three-ten-to-the-minus-six. It
9 represents that set of assumptions.
10 MR. RUBIN: I believe that's correct.
11 DR. APOSTOLAKIS: With that, I can see what that
12 means. But the earlier statement was there is nothing
13 magical about it.
14 MR. RUBIN: There most certainly is not magical.
15 DR. APOSTOLAKIS: You can pick a number and say
16 yes, but ten of them are above it.
17 MR. KELLY: It's based on a .5 g HCLPF value.
18 DR. APOSTOLAKIS: Okay. But not fully quantified
19 to the seismic checklist approach. What does that mean?
20 MR. KELLY: We did not do a plant-specific
21 evaluation for any of the plants. We used hazard curves for
22 the particular sites, but we don't have fragilities for
23 everybody's spent fuel pool. We used some generic
24 fragilities there and that's, in part, why, when Dr. Kennedy
25 was talking about we had the checklist which would provide

1 assurance that you're at least as good as .5 g.

2 MR. RUBIN: Mr. Kelly, I think Dr. Kennedy wanted

3 to add something to this.

4 DR. KENNEDY: Bob Kennedy, again. To the best of

5 my knowledge, there are only two plants where seismic

6 fragility estimates have actually been made. What was done

7 for all of these plants was that NEI committed that they

8 would do a seismic review of the spent fuel pools in

9 accordance with the checklist and this checklist was aimed

10 at providing high confidence of a low probability of failure

11 capacity of .5 g.

12 So all of these annual frequency estimates,

13 seismic-induced annual frequency of failure estimates, are

14 based on the plant having a HCLPF capacity of 0.5 g.

15 Now, certainly plants -- certain plants are likely

16 to have HCLPF capacity significantly greater than that.

17 There's, in my judgment, the likelihood that some of the

18 plants won't pass the checklist and will have HCLPF

19 capacities less than 0.5 g, but those will be identified by

20 having gone through the checklist.

21 So if the plant passes the checklist, has a HCLPF capacity

22 in excess of 0.5 g, the probabilities or annual frequencies

23 that I computed could be conservative because they assume

24 that is the HCLPF capacity of the plant, and a detailed

25 study of the plant might justify higher capacities.

1 The three-times-ten-to-the-minus-six number for
2 Livermore was selected because a large number of plants come
3 up fairly close to that number and there is no real gap in
4 the data below that number.
5 As you get to the
6 three-times-ten-to-the-minus-six, there are still eight
7 sites above that number, but there's a significant, starting
8 to become a significant gap from site to site. So the
9 three-times-ten-to-the-minus-six covers the vast majority of
10 the central and east coast sites, with a HCLPF capacity of
11 .5 g, and then the next site up goes all the way to four,
12 and they start bouncing up.
13 It was an arbitrary choice as a spot where there
14 seemed to be a spot that you could draw a line.
15 DR. APOSTOLAKIS: Okay. Fine. Thank you.
16 MR. KELLY: Okay. We had a number of stakeholder
17 comments that we addressed in the draft report.
18 Unfortunately, we missed some. Mr. Lochbaum, in particular,
19 brought up worker safety and we did not directly address
20 that in the report, but we will be addressing that directly
21 in the final report.
22 There was also a comment that we received on
23 partial drain-down leading to zirc fires potentially greater
24 than five years after plant shutdown. We are looking at
25 that now and we will be addressing that in the final report.

1 DR. WALLIS: Can I ask about this bottom bullet
2 here? You said the criticality issue was addressed.
3 MR. KELLY: Yes.
4 DR. WALLIS: And I read what Tony Elsies wrote and
5 it looks as if the low density GE racks, if squashed
6 suitably, could go critical.
7 MR. KELLY: That's correct.
8 DR. WALLIS: And there's a sort of suggestion that
9 this could be avoided if you scatter the most reactive
10 assemblies throughout the pool and so on. There is no
11 conclusion that certain things should or should not be done,
12 simply as a tentative statement that this might happen and
13 certain things could be done to make the consequences less
14 severe. That's all.
15 MR. KELLY: I believe it also discussed the
16 frequency of the occurrence, which was --
17 DR. WALLIS: What's the conclusion? Does this
18 require any action or you're just going to leave it up to
19 the licensees to decide if they want to scatter their
20 reactor assemblies throughout the pool or what?
21 MR. RUBIN: As you point out, there is no direct
22 requirement or recommendation for action, namely, because,
23 as Glenn was pointing out, it didn't seem to be a
24 significant risk driver, significant risk contributor.
25 We had thought that in a qualitative sense at the

1 beginning of the study, for the draft study, but we didn't
2 have at least a halfway complete thought process to consider
3 the various scenarios, the possible vulnerabilities, what
4 assemblies might be vulnerable to criticality, and, in fact,
5 what initiators or forcing functions could cause the event.
6 So we tried to go through a logical thought
7 process to develop these, looking at the frequency of the
8 event that could cause a criticality and the most likely
9 criticality result. It didn't seem to be a concern and
10 that's what we're pointing out in the report, and we wanted
11 the thought process to be visible for these kinds of
12 dialogues.
13 DR. WALLIS: Well, I think you have to say that
14 somewhere, that here is a technical analysis and it leads up
15 to something that looks interesting, and then it goes away
16 and it's gone away on the basis of risk, presumably, the way
17 so many of these technical things do.
18 I mean, someone gets interested in something,
19 works it out, and then, gee whiz, it doesn't matter anyway.
20 I think you need to point that out, why you did the work and
21 it didn't matter or something. It needs to be concluded and
22 rounded off in some way.
23 MR. RUBIN: We'll look at that. I thought there
24 was a punch line at the end, but we may have lost it in the
25 trees of the forest. So thank you.

1 MR. KELLY: Based on our analysis to date and the
2 sequences we evaluated, we found that the zirconium fires
3 would generally not be possible after five years after
4 shutdown.
5 DR. POWERS: When you conclude that a zirconium
6 fire is not possible --
7 MR. KELLY: Pardon?
8 DR. POWERS: When you conclude that a zirconium
9 fire is not possible, I think that means that -- I'm not
10 sure what that means. It means that the oxidation of
11 zirconium is not very rapid after five years.
12 MR. KELLY: What that means is that we believe
13 that if you were to remove cooling from the fuel in the
14 state that it exists five years after shutdown, that the
15 fuel would not heat up to the point that the cladding would
16 begin a rapid oxidation at about 800 degrees Centigrade,
17 eventually leading to a zirconium fire.
18 We believe that the heat transfer mechanisms and
19 the reduced decay heat would be adequate at that point to
20 prevent the fuel from heating up to that 800 degrees
21 Centigrade.
22 DR. WALLIS: Are you going to give a presentation
23 on this or is this your -- all you intend to say about the
24 fire issue?
25 MR. RUBIN: I believe this was the level that Mr.

1 Kelly's presentation was going to go into, but, of course,
2 we have the thermal hydraulic analyst, Joe Staudenmeier, who
3 completed this study, who is available for more details.
4 Should we call him up?
5 DR. WALLIS: Well, I read Appendix A a couple of
6 times and there are lots of uncertainties in these analyses
7 which are pointed out, about well mixed atmospheres and the
8 natural circulation and what are the resistances to the
9 various pods, through the matrices and the spacers and
10 everything.
11 And it seems as if your conclusion is pretty iffy
12 and then you get to the end of the appendix and it looks as
13 if the licensee is required to do an analysis of all these
14 things, and the requirements are that it be a pretty good
15 analysis. It looks as if it's got to be better than
16 anything which was reviewed by the NRC.
17 So I have a question about how do you expect the
18 licensee to do an analysis which is better than anyone has
19 done before.
20 MR. KELLY: That's one of the areas that --
21 DR. WALLIS: And if he does or she does or they
22 do, is the NRC competent to tell if it's a good analysis or
23 not, not having any sort of knowledge any better than
24 anybody else?
25 MR. KELLY: I believe this is part of the -- our

1 -- if you go up to the main body of the report and you look
2 at the areas that we feel that things that a licensee has to
3 do to qualify for an exemption or things that we're
4 proposing would be done for the technical justification for
5 rulemaking, you're not going to find that they have to
6 perform a calculation of their heat-up.
7 We did say that if someone wanted to come in and
8 request for less than the five years, that there were
9 recommendations in there on what needed to be done.
10 It may be that we need to go back and look at what
11 we've asked for there in Appendix A to determine whether or
12 not we're asking for more than can really be provided.
13 But I think that Joe Staudenmeier would be the
14 best person to answer those questions, because he's the one
15 who is intimately involved with the appendix.
16 MR. RUBIN: We can call him up and I think --
17 DR. WALLIS: Can I ask you why you're there and he
18 isn't? I tend to look at these technical analyses and then
19 spend less time on the PRA. We spend a lot of time here on
20 the risk. And there are uncertainties in the technical
21 analysis which are pointed out, but they involve factors of
22 two, four or something like that, here and there.
23 The significance of it all goes away because of
24 some risk analysis which has uncertainties which are maybe
25 factors of ten or 100 in it. I just get a little queasy

1 feeling about making the technical understanding on the
2 importance based on risk which seems to have a lot of
3 uncertainty in it.
4 I don't know quite what I should conclude, but I
5 do have a queasy feeling about that approach to the problem.
6 DR. KRESS: Might I ask where this piece of
7 information would be used in the rulemaking anyway?
8 MR. RUBIN: I could address that very briefly. I
9 don't know if we have any of our rulemaking people here
10 today -- yes, we do. But I'll shoot my mouth off first and
11 let someone more knowledgeable correct me.
12 You're very correct on that there are a certain
13 amount of uncertainties in the thermal hydraulic
14 calculations. We were hoping to identify a time that would
15 be a high confidence, lower threshold where we would not be
16 concerned with the rapid oxidation occurring.
17 This is our high confidence number right now. In
18 the rulemaking, this would identify a point beyond the, say,
19 one year to five year point where there would be a benefit
20 from keeping some evacuation capability, maybe a less
21 formal, somewhat ad hoc, but still some evacuation planning
22 available to get the reduction of early fatalities that Mr.
23 Schaperow indicated were possible.
24 Beyond the five years -- let me correct that.
25 Beyond the point where you can get the zirconium fire, you

1 really don't have a significant public risk driver, and so
2 there may be a step change at that point, wherever it be,
3 where evacuation, even insurance, you're not buying yourself
4 anything from keeping those programs in place because you
5 don't have the potential for risk.
6 Now, I'll allow the real expert to contribute
7 anything.
8 DR. WALLIS: Well, maybe we should see the real
9 expert, and I'd like to know about this five years, because
10 there are some numbers here about six kilowatts per MTU and
11 then this is someone's prediction, but there was something
12 wrong with the model; therefore, it could actually be as low
13 as three. Now, that just seems to me that someone guesses
14 it may be off by a factor of two, but there isn't any
15 technical justification for whether the factor is two or
16 four or 25.
17 And if you start getting factors of four or five
18 on this power, then it doesn't decay that rapidly after five
19 years anyway. So it stretches out to maybe ten years.
20 MR. RUBIN: Well, there are a lot of plants, a lot
21 of fuel assembly designs, a lot of burnup levels, but I will
22 let Mr. Staudenmeier contribute his views on that.
23 DR. WALLIS: It would be nice to hear from him.
24 MR. RUBIN: Joe?
25 DR. POWERS: In the course of discussing what

1 impact the hydride, zirconium hydrides in the high burnup
2 fuels will have on the ignition probability.
3 DR. KRESS: Particularly the 800 degree choice.
4 DR. POWERS: And I would also appreciate knowing
5 whether in analyzing the heat source, that we also took into
6 account that the nitrogen itself will react with the clad
7 exothermically. It's not just the oxygen.
8 And indeed, some of the recent work in this field
9 has shown that not only the nitrogen does react, but it also
10 reacts to create a duplex corrosion structure and
11 differences in crystal structure between the dioxide and the
12 mononitride are such that it makes the oxide susceptible to
13 breakaway exfoliation and consequently deviations from
14 parabolic reaction kinetics and substantial accelerations in
15 the rate of reaction.
16 MR. STAUDENMEIER: Joe Staudenmeier, Reactor
17 Systems Branch. The five year number was based on
18 calculations where we were assuming a normal building
19 ventilation rate and fixed geometry of the fuel in the
20 calculations. The reason that the number, the decay heat
21 number went down from six kilowatts per metric ton to three
22 kilowatts per metric ton, went from changing the assumption
23 from this perfect ventilation, which is pretty much that the
24 building doesn't exist at all and it can get an infinite
25 amount of air from outside, to restricting the ventilation

1 that can get into the building and provide cooling for the
2 building.
3 Obviously, every possible scenario wasn't
4 calculated because of the fixed geometry assumption.
5 There's situations you could get into with a cask drop of
6 compression of the fuel or changing the geometry totally
7 that we wouldn't know even what the geometry was. I guess
8 that can cause heat-up rates to get up higher, but it can
9 also restrict air flow that could fuel the runaway reaction
10 also.
11 DR. WALLIS: This six or three kilowatts per
12 metric ton is some average for the bundle.
13 MR. STAUDENMEIER: That's right.
14 DR. WALLIS: There are not spots in the bundle and
15 you're not worried about an ignition in the local area in
16 the bundle.
17 MR. STAUDENMEIER: There is a power profile that's
18 input into the calculations. It doesn't assume average
19 power all throughout the calculations. Some things that
20 still haven't been evaluated yet are sub-channel analysis
21 for BWR assemblies, which have a very high peaking factor of
22 between peaked averaged rods. That can get up to like 1.4
23 peak rod compared to an average rod. PWRs are down in the
24 range of 1.1. So it's not going to be a big driver there.
25 And also where the pin is within the assembly can

1 alter that. The hottest pins are going to be in the middle
2 of the assembly because they can radiate out to the channels
3 at the edge. That hasn't been totally evaluated yet. The
4 previous calculations were just assumed using an average rod
5 and with a normal type of power shape.
6 DR. WALLIS: Some of your folks did a fluent
7 analysis where you actually looked at more realistic natural
8 circulation within a closed building and so on.
9 MR. STAUDENMEIER: Yes.
10 DR. WALLIS: Yes. There's a fluent analysis and
11 then there's another analysis done by PNNL.
12 They made things look a little more iffy, I think.
13 I get the impression that they said things could be worse
14 than with the other assumptions before.
15 MR. STAUDENMEIER: Originally, it was looking like
16 that, but with some more recent calculations, it's been
17 looking better with the fluent analyses.
18 DR. WALLIS: Are the recent calculations made to
19 look better or are they somehow more realistic on a
20 different criterion?
21 MR. STAUDENMEIER: I guess I'd have to see which
22 calculations you were talking about, if they are the most
23 recent.
24 DR. WALLIS: But I don't know. The difficulty is
25 I'm looking through a glass very darkly here, because I get

1 references to things, but there's no details of what's in
2 there and I don't want to see a huge stack of paper, but I
3 just want to get confidence that it was done right.
4 MR. STAUDENMEIER: These fluent calculations are
5 very sensitive to input assumptions and things like that.
6 Actually, we've just -- Chris Boyd is just finishing up some
7 sensitivity studies on input assumptions and they're
8 sensitive, but not overly. I mean, it goes in the way you
9 might think it does. It's not real sensitive to heat
10 transfer coefficients, because there isn't a big film
11 temperature drop between the cladding and the air.
12 It's sensitive to flow resistance. It's not very
13 sensitive at all for heat transfer between the building and
14 the outside because it's very low heat transfer to begin
15 with for that. There's other things that we're looking at
16 with some other calculations. Pacific Northwest National
17 Lab is doing some sub-channel calculations for us. They
18 have a little different approach. They don't solve the
19 whole problem all together. They have a CFD code that looks
20 at the zone from the top of the bundles up, assuming an
21 average power source across there and then doing some
22 detailed sub-channel calculations within the bundles.
23 DR. WALLIS: There's still a lot of work in
24 progress.
25 MR. STAUDENMEIER: There's still some work going

1 on, in progress, yes. And also looking at the partial
2 drain-down at PNNL with the sub-channel analysis.
3 DR. WALLIS: Could I ask whether this is going to
4 make any difference? There's work in progress, but PRA says
5 it's okay. So is it going to make any difference?
6 MR. STAUDENMEIER: I think the work in progress is
7 showing that the time will probably be less than five years
8 if we went and -- but you could come up with assumptions
9 that -- I mean, if you made the assumption that instead of
10 the rated building flow through the building, that there was
11 no building flow at all, then you could obviously come up
12 with a different number for how many years it's going to
13 take, because then your only heat removal from the building
14 is through convection and radiation from the wall out to the
15 atmosphere.
16 DR. WALLIS: So it's unlikely that someone would
17 leave the building closed for that long if something was
18 going on.
19 MR. STAUDENMEIER: Right. Yes. That would also
20 bring in a thing that you have very little air to fuel a
21 reaction then, too. It becomes fuel limited.
22 DR. WALLIS: Maybe the best thing is to blanket
23 the whole thing.
24 MR. STAUDENMEIER: Yes. If you could seal off all
25 air, that would be the best thing. It would get hot and not

1 do anything, except just get hot.

2 DR. SHACK: When you make the assumption of the

3 three kilowatt decay heat, what temperatures are you

4 reaching in the clad?

5 MR. STAUDENMEIER: Well, that's an input, that

6 three kilowatts. We look at different times and the power

7 goes down as --

8 DR. SHACK: When you use that input, then how hot

9 does the clad get?

10 MR. STAUDENMEIER: Well, our acceptance

11 temperature was below 800 degrees or below runaway reaction.

12 DR. SHACK: You did go all the way to the 800.

13 MR. STAUDENMEIER: Actually, the most recent

14 calculations we've been doing at that heat load level have

15 been turning out quite a bit below the 800 degrees, like

16 down in the 600 range.

17 DR. POWERS: If I think about it, air flowing over

18 a surface and reacting exothermically with it, and I keep

19 the nitrogen in, it seems to me that I have temperatures

20 that are pretty hot.

21 MR. STAUDENMEIER: The nitrogen, I think the heat

22 of reaction from the nitrogen is about a quarter or what the

23 oxygen reaction is and the reaction rate is, I think, down a

24 couple orders of magnitude at a given temperature from what

25 the oxygen reaction is, but there's -- in the previous

1 studies, there's some weird effects that go on apparently
2 that pure oxygen doesn't give you the highest reaction rate;
3 that if you mix in some nitrogen, you can get a higher
4 reaction rate because of something going on with, I guess,
5 the crystal chemistry and the metal that people really
6 didn't seem to understand.
7 It was just something that was pointed out.
8 DR. POWERS: At least the micrographs that I've
9 seen show that the -- in the duplex, you get a delamination
10 at the interface between the dioxide, which has a fluoride
11 monoclinic type structure, but based on a fluoride, and the
12 basically cubic zirconium nitrate, there's just no epitaxy
13 there.
14 So you get delamination very easily and that's why
15 you get this orange peel effect in the corrosion product,
16 where it's dimpled, and instead of a nice, smooth oxide, the
17 way you do in steam or pure oxygen.
18 MR. STAUDENMEIER: Yes, and as far as --
19 DR. POWERS: And that's exasperated, by the way,
20 in the cylindrical geometry.
21 MR. STAUDENMEIER: And as far as a parabolic
22 reaction rate, I agree with you that that's very iffy. The
23 data that I've seen in what these reaction curves are based
24 on only go out to an hour exposure. And there is evidence
25 that going out longer than that, the oxide does start to

1 peel off and as you know, the parabolic oxidation rate is
2 diffusion limited. So the thicker the oxide layer, the
3 lower it goes down.
4 If you peel that off, then you jump the reaction
5 rate right back up again.
6 DR. POWERS: Have you looked at the problem of
7 hydride inclusions?
8 MR. STAUDENMEIER: The Office of Research was
9 looking at -- I asked them to look at hydride. They
10 couldn't find anything that they thought would change things
11 significantly. I'm not familiar with the chemistry aspects
12 at all beyond knowing what parabolic reaction rate curves
13 mean and assumptions that go into them.
14 DR. POWERS: I'm not either. I know what uranium
15 hydrides do in air and other heavy metal hydrides.
16 Zirconium hydride I have no experience with. The other
17 heavy metal hydrides are spontaneously combustible.
18 DR. WALLIS: Glenn, this is interesting, but it
19 doesn't matter. Is that --
20 MR. KELLY: No. It does matter. As a matter of
21 fact, one of the inputs that the calculations, the heat
22 transfer calculations give us is the amount of time at which
23 you can get a zirconium fire and we've indicated that we
24 think, and eventually we'll come to it in the slides here,
25 where we believe that there are times when it's appropriate

1 to -- there's a technical basis for saying that you don't
2 need an EP, potentially you don't need indemnification, and
3 that clearly is independent of the risk assessment numbers.
4 DR. POWERS: Dr. Kress, you need to move this
5 discussion along.
6 DR. KRESS: I think we're getting near the end.
7 MR. KELLY: Just quickly, I wanted to take this
8 opportunity to indicate how the numbers that we chose for
9 pool performance guidance, guideline, and the numbers that
10 we got as bottom line risk numbers from our report, how they
11 compare to other risk measures.
12 I understand we've already had a lot of discussion
13 about how people aren't necessarily happy with the numbers
14 that -- the measures that we've chosen, but just to give you
15 an idea, in comparison with some others.
16 Again, our frequency that we came up with for
17 getting a zirconium fire was less than
18 three-times-ten-to-the-minus-six per year. Reg Guide 1.174
19 tried to release baseline guideline, where below that you
20 can -- we would allow a small increase in risk for licensing
21 type activities. That guideline was
22 one-times-ten-to-the-minus-five per year.
23 The LERF numbers coming out of the IPEs ranged
24 somewhere between two-to-the-minus-six and
25 two-times-ten-to-the-minus-five per year, and our pool

1 performance guideline that we documented in our report, we
2 chose ten-to-the-minus-five per year.
3 And I understand, based on your comments, we'll
4 probably be giving some more consideration to what, if
5 anything, we need to do with that proposed guideline.
6 DR. SHACK: There's not a whole lot you can do
7 about that three-times-ten-to-the-minus-six, though. I
8 mean, it's seismically dominated and unless you eliminate
9 earthquakes or rebuild the spent fuel pool.
10 MR. KELLY: We're not talking about changing that.
11 That number is what it is. But the question is, is that
12 okay, is that enough, is that low enough that I feel that I
13 have a technical basis on a risk-informed basis to want to
14 give an exemption or want to do something a little
15 differently with the rule.
16 DR. SHACK: But my point is if it isn't okay,
17 there's not a whole lot you can do about it from a
18 regulatory standpoint.
19 MR. KELLY: In which case, you would keep --
20 DR. KRESS: You could ask what it is after two
21 years, for example.
22 DR. APOSTOLAKIS: Or you can fund another study at
23 Livermore to change the seismic curves.
24 MR. KELLY: What we found is that we believe
25 there's three basic phases at the spent fuel pool.

1 Immediately after shutdown, you have a period for about the
2 first year where you can get large early releases off-site,
3 early here meaning several hours, releases due to zirconium
4 fire.
5 We expect that for the first few years, the design
6 basis systems, for the first year or so, that the design
7 basis system will be in place. The operating practices will
8 be retained. They'll have the operators there, most likely,
9 and this is a period where we'd expect there would be the
10 full requirements of EP indemnification and security.
11 The early decommissioning phase, you get large
12 releases, would be late, that's ten hours or later after the
13 pool was uncovered. Relaxation of EP requirements probably
14 could be justified technically.
15 To get these exemptions, industry would need to
16 meet its commitments, the seismic checklist and the staff
17 assumptions, and we expect that these would be factored into
18 the proposed rule.
19 DR. WALLIS: These staff assumptions are about
20 what industry will do?
21 MR. KELLY: Just as we -- in our report, we
22 documented the commitments that were made, we've also
23 documented those areas which were really clarifications that
24 we felt, when we went ahead and did the assessment, what was
25 it we needed to assume.

1 The frequency of the large releases was within the
2 Reg Guide 1.174 guidance. We do believe that consideration
3 for insurance relief during an intermediate phase would be
4 appropriate.
5 And the third phase is where we believe that
6 zirconium fires are no longer possible. We've talked about
7 the five years and we believe that there is a -- once you
8 get into that third phase, that there would be a technical
9 justification for the elimination of off-site EP.
10 DR. WALLIS: It's interesting you say no longer
11 possible, whereas your whole slant earlier was the
12 probabilistic.
13 MR. KELLY: Well, no.
14 MR. PARRY: This is a deterministic calculation, I
15 think.
16 DR. WALLIS: I doubt if you could say it's
17 complete and absolutely impossible.
18 MR. PARRY: Okay. Small.
19 MR. KELLY: Based on the thinking in Reg Guide
20 1.174 about how you go about making a good risk-informed
21 decision, we've looked at the baseline risk and here we feel
22 that the numbers that we've seen, again, come out within our
23 PPG guideline, which was based on Reg Guide 1.174.
24 The thermal inertia and the large volume of water
25 in the pool give us significant margins, in particular, with

1 respect to time for the heat-up of a zirconium fire.

2 Given there's large margins in the spent fuel

3 pools, we felt the defense-in-depth was not a major issue.

4 But the risk findings say that it's not an -- that having a

5 zirconium fire is not an insignificant issue. If you were

6 to have one, it would be very significant.

7 Therefore, given these risk analysis findings and

8 including the uncertainties associated with that, we believe

9 that there is technical justification for retaining a

10 baseline level of emergency preparedness, which would

11 include procedures to classify the accidents and to notify

12 the off-site authorities.

13 DR. WALLIS: Defense-in-depth not a major issue,

14 your report, I think, stated that sabotage is not included,

15 presumably in looking at security and sabotage,

16 defense-in-depth does become an issue. That if something is

17 -- that if some saboteur manages to do something, that

18 something else doesn't follow into some kind of backup and

19 so on.

20 MR. KELLY: That's correct, right. Our report

21 does not directly address sabotage. What we have done and

22 when we've completed our final report, we will be providing

23 information to the security people about those areas that we

24 feel are most important to protect. So that will be dealt

25 with separately from the indemnification and emergency

1 preparedness.

2 DR. APOSTOLAKIS: I wonder what the sentence

3 defense-in-depth is not a major issue means. That doesn't

4 mean that I know what it should mean.

5 MR. KELLY: Can I tell you what we meant, George?

6 DR. APOSTOLAKIS: Sure.

7 MR. KELLY: What we meant here is that we clearly

8 understand that the traditional measures of defense-in-depth

9 that you have in an operating reactor, where you have --

10 DR. APOSTOLAKIS: Multiple.

11 MR. KELLY: -- all these automatic systems,

12 containment. You don't have them here for spent fuel pools.

13 Whether or not it's even decommissioning spent fuel pool.

14 What you do have is a long time before you're going to get

15 yourself in trouble. You have the water that's in the pool,

16 you have the time that it takes for the fuel itself to heat

17 up.

18 So from the point of view, again, understanding

19 the context that we did this assessment, which is to

20 determine whether or not there was technical justification

21 for providing exemptions for EP and indemnification, under

22 those circumstances, we felt that defense-in-depth was not a

23 significant issue because of the time.

24 DR. APOSTOLAKIS: I think what you mean is that

25 the uncertainties are not large enough to justify a

1 structuralist approach application of defense-in-depth.
2 That's what you're saying, because you applied the
3 rationalist already. You told me earlier, Gareth, that it
4 would put level indicators, temperature indicators and all
5 that. Why? Because your earlier studies showed that human
6 error was a major contributor and it led to unacceptable
7 numbers.
8 So now you did these extra things to reduce the
9 number and you are happy that the uncertainties are
10 reasonably spread out over the thing. So this is a classic
11 application of -- it's rapidly becoming a classic
12 application over the rationalist approach to
13 defense-in-depth.
14 So what you really mean is that the structuralist
15 interpretation of what if I am wrong really is not a major
16 issue here, because you have reasonable confidence that you
17 are not wrong. Is that the correct interpretation?
18 MR. KELLY: It's true that I have reasonable
19 confidence I'm not wrong.
20 DR. APOSTOLAKIS: Five innocent words. What?
21 MR. KELLY: Yes.
22 DR. APOSTOLAKIS: Because you did a lot of things
23 and Dr. Kennedy talked about the checklist and criteria and
24 so on.
25 MR. KELLY: We tried to cross the T's and dot the

1 I's.

2 DR. APOSTOLAKIS: This is really -- I hate to say

3 that -- it's almost risk-based. I mean, everything you've

4 done is really based on risk numbers.

5 MR. KELLY: Well, not the areas for

6 indemnification and that, because we recognize that there

7 are -- our recommendations, we expect, as we go forward,

8 will be based on the deterministic analysis of the times for

9 the --

10 DR. APOSTOLAKIS: All these things are input to

11 the PRA.

12 MR. KELLY: That's correct, they are.

13 DR. APOSTOLAKIS: The only thing is that you say

14 the technical results provide justification for retaining a

15 baseline level of EP, but you have not quantified the impact

16 of that. We saw some sensitivity studies essentially.

17 MR. RUBIN: Excuse me. In essence, that was the

18 justification. It shows -- Mr. Schaperow's work shows that.

19 DR. APOSTOLAKIS: So that makes it risk-informed.

20 MR. RUBIN: I guess I should say yes.

21 DR. APOSTOLAKIS: Everybody wants to go to a

22 break. Dr. Kress, do you agree with what I said?

23 DR. KRESS: Partially.

24 DR. APOSTOLAKIS: Where do you disagree? That's

25 what I want to know. It seems to me this is almost

1 risk-based.

2 DR. KRESS: It is.

3 DR. APOSTOLAKIS: And the rationalist approach has

4 been applied.

5 DR. KRESS: The five years is not risk-based.

6 DR. WALLIS: I thought you said it very well and

7 it helped, I think, to steer us in the right direction in

8 thinking about defense-in-depth. We've been going in that

9 direction for some time.

10 DR. APOSTOLAKIS: I think what Gareth said earlier

11 is really application of the rationalist approach. Anyway,

12 I've said enough.

13 DR. KRESS: Where I disagree with you is where you

14 said that the uncertainties are small enough. I don't think

15 we know what the uncertainties are. We haven't quantified

16 them very well and --

17 DR. APOSTOLAKIS: Do you disagree with the

18 statement up there?

19 DR. KRESS: Yes. I would have said that the

20 structuralist what if we're wrong still applies here, to

21 some extent, and, therefore, we will have some sort of

22 emergency plan.

23 DR. APOSTOLAKIS: That's fine.

24 MR. RUBIN: And indeed we agree with you, Dr.

25 Kress.

1 DR. KRESS: So I think you characterized it just a
2 little wrong.
3 DR. APOSTOLAKIS: You agree with too many people,
4 Mark.
5 MR. RUBIN: I'll try to do better.
6 DR. APOSTOLAKIS: You agree with that statement,
7 too, right?
8 DR. KRESS: I think we would like to see your
9 slide on the impact on rulemaking before we close.
10 MR. KELLY: The slow time it takes for the
11 releases to occur, we believe, justifies reducing EP
12 requirements during that one to five year period.
13 The risk analysis, we believe, does not justify a
14 reduction in security function directly. It may be that it
15 may be justified based on -- a reduction might be justified
16 based on as much less complexity needed for a spent fuel
17 pool than for the entire operating reactor.
18 The current report does not take a position on
19 indemnification. We note that the frequency of a zirconium
20 fire is not incredible. The Commission may decide that it's
21 low enough that they want to get rid of indemnification. We
22 note that operating plants do have large releases at
23 frequencies similar to what we've calculated.
24 DR. KRESS: And the implication of that is they
25 are required to have indemnification even at those values.

1 MR. KELLY: One might take that to be the case.
2 DR. POWERS: What does the frequency have to be
3 before it's incredible?
4 MR. KELLY: I am the one to make that judgment,
5 I'm afraid.
6 DR. WALLIS: Well, you made the statement.
7 MR. KELLY: Well, we felt that it was high enough
8 that it was credible, so therefore --
9 DR. APOSTOLAKIS: The age of the earth's crust,
10 three-ten-to-the-ninth years. Three-ten-to-the-ninth. So
11 you decide what is incredible and what is not.
12 DR. POWERS: There has been a long tradition,
13 beginning in the time of the AEC, that accidents that have
14 probabilities of less than about ten-to-the-minus-six are
15 considered incredible.
16 DR. KRESS: Yes. I think that's the answer.
17 MR. KELLY: We believe the rulemaking should
18 include a requirement to monitor performance scenarios such
19 as industry commitments, staff assumptions and the seismic
20 checklist. And lastly, in the late decommissioning phase,
21 after it's no longer possible to have a zirconium fire, we
22 believe there isn't a technical basis for retaining
23 emergency preparedness.
24 That concludes my presentation. Are there any
25 questions?

1 DR. KRESS: I might ask if there's anybody in the
2 audience or public who wish to make any comments or give us
3 a reaction to this. Seeing none, I guess I can turn it back
4 to you.
5 DR. POWERS: Thank you, Dr. Kress. I will declare
6 a recess until three of the hour.
7 [Recess.]
8 DR. POWERS: Let's come back into session. I
9 neglected to remind members at the conclusion of the last
10 session that the Commission has asked us to do not just a
11 report on this, the work on the spent fuel pool, but a
12 technical review; not only a technical review of the
13 phenomenology, but an assessment of the risk goals of the
14 study, as well.
15 So it's one of the reasons that we plunged into
16 the details so much on that previous study.
17 We turn now to a very interesting topic, one
18 that's been near and dear to the heart of the ACRS for
19 loathe these many years, and that's digital instrumentation
20 and control at nuclear power plants. Professor Uhrig, I
21 think you're going to lead us into this and plans for
22 research in this area.
23 DR. UHRIG: Thank you, Mr. Chairman. Digital
24 instrumentation systems are not new to nuclear power plants.
25 They've been around since the late '60s, early '70s, in the

1 Canadian CANDU reactors. They came into use in the United
2 States in the late '80s and early '90s, such things as the
3 GE VTEC instruments, the Eagle-21 safety and control system.
4 The staff's original position on digital systems
5 was that all of these were unreviewed safety problems and
6 had to have Commission approval. This was subsequently
7 modified, but the discussions led to the Commission asking
8 the National Academy of Sciences to undertake an extensive
9 study of the use of digital instrumentation in nuclear power
10 plants.
11 During the two years of this study, the staff
12 resolved many of the issues associated with licensing
13 digital systems. They upgraded the standard review plan,
14 NUREG-0800, to include digital systems, and, in a sense,
15 this plan that we're going to hear today is the first real
16 formal response to the Academy study of some of the things
17 that -- the recommendations that they made.
18 So we're looking forward to hearing and at this, I would
19 call on Sher Bahadur to introduce the topic and the
20 presenters.
21 MR. BAHADUR: Thank you, Bob. I'm Sher Bahadur,
22 Branch Chief of the Engineering Research Applications Branch
23 in the Office of Research. Last year, about this time,
24 Research had gone through a major reorganization. Then the
25 digital I&C was separated from human factors and came into

1 my branch.

2 The purpose of this briefing is to present to you
3 the plan that we have developed on the research part of the
4 digital I&C. With me are Steve Arndt and Matt Chiramal, and
5 I'll go through some of the basic components of this
6 briefing this morning and which parts will be taken by Steve
7 and Matt.

8 As I was saying, the purpose is to bring this plan
9 to you for your review and what you will hear today is the
10 regulatory framework in which the research in I&C will be
11 applied and the plan, its background, challenges, issues and
12 planned activities, and the schedule.

13 I want to thank the committee, before I go any
14 further, for allowing us to come here and present this to
15 you on such a short notice, because this, in turn, will
16 allow us to finalize the plan before the budget cycle for
17 2002 gets final. So it will be very timely, from our point
18 of view.

19 I also thank Bob and Dana in particular for
20 allowing us to let you give the preliminary draft of this
21 plan earlier to get your feedback at that time in a formal
22 manner and what you will hear today is not much different
23 than what you had seen, except that from that time on to
24 today, this plan has been coordinated with NRR at the
25 division level.

1 As you had mentioned, we have had this plan on our
2 plate for a long time, and what you will hear today is our
3 effort in-house to develop this plan, and we have developed
4 this plan based on input from a number of sources.
5 What I have done is I have listed that for you.
6 For example, we had had a workshop as early as 1989, the
7 workshop on the man-machine interface, and the findings of
8 that workshop were then summarized into NUREG CR-5348.
9 Later we also had a workshop on the digital system
10 reliability that was sponsored by NIST and NRC jointly and
11 the findings of that were also summarized in another NUREG.
12 Just about the same time, the agency had started
13 looking deeper into the digital I&C issues and we requested
14 the National Research Council, Academy of Sciences
15 subcommittee to look into this more in detail and a report
16 was produced in 1997 on the instrumentation and control
17 systems in nuclear power plants.
18 In 1998, this committee has returned a report on
19 the research activity and there, again, underlying the
20 necessity for us to develop the plan. With that in mind, we
21 held an expert panel meeting last fall on the digital system
22 research and that meeting was attended by about 12 experts
23 all over the country, including Doug Chapin, who came from
24 NPR Associates; Barry Johnson, who came from University of
25 Virginia; and then there were representatives from SOHAR,

1 University of Pennsylvania, Duke and other industries.
2 DR. APOSTOLAKIS: Were these mainly computer
3 experts, computer science experts?
4 MR. BAHADUR: These were mostly the software and
5 the hardware people who were working on problems associated
6 with safety-related issues for other industries.
7 For example, Barry Johnson from University of
8 Virginia had been working in the railroad industry, also
9 with NASA and Boeing. Similarly, the Penn State people had
10 been working with some NASA projects.
11 So I would say they were mostly the
12 hardware/software people, but they had application
13 experience in other areas.
14 MR. ARNDT: Some of the members also had nuclear
15 experience. For example, Doug Chapin, who does a lot of
16 work in the nuclear area and was the chairman of the --
17 DR. APOSTOLAKIS: Was Dr. Levinson a member of the
18 group?
19 MR. ARNDT: Pardon me?
20 DR. APOSTOLAKIS: Dr. Levinson, was she a member?
21 MR. BAHADUR: Dr. Levinson came as an observer. I
22 don't remember -- I don't think -- she was not there, no.
23 Dr. Levinson could not make -- she was invited, but could
24 not make the meeting.
25 In addition to getting the information from these

1 sources, the staff also worked very closely with NRR to see
2 their needs, because this plan is outlining research which
3 will assist NRR to make its review function efficient,
4 timely and realistic. So we worked very closely with the
5 NRR staff and as a result of our work, while this plan was
6 being developed, we also received a consolidated user need
7 from NRR, which ties very closely with the plan which we
8 presented to you.
9 DR. POWERS: The plan that you developed, of
10 course, speaks frequently of the need to develop tools to
11 aid the line organizations in doing their review.
12 I wonder if a -- I know that NRR has some explicit
13 and quantitative guidelines for the timeframes that they
14 want to handle licensing actions and the amount of manpower
15 they want to devote to those. Did they give you some
16 quantitative guidance on what their aspirations were as far
17 as things like the amount of time that they wanted -- your
18 plan makes the point that these are very resource-intensive
19 reviews that they have to do.
20 Did they give you quantitative guidance on the
21 kinds of resources they want to devote to each review?
22 MR. BAHADUR: Yes. Let me -- I don't want to
23 steal Matt's thunder and also Steve's, but let me just give
24 you a very general answer to that.
25 What you would see in this plan is three-pronged

1 activities. Activities that we are proposing to meet the
2 immediate requirements of NRR, what I call the short-term
3 goals; the activities that we do to meet the requirements of
4 NRR in the intermediate, plus, also, what anticipated
5 problems could be at that time, and, lastly, something to
6 keep pace with the ever changing technology so that the NRC
7 keeps abreast of the information that the industry might
8 bring to us.
9 You would see that kind of thread coming out of
10 both Matt's presentation of the regulatory framework and
11 then Steve's presentation on the plan itself.
12 I think with that in mind, let me just say that
13 this briefing would be in two parts, as I said before. Matt
14 Chiramal, who is a senior level staff member from the
15 Division of Engineering, NRR, will present that. Then the
16 description of the plan itself will be presented by Steve
17 Arndt. Steve is in the Division of System Analysis and
18 Regulatory Effectiveness, but he has been on a special
19 assignment, rotation assignment in my branch, specifically
20 to work on this plan, which he has done in the last three
21 months.
22 So with that in mind, if you don't have any other
23 general questions, I will request Matt to cover the
24 regulatory framework.
25 DR. APOSTOLAKIS: So Steve will leave in three

1 months, this project?

2 MR. BAHADUR: Pardon?

3 DR. APOSTOLAKIS: Steve will leave this project in

4 three or four months?

5 MR. BAHADUR: Steve's major function was to work

6 on this plan and to bring it to its completion. As you and

7 I speak today, his rotation has been already up last week.

8 However, he will continue to work on the plan until it's

9 finalized.

10 DR. POWERS: Is he going to come back and work on

11 human performance then?

12 MR. BAHADUR: No comment.

13 MR. CHIRAMAL: My name is Matt Chiramal. I'm a

14 senior level advisor in NRR. Now I'm in the Electrical

15 Instrumentation Branch. I'm with the Division of

16 Engineering, Electrical Instrumentation Branch, called EEIB.

17 I've been here before when we developed the SRP Chapter 7

18 and that's what we are using for guidance in the review of

19 both the advanced reactor, which we haven't had since the

20 1997 version of the SRP was issued, and any retrofits,

21 including the topical reports we are reviewing at this time.

22 The SRP Chapter 7 is based upon IEEE 603, which is

23 now part of the regulations, and its companion standard,

24 IEEE 7432 on digital systems. That's the framework on which

25 the SRP was based.

1 We have at this point five topical reports
2 in-house, of which number one the Siemen's Teleperm XS and
3 the ABB-CE Common Q are the ones that will be completed this
4 year.
5 The others are in waiting in the wings. Some of
6 them are on hold. For example, the Triconex will come in
7 probably later this year, but the Westinghouse units are on
8 hold because Westinghouse has not decided what to do as yet.
9 We expect to see applications based on these
10 platforms coming in in the near future from different
11 licensees and different utilities.
12 DR. APOSTOLAKIS: What does platform mean in this
13 context?
14 MR. CHIRAMAL: Platform means it's a basic
15 structure, it's a hardware/software operating system
16 platform on which you can build specific applications into
17 that system. So they can use it for a reactor protection
18 system, engineering safety feature, actuation system, or an
19 information system, any digital application, as long as it
20 works on the -- it can be built into the platform.
21 DR. UHRIG: Would you consider that an integrated
22 system, the platform constitutes an integrated system?
23 MR. CHIRAMAL: Yes. It's a system on which you
24 can integrate other modules and applications.
25 DR. APOSTOLAKIS: But it does not give also an

1 assessment of the reliability or whatever. Is that done
2 off-line or it's not done at all?
3 MR. CHIRAMAL: The quality and the reliability of
4 the platform and its operating system and the way it could
5 interface with the thing, that part of it is done in our
6 review at this stage.
7 DR. APOSTOLAKIS: Okay.
8 MR. CHIRAMAL: At this point, we believe that we
9 are using the SRP Chapter 7 in parts, depending on what we
10 get, which part of the system is being modified. We
11 consider it adequate for the review of the systems that come
12 in at this time.
13 DR. POWERS: When you say it's adequate, do you
14 mean it's technically adequate or it's operationally
15 adequate or both?
16 MR. CHIRAMAL: Both.
17 DR. POWERS: Both. So you don't mind spending
18 these -- I mean, the plan speaks of resource-intensive
19 reviews.
20 MR. CHIRAMAL: Yes. We do spend a lot of time
21 interacting with the vendor and trying to get into the deep
22 -- deeply into the process as well as the applications, how
23 it works, and we spent quite a bit of time in that area and
24 one of the areas we're looking for is to try and expedite
25 that review process a little bit so that when we frame it at

1 this time, give that to the public to review, then we don't
2 have to ask that many questions and RAIs and things like
3 that.
4 DR. POWERS: I guess what I'm trying to understand
5 is you have a user need over there, but you find the
6 guidance is adequate. Well, it must be inadequate in some
7 respect and I assumed it was inadequate -- based on the
8 plan, I assumed it was inadequate because it takes too much
9 time and resources to carry out one of these reviews.
10 MR. CHIRAMAL: The thing is, at this point in
11 time, we believe that's the best we have.
12 DR. POWERS: I understand that.
13 MR. CHIRAMAL: Right.
14 DR. POWERS: But there must be some inadequacy to
15 it. Something that you'd like to be better.
16 MR. CHIRAMAL: Yes. It's a little convoluted and
17 so we'd like to sort of smooth it out a little bit by having
18 some sort of a tool that can do some of the reviews that we
19 do.
20 DR. POWERS: I think what you're telling me or at
21 least what I think I understand is what you've got now is
22 technically adequate. I mean, having gone through the
23 review, you're confident that the digital I&C system will
24 perform adequately, provide adequate protection to the
25 health and safety of the public. But it takes a lot of time

1 and time translates into money, time translates into delay,
2 and you'd like to speed the whole thing up and maybe even do
3 a better job, but certainly speed the whole thing up.
4 MR. CHIRAMAL: That's correct.
5 MR. BAHADUR: Let me see if I can just say it the
6 way I understand where we are in terms of what's adequate
7 right now versus why the research is needed in this area.
8 The industry is gradually and slowly changing from
9 the analog to digital. While this activity is going on, as
10 Matt said, the existing review process is there to take care
11 of this.
12 But there's an ever changing technology and NRC
13 will continue to get into areas in which perhaps we are not
14 ready right now to do an adequate review.
15 So the way I see the function of this research is
16 to help NRR make its review effective and realistic in the
17 face of the ever changing technology.
18 Yes, I agree that there's no overlying safety
19 issue at this time that we have to worry about, but we don't
20 know what and how the changes in the industry is going to
21 be. And for us to be in a position where we can provide
22 that realistic review, we need to understand and prepare
23 ourselves, and that's what you will see the plan is leading
24 towards.
25 DR. POWERS: Well, I caution you that if I'm in

1 the role of the Commissioner and I have finite numbers of
2 dollars to dole out to research and somebody tells me, well,
3 the chapter is adequate, then I may not read the rest of
4 this. I say, fine, we don't need to do anything there right
5 now, let me move on to these things where somebody says it's
6 inadequate.
7 Whereas I think you're telling me that there's an
8 inadequacy here in two things. It takes a lot of time and
9 effort to do things and the digital systems you see today
10 are going to be obsolete and unavailable next week.
11 MR. BAHADUR: And there is something in between,
12 as well, and that is that while it's taking us a longer time
13 to do the review, it's also possible that the review we are
14 conducting is not realistic and, therefore, we have to make
15 certain assumptions which bring an awful lot of conservatism
16 into it, because we don't understand right now what's
17 happening.
18 One of the issues --
19 DR. POWERS: So you're introducing a third point
20 which says it's adequate all right to protect the health and
21 safety of the public, but it's very conservative.
22 MR. BAHADUR: For example, one of the issues which
23 was brought out by Doug Chapin in the expert panel, from NPR
24 Associates, was exactly this. His point was that in all
25 these environmental qualification requirement, I think the

1 NRC needs to gain an understanding of realism, what's
2 actually happening out there, so that we can accordingly
3 modify our review criteria.
4 DR. APOSTOLAKIS: But I thought there were two
5 more reasons. One is that when SRP Chapter 7 was written,
6 naturally you had to rely on the state-of-the-art at the
7 time.
8 MR. CHIRAMAL: That's correct.
9 DR. APOSTOLAKIS: And it is too much perhaps
10 process oriented rather than product investigation and
11 analysis. And now perhaps we can do better and combine
12 process with product.
13 MR. CHIRAMAL: Actually, the emphasis on process
14 for digital I&C was mainly added to review the quality of
15 the software. The product orientation was always there in
16 the SRP, the testing, the --
17 DR. APOSTOLAKIS: Yes, but I remember our debate
18 at the time that one of the arguments you made was that
19 there aren't -- there were no really good methods, proven
20 methods for investigating the adequacy of the software
21 itself.
22 MR. CHIRAMAL: Right. And that's why we emphasize
23 process a lot in the SRP.
24 DR. APOSTOLAKIS: But now things may be changing,
25 that's my point. That's an additional reason for you to

1 investigate possibility of --

2 MR. BAHADUR: That's an excellent point, George,
3 and I think we're almost coming to a point where if I speak
4 anything more, I might as well be giving the presentation,
5 and Steve is rearing to go. So once Matt completes his, I
6 think Steve is going to be on and touching on this.

7 DR. APOSTOLAKIS: And the third, maybe a fourth
8 point. I think it's important to say up front why you have
9 to do --

10 MR. CHIRAMAL: Yes.

11 DR. APOSTOLAKIS: The last one is to support the
12 major initiative of the agency to risk-inform the
13 regulations.

14 MR. CHIRAMAL: That's correct.

15 DR. APOSTOLAKIS: Right now we don't know how to
16 handle digital software embedded in systems in the plant and
17 as I saw in your plan, you have some projects there that
18 will help us quantify the availabilities of systems perhaps
19 and so on.

20 MR. CHIRAMAL: And that's part of the user need,
21 is to keep up with the emerging technology, and the
22 technology is advancing more rapidly than the standards are
23 keeping up with it.

24 DR. APOSTOLAKIS: Do you think risk-informing the
25 regulation -- to support risk-informing the regulations is a

1 major argument why you want to do this.

2 MR. BAHADUR: And I think Matthew has that on this

3 slide, on your second bullet.

4 MR. CHIRAMAL: Right.

5 MR. BAHADUR: It outlines those things. So why

6 don't we move to that.

7 DR. WALLIS: I'm a little concerned that the ACRS

8 is explaining the need for this work. I agree with the

9 Chairman. I would like to see a much better discussion of

10 what's adequate, what do you mean by adequate, what could be

11 done better or what measure and what could be better this

12 year, what do we see coming down the road, what do we need

13 to anticipate in five years and so on.

14 MR. CHIRAMAL: And that's part of the keeping pace

15 of the technology, is that we do not know what --

16 DR. WALLIS: But be more specific about it.

17 MR. CHIRAMAL: For example, you could have a

18 network system put into place. Again, it depends entirely

19 upon what's available out there, what is going to be

20 applicable to nuclear plants.

21 DR. WALLIS: But you want to anticipate that. You

22 don't want to be caught off guard and you don't know what to

23 do with it.

24 MR. CHIRAMAL: And that's part of the user need

25 which the plan will address. As Dr. Apostolakis was saying,

1 we also would like to have -- address the reliability and
2 risk concentrations of digital I&C, which, at this point, is
3 not -- is purely qualitative.
4 And the last bullet is keep current with the
5 industry standards, because here, again, one of the things
6 we would like to do is to work with the industry and come up
7 with the standards that can be used in the application of
8 digital systems and nuclear plants.
9 In that sense, that's why the SRP Chapter 7
10 guidance is based upon the two standards that we mentioned
11 earlier.
12 And that concludes my part of the presentation.
13 Steve?
14 MR. ARNDT: Good morning. AS my colleagues have
15 previously noted, my name is Steven Arndt. I am currently
16 assigned to a different part of Research, but have been
17 working in this area for the past couple months to help the
18 various experts in this area to put together this plan.
19 Since my colleagues and the committee have already
20 done a lot of my work, this should be pretty easy for me
21 today. I'm going to go through very quickly the program
22 goals, outlines and outputs, and then get into the specific
23 applications of the research that we're trying to do to
24 support NRR.
25 You will have noticed in the actual paperwork that

1 we sent you to look at references to the user need. It was,
2 unfortunately, not available when we sent you the documents.
3 It is now available and is appended to the back of this.
4 DR. WALLIS: This program goal is presumably an
5 NRR goal.
6 MR. ARNDT: It's an agency goal.
7 DR. WALLIS: Okay. It's not the goal of your
8 research.
9 MR. ARNDT: No. It's the program as opposed to
10 the plan goal. It's a program of proving digital I&C
11 systems.
12 DR. APOSTOLAKIS: But you really don't care
13 whether unanticipated failures in digital systems will
14 occur, because some of these failures may do nothing to the
15 reactor.
16 MR. ARNDT: Yes.
17 DR. APOSTOLAKIS: So this can't be the goal of the
18 program.
19 MR. ARNDT: It's not -- it's unanticipated
20 failures that really affect safety of the plants.
21 DR. APOSTOLAKIS: The safety of the plant, yes.
22 MR. ARNDT: Right.
23 DR. APOSTOLAKIS: Again, I'm always confused by
24 this need to list goals, but it seems to me one of your
25 major goals is to support the agency's initiative to

1 risk-inform the regulation.

2 MR. ARNDT: Right. And the outputs of the plan,
3 the outputs of the program that we're putting forth are the
4 three areas that we previously discussed.

5 DR. APOSTOLAKIS: I think you need to reword the
6 program goal.

7 MR. ARNDT: Okay.

8 DR. APOSTOLAKIS: And I don't think you should
9 refer to the ever changing technology in the goal. In other
10 words, if the technology did not change, are you assured
11 right now that the introduction of digital systems would not
12 do something bad? I don't think it's the changing nature of
13 the technology that is really driving the program. It's an
14 important element.

15 MR. ARNDT: We'll look at that goal. The outputs
16 are, first of all, to improve the methods and tools needed
17 to support the improvements to the regulatory process.
18 That's what Sher and Matt have already mentioned. The
19 process is not as good as it could be. It's not as
20 efficient as it could be and a lot of the programs are
21 specifically designed to address user needs from NRR to make
22 things better.

23 DR. POWERS: What I don't understand, I mean, this
24 word improved shows up in your plan frequently and I can
25 improve things incrementally. I can improve things hugely.

1 I can improve things somewhere in between.

2 And without having some understanding of what kind

3 of improvements or what magnitude of improvement that you're

4 trying to make and in which ways, I mean, you could print

5 the SRP in bolder, bigger type face so it would be easier to

6 read.

7 MR. ARNDT: Right.

8 DR. POWERS: And you could print the IEEE standard

9 in bigger type face so it would be readable, period, and

10 that would improve the process. Can you give me some idea

11 of what magnitude of improvement? Reduce the number of man

12 hours by 50 percent, ten percent, one percent?

13 MR. ARNDT: Certainly we intend for it to be

14 considerably more than one percent. An example is the

15 topical reports that Matt was talking about are taking

16 something more than one man year per to review, which is

17 considered too long.

18 Once those are approved, we'll have the individual

19 plant-specific applications of the topical reports, which

20 could be a lot of them considering where the technology is

21 going, and if they are some significant fraction of that,

22 then it's also going to be too high.

23 So we're looking at significant improvements based

24 on more, in many cases, definite standards. One example

25 that Matt mentioned is that in some of the software QA

1 issues, they are more process oriented than product
2 oriented, a lot of them, parts of the SRP talk about review
3 the test coverage, review the plan to be used, determine
4 whether or not various methodologies are appropriate.
5 And many of the tasks in the plan say look at
6 these methodologies that people are using, compare them to
7 specific criteria and give us a tool that says, yes, if they
8 use CMM and they use a test coverage of 50 percent, then
9 that's reasonable or not reasonable or industry typical or
10 something like that.
11 DR. POWERS: If, at some point, in your plan, if
12 only to say very qualitatively what you said, you're looking
13 for significant improvement, that would help me understand
14 the work a lot better.
15 MR. ARNDT: Okay.
16 DR. POWERS: I find appealing the kinds of goals
17 that NRR sets out to itself, where it says it wants the
18 process licensing actions and so many per year, so fast,
19 things like that, a much more quantitative statement of
20 their own personal goals, that kind of comparison to that
21 kind of information would considerably aid you in
22 understanding what's being achieved.
23 MR. ARNDT: Okay.
24 DR. POWERS: And the magnitude. Because otherwise
25 I can read it as, well, we're going to muck around with this

1 for a while and we'll probably find some way to improve it,
2 if no more than to put it on bolder type face or something
3 like that.
4 MR. ARNDT: Right. Well, as you noted in reading
5 the plan, each of the activities has a background, a
6 specific task and a specific outcome, and I think one of the
7 things that we could do to address that is to be a little
8 bit more specific in our outcomes.
9 DR. POWERS: That would really help a lot.
10 MR. ARNDT: Okay.
11 DR. POWERS: So I know the magnitude of effort and
12 some idea on what I'm getting for the money.
13 MR. ARNDT: Okay.
14 DR. POWERS: Even if research is difficult to
15 quantify, but anything that helps me understand the
16 magnitude of the effort just makes it a lot more palatable
17 to understand.
18 MR. ARNDT: Okay.
19 DR. WALLIS: Do they have tools today?
20 MR. ARNDT: In some cases, they have qualitative
21 tools. In some cases, they have quantitative tools.
22 DR. WALLIS: Do they have computer programs or
23 something that they can apply?
24 MR. CHIRAMAL: Yes, we do have a program where we
25 have a list of -- a checklist and we check off whether

1 that's available, have we looked at this.

2 DR. WALLIS: You have a checklist.

3 MR. BAHADUR: Yes.

4 DR. WALLIS: It's a tool. Is that the level of a

5 checklist?

6 MR. BAHADUR: It's actually making sure that all

7 the requirements are traceable to the outputs of the system

8 and it's like --

9 DR. WALLIS: How do you improve a checklist? I'm

10 wondering if you have any tools today, maybe the thing is

11 that you need improved people rather than tools. Do you

12 know what they're doing at all or -- we're not convinced the

13 tools are appropriate in this business and what the tools

14 are today.

15 MR. ARNDT: We'll talk a little bit about that,

16 explain that at a later point in the plan. But

17 specifically, for example, a tool may be referenced, did

18 they follow this particular standard, and an approved tool

19 maybe how they followed it or what particular methodology

20 they used.

21 DR. WALLIS: It's a bureaucratic level, though.

22 It's not an intellectual tool level or engineering tool

23 level where you get one person to do the job of ten by

24 having some computerization of the checklist or something.

25 MR. ARNDT: In some cases, that's true. In other

1 cases, we're specifically looking at, for example, metrics
2 to say the software testing is acceptable if you have met
3 these particular metrics, which is an advancement and an
4 engineering kind of tool.
5 Let me go on and talk about, again, the outcomes.
6 We want to, by doing the things in the plant, improve the
7 regulatory review process, reduce the time it takes to
8 develop new regulatory guidance, and this really goes to
9 what Bob and Sher were mentioning earlier -- be ready when
10 these new technologies become available and to improve the
11 capabilities of addressing digital I&C systems and digital
12 systems as a whole in PRAs and other risk-informed tools.
13 Very important in that very immature industry.
14 This is just basically a chart of what we're
15 doing, how it's organized, the research programs, outputs
16 and outcomes, and the various programs we have are divided
17 into four categories. These are somewhat arbitrary because
18 the specifics of the individual tasks sometimes cross the
19 organizational boundaries.
20 We have, in particular, the systems aspects of
21 digital I&C, which reference back to the National Academy
22 study. It's an area that affects the general design and
23 applicability of the systems. Software quality assurance
24 issues, qualitative and quantitative. The digital risk
25 issues, the assessment of the risk of the systems, and how

1 that affects our regulatory review process, and the whole
2 issue of emerging technologies.
3 One of the things that we're planning is that as
4 the emerging technologies become actual things that people
5 are designing and planning on putting into plants, they will
6 move from this category as the plant evolves in time into
7 one of these categories.
8 So, for example, smart sensors is something that
9 people are just starting to look at for nuclear
10 applications. As those become things that Westinghouse and
11 Siemen's are actually building and starting to write topical
12 reports on and things like that, then they would move into
13 the more immediate type research.
14 DR. WALLIS: It looks to me like a generic
15 transparency. If I put thermal hydraulics every time I saw
16 I&C here, it would still be valid.
17 DR. BONACA: Yes.
18 MR. ARNDT: Yes. And as you will hear this
19 afternoon, the human factors plan is similar.
20 DR. APOSTOLAKIS: The difference is that in
21 thermal hydraulics, you know how to do these things and
22 there are no emerging technologies. How are the system
23 aspects of these technologies different from risk assessment
24 of digital technology?
25 MR. ARNDT: The systems -- well, let's go about it

1 from this way. The digital risk assessment issues have to
2 do specifically with the technology associated with putting
3 numbers to the risk of these systems, the reliability of the
4 systems, the data associated with that, the ability to
5 understand the failure modes with respect to a PRA, those
6 kind of aspects.
7 The systems aspects, although applicable to the
8 digital -- rather the risk, as I mentioned earlier, these
9 things cross boundaries, look at the more traditional
10 engineering type issues, like what characteristics of
11 software operating systems, what characteristics of
12 environmental qualification do we need to ensure that
13 particular system will not endanger the health and safety of
14 the public.
15 So basically these are more deterministic type
16 issues as opposed to failure mode and failure rate issues.
17 DR. APOSTOLAKIS: So it overlaps a lot with the
18 quality assurance part, too.
19 MR. ARNDT: Yes, it does.
20 DR. APOSTOLAKIS: Anyway, fine.
21 MR. ARNDT: This is basically just a reiteration
22 of the four areas. This next graphic is just a tool to talk
23 a little bit about the fact that the issues associated with
24 this have implications to other agency programs, including,
25 for example, the human performance plan, the risk-informed

1 regulation implementation plan.

2 For example, what is known as a front of the panel

3 type issue, the man-machine interface issues, the

4 computerized procedure issues, things like that that we're

5 dealing with in our human performance plan also have

6 implications to the digital system issues, as well as vice

7 versa.

8 For example, the human factors program that you

9 will hear about this afternoon has got several issues on

10 high burnup control systems. That also affects the kinds of

11 things that we will be interested in in the digital I&C

12 plan. So we have a close coordination with them.

13 Also, as the risk-informed regulation plan gets

14 developed, the kinds of issues, like, for example, the

15 digital systems are very poorly modeled, if at are, in PRAs

16 and whether or not that should be part of the standard, for

17 exactly, the research into that becomes an important issue.

18 So we work with Nathan and various other people in

19 the risk area to coordinate the program.

20 I would like, at this time, to go through briefly

21 --

22 DR. APOSTOLAKIS: Are you using -- what kind of

23 font are you using, Steve?

24 DR. POWERS: Steve, you don't need to answer that

25 question.

1 MR. ARNDT: Thank you, Chairman Powers.
2 DR. APOSTOLAKIS: This is not current technology.
3 MR. ARNDT: Speak to the CIO.
4 DR. APOSTOLAKIS: You used the typewriter perhaps?
5 DR. SHACK: It's digital, George. It's probably
6 colored it and they printed it in gray scale.
7 DR. APOSTOLAKIS: Increased management attention
8 is needed here.
9 DR. SHACK: It's a technical problem.
10 MR. ARNDT: What I would like to do now is go
11 through briefly the specific areas that we have highlighted
12 and talk a little bit about what we're doing.
13 The first several areas under system aspect have
14 to do with environmental stressors. These areas,
15 particularly the EMI/RFI and the environmental qualification
16 areas, things that have been ongoing and if you'll reference
17 the discussion of schedule in Chapter 5, you will see the
18 start dates for most of this work has been some time ago and
19 we're in the process of wrapping up the particular issues,
20 but they exist in the plan because it's a from now forward
21 plan.
22 DR. POWERS: In the plan itself, you come along
23 and say we're going to complete these.
24 MR. ARNDT: Yes.
25 DR. POWERS: Several times in this particular

1 column here, you're going to complete these. But you don't
2 explain to me what completion means.
3 MR. ARNDT: Okay.
4 DR. POWERS: I'm sitting there -- I'm totally at
5 sea, because my initial reaction, of course, was EMI/RFI,
6 oh, I've heard more about that than I want to hear about, I
7 thought it was done. So I was really ready to hatchet up my
8 coffee on that, and then I read, well, it's just completing
9 this, but I didn't know what that meant. I mean, that could
10 be ten years worth of activity. That could be two and a
11 half hours.
12 MR. ARNDT: In Chapter 3 and Chapter 5, we
13 reference what the tasks are to complete it and the
14 schedule. For example, the EMI/RFI will be finished in
15 about 18 months. And where we are currently is we've
16 completed the research, we've completed the experimental
17 program. We presented this at a public workshop in
18 September and we got some comments on it.
19 Most of those had to do with these are good
20 guidelines, but it seems to be overly restrictive in certain
21 areas. So one of the things we did when we met with the
22 public in that was to look at how can we find ways without
23 causing problems to be less restrictive and reduce the
24 burden on the public.
25 The particular issue was that the guidelines as

1 they exist today basically say for this kind of equipment
2 and this kind of environment that we have measured in the
3 plants, you need this level of protection, and what we're
4 currently looking at is segmenting that and saying, all
5 right, if you can show us that this particular area has a
6 much lower environmental stress in the EMI area, then we can
7 relax those regulations.
8 So this is something that has been specifically
9 requested by the industry and we're looking at that aspect
10 of it. We're also looking at some other aspects; for
11 example, signal line EMI. RFI was not completely addressed
12 in the original research. So we're looking at that, as
13 well.
14 DR. POWERS: This whole task on EMI, I know RFI
15 was very puzzling to me, because you want to complete some
16 work, then you want to look and see if you've been overly
17 conservative, and then you want to investigate the potential
18 of endorsing an IEC consensus standard.
19 Why not just go to there?
20 MR. BAHADUR: If the question is why don't we go
21 to the standards directly and endorse them, I think it would
22 be a little bit difficult to take any standards and just
23 blindly endorse them without understanding.
24 DR. POWERS: You wouldn't be blind. You've done
25 quite a lot of work in this area.

1 MR. BAHADUR: We have done work, but I think there
2 are a couple of issues which were raised in the public
3 meeting that we need to look into before we go back and look
4 at the standards and endorse them.
5 DR. POWERS: Why don't you look at the standard
6 and say, okay, the standard covers all these things, I
7 really don't know whether it's adequate in two out of 16
8 that it covers, and it does cover these other things that I
9 found in the course of my research, and use the standard as
10 the guide on what you do on finishing this work up rather
11 than finishing up the work.
12 I mean, the way it's organized now is you do the
13 work and then you endorse the standard. I'm wondering why
14 don't you do it the other way around or look at the standard
15 and then decide what you have to finish up.
16 MR. BAHADUR: I have Christina Antonescue here in
17 the audience and she is the project manager on this project,
18 and I would like to see if she can add some details.
19 MS. ANTONESCUE: We have used consensus standards
20 and the consensus standards that we used were the military
21 standards and IEEE standards. At this time, we are moving
22 towards IEC standards and that's the future. We have not
23 reviewed the standards in detail, so we cannot really
24 endorse them at this point.
25 That's why we need to extend the project and look

1 at these IEC standards.

2 DR. POWERS: What I'm asking is --

3 MS. ANTONESCUE: And they're not balloted yet.

4 They're not finalized standards.

5 DR. POWERS: What I'm asking is why do you need to

6 go through these task A and task B under verify EMI/RFI

7 qualification, then look at the standard. Why not look at

8 the standard now and then decide how much needs to be done

9 in A and B?

10 MS. ANTONESCUE: The over-conservative nature was

11 brought up by the industry at one of our meetings we had

12 with NPR, and the question was raised that the existing I&C

13 standards that we're using that time, that includes the SER.

14 So the reg guide that we have provided since is an

15 improvement and the industry has acknowledged that.

16 So we are revisiting this over-conservative nature

17 that was brought up at the NPR meeting and we're looking at

18 additional data that we're going to collect in the future

19 and just to address this specific question that was raised.

20 DR. POWERS: Suppose you go in and you say you've

21 convinced me -- I don't know who from the industry is trying

22 to convince you, but Joe has convinced me that indeed we

23 were over-conservative and you change the process and the

24 IEC consensus standard, when it finally comes out, ratchets

25 it up even tighter than you were before, now what happens?

1 MR. BAHADUR: I think that's a very interesting
2 issue, because every time we say we're going to improve the
3 methods, there's always an underlying assumption, like we
4 are going to reduce the burden, which isn't always true.
5 In this particular case, when we endorsed the mil
6 standards, in my mind, the mil standards were way too high.
7 It's easy to endorse an existing standard. It's very
8 difficult to unendorse a particular standard, unless we have
9 something over pressing against that particular standard.
10 What is happening right now is when we went to the
11 public meeting and we got this sentiment from the industry
12 that the mil standards are really way too high for us to
13 apply, and the question is, okay, if it's too high, what is
14 there which is representative of the actual condition in the
15 industry.
16 DR. POWERS: I would be interested in knowing how
17 they persuaded you they were way too high. Did they do a
18 risk analysis?
19 MR. BAHADUR: And these are the kind of questions
20 that we need to answer and the result of that public meeting
21 was that we should get in touch with EPRI, see if there is a
22 cooperative possibility of looking into this issue, see
23 whether the mil standards indeed are really higher than the
24 industry needs, and come to realistic standards and endorse
25 them.

1 So it's a three-step process, in my mind, which is
2 what we plan to do in this particular activity.
3 MS. ANTONESCUE: These tasks are all in parallel,
4 we're working in parallel, and basically the IEC standards
5 are more superior than the military standards and that's the
6 reason we are investigating now the potential endorsing of
7 these IEC standards.
8 MR. BAHADUR: And you will see in the schedule, on
9 page 39, against this activity, the start date for activity
10 -- or tasks one and two are second quarter in the financial
11 year 2000. And then in the third -- and then while these
12 are going on, when the results start flowing in, then we
13 move to task three.
14 DR. POWERS: Well, I'm reminded, it is not
15 surprising that the industry would think that the standards
16 were too strict and that may be true of any standard that
17 you set up.
18 MR. ARNDT: Just to clarify something. The
19 question you asked a few minutes ago, what studies were
20 done, both the industry did a study on this and the agency
21 did a study on this, both for levels of susceptibility of
22 equipment and levels in the plant.
23 So they did a study. We thought some additional
24 information needed to be independently developed and we did
25 a study as well. So we have a different --

1 DR. POWERS: So it wasn't based on risk. It was a
2 comparison between the study that will affect things and the
3 level of EMI/RFI that you actually have.
4 MR. ARNDT: Right.
5 DR. POWERS: For the deterministic side.
6 MR. ARNDT: Yes.
7 MR. CHIRAMAL: Actually, EPRI did a survey of a
8 number of the operating nuclear plants and came up with an
9 envelope of EMI/RFI levels at each plant and that obviated
10 the need for testing at each plant site before installing
11 equipment. So we have used that as guidance in the SRP at
12 this point.
13 DR. POWERS: But it seems to me that an EPRI study
14 on a few plants is not going to be adequate for modifying
15 the reg guide. If EPRI had done a survey of all the EMI/RFI
16 activities that ever show up at all plants, maybe you could
17 modify the reg guide.
18 MR. CHIRAMAL: I think part of the research effort
19 was to do just that.
20 MR. ARNDT: The environmental qualification area
21 is one that's also an ongoing activity, looking at
22 environmental stressors, such as smoke and others. A
23 significant amount of research was done in that area at Oak
24 Ridge and Sandia. We're in the process of wrapping that up
25 now.

1 The area of lightning protection is one that's
2 been discussed extensively, both at this committee and
3 various other areas. We are in the process right now if
4 putting the other research plan for that and that effort
5 will be looking at those issues.
6 The requirements assessment program is a very,
7 very interesting area. It's something that's been
8 articulated by many of the experts in the field, both in the
9 nuclear applications and in general fields, as one of the
10 most potentially significant areas of improvement. Root
11 cause analyses have found a significant fraction of digital
12 system failures can be traced directly back to either poorly
13 articulated system requirements or poorly interpreted system
14 requirements as it goes through the life cycle of the plant,
15 of the development of these systems.
16 DR. POWERS: Steve, I always love it when you talk
17 to us, because you build such enthusiasm for the things that
18 you support. Now, he says, gee, most significant,
19 tremendous leaps can be made here, sounds good to me.
20 Then I read what's written, a technical report
21 will be written. Maybe you could work a little on the
22 language here to build the same sort of enthusiasm for this
23 work that you yourself have so that I really honestly think
24 -- and, you know, if I get another NUREG coming to me, it's
25 probably not going to change my life a whole lot.

1 MR. ARNDT: Okay.

2 DR. POWERS: If I get a new understanding and a
3 new way of doing business that you're talking about here,
4 that will change my life, and that kind of enthusiasm just
5 doesn't come through in it.

6 MR. ARNDT: It doesn't come through.

7 MR. CHIRAMAL: The point is well taken. The next
8 area is the diagnostics and fault tolerance. Again,
9 something that is an issue that has really come to the
10 forefront with the increased use of digital applications.

11 One of the real advantages of digital applications
12 is you have these on-line diagnostics, fault tolerance
13 systems. Also one of the issues associated with is the fact
14 that as you have these complex --

15 DR. POWERS: This whole area just perplexes me.
16 Throughout the beginning of your document, you repeatedly
17 say one of the problems that you encounter is the high level
18 complexity. And though I can sit here and argue with you
19 over what you mean by complexity and whatnot and be picky, I
20 didn't.

21 I just accepted that these things were complex.
22 And then I come to this area and it says, gee, these things
23 self-diagnose themselves, they can recalibrate themselves,
24 they do all that. I say now I know why they're complex.
25 They put all this extra garbage that we never had in the

1 analog systems and it made them very complex and,
2 consequently, difficult.
3 Why don't we just get rid of that stuff, do the
4 simple job that the analytic -- or make them very simple
5 systems.
6 MR. ARNDT: Well, there's two or three different
7 reasons. First of all, we don't design these things, they
8 do. They bring them to us and there's a lot of potential
9 advantages to having diagnostics in these systems, both in
10 reliability, stability. They can do drift correction and
11 these kinds of things.
12 We also have the issue that a lot of these things
13 are either COTS or modified COTS and the other industries
14 are not as concerned about safety critical failures as we
15 are, so they are very interested in reliability, and the
16 COTS systems are becoming more and more embedded with these
17 kinds of systems.
18 DR. WALLIS: What is a COT?
19 MR. ARNDT: I'm sorry. Commercial off-the-shelf
20 system.
21 DR. SEALE: One of the interesting things about
22 built-in diagnostics is they don't shut the plant down when
23 you do the test.
24 MR. ARNDT: Right.
25 DR. SEALE: That has some remedial value.

1 DR. POWERS: Well, sometimes they do. I mean, we
2 have -- you have one, I think, in this report, a lovely
3 example where the system is off doing its self-diagnostic
4 and then it gets a signal that says do something and it
5 promptly ignores it.
6 So there's a real problem here and obviously
7 there's some happy medium that m analysis exist. But I
8 think what you're telling me is much as I would like nice,
9 simple digital systems, I can't get them.
10 MR. ARNDT: Right.
11 DR. POWERS: That the complexity is built in
12 there. I think that's a thought that needs to come across
13 in the report when you come in. It's not that it's really
14 missing. I think that if you add two and two between
15 various sections, you come up to this conclusion that the
16 complexity is indeed the source of the problem, but you're
17 stuck with it.
18 But it would be nice if you made that very clear,
19 that you just can't go out and buy a simple digital system
20 that only does the activities of the analog system. That
21 just doesn't exist out there, and I think that's a very
22 crucial point, that you're stuck with the complexity.
23 MR. ARNDT: Right.
24 DR. UHRIG: Well, isn't there a distinction here
25 in that regard with reference to safety systems versus I&C?

1 Safety systems fundamentally are as simple as you can make
2 them. Below this level, operate; above this level, trip.
3 It's go/no-go.
4 Whereas the I&C systems have all the bells and
5 whistles that we've been discussing here. So you need to
6 make a distinction between the two systems.
7 MR. ARNDT: By and large, that's correct, although
8 we're starting to see not necessarily in applications, but
9 in vendor designs, even things as critical as SFAS, they're
10 starting to have these kinds of things in them. So, yes, by
11 and large, RPS, SFAS, these kinds of systems are much
12 simpler. They are, by and large, specifically designed for
13 nuclear application.
14 But even in those systems, we're starting to see
15 this problem. The operating systems is something that's a
16 significant issue in all digital systems. Everyone who has
17 a PC understands that operating systems can have significant
18 impact on your applications. That's true for real-time
19 digital systems, as well.
20 The operating systems are much simpler and have
21 less overhead, but they still have significant impact on the
22 actual operation of what's going on and we need a better way
23 of dealing with them.
24 The next area is the whole issue of software
25 quality. We've broken it down into two basic areas,

1 software engineering criteria and software testing. The
2 engineering criteria is basically the design aspects, if you
3 will, of the process, understanding the difficulties of
4 setting the limits in the design process, trying to figure
5 out how to measure these kinds of things, trading off,
6 process oriented QA issues, like the capability maturity
7 model versus specific application metrics.
8 The current SRP has a laundry list of things you
9 need to look at to see whether or not they've done a good
10 job, but no metrics on how good the job is.
11 This is an example where we're trying to provide
12 methods and tools to improve the efficiency and
13 effectiveness of that process.
14 DR. UHRIG: Are you beginning to see any tendency
15 towards automatic code generation?
16 MR. CHIRAMAL: Yes. The Siemen's Teleperm XS does
17 that. They have a tool called SPACE that takes the
18 requirements and translates them to code through a machine
19 and then verifies it through the same machine backwards.
20 DR. UHRIG: And this is part of the review that
21 you have to go through.
22 MR. CHIRAMAL: Yes.
23 DR. UHRIG: So this is part of the evolving
24 technology.
25 MR. CHIRAMAL: That's correct.

1 MR. ARNDT: Right. One of the real issues in
2 emerging technology, involving technology is not only are we
3 seeing new applications, new systems, but we're seeing
4 changes and improvements in the current systems.
5 AS you well know, the issues of artificial
6 intelligence have been around for a long time, but up until
7 very recently, they haven't actually been getting into the
8 plants. The issue of code generation and automated
9 processes have been around for a long time, but they're only
10 now starting to really get into the process of designing
11 these systems and going into the plants.
12 So we have both the issues of the changing of
13 technology, the new technology, and the changing methods,
14 all of which we have to try and deal with.
15 Software testing is the specific issues of what
16 needs to be done in software testing. The current SRP
17 basically says you have to do software testing, but it
18 doesn't have a set of metrics by which we say how much
19 testing, what kind of testing, what kind of results. The
20 research in this area is to try and understand what is good
21 software testing, what is a good set of numbers, what are
22 the standard methodologies.
23 It's a very immature, if I can say, issue because
24 when we had our expert panel meeting, we said here's -- I
25 forget the number -- it was like 40 different software

1 testing methodologies and we asked the experts to rank them
2 and come up with some kind of qualitative valuation, and
3 they weren't able to do it. It's something --
4 DR. UHRIG: Was it simply a divergence of opinion
5 or is it that everybody was not familiar with 40 different
6 types of techniques or what was the problem?
7 MR. ARNDT: I think it was a combination of all
8 those things and also the applicability. We are primarily
9 interested in real-time safety critical type application,
10 which is a small, but significant part of the industry and
11 most of the software testing metrics out there are not
12 designed for that kind of application. They're designed for
13 general application.
14 DR. APOSTOLAKIS: Did the fact that the software
15 is usually part of a system come into this? In other words,
16 there are inputs that are generated by the rest of the
17 system.
18 MR. ARNDT: That's right, and how it functions on
19 the particular piece of hardware and things like that. The
20 issue of whether or not software testing and software
21 assurance needs to be integrated with the particular
22 application, which is what you're mentioning, and the
23 particular platform that it was using is another issue,
24 because perturbation based on flipping a bit here or there
25 or having this various input is something that most software

1 testing doesn't look at.

2 Some does, some of the metrics look at that.

3 DR. APOSTOLAKIS: What do you mean by metrics?

4 MR. ARNDT: Things like --

5 DR. APOSTOLAKIS: Give me an example of a metric

6 that applies here.

7 MR. ARNDT: Percentage coverage of a software

8 test.

9 DR. APOSTOLAKIS: Percentage of what?

10 MR. ARNDT: Theoretically, you have some large

11 countable infinity of different paths you can go through

12 with a piece of software.

13 DR. APOSTOLAKIS: Do you know those?

14 MR. ARNDT: Most people don't know them. In

15 theory, you can know them. Software test coverage is a

16 metric on how many of those you were actually trying. So 20

17 percent, 50 percent, one percent of different ways you can

18 work your way through the software.

19 DR. APOSTOLAKIS: Now, these ways are determined

20 by the rest of the system, aren't they?

21 MR. ARNDT: In most cases, yes.

22 DR. APOSTOLAKIS: So if you don't know those,

23 you're talking about 20 percent of something you don't know.

24 MR. ARNDT: For example --

25 DR. POWERS: We've had one speaker from the

1 reviewers come in and say he can't do this on the software,
2 you've got to do it on the integrated system.
3 MR. ARNDT: Right.
4 DR. APOSTOLAKIS: Yes.
5 MR. ARNDT: That's Dr. Johnson's theory. And if
6 you look at, for example, the software testing review that
7 NRR did on the platforms that it did, they looked at
8 platform -- that is to say, the hardware, the software, and
9 the general application, did a review. In point of fact, if
10 you want to do it completely, you then go back and look at
11 the specific applications again.
12 At some point, you have to make a decision about
13 how general do you want the specific metrics to be. But
14 right now, the review guidance is very general and we want
15 to make it more specific.
16 DR. APOSTOLAKIS: Maybe you can explain to me
17 better if I give you an example of something that actually
18 happened.
19 MR. ARNDT: Okay.
20 DR. APOSTOLAKIS: In one of the fighter planes,
21 the following thing happened. The pilot, of course, can
22 raise the landing gear when the plane is flying.
23 MR. ARNDT: Right.
24 DR. APOSTOLAKIS: And it just so happened that he
25 did it accidentally when the plane was on the ground and the

1 gear was lifted, raised. Is that a software error?
2 MR. ARNDT: In all likelihood, it's actually a
3 design specification error.
4 DR. APOSTOLAKIS: But how would software testing
5 find this? The software did what it was designed to do.
6 MR. ARNDT: Yes. And if the --
7 DR. APOSTOLAKIS: But the context was different.
8 MR. ARNDT: Right, the context was different. The
9 requirement was poorly interpreted. And if you look at
10 software testing procedures, they are generally generated
11 specifically from the requirements. For example, you'll say
12 these are the requirements for this airplane, and I'm a
13 pilot and I take this personally, you want the landing gear
14 part of the software to go down when it's supposed to, come
15 up when it's supposed to, operate properly.
16 There may be an interlock that says when you're
17 below so many feet, it automatically comes down.
18 DR. APOSTOLAKIS: Right.
19 MR. ARNDT: And there will be a set of
20 requirements, and one of them is don't lift it while you're
21 on the ground.
22 DR. APOSTOLAKIS: Right.
23 MR. ARNDT: And that requirement will then be fed
24 into the preliminary design report, the design reviews and
25 the testing requirements and a good testing program will

1 specifically test all the design requirements and all the
2 testing.
3 DR. APOSTOLAKIS: So you don't do that here in
4 this box.
5 MR. ARNDT: No. You do that in the --
6 DR. APOSTOLAKIS: The requirements box.
7 MR. ARNDT: -- requirements box.
8 DR. SEALE: But to test the software, you have to
9 try to raise it while it's on the ground to see whether or
10 not the requirement got properly put in it.
11 MR. ARNDT: Right, exactly. And like I say, all
12 of these are interrelated.
13 DR. SEALE: Successfully, I hope. Unsuccessfully,
14 I hope.
15 MR. ARNDT: And depending upon the sophistication
16 of the program, a lot of people build simulations of the
17 software and hardware and test them both in simulation
18 space, as well as in real hardware space.
19 DR. APOSTOLAKIS: So here then you would test only
20 the ability of the software to raise the landing gear.
21 MR. ARNDT: Right.
22 DR. APOSTOLAKIS: Independently of the context.
23 MR. ARNDT: Independently.
24 DR. APOSTOLAKIS: And in another box you would
25 worry about that.

1 MR. ARNDT: Whether or not the requirements had
2 been appropriately written into the software.
3 MR. CHIRAMAL: Dr. Apostolakis, software testing
4 is two methods. One is you check the functions that are
5 performed by the software. The other is things like in
6 designing, you test the modules for its input and outputs
7 and then you join the modules and you do some testing, and
8 that's part of software testing also.
9 At present, in the SRP, what we have done is we
10 referenced the IEEE standards on unit testing and functional
11 testing.
12 DR. APOSTOLAKIS: So then the whole discussion
13 shifts back to the box that says requirements assessment.
14 MR. ARNDT: Right.
15 DR. APOSTOLAKIS: Because, again, you have to look
16 at the whole system to be able to test those requirements.
17 MR. ARNDT: That's right.
18 DR. APOSTOLAKIS: And its various uses.
19 MR. ARNDT: And there's a lot of controversy in
20 that area as to what the best ways of doing that are.
21 DR. APOSTOLAKIS: You have to look at the system.
22 There can't be a controversy about that.
23 MR. ARNDT: No, there's not.
24 MR. CHIRAMAL: But to assure the quality of
25 software, you've got to do some software unit testing,

1 module by module, part by part, to make sure that it does
2 its function.
3 DR. APOSTOLAKIS: But when you are testing the
4 requirement or you're checking the validity of the
5 requirements.
6 MR. CHIRAMAL: That's integrated testing when you
7 put the software and the hardware together.
8 MR. ARNDT: The next area is the whole issue
9 associated with improving, in many cases developing our
10 ability to understand digital systems in a risk context.
11 The first area --
12 DR. APOSTOLAKIS: I'm a little bit puzzled myself
13 here.
14 MR. ARNDT: Okay.
15 DR. APOSTOLAKIS: We're talking about the plan,
16 but some elements of this plan are already being
17 implemented, right? I understand University of Virginia has
18 been doing work in this area.
19 MR. ARNDT: Yes, that's correct.
20 DR. APOSTOLAKIS: So the plan is coming after we
21 started doing certain things.
22 MR. ARNDT: The plan is a from today forward plan
23 and some of the activities are being integrated, have
24 already started. For example, the University of Virginia is
25 doing work in digital system failure assessment, looking at

1 how things work, primarily hardware/software assessment and
2 that kind of issue.
3 We have done some in data analysis in-house, and
4 we intend to do some more.
5 One of the little short studies we did is appended
6 to the plan.
7 So, in several of these areas, including this
8 area, we've started doing work in some areas, we've done a
9 lot of work, and we'll be completing it within this
10 five-year plan, and in some areas, we haven't even started
11 yet, and we'll only just begin to start working by the end
12 of our five-year planning horizon.
13 DR. POWERS: In your document itself, you have a
14 task list in here that says something to the effect,
15 identify and develop risk analysis models for I&C systems.
16 Are there such beasts to be identified?
17 MR. ARNDT: There have been various proposals put
18 forth -- for example, software, a fault tree analysis, and
19 things like that.
20 DR. POWERS: It would have been useful in the
21 report, and actually interesting, if you'd give me some
22 indication of the range of proposals that existed, because
23 this has always been an area of such substantial heat
24 between the analogs and the digitals --
25 MR. ARNDT: Yes.

1 DR. POWERS: -- and saying that, well, digitals
2 just are incompatible with the concepts of risk because of
3 their peculiar failure characteristics, they either don't
4 work when you get them or they last forever and immune to
5 everything except a GI with a hammer or something like that.
6 You know, in reading the plan, especially in those
7 activities where you have things like I'm going to identify
8 and I'm going to look at what the possibilities are out
9 there to give some indication of what the -- there was some
10 hope to find things --
11 MR. ARNDT: Okay.
12 DR. POWERS: -- and some indication of the range
13 and the variability of things, then make it much more
14 obvious that a research program is merited here, as opposed
15 to me just pulling out the handbook and saying do this.
16 MR. ARNDT: Okay.
17 So, for example, in this area, we could articulate
18 we're going to look at areas such as --
19 DR. POWERS: Uh-huh.
20 MR. ARNDT: -- and list three or four.
21 DR. POWERS: Yeah. I don't think anybody is
22 asking you be comprehensive in a plan, because you haven't
23 done the work, but it would have been useful to understand
24 that there were -- where there were technical capabilities
25 out there and differences of opinions among experts that you

1 really needed to assess --

2 MR. ARNDT: Right.

3 DR. POWERS: I think that would have helped me a

4 lot more to understand the nitty-gritty of the thing,

5 because I knew the product I was getting was just a report.

6 MR. ARNDT: Right.

7 DR. POWERS: I'd really rather have some

8 understanding.

9 DR. APOSTOLAKIS: Actually, one of the methods, I

10 guess, the words in the box would not be acceptable, because

11 you are not assessing the risk of digital I&C systems; you

12 are assessing the risk of the high-pressure injection system

13 if it includes digital I&C, because that method completely

14 rejects the idea of assessing the risk from software.

15 The software drives the hardware, gets information

16 from the process, and comes back and tells the process do

17 this.

18 So, what you want to know is what is the risk or

19 the reliability from the process itself when you have

20 embedded software to do all these things, but the software

21 itself, you know, is just buried there, and that work was

22 funded by the NRC, by the way.

23 MR. ARNDT: Yes.

24 The whole issue of whether you talk about how

25 software affects or digital systems affects the reliability

1 of plant systems or the plant itself or talk about software
2 reliability, which is, depending upon who you ask, a
3 misnomer, to a certain extent it's semantics, but it does --
4 DR. APOSTOLAKIS: It's very important. Semantics
5 is very important sometimes.
6 MR. ARNDT: It is important in many cases.
7 DR. APOSTOLAKIS: Because there isn't such a thing
8 as a reliability of a computer code.
9 MR. ARNDT: Right.
10 DR. APOSTOLAKIS: Professor Levinson has given
11 several talks in the public where she said, you know, people
12 come to me and they give me a software package and they say
13 can you tell me how reliable it is, and my answer, without
14 looking at it, is that the reliability is one.
15 MR. ARNDT: Yeah.
16 DR. APOSTOLAKIS: Unless you tell me where you're
17 going to use it, the question is meaningless.
18 MR. ARNDT: Right.
19 The various areas we have here include, of course,
20 the basics that you want to do for any kind of risk
21 assessment kind of thing, look at the data, understand the
22 failure modes.
23 DR. APOSTOLAKIS: That intrigues me. What kind of
24 data? I mean I thought this was a new technology.
25 MR. ARNDT: It is a new technology, and you get

1 into the issue that we do in many cases, what is the
2 applicability of the data, how much data is available, if
3 any?
4 DR. APOSTOLAKIS: I gave you a piece of data with
5 a fighter plane.
6 MR. ARNDT: That's right.
7 DR. APOSTOLAKIS: What do you do with that?
8 MR. ARNDT: Well, you have to assess whether or
9 not it makes any sense to include it into a database that
10 we're going to care about, and a more difficult issue than
11 your particular example is all these commercial
12 off-the-shelf systems, many of which exist in the process
13 industry, in the petrochemical industry, in the medical
14 industry, in the railroads.
15 Lots of different people do real-time processing,
16 and the have done it more than we have, not a lot more,
17 because it's a new technology, and also the whole
18 applicability of do we care what the failure rate of a
19 system that's based on an 8088 is compared to what we're
20 going to do with a new system today?
21 It's a tough issue, but unless we start looking at
22 it and trying to assess it -- failure models without data
23 don't mean anything.
24 DR. POWERS: To some extent, you actually
25 articulate that in the existing report, but to the extent

1 that you can make it can clear in the data analysis --
2 there's a lot of data out there that would not contribute to
3 a useful database.
4 MR. ARNDT: Right.
5 DR. WALLIS: To go back to what we talked about at
6 the beginning, I get the impression you're working on a very
7 extensive problem, and you have -- there isn't that much to
8 start with, and if you can say we know all these things
9 today and these are the areas we really need improvements in
10 or something, but you're starting with the whole problem
11 laid out as a burgeoning problem, and that makes me worry
12 about how much you really need to do to understand it. It
13 is really like that, or is a lot already known and there are
14 just certain weak areas?
15 MR. CHIRAMAL: One of the problems the experts say
16 is that you cannot -- it's very difficult to quantitatively
17 assess the reliability of digital systems.
18 DR. WALLIS: But you say everything is adequate.
19 You started off saying everything is adequate. I get the
20 impression it's adequate because no one knows much at all.
21 You don't know where it's inadequate. Am I getting the
22 wrong impression?
23 MR. ARNDT: Not entirely.
24 One of the issues that Matt highlighted is that if
25 you're trying to bring this into a risk-informed-type

1 application, then you have to be able to put a number to it,
2 and if you don't know a whole lot and you don't have a lot
3 of experience, you have to put the number quite high, and
4 depending upon the experts you talk to, most people say an
5 integrated software system cannot be shown to be any better
6 than maybe 10 to the minus 3.
7 There's a lot of people who believe that
8 integrated software systems are much more reliable than that
9 in particular applications.
10 In point of fact, we have a lot of examples where
11 we have high-demand systems that are software-driven that
12 operate for years without problems, but you cannot
13 theoretically or analytically show that they're anymore
14 reliable than 10 minus 3.
15 That's a big problem when you're trying to deal
16 with systems in a risk perspective that have these embedded
17 software-based systems in them.
18 In a lot of ways, the issue is understanding how
19 to assess these with some kind of certainty when people are
20 claiming --
21 DR. APOSTOLAKIS: Well, again, there are other
22 people who think that statements of this type don't make
23 sense.
24 MR. ARNDT: That's right. I mean the concept
25 we're talking about, reliability for software --

1 DR. APOSTOLAKIS: In isolation.

2 MR. ARNDT: -- in isolation --

3 DR. APOSTOLAKIS: Guess which side I'm on?

4 MR. ARNDT: Yeah, I can take a guess. Hotly

5 contested discussion.

6 DR. APOSTOLAKIS: Now, risk importance -- you say

7 in the report that you are really looking at the risk

8 importance of some, again, positions in the PRA, whether

9 it's an analog system or digital, it doesn't matter, it's a

10 function, right?

11 MR. ARNDT: Right.

12 DR. APOSTOLAKIS: Again, I wonder whether that's

13 consistent with the view that the software will be embedded

14 everywhere, in the whole system.

15 Can you really say this is now an event that's

16 caused by the software? I don't know.

17 MR. ARNDT: In some cases, you can. In some

18 cases, you can't.

19 DR. APOSTOLAKIS: Yeah. I think that's a good

20 answer, because it's all-inclusive.

21 MR. ARNDT: That's right. And if you look at the

22 database that we're working on and some of the study work we

23 did, a lot of stuff, even in a detailed analysis, you don't

24 know, because the root cause didn't go far enough to do it.

25 DR. APOSTOLAKIS: That's right.

1 MR. ARNDT: In some cases, we have very specific
2 examples that it was a problem because of that.
3 DR. APOSTOLAKIS: And the other thing that we
4 worry about is that the digital software may introduce new
5 failure modes --
6 MR. ARNDT: That's right.
7 DR. APOSTOLAKIS: -- which are not in the PRA.
8 Therefore, you cannot assess the risk importance.
9 MR. ARNDT: That's right.
10 DR. POWERS: It seems to me that one of the
11 problems -- correct me if I'm wrong.
12 MR. ARNDT: Okay.
13 DR. POWERS: Dealing with these digital systems,
14 you have the problem that, unlike lots of components, it
15 either works or it doesn't.
16 You can have the intermediate situation of it
17 works badly.
18 MR. ARNDT: Yes.
19 DR. POWERS: Okay.
20 So, the kind of binary logic that's inherent to
21 most of the trees that we use in PRAs is really not -- may
22 not be applicable to these things.
23 MR. ARNDT: It's not applicable. It's not as bad
24 as all that, because most safety-critical real-time systems
25 have -- assuming they work properly -- self-diagnostics and

1 things like that, that if you have an unexpected state, it
2 will tell it to turn off or whatever.
3 Of course, you can run into the whole problem of
4 the diagnostics or the air correction or the watchdog timer
5 or whatever it is causing an additional problem, but the
6 whole issue of how it fails, what it looks like when it
7 fails, does that failure promulgate along an information
8 pathway that we have not looked at, the whole issue of how
9 are these things connected or not connected is something
10 that is different from what we've looked at before.
11 DR. UHRIG: Steve, we're going to have to wind up
12 here fairly soon.
13 Could you sort of hit what you consider the high
14 points?
15 MR. ARNDT: Okay.
16 Well, if George will let me --
17 DR. APOSTOLAKIS: You're going so slowly.
18 DR. POWERS: You've really been bogged down here,
19 Steve.
20 MR. ARNDT: Okay.
21 DR. APOSTOLAKIS: It takes you 10 minutes to go
22 through one view-graph.
23 MR. ARNDT: The last and probably most important
24 part is the whole issue of emerging technology, and the
25 first block is technology review and infrastructure -- I'll

1 talk about more in a second. So, let's skip that briefly.
2 We've looked at three or four general classes of
3 emerging technologies that we know or have a pretty good
4 understanding are going to have specific applications to
5 nuclear technology, and we want to look at them
6 specifically.
7 They include the whole issue of on-line
8 maintenance and predictive maintenance, advance
9 instrumentation, be it for improved accuracy or improved
10 reliability or just new systems, I mean new different types
11 of sensors that we haven't looked at before, smart
12 transmitters.
13 DR. POWERS: Let me ask this question. You're
14 saying let's go off and look at all these systems that may
15 or may not be used.
16 MR. ARNDT: Right.
17 DR. POWERS: Okay.
18 Maybe you're a pretty bright guy and you can say
19 these probably will and these probably won't.
20 Why doesn't the NRC take a different tack and say
21 we want the integrated system to have such-and-such a
22 reliability, and you, industry, if you want to use these new
23 stuff, show us that this is here, that it does that, it
24 meets this standard, and not go off in the emerging
25 technologies, because it's such a vast and speculative

1 field, and it changes every week.

2 I mean my impression is it changes0every week.

3 How do you keep this from proliferating -- I mean

4 I understand firewalls of security, that you might want to

5 look at that, but --

6 MR. ARNDT: Yeah.

7 DR. POWERS: -- the rest of it -- why not say it's

8 hopeless for me to stay abreast of this?

9 MR. ARNDT: Okay. Well, there's a couple reasons.

10 First of all, from a programmatic standpoint,

11 these are all out-year-type issues, and this plan will get

12 revised, etcetera.

13 So, as we know more, we'll either add resources or

14 delete resources from things that are important, but the

15 more important issue is, because it moves so quickly, two-,

16 three-year kind of timeframes, if we don't start looking at

17 these issues before the industry drops a topical report on

18 us, we cannot stay efficient and effective.

19 More importantly, we may not be able to catch

20 everything, because we simply don't understand the

21 particular applications that they're bringing to us, and

22 even if we set a standard, that standard may not be

23 applicable to a new technology.

24 DR. POWERS: I think it's an issue you need to

25 confront directly in the report, and I think I understand

1 your answer --

2 MR. ARNDT: Okay.

3 DR. POWERS: -- that you couldn't -- you wouldn't

4 know how to read the topical report if you remain ignorant

5 on everything.

6 MR. ARNDT: Right.

7 DR. POWERS: It would be fate-based regulation,

8 one that I'm particularly in favor of, but that's not maybe

9 what the agency wants.

10 DR. APOSTOLAKIS: Would this be anticipatory

11 research?

12 MR. ARNDT: Yes.

13 DR. APOSTOLAKIS: And the Office of Research is

14 supposed to do that, right?

15 MR. ARNDT: That's right. And specifically, we

16 have a task in emergency technologies for technology review

17 and infrastructure.

18 DR. APOSTOLAKIS: So, what is the smart equipment

19 again?

20 MR. ARNDT: Pardon me?

21 DR. APOSTOLAKIS: Smart equipment?

22 MR. ARNDT: Smart transmitters, smart sensors.

23 This area is of particular importance because

24 we're trying to do three things.

25 We're trying to deal with the standards as they

1 change and endorse them or determine what they are and
2 influence them, something that is near and dear to my NRR
3 colleagues.
4 DR. POWERS: Let me ask you about these standards.
5 MR. ARNDT: Yes.
6 DR. POWERS: I'm not an electrical engineer and
7 I'm not a digital person, but I do trouble myself to go look
8 at these IEEE standards in this area, because it's such an
9 important area, and they're immense, and they're all written
10 in 8-point type and dual column, and they seem to be written
11 for digital systems that control airplanes, for feedback and
12 control systems, and the kind of systems we have in nuclear
13 power plants are, Professor Uhrig pointed out, you know,
14 safety systems, they're supposed to be simple.
15 Do we look to these standards and say what is the
16 ore out of this needed for the simpler systems we have, or
17 are they just not dissectable, it's an all or nothing kind
18 of thing?
19 MR. CHIRAMAL: It's the latter, it's all or
20 nothing, because these particular IEEE standards are not
21 designed for nuclear engineering; it's for all applications
22 of software, and hardware, of course, and it's general IEEE
23 standards.
24 When we endorsed it with the reg guide, we put
25 some caveats on certain aspects of it.

1 MR. ARNDT: And one of the biggest issues is some
2 of these are very good and very applicable, some of them are
3 not real great and not very applicable, and all combinations
4 thereof, and they also change a lot quicker than ASME code
5 standards and things like that.
6 So, working on and keeping abreast of the ones
7 we're interested in is something that we have to consciously
8 do if we want to do a good job, and it's part of the
9 infrastructure of dealing with this issue.
10 Another part that we need to be more conscious of
11 than we have in the past, even though we've done a lot of
12 work in this area, is dealing with interacting and
13 interfacing with other people, and one of the tasks is to
14 specifically do that, and we have a whole section of things
15 that we want to do in that area, and we'll continue to
16 expand that area, as appropriate.
17 And the third area is we want to physically look
18 at what's going on in the industry and determine what we
19 need to do, read the reports, go to the conferences,
20 understand what's involved from that activity, new
21 activities and emerging technology will be added or deleted,
22 and from emerging technologies, those activities will be
23 pushed into the short-term activities in the other major
24 categories.
25 So, we see this as a flow from reviewing what's

1 going on to looking at it as an emergent technology to
2 looking at it as a specific application.
3 DR. POWERS: Let me ask a question that you may
4 not -- you may be the wrong person to ask, and that's okay.
5 I get this guy, he is on top of the latest and the
6 greatest coming out of this field, that's been his job.
7 Am not just creating a guy who promptly gets
8 offered millions of dollars to go off and work for a Silicon
9 Valley company where he can retire at the age of 35 and
10 things like that?
11 MR. ARNDT: I haven't got any offers recently.
12 DR. APOSTOLAKIS: The guys who can go and do that
13 are not the right people to do this kind of work.
14 MR. ARNDT: It is an issue.
15 Mike, do you want to talk to that a little bit?
16 MR. MAYFIELD: Mike Mayfield from Division of
17 Engineering Technology.
18 Maintaining the staff, training the staff, as you
19 develop very skilled, high-quality folk, you always run the
20 risk that they're going to go elsewhere. That's just a fact
21 of life.
22 I don't know of any way of chaining them to their
23 desk.
24 DR. POWERS: This is a real problem.
25 MR. MAYFIELD: It is a problem. It's a problem

1 for us. It's a problem in the industry, as well, because
2 highly-trained people are a sought-after commodity, and they
3 tend to move.
4 I don't see this as any different problem than,
5 frankly, the one Sandia faces or any of the other national
6 labs face.
7 DR. SEALE: Stupidity is not the answer.
8 MR. MAYFIELD: Yeah. Keeping a dim-witted set of
9 folks is not the direction we want to go, and it's just the
10 realities of business today.
11 DR. POWERS: So, this digital system is just going
12 to be a big manpower problem.
13 DR. APOSTOLAKIS: When are we going to actually
14 see the work that is being done under these boxes? I'm
15 seeing two plans today, and I'm OD'ing on plans.
16 DR. POWERS: He has completion dates on some of
17 these things.
18 DR. APOSTOLAKIS: I don't want to see it after
19 they're completed.
20 Can we have a subcommittee meeting, Mr. Chairman
21 of the subcommittee, where we're going to have some detailed
22 exposition of what is going on?
23 DR. UHRIG: That's one of the possibilities. We
24 have not considered that at this point.
25 As Steve mentioned earlier on, this came up

1 relatively rapidly, got on the agenda, and the plan has been
2 developed over a relatively short period of time, and it was
3 put on the agenda without a subcommittee meeting.
4 DR. APOSTOLAKIS: I'm not talking about the
5 subcommittee on the plan itself. I mean the boxes, what's
6 going on inside the boxes.
7 MR. ARNDT: We had a subcommittee meeting, I
8 think, about a year-and-a-half ago that talked about several
9 of the issues.
10 I think Don was the subcommittee chair then, and
11 we, of course, brought Dr. Johnson from Virginia in to talk
12 about some of the work that he was doing, but --
13 DR. APOSTOLAKIS: When is that work going to be
14 completed, by the way?
15 MR. ARNDT: I don't recall the exact date, but we
16 hope to have a product on that.
17 John?
18 MR. CALVERT: John Calvert from Research.
19 We're going to have -- right now we're working on
20 a pilot project with Calvert Cliffs, taking a digital
21 feedwater system and applying the University of Virginia
22 methodology and come up with is their methodology workable
23 and applicable to a project, and based on that, then we can
24 decide what we have to do from there, but --
25 DR. UHRIG: What's the timeframe of that? A year?

1 MR. CALVERT: The timeframe is -- it's scheduled
2 for the end of this year, but we're running into -- or we
3 have run into proprietary agreements and things like that
4 that we had to work out.
5 DR. APOSTOLAKIS: Are there any interim reports
6 that we can review?
7 MR. CALVERT: Not at this time.
8 MR. ARNDT: We have some interim reports on some
9 of the other projects, some of the software QA issues and
10 things like that, that we could forward to the committee if
11 they're interested in looking at them.
12 DR. POWERS: Maybe we can just go ahead and wrap
13 up the presentation and discuss the schedules off-line.
14 MR. ARNDT: Okay.
15 DR. POWERS: Because I promised to let you go to
16 lunch.
17 The committee is willing to sit here till late
18 hours at night, but I did promise you.
19 DR. APOSTOLAKIS: You are not.
20 MR. BAHADUR: This brings me to the last slide of
21 the presentation. I know we are in a time crunch right now.
22 I just want to bring a couple of things for your
23 information.
24 As you have noted, this is a forward-looking plan,
25 but not really just forward-looking plan. In the past,

1 digital I&C effort have been mostly to respond to NRR user
2 need, and work has been conducted in that area for the last
3 five, six years.
4 So, what this plan does is it brings us to the
5 level where we are today and then how we can fit whatever we
6 have done plus what we propose to do in the overall picture
7 of the goal that Steve had presented.
8 We came to subcommittee last fall, where we talked
9 about the work with the University of Virginia, and I agree
10 with George that I think this committee needs to see what
11 all we have done so far in the digital I&C, and we can
12 discuss that off-line, but my one suggestion would be that
13 whatever work we have done so far as a user need response in
14 the I&C area.
15 We can make a full package out of that and send it
16 for your review, and if you see the need, we can come and
17 discuss that with you, or if you just want to read, then
18 that's okay, as well.
19 What I plan to do is, once this plan gets approved
20 and I get the necessary resources, I will continue to work
21 the approach that we have taken in the past but supplement
22 that a little more by conducting the work not only with the
23 contractors and the DOE labs but also bringing an awful lot
24 of work in-house.
25 We plan to do work, cooperative research with

1 EPRI, and then, of course, we'll be doing work with the
2 universities. The University of Virginia is one example
3 where we have been doing some work, and on the international
4 arena, we will do the work with Holland, which will give us
5 a window to see what other countries are doing in this area.
6 DR. APOSTOLAKIS: Is Livermore your main
7 laboratory on this?
8 MR. BAHADUR: Livermore did some work in the past.
9 Right now, I don't have any active project with Livermore.
10 What we're looking for for this briefing would be,
11 after the committee has a chance to review and see the
12 report, is to -- a letter to the Commission, because we plan
13 to send this plan to Commission as information.
14 DR. UHRIG: When?
15 MR. BAHADUR: The plan is to send it -- I was
16 shooting for May. The end of May, we would be sending the
17 information paper to the Commission.
18 If the committee were to write in its letter the
19 importance of this area being acceptable to the committee,
20 the approach that the staff has taken is in the right
21 direction, and then if the improvements are needed in this
22 plan, then specific suggestions as to what need to be done.
23 I mean I heard an awful lot about where the plan
24 could be improved in terms of putting the similar enthusiasm
25 into the plan as was in the presentation, and those kind of

1 views are very useful to us, but in more philosophical
2 sense, have we taken the approach that we should have taken,
3 keeping in mind that the goal is not only to meet the NRR's
4 immediate user need but to also keep in mind that the agency
5 is going in the risk-informed direction, whether we are
6 responsive to that, and also the imaging technology, which,
7 whether we like or not, is here to stay, and if we accept
8 that the emerging technology is here to stay, then the NRC's
9 preparedness is a question, and whether this particular plan
10 leads to a research activity which help NRC to get prepared
11 to respond to the industry.
12 That's the kind of comments we are seeking from
13 the committee.
14 DR. APOSTOLAKIS: Well, there are two things that
15 come to mind, especially judging from a recent experience
16 with another area, LPSD, low-power and shutdown, where they
17 produced a report, as well, with all sorts of research
18 needs.
19 I think you need to do two things.
20 One is to go back and work on the goals and the
21 importance of this and not leave it up to us to define them
22 and maybe identify them in bullet form, you know, and the
23 other one is I think you need to prioritize these things.
24 MR. BARTON: A lot of work here.
25 DR. APOSTOLAKIS: You have a hell of a lot of work

1 there, and what do you expect the Commission to do, to give
2 you the resources to attack all of these?
3 MR. BARTON: A zillion dollars.
4 DR. APOSTOLAKIS: Probably you will get a five to
5 zero decision against.
6 MR. ARNDT: The plan is that the resources
7 associated with this will be prioritized within the research
8 prioritization scheme.
9 The plan will go to the Commission as a
10 information notice as to this is what we're planning on
11 doing and this is why we're planning on doing it, and the
12 resources will be dealt with as part of the research
13 prioritization process.
14 DR. UHRIG: You're going to put all the resources
15 at risk.
16 DR. APOSTOLAKIS: It didn't work out that way for
17 other areas.
18 DR. POWERS: Well, that's a strategy I think we're
19 going to have to let them wrestle with.
20 DR. UHRIG: I think we've reached the witching
21 hour.
22 DR. POWERS: Okay.
23 MR. ARNDT: Thank you again.
24 MR. BARTON: No, that's 7:30 tonight.
25 DR. POWERS: I will recess until 1:40. Maybe I'll

1 recess until 1:30.

2 [Whereupon, at 12:40 p.m., the meeting was

3 recessed, to reconvene at 1:30 p.m., this same day.]

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1 A F T E R N O O N S E S S I O N

2 [1:30 p.m.]

3 DR. POWERS: Let's come back into session.

4 We are now going to discuss performance

5 indicators, but this is a new breed of performance

6 indicators, not the ones that we've discussed in the past,

7 and these are to be risk-based performance indicators, and

8 George, I guess you'll take us through this?

9 DR. APOSTOLAKIS: Yeah.

10 We had a subcommittee meeting in December. The

11 staff presented to us what they are trying to do in this

12 area and also the results of some data collection of

13 unavailabilities of systems and so on. So, today, they are

14 briefing the committee on that work.

15 I guess you're requesting a letter, right?

16 MR. BARANOWSKY: Yeah, or at least some comments

17 to us that we can use to see what the opinion of the

18 committee is, because we do have plans to go to the

19 Commission in June, and we need to say that we have

20 discussed this and how we are addressing ACRS comments, if

21 any.

22 DR. APOSTOLAKIS: So, the floor is yours.

23 MR. BARANOWSKY: Okay.

24 So, for the record, I am Patrick Baranowsky, chief

25 of the Operating Experience Risk Analysis Branch, and we are

1 going to be talking about risk-based performance indicators
2 and industry-wide performance measures today, which are sort
3 of integrated aspects of the same thing but somewhat
4 different.
5 With me is Steve Mays, assistant branch chief, and
6 Hossein Hamzehee, who is the project lead for this technical
7 work that we have ongoing.
8 We use Idaho National Engineering and
9 Environmental Laboratory, and what's the name of the other
10 group?
11 MR. HAMZEHEE: ISL.
12 MR. BARANOWSKY: ISL. It's the split-up of
13 Scientech into piece-parts, and the one that's working
14 regulatory matters is called ISL.
15 This topic, by the way, in addition to having
16 discussed it with you in December, we've also had a meeting
17 with our counterparts, including the office director of NRR
18 and the Executive Director for Operations, and the second
19 chart here shows what I want to cover today.
20 In addition to the purpose of talking about
21 risk-based performance indicators, I want to give some
22 background, and it's important for us to talk about what are
23 risk-based performance indicators, because I think there
24 might be some misperceptions as to what we mean by those,
25 what are the benefits of risk-based performance indicators,

1 how do they fit into the revised reactor oversight process,
2 and the process for developing risk-based performance
3 indicators, including some early results of work that's not
4 really at the stage where we need technical review but we
5 want to give you a flavor of how that's starting to come
6 out.
7 Just as a bit of background, you know, this idea
8 of risk-based performance indicators was brought to the
9 attention of the Commission back in August of 1995, and we
10 put together a plan for risk-based analysis of reactor
11 operating experience which was going to lead up to the
12 development of risk-based performance indicators back in
13 December of 1995, and we have talked to the ACRS
14 conceptually about this, and the concepts are getting a
15 little bit more detailed now, and so we're back again.
16 Risk-based performance indicators were also
17 indicated as a future development activity in the EDO
18 tasking memorandum of August 1998 that identified steps for
19 developing the revised reactor oversight process, and the
20 old AEOD, now defunct, sent out a risk-based performance
21 indicator proposed program plan in October 1998 to both NRR
22 and RES.
23 Not very much happened until about -- maybe a year
24 ago, and then, recently, the Chairman's tracking system
25 recognized this as a separate activity to be tracked and

1 part of the evolutionary aspects of the revised reactor
2 oversight program, and so, we have issued this so-called
3 white paper, which provides some concepts and philosophies
4 and how we plan to go about developing risk-based
5 performance indicators and provided an early draft to you
6 about a month or so ago.
7 It's had a few changes, and then it was sent out
8 to the public a couple of days ago.
9 Those changes are fairly small and involve various
10 technicalities that I don't think impact the thrust, the
11 gist of the paper.
12 DR. APOSTOLAKIS: On that point, as you have up
13 there, we discussed this two years ago, or something like
14 that.
15 I was a bit surprised when I read the white paper
16 that it talks about it at a higher level, talks about how
17 you plan to go about doing those things.
18 I thought it was going to be more specific as to
19 how you're actually doing it.
20 Is it because people weren't paying attention and
21 now there is revived interest?
22 MR. BARANOWSKY: That's quite a bit of it.
23 I think what we found was, in talking to both
24 folks in NRR and in industry, there were a lot of
25 misconceptions about the high-level concepts and that we

1 didn't do a really good job in laying those out in some of
2 our earlier discussions.
3 So, we tried to take a lot of care, in talking to
4 people about their perceptions of this, in putting this
5 conceptual paper together.
6 Now, as it turns out, a lot of the technical work
7 that's the foundation for the risk-based performance
8 indicators, is work that's been done in my branch on the
9 risk-based analysis of reactor operating experience for
10 which we have a briefing scheduled tomorrow morning, and so,
11 I think the technology isn't something that's new.
12 We're trying to use things that we have already
13 worked on and had a fair amount of interaction with you, as
14 well as NRR and other public organizations on in the past,
15 and just adapt them to the performance indicator business.
16 In fact, that's why we expect to be able to
17 produce a technical report, which I think is the meat that
18 you're looking for, in July of this year.
19 Now, that's not really very much time.
20 So, we're going to give you a flavor of the kind
21 of technical work that we're doing, but I don't think we
22 want to go over our incomplete papers, if you will, in an
23 ACRS meeting.
24 When we talk to you in July -- Steve will go over
25 the schedule, but that's the beginning of a more significant

1 technical review that will involve external and internal
2 stakeholders, then coming back to the ACRS again for more
3 technical discussion, maybe some workshops, and then finally
4 going to the Commission after all those technical reviews
5 and views are incorporated and revisions made and whatever
6 comes out comes out.
7 DR. APOSTOLAKIS: So, you have already done, then,
8 the work -- some of the work that you are proposing in this
9 white paper.
10 MR. BARANOWSKY: Yes.
11 DR. APOSTOLAKIS: It's not like you are starting
12 now.
13 MR. BARANOWSKY: Yes.
14 I mean we have a pretty good idea about what kind
15 of information needs to be collected, what kind of models,
16 what kind of statistical approaches need to be taken in
17 order to be able to have valid indications that have good
18 statistical characteristics and reflect what we think are
19 pretty good plant performance characteristics, too.
20 MR. BONACA: So, in part, you're using some of the
21 information you presented in December when we were looking
22 at the risk-based analysis of performance data, right?
23 MR. BARANOWSKY: Yeah.
24 MR. BONACA: That's really the information that
25 you're using.

1 MR. BARANOWSKY: Right.

2 MR. BONACA: I'm asking the question because

3 tomorrow morning we have a presentation, in fact, on that

4 subject.

5 MR. BARANOWSKY: Right.

6 MR. BONACA: The two issues are very much tied

7 together.

8 In fact, you presented this in December as a key

9 element of the other presentation.

10 MR. BARANOWSKY: Right.

11 MR. BONACA: Okay.

12 MR. BARANOWSKY: In fact, the chart that I used

13 that shows the different program elements that we have, and

14 right at the top are risk-based performance indicators, and

15 we'll go over that tomorrow, but all this stuff feeds in

16 there.

17 So, there's a lot of technical work that's on the

18 table that's behind this that we've talked about in the past

19 that I don't want to go over today mainly because what is a

20 risk-based performance indicator needs to be, I think,

21 appreciated, and that was one of the issues that was raised,

22 in fact, as to what is the definition of a risk-based

23 performance indicator.

24 We've changed that definition several times. Now

25 we think we have the right one, and I think it's important

1 that we have the perspective of what we mean by risk-based
2 performance indicators.
3 It's not tracking plant performance at the public
4 risk level, but it's more or less having the logic
5 associated with risk connected to the indicators. Maybe
6 that's the time for me to leave into Steve, who wants to
7 pick up on the balance of the presentation, if that's okay.
8 DR. APOSTOLAKIS: One last question.
9 MR. BARANOWSKY: Okay.
10 DR. APOSTOLAKIS: The work that you will complete
11 or the paper you will complete by July or so -- will that be
12 the final piece of work?
13 MR. BARANOWSKY: No. That's the, I guess I would
14 call it, draft of phase one --
15 DR. APOSTOLAKIS: Okay.
16 MR. BARANOWSKY: -- which Steve will explain.
17 DR. APOSTOLAKIS: Okay.
18 MR. BARANOWSKY: We're going to do this in phases,
19 because it's not so easy to do everything at once, and yet
20 we want to take advantage of what we think is already
21 available for use.
22 DR. APOSTOLAKIS: Okay.
23 MR. BARANOWSKY: Steve?
24 MR. MAYS: Okay. I'm Steve Mays from the Office
25 of Research, and for Dr. Seale and Dr. Kress, let the record

1 show that I am wearing both a coat and a tie.

2 When we met before with the ACRS --

3 DR. SEALE: I'm impressed.

4 MR. MAYS: When we met before with the ACRS

5 subcommittee in December -- and other comments we got from

6 other people that Pat has already alluded to about what do

7 you mean by risk-based PIs, and we've struggled quite a bit

8 on that, whether we wanted to get down and give definitions

9 of reliability and availability and frequency or something

10 more global or something in between, and we've finally come

11 to a decision about trying to have a more global definition,

12 because once we can get some agreement on that, I think the

13 rest of the steps of what you choose or not to choose to

14 have in a particular risk-based PI program become a little

15 more clear as to the rationale for why you do that.

16 So, we've put together a definition in response to

17 that which is a little more global than our previous one,

18 and it says risk-based performance indicators are indicators

19 that reflect changes in a licensee's performance that are

20 logically related to the risk and associated models, and

21 that means, quite frankly, that if I don't have a logical

22 relation between whatever indication I'm measuring and how

23 that impacts risk, it's not a risk-based performance

24 indicator.

25 Now, it may be some other kind of performance

1 indicator, but it's not going to be a risk-based performance
2 indicator, and it's not part of the ones we're going to be
3 working on developing in this process.
4 DR. APOSTOLAKIS: Why did you feel that you had to
5 add the word "and associated models"?
6 MR. MAYS: I think we had to do that to make it
7 clear to people that there had to be a link between what you
8 were thinking about indicating and how that would reflect on
9 risk, and the reason for that is another point that I was
10 going to bring up in the next slide, but I'll bring it up
11 now, and that is, risk-based performance indicators are not
12 something we're doing just for the sake of having risk-based
13 performance indicators.
14 They're things to be done in the context of a
15 regulatory process, and the regulatory process for which
16 they're supposed to be incorporated is the revised reactor
17 oversight process.
18 Part of that process has concepts in there about
19 being able to measure changes in performance that are
20 related to risk in certain, basically, decades of risk
21 contribution, and so, it was important to talk about the
22 models for risk, as well, in order to be able to go from
23 here to something that's part of the oversight process,
24 which is how do you establish thresholds.
25 So, that was the reason for choosing those words

1 that way, and that's why thought it was important to make
2 sure people understood that. That's why we went to the more
3 global definition.
4 DR. WALLIS: So, the indicators represent changes?
5 MR. MAYS: That's right.
6 DR. WALLIS: The indicators are a measure of
7 change?
8 MR. MAYS: That's correct.
9 DR. APOSTOLAKIS: Reflect change.
10 MR. MAYS: They reflect changes.
11 DR. WALLIS: But you actually plot something, and
12 then you have to take the slope of it. You're not going to
13 plot the change itself as the indicator?
14 MR. MAYS: Correct. We will plot performance
15 that, if it does change, we will be able to detect the
16 change.
17 DR. WALLIS: The indicator isn't itself a measure
18 of change.
19 MR. MAYS: That's correct.
20 DR. KRESS: The word "logically" intrigues me.
21 Did you use that purposely instead of "quantitatively"?
22 MR. MAYS: Yes. In fact, we used that instead of
23 "intuitively."
24 I think risk-informed thinking is usually
25 intuitive, in addition to being sometimes logical, but not

1 always logical, and we want to say this will always be
2 logical, and that's the difference between purely
3 risk-informed, where I would draw the line, if you will, and
4 risk-based.
5 DR. WALLIS: Logically would really mean
6 mathematically, quantitatively, rather than by word
7 argument.
8 MR. MAYS: Yes, and I think he's going to show a
9 chart that tells you what we're talking about here, and
10 performance in this context was -- we wanted to indicate,
11 also, when we say what kind of performance we're measuring,
12 we're measuring performances of all aspects of plant
13 operation, as they relate to meeting the cornerstone
14 objectives.
15 So, again, this is within a context of the revised
16 reactor oversight process.
17 MR. BONACA: So, this really includes almost a
18 concept of leading indicator.
19 MR. BARTON: Oh, yeah.
20 MR. BONACA: Right? I mean because you have
21 indirect -- I mean you have areas of activities that you're
22 measuring, and it should give you a lead indication, a
23 leading indication, is something integrated.
24 MR. MAYS: That's correct, and I think that's an
25 important point which I don't have in the slides here, and

1 I'll address it right now if I can.

2 Any time you're collecting data and doing analysis

3 of anything, that data and that analysis is lagging of the

4 particular thing you're measuring.

5 That doesn't make it a lagging indicator, because

6 what we're doing is we're looking at what it is that affects

7 public risk and what are the pieces that contribute to that.

8 So, if I have data and analysis and there's some

9 time period associated with, for example, diesel generator

10 reliability, then that indicator is lagging for diesel

11 generator reliability, but diesel generator reliability,

12 because of the logical model and association, is leading of

13 public risk.

14 MR. BARTON: Right.

15 MR. MAYS: And I think that's a very critical

16 thing that we've had some discussions that have gotten a

17 little confused about.

18 We're talking about disaggregating risk into

19 constituent parts for which, if we have indication at that

20 level, that would be leading of the indication of public

21 risk.

22 So, that's an important piece, too.

23 DR. APOSTOLAKIS: So, the first bullet, then,

24 should read -- I think what you said and what's written

25 there are a little different.

1 These performance -- risk-based performance
2 indicators are indicators that reflect changes, that are
3 capable of reflecting changes.
4 Can you put those words there?
5 MR. MAYS: Certainly.
6 DR. APOSTOLAKIS: In other words, you are not
7 defining what the indicator is; you are defining what the
8 risk-based indicator is.
9 I think that's more accurate than what you're
10 trying to do.
11 MR. MAYS: Okay.
12 So, getting into how we go about developing the
13 indicators -- I'm going to over this somewhat briefly now
14 and in a little more detail later to give you some examples
15 of where this tends to go.
16 So, we've got a -- basically a five-step process
17 of looking at that, and the first thing is to look at the
18 risk-significant key attributes under each of the
19 cornerstones of safety, and there's two figures that come
20 after here that I'll refer to as I go down this chart.
21 Let's put the key attributes chart up, Figure 1.
22 This is an example out of SECY 99-007 for the
23 mitigating system attribute, and you'll see that it is
24 broken up into key attributes, and the concept here is that,
25 if we are able to sample -- and I think it's an important

1 word -- sample performance of the plants under this
2 cornerstone in these areas and come to the conclusion that
3 the attribute areas are being satisfactorily maintained,
4 then we can come to the conclusion that the mitigating
5 systems cornerstone is being maintained.
6 MR. MAYS: So what we need to do in terms of
7 risk-based performance indicators is say which of these key
8 attributes has the largest risk contribution. We need to be
9 able to say that because it's fairly obvious that not all
10 these are going to have exactly the same risk contribution.
11 So, we want to say what are the most risk important
12 contributions under each one of these mitigating system
13 cornerstones, and that's the area we want to go look to see
14 if we can develop indicators.
15 DR. APOSTOLAKIS: So, are you going to develop
16 RBPI's for the most risk significant?
17 MR. MAYS: That's correct. We're going to look at
18 these areas. We're going to determine which were the most
19 risk significant and lay out our logic as to why. We're
20 going to look at see once we do that -- go back to the first
21 slide before that. Once we decide which key attribute areas
22 have the most risk significance, then we say okay, within
23 those, can we gather data and information to be able to put
24 together risk based performance indicators. Then we have
25 several other steps here about identifying the particular

1 indicators that are capable of detecting performance changes
2 in a timely manner and are capable of having thresholds
3 established in accordance with the concepts in 99007.
4 Now, anything that causes us not to be able to
5 fulfill one of those will be a reason why that particular
6 area is not a risk based performance indicator, but the
7 reason we're doing this is to make sure that as we go down
8 here, when we find key attribute areas that are risk
9 significant but for some reason can't -- don't have data,
10 well then you can make a decision. Do you want to go get
11 data or do you want to rely on risk informed inspection
12 activity to cover that part of the cornerstone. Or, if
13 you've got data but you don't have an indicator that
14 provides you timely performance, then that's another aspect
15 of how risk informed baseline and other inspections can be
16 brought into play.
17 So, we're trying to map out under the cornerstone
18 areas the risk significant attributes as well as where we
19 can get to risk based performance indicators because
20 whatever we don't cover with indicators, we have said we
21 were going to indicate for the inspection program what
22 aspects of that cornerstone are important so that those can
23 be emphasized there.
24 MR. BARANOWSKY: Let me just make sure that
25 there's not a misperception here. Go back to figure 1.

1 We're not going to have indicators individually for each of
2 these areas which we did not have when we went through the
3 framework the first time around, but we want to make sure
4 that the indicators reflect performance in each one of these
5 areas. The next figure that Steve's going to talk about are
6 the areas where the indicators are potentially capable, and
7 we have to see how all these attributes would map into those
8 indicators.
9 MR. MAYS: So, the next slide, figure 2 --
10 DR. APOSTOLAKIS: Wait, wait, wait, let's look at
11 this. If I could have a performance indicator at the system
12 level, why would I care about the lower level? I mean,
13 shouldn't there be some sort of a rule added to your slide 5
14 where you say RBPI's are developed by, that says that your
15 initial effort will be to define those as high in the risk
16 hierarchy as you can, and only if you can find it, for
17 example, in this case impossible to come up with something
18 meaningful at the system level or the train level, then you
19 go down to human performance and so on.
20 MR. MAYS: I think that's a good point, and we --
21 DR. APOSTOLAKIS: Well, you were doing that anyway
22 without stating.
23 MR. BARANOWSKY: I think that's a good point.
24 MR. MAYS: We were doing that anyway. I think
25 it's also important because we choose to say I'm going to

1 have a system level indicator, you have to be able to show
2 that the areas that are a part of the oversight process for
3 these areas like design and configuration control are
4 reflected in that indicator. If they're the kinds of
5 performance that wouldn't be reflected in there, then those
6 also have to be covered in some other way consistent with
7 the risk, and so that's why we were breaking it down in that
8 direction.
9 DR. APOSTOLAKIS: But I think it's important for
10 you to emphasize that because that will help also the
11 reactor oversight process. It help to reduce the baseline
12 inspection program. If you make a convincing case that this
13 particular indicator covers a lot of these other things,
14 then there's no reason for us to cover the baseline
15 inspection.
16 MR. MAYS: Well, we have to lay out that logic.
17 MR. BONACA: Well, you have to have a balance
18 there, right? I mean, a balance is how far do you want to
19 make it a living indicator?
20 MR. MAYS: Well, there will always be a baseline
21 inspection that either looks at areas that we don't have
22 good indicators for or that performs some sort of a V in V
23 function to make sure that the indicators are true.
24 DR. APOSTOLAKIS: Right.
25 MR. MAYS: They might be somewhat different in

1 terms of the inspection activities, but we will cover the
2 full thing with the inspection program.
3 Figure 2 is something that you've seen before in
4 various different configurations before, but this gives you,
5 again, what are the elements, the logical elements of risk
6 where an indicator of performance might be related to risk,
7 and you can see in this particular one we have things like
8 sequence level indicators which would be at the higher
9 level, system train and others. When I get to the specific
10 examples later, which you will see later in the package, you
11 will see that we looked at, for an example plant, that there
12 were some that we chose to use system level indicators and
13 some that we were looking at train and other things, so
14 you'll see some of that a little bit later one.
15 DR. APOSTOLAKIS: But again, here you may be
16 sending the wrong message. Maybe you want to work a little
17 bit on the right-hand side column there because that sends
18 the message that there will be indicators at each level, and
19 basically what we just said is that if you manage to get one
20 for the sequence level, the others are not needed unless
21 there is a special reason. I think that logic has to become
22 transparent.
23 MR. MAYS: Yeah, and that's true, but what we know
24 from our past experience is that we're going to have to go
25 down a fair amount in order to get responsive indicators.

1 DR. APOSTOLAKIS: Right.

2 MR. MAYS: We think we're going to be between the
3 two solid bars mostly.

4 DR. APOSTOLAKIS: Yes.

5 MR. MAYS: But we might be below that bar on the
6 bottom. Now, the reason these will be risk based is all the
7 information that goes in there is going to be folded through
8 some sort of a risk model as opposed to saying I'll count up
9 human errors and ten is too many, 14 is way, way too many.
10 We don't do stuff like that, okay, but it could be some
11 human error things or whatever where there is more data
12 density because it's more responsive. Then it could be
13 rolled up into higher and higher levels of information.

14 DR. APOSTOLAKIS: I have a question, it just
15 occurred to me, that relates also to the definition. There
16 seems to be, you know, out there near unanimous consensus
17 that having a learning organization is very important, and
18 the key thing there is to have feedback from operating
19 experience, both yours and other people's and use that in a
20 meaningful way.

21 Now, let's say you go to a plant, and there isn't
22 such a formal mechanism for learning, is that an indicator
23 of some sort, or in your definition, it does not?

24 MR. MAYS: I'm sure it's an indicator of some
25 sort. The question is, for our purposes, would it be a risk

1 based indicator inside the concepts of the revised reactor
2 oversight process. In order to make that connection, you'd
3 have to say failure to be a learning organization would be a
4 causal factor that would lead to something else, which would
5 then be related to risk. So, you would have to make that
6 kind of an argument and be able to show that what you were
7 measuring at the learning organization definition level, if
8 there was such a thing, had a cause and effect relationship
9 to get to something that you would be able to relate to
10 risk.
11 So, that's the difference between have an
12 intuitive thing that says, you know, if you have a good
13 staff you'll do good work and if you have a poor staff
14 you'll do poor work, to say what kind of a poor staff
15 constitutes and is logically related to equipment
16 performances or other things which we know will affect risk.
17 DR. APOSTOLAKIS: So things that may have an
18 impact on risk but have not been quantified would not
19 qualify for you to provide a performance indicator, a risk
20 based performance indicator?
21 MR. MAYS: That's correct.
22 DR. APOSTOLAKIS: The proper place would be
23 perhaps a baseline inspection or somewhere else. Okay,
24 that's a good clarification.
25 MR. BONACA: Okay, but I thought that however,

1 it's clear at the performance level if you had a number of
2 situations where you have a train level indicator failure or
3 branch failure and then you have another basic event level
4 indicator and the system level, and all three correlate to
5 below the line on failure over the experience, then at the
6 specific level, I guess the inspection process would throw
7 out that conclusion.
8 MR. MAYS: That's a good point because part of
9 what you're talking about is basically causal factors.
10 MR. BONACA: Right, exactly.
11 MR. MAYS: So, if the causal factors is a learning
12 organization, we do have in the oversight process inspection
13 activity aimed at problem identification and corrective
14 action programs. So, if you were to see that not being a
15 learning organization, for example, was causing you to have
16 problems in these areas and you had a problem in your diesel
17 generators and a problem in your HPI system and a problem in
18 your such and such, and those all had the same common cause,
19 that would be a basis for part of, Pat said, verification
20 and validation, and say do I have a corrective action
21 program that's capable of being identified and corrected in
22 these programs because that's what I have to have in order
23 to be confident that these PI's are telling me what they're
24 supposed to be telling me.
25 Also, the residents and the region folks would

1 then be able to say, based on this information, these are
2 the areas I need to inspect to make sure that that
3 supporting feature is being maintained.
4 DR. APOSTOLAKIS: In figure 2, wouldn't it be more
5 consistent with what you said earlier, to replace the tier
6 labeled sequence level indicator by the cornerstones?
7 MR. MAYS: I don't think it's quite that clean
8 because if you look underneath there in the sequence level
9 indicators, that gets input from both initiating events and
10 system reliabilities, and in the oversight process,
11 initiating events is its own separate cornerstone from
12 mitigating systems. So, they start to mix together in a
13 risk model a little bit differently than they're broken out
14 in the oversight process, so I'm not sure that that would be
15 --
16 DR. APOSTOLAKIS: Well, but you said that you
17 wanted to support the revised reactor oversight process, and
18 that's what they do. That's what you should do, too, I
19 mean, provide them with indicators in the initiating event
20 cornerstone because now -- I mean, they have four, I think.
21 In addition to the two you have there, initiating events and
22 system reliability, availability --
23 MR. MAYS: It's seven, actually.
24 DR. APOSTOLAKIS: -- but you expanded this a
25 little bit. Anyway, they also have the integrity of the --

1 MR. MAYS: Containment.

2 DR. APOSTOLAKIS: -- pressure boundary.

3 MR. MAYS: Barrier integrity, and they have

4 emergency preparedness and security and safeguards and --

5 DR. APOSTOLAKIS: I don't know that you want to

6 get into that, but the boundary, for example, might be

7 important. I mean, you know that you're not going to get

8 any indicators of the health effects level. I mean, you

9 know that the core damage frequency, although that might be

10 an indicator. Maybe that will be your global indicator.

11 MR. MAYS: When we talk about the integrated

12 indicator, that's the reason that was put at that level.

13 DR. APOSTOLAKIS: That was a secret in the plan.

14 MR. MAYS: Now, this is spelled out very clearly.

15 DR. APOSTOLAKIS: I don't think it is. I don't

16 think it is.

17 MR. MAYS: The integrated indicator talked about

18 having indications of core damage frequency which involved

19 two cornerstones rather than one, so that was why it wasn't

20 broken out separately.

21 DR. APOSTOLAKIS: I think you should think about

22 it.

23 MR. MAYS: Okay.

24 DR. APOSTOLAKIS: Maybe the cornerstone should be

25 there, and then the other stuff you want to do should be in

1 a separate figure because now we can start arguing why do
2 you have the containment failure, health effects, and core
3 damage frequency on the same level when first you have to
4 have core damage and then containment and so on. But also,
5 you said that you want to support the revised process, so
6 that's what they do. That's what you should do, too, but
7 then you go beyond that and integrate, which is a good
8 point.
9 MR. MAYS: Okay. The next --
10 DR. APOSTOLAKIS: No, wait. Now, if I go to the
11 very bottom, according to what you said earlier, you will
12 not have performance indicators for QA, right? You will not
13 have performance indicators for safety culture because these
14 things are not quantified in the PRA.
15 MR. MAYS: No, that's not what we said.
16 DR. APOSTOLAKIS: I thought that's what --
17 MR. MAYS: What we said was you had to have a
18 logical connection to the risk in associated models. I
19 didn't say you had to have a detailed model of QA or that
20 relates in the PRA. It says I have to make a logical
21 connection between what I might measure in QA and how I
22 might put that into a risk model, so I have to have a
23 logical connection there that people will agree to that yes,
24 this thing measures QA and those changes in QA can be
25 expected to be manifested in these areas of the risk model.

1 DR. APOSTOLAKIS: But you also said, Steve, that
2 things that are not in the PRA you will not develop
3 performance indicators for --
4 MR. MAYS: No, I think what I --
5 DR. APOSTOLAKIS: -- and QA is not.
6 MR. MAYS: What I -- I didn't --
7 DR. APOSTOLAKIS: You're taking it back?
8 MR. MAYS: No, that's not what --
9 DR. APOSTOLAKIS: Because we can do that.
10 MR. BARANOWSKY: The only thing we said, it has to
11 be logically connected to risk and the models.
12 MR. MAYS: Right.
13 MR. BARANOWSKY: We didn't say it has to be an
14 existing model.
15 MR. MAYS: Right.
16 MR. BARANOWSKY: We have the right to logically
17 connect it as long as peer review says that's a reasonable
18 thing to do. Now, what we're not going to do is figure out
19 advancing the state of the art in PRA and how to relay QA
20 actions to equipment performance, but if we can figure out
21 what kind of information to collect and it looks practical
22 and useful on QA or anything else and relate it through
23 these models, it would probably be cause/effect kinds of
24 things.
25 DR. APOSTOLAKIS: So, if I could make an argument

1 that the learning organization effects positively the human
2 performance of a plan, then you would say yeah, maybe we can
3 find the performance indicator for it.
4 MR. BARANOWSKY: Yeah, in fact, usually the way we
5 do that, we get knowledgeable people together and we say
6 well, how does that happen? They'll say well, this doesn't
7 work and that causes that to happen. So, we start to work a
8 progression and therefore a model.
9 DR. APOSTOLAKIS: Well, then I misunderstood.
10 MR. MAYS: Okay. The next slide talks about how
11 these fit in the reactor oversight process. I'm not going
12 to go over all the details on those right now. This is
13 really basically a what should risk based PI's be able to do
14 kind of slide. It's a test when you get down to the end to
15 say am I able to do these things with this risk based PI as
16 an intended consequence.
17 DR. POWERS: Could you explain better to me the
18 second bullet?
19 DR. APOSTOLAKIS: I was about to do that.
20 MR. MAYS: Risk based PI's should cover all modes
21 of operation.
22 DR. POWERS: Does that mean each has to cover
23 everything or that you should have a set that covers
24 everything?
25 MR. MAYS: Again, going back to the first concept

1 of sample, when I say covers all modes, it means in each
2 mode of plant operations, we should try to have some risk
3 based PI's that covers that particular area. So, we're
4 going to look at shutdown. We're going to look at fires or
5 external events, so those are the kinds of things we're
6 going to be looking at to see where we can put together risk
7 based PI's. We're not excluding --
8 DR. POWERS: So what you're saying is that you
9 have to have a set that covers all modes of operation, not
10 that each one covers?
11 MR. BARANOWSKY: Right.
12 MR. MAYS: That's correct.
13 DR. POWERS: I'll be fascinated to hear how you're
14 going to find -- well, I'm adequately informed. I know from
15 the past --
16 MR. MAYS: And so are we.
17 DR. POWERS: -- that you have superior shutdown
18 models that everything we need. So, hey.
19 DR. APOSTOLAKIS: Hey, go back a screen. Can you
20 elaborate a little bit on the last bullet?
21 MR. MAYS: Okay. Risk based PI should be minimal.
22 Establish plant specific thresholds consistent with revised
23 reactor oversight process. Again, as I said before, we're
24 not doing risk based PI's just for the sake in doing them.
25 We're doing them to be able to be part of a regulatory

1 process which is the revised reactor oversight process. We
2 want to be able to put together to the extent possible plant
3 specific thresholds that reflect the risk at that particular
4 plant for that particular performance change, and to do
5 those consistent with the -- right now the decades of risk
6 color scheme that's in the green, white, yellow, red scheme
7 that's in the revised reactor oversight process.
8 If we are unable to do that, then that would make
9 that not a candidate for a risk based performance indicator.
10 As you'll see when we get down in here later, one of the
11 things we're looking to do in the industry-wide performance
12 measures is for things for which we can't do plant specific
13 performance indicators. Perhaps we can do industry-wide or
14 group trends, which is another piece of the feedback
15 mechanism into the oversight process.
16 MR. BARANOWSKY: Well, I think there's one more
17 aspect to that, and that is if we have a sort of a global
18 indicator that is not capable of reflecting significant
19 differences in plant risk, then we would take that indicator
20 and make it into two or three slightly different ones that
21 can reflect plant differences in order to put the risk
22 context proper for different plant designs. So, the simple
23 example we always use is two, three or four diesel
24 generators, how do you want to treat those, especially if
25 you were at the system level. You would have different

1 system reliability parameters that would be acceptable in
2 the different color schemes that we have for the thresholds.
3 MR. MAYS: Next, the benefits we hope to bring the
4 revised reactor oversight process with this effort is to
5 first get reliability indicators at the component system and
6 train level. That will do two things. One, it will be a
7 greater coverage of risk perspective in each of the
8 cornerstones than we currently have, and because of both the
9 breadth of coverage of those and the nature of them, some of
10 them being at the component level, would give us more
11 indication of cross-cutting issue performance. Those are
12 two things that have been discussed with the ACRS, at the
13 meetings with the industry and public interest groups.
14 We're trying to scratch that itch by giving us a little more
15 capability in that area.
16 We're also looking to provide shutdown and fire
17 events. Again, the key words in the bullet is consistent
18 with the available models, data, and methods. What we're
19 not going to be doing in this particular program is going
20 out and defining the definitive shutdown risk model for how
21 to model risk of shutdown at all the plants. We're not
22 going to be doing that in this program. We're going to take
23 the insights and the information from existing risk models
24 as our basis for saying what's the important areas and what
25 areas should we be looking for, and develop indicators from

1 that.

2 DR. POWERS: Am I understanding the shutdown

3 models, we've got everything we need?

4 MR. BARANOWSKY: No, what he's saying is, in fact

5 --

6 DR. POWERS: I heard management talked to the

7 Commission, said that they have all the tools they need in

8 this area.

9 MR. MAYS: I can't comment on that specifically

10 because one, I wasn't there and two, I didn't make the

11 comment, but I do think there is significant discussion

12 within the agency and within the commission about what the

13 shutdown risk levels are and what level of information you

14 need to --modeling you need to have to understand them and

15 deal with them in a regulatory atmosphere. The point I

16 wanted to make here is that what we're not going to be doing

17 is going out and getting the definitive shutdown risk

18 models. We're going to take whatever is extant and try to

19 use that in a logical way to extent that we have models and

20 information. So, we're not going to be developing the new

21 models. We'll be developing risk based PI's consistent with

22 our current understanding.

23 MR. BARANOWSKY: Including our understanding of

24 what their limitations are. That's the part that I think is

25 important. So, if after we go through this and have a

1 review of the shutdown models, we determine that they have
2 significant limitations, then that has to be addressed
3 through other elements at a revised reactor oversight
4 process, namely inspections.
5 DR. POWERS: Yes, as far as I know, that must be
6 great. There's certainly no reason to pursue this any
7 further --
8 MR. MAYS: That's good to hear.
9 DR. POWERS: As I understand it.
10 MR. MAYS: That's good to hear.
11 DR. POWERS: That was news to me.
12 MR. MAYS: Okay. The other thing which was an
13 ACRS concern that was raised and other people raised the
14 concern, was about the thresholds and the current reactor
15 oversight process not being plant specific. We're going to
16 endeavor to make plant specific thresholds, and as we cited
17 in the oversight paper, we're not going to be making plant
18 specific thresholds just for the sake of doing it. If you
19 have 10 or 15 indicators at every plant and you have 103
20 plants, you can quickly figure out how many thresholds you
21 have, especially if you have four bands.
22 So, we're not interested in putting together 5,000
23 new thresholds, all of them unique and individual. That
24 just doesn't make much sense. So, what we're trying to do
25 is make thresholds that are consistent with how much risk

1 contribution those things make and again, we gave the
2 example before about plants with two diesels versus plants
3 with four diesels, things of that nature.
4 DR. APOSTOLAKIS: But the question of whether you
5 have to do it is really an open one. I mean, if you develop
6 a process here that, you know, after the review and
7 everything people say well, this is reasonable and then you
8 come back and say well, gee, you know, I can't develop 5,000
9 of these numbers. I'll do the best I can. Maybe I'll group
10 the plans, I'll do this, but you, Mr. Licensee, if you want
11 to do better, take my method and come back and give me more
12 specific numbers.
13 MR. BARANOWSKY: Yes, but I don't think people
14 will want to do that.
15 DR. APOSTOLAKIS: Well, you never know. You never
16 know.
17 MR. BARANOWSKY: Well, that's why we're going to
18 have a lot of interaction over the summer.
19 DR. APOSTOLAKIS: If there is benefit to them
20 doing it, they will do it.
21 MR. BARANOWSKY: Yeah. We're not really closing
22 the door here, but our intent is not to have people nervous
23 about having this broken down so finely that it takes an
24 army of people to manage it.
25 DR. APOSTOLAKIS: Sure.

1 MR. MAYS: As we alluded to earlier, we're going
2 to try to put together an integrated indicator to identify
3 changes in multiple performance areas. One of the things
4 that the ACRS raised was that the thresholds as they're
5 current set are based on that one parameter changing and
6 everything else being in its nominal value. We think
7 there's some benefit to putting together a model that would
8 allow us to be able to reflect changes in multiple
9 parameters as they occur. So, that's part of our phase 2
10 work, but that's one of the concepts we wanted to have on
11 here, and that was the reason for the sequence level
12 indication on the previous chart.
13 DR. APOSTOLAKIS: Which is really the great
14 strength of a PRA. I mean, that's what you're saying, let's
15 go back to the PRA.
16 MR. MAYS: Well, again, the example I used back in
17 August of '95 with the Commission was what if your diesel
18 generator reliability is not as good as it was before in a
19 BWR, but your loss of off-site power frequency has gone down
20 and your RCSI and your HPSI are very reliable and you've
21 increased your battery capacity from four hours to eight
22 hours. Well, the fact that your diesel generator
23 reliability went down may not be that significant in light
24 of those things, or, if it went down and all those other
25 things were going down, too, well then now you have a bigger

1 problem than you see with any one of them individually, and
2 that was the reason for wanting to put together something in
3 an integrated fashion.
4 The last one on here, the trending and risk
5 significant performance, this is an important piece not only
6 because it provides feedback mechanism and general
7 perspective for the oversight process. We also have a
8 strategic plan to report to Congress on our performance and
9 monitoring and one of which has no statistically significant
10 adverse industry trends and safety performance. So, this is
11 intended to also satisfy those kinds of concerns.
12 DR. APOSTOLAKIS: There are two methodological
13 issues I want to raise, and I see that we are really talking
14 about the value and so on later, so maybe this is just as
15 good a place as any
16 One is a question that was raised by this
17 Committee way back when we were talking about -- before
18 1174. The question is how much analysis or how many -- what
19 kind -- how much processing of the numbers, the raw data
20 that you are getting from the plant would you be allowed to
21 do before you produce a number for the performance
22 indicator? An extreme is to say well, gee, my performance
23 indicator is the core damage frequency, and the answer to
24 that is no, it can't be because there are so many
25 calculations you have to do from the plant specific data and

1 so many judgments that it is useless as an indicator. It's
2 perhaps useful -- not perhaps, it is useful as an integrator
3 but you don't call that a performance
4 indicator in this sense.
5 The other extreme is what we do in the
6 maintenance. We calculate our -- I mean, we measure hours,
7 we count hours. It's up or down and then we divide, you
8 know, divide the number of hours it was unavailable by the
9 bottom, a very simple mathematic calculation. Now, in
10 between there is a lot of stuff. How far would you allow
11 people to go, or in your world, would you be willing to go?
12 Is it only addition, subtraction, division, and
13 multiplication that would be allowed? Would you say well,
14 gee, you know, this is a simple model but everybody accepts
15 it, so the indicator should be the output of the model, you
16 know, given certain inputs from the plant? I don't know,
17 but this is a practical question, I think, that will come up
18 time and time again.
19 MR. MAYS: It is a practical question, and we're
20 working on that right now. That's one of the reasons, as we
21 stated earlier, for wanting to lay this logic out. The
22 logic is we want to have these things related to risk at a
23 level for which we can get data and a level for which we can
24 detect performance changes in a timely manner and at a level
25 in which we can produce thresholds that are consistent with

1 the oversight process. Those criteria will dictate to us
2 what kinds of methods we have to use.
3 Now, we've already in previous discussions, we've
4 shown the ACRS and the Commission and the world the kinds of
5 things we felt were necessary to come up with realistic
6 estimations of reliabilities, of trains and things in our
7 system studies and our component studies. I envision that
8 we will use similar techniques in the risk based performance
9 indicators, and that means there will be some analysis of
10 this information in order to be able to come up with
11 meaningful results. When I say analysis, I mean mostly
12 likely some sort of Bayesian updating process. That's why
13 it's so important to us to get the data from the industry,
14 in a larger sense, so you have a basis for how you're
15 constructing priors and how you're doing updates.
16 Now, once you have that kind of information on the
17 table and people can see the efficacy of the indicators by
18 their ability to meet these goals, then the actual
19 calculational things is really straightforward after that in
20 terms of once we agree that we're going to use a prior with
21 this much data in it calculated this way and an update
22 period of X numbers of years with these kinds of failures
23 and demands, the mathematics after that is fairly
24 straightforward. The real issue is gathering together
25 mechanisms to do analysis that meet these objectives, and

1 once we meet the objectives, whether we do it or whether
2 utilities do it, that's an open question, but we're not
3 intending to make it so complicated that only five PRA gurus
4 in a smoke-filled room can do this. We're trying to make it
5 so that it has some transparency --
6 MR. BONACA: But it seems to me from where you're
7 going, I mean, and what we heard in December, is that the
8 EPIX database will give you really information literally at
9 the maintenance level for all those components. So, the key
10 issue is, is the industry going to be conscientious in
11 putting all this information, I mean, because I understand
12 this is a voluntary reporting system. So, that's an issue
13 we need to discuss at some point. If you're going to rely
14 on that information, I have to make some other judgments
15 here.
16 MR. MAYS: Right, I agree with you, but the
17 question I think that George was asking was about what kind
18 of mechanisms do you assemble that data. There are two
19 issues. One is that you have to have data that gives you
20 good information and is part of V and V. You can verify it
21 that it's giving you the right information that's
22 appropriate for giving you the indication you're trying to
23 calculate. I think George's question was what kind of
24 methods do you use for calculating the indicator, something
25 really simple, something a little more complex, and my

1 answer to that is it really doesn't matter to me whether
2 it's simple or a little more complex, so long as it meets
3 the objectives. Now, obviously if you can use a simple
4 means and meet the objectives as opposed to a complex means,
5 you go with the simple one.
6 DR. APOSTOLAKIS: Yes, but if it's complex, you
7 may not have wide acceptance.
8 MR. MAYS: That's a potential thing we have to
9 deal with, and part of what we're going to do is put
10 together of what our concept is of what it takes to do these
11 indicators to meet these goals, have interactions with you
12 and with industry and public citizens and other people and
13 say all right, this is what we think the indicators ought to
14 look like and how they have to be done and how they ought to
15 be communicated, and we'll get feedback from them and we'll
16 find out where we go from there.
17 MR. BONACA: That's why I made that comment,
18 however, because I wanted to say that in the spectrum that
19 George was pointing out to from CDF to maintenance rule,
20 supposedly you're getting a database that would give you --
21 you could go all the way to the maintenance rule criteria
22 for some specific important piece of equipment. I'm saying
23 that you have a lot of flexibility there.
24 MR. BARANOWSKY: Well, that's going down -- you
25 could do that. We could go to a really low level of

1 information and by knowing its relationship to risk, we
2 could say, we could bean count things if you want. I don't
3 think we want to go to that level because then you're going
4 to have a very custom approach for bean counting at every
5 plant, and it will not be clear unless you run it through
6 the models, of what the implications are of going over the
7 bean count two or three dots. So, we have to figure
8 something out in between for a balance to be struck.
9 DR. APOSTOLAKIS: If we go to the proceeding
10 slide, there is an example, I think, of what we're talking
11 about. The bottom bullet -- yeah -- says that you will look
12 at common gross failures, right, the very last two lines,
13 slide 9.
14 MR. HAMCEHEE: Trending of risk significant.
15 MR. MAYS: Oh, okay.
16 DR. APOSTOLAKIS: Now, as you know very well, what
17 is a common cause of failure or potential common cause of
18 failure is not always agreed upon. We have to make
19 judgments. You know, you caught it in time and it could
20 have failed the other component and so on. So, I was
21 wondering how a performance indicator can be created for
22 that kind of event when there is judgment all over the
23 place, disagreement and so on.
24 MR. MAYS: Well, I think for the common cause
25 failure example, I think we've done enough work in the

1 common cause failure area and gathered enough data to pretty
2 well conclude that it is unlikely that common cause failure
3 would be an individual plant specific indicator. So, what
4 we're talking here in the trending is we have a pretty well
5 defined definition of common cause failure and how you code
6 it as part of the common cause failure database work that
7 we've been doing, and we've put together trends in that, and
8 we'll show you some of those a couple of slides later.
9 So, the issue here is can we give some indication
10 on the industry level about where something has happened,
11 and the definition of what we mean by common cause failure,
12 I agree, it has to be clear and has to be understood so that
13 the insight one would draw from that trend would be a
14 correct insight as to what the safety program is doing or
15 not doing. In all these cases, the definitions of what
16 these particular indicators are and what the trending
17 indications are have to be clear so that people will be
18 clear as to what inferences to draw from them.
19 DR. POWERS: I think that's one of the issues of
20 trending, is drawing the right inference, is a very
21 important one. I see lots of plots of pieces of industry
22 data in which somebody's put a straight to -- fit it to a
23 straight line and even put some error bounds around it,
24 confidence bounds around that. When I look at the data
25 underlying it, it appears to me that there are maybe

1 processes involved, one of which clearly has this downward
2 trend that they're proud of, but there seems to be one that
3 has -- it's not a straight line. Maybe it's a cyclical
4 behavior in there. Are you looking at more complicated
5 trending, more time series analysis than just the straight
6 line sort of things? I believe you even have an example of
7 some trends in here and which did show the five year cycle.
8 MR. BARANOWSKY: Yeah, I think most of the work
9 that we're doing on trending is not looking for anything too
10 sophisticated, but the key to doing it correctly is to have
11 the up-front definitions of what counts in the data that
12 goes into the trends so that one can then go back and given,
13 the trend, ask yourself does it have a statistical
14 significance and does it make sense from an engineering
15 point of view. I mean, we do that on every single trend
16 activity that we do. Those answers have to make sense to us
17 together.
18 So, the important thing for us in trending is not
19 whether it has some interesting dips and dives to it because
20 we're not trying to look at really fast moving changes in
21 these things normally.
22 DR. POWERS: Well, what if the dips and dives in
23 it is indicative of another mechanism? I mean, yes, for the
24 last ten years you've had a downward trend, but you have
25 this other mechanism going on and once you get down a little

1 bit, suddenly that becomes the dominant trend, and so you
2 have these cycles.
3 MR. BARANOWSKY: Well, I think you can see the
4 cycles in some of the plots, and that's when we go into the
5 causal factors, if you will, that are behind the ups and
6 downs as opposed to doing a statistical analysis, and so
7 maybe we're saying the same thing.
8 DR. POWERS: Maybe we're saying the same thing.
9 MR. BARANOWSKY: We're trying to analyze the data,
10 not just mathematically but also, you know, functionally, if
11 you will.
12 DR. POWERS: Well, I mean, there are some criteria
13 that these people are -- to do things like time series
14 analysis on the stock have for when the dips and dives
15 actually count and when they're just random variations.
16 MR. BARANOWSKY: Right.
17 DR. POWERS: They do more sophisticated than
18 straight lines.
19 MR. BARANOWSKY: Right. There are statistical
20 techniques like doing the fast Fourier transform, finding
21 the underlying frequency of changes, doing the filter and
22 see how much that for other -- we're not doing those kinds
23 of applications in here. We haven't seen that kind of
24 fluctuations. The one example I would give with respect to
25 what you were talking about, when we did the ASP results, we

1 shared with the Commission as well as with the ACRS, and we
2 bend the frequency of ASP precursors according to their
3 orders of magnitudes -- you know, 10 to the minus 6 is
4 fives, fours. We found, you know, decreasing trends on all
5 of those except for the ones greater than 10 to the minus 3.
6 We saw that case where we didn't have a significant trend,
7 where we saw it would be up one year and none for a few
8 years and then up for a year.
9 What we did is we went back and looked at that and
10 said we can't fit a trend line to this particular area, and
11 furthermore, we went back and looked at what the
12 contributions were and we found that in the ASP report that
13 the 10 to the minus 3 type ASP precursors were occurring for
14 unrelated reasons. There were no common threads between
15 them, and that gave us the idea that maybe this is just the
16 random level of occurrence that that particular thing
17 happens because there were no particular commonalities among
18 those.
19 So, I mean, that's the kind of things we do but we
20 haven't found the need to go into that level of
21 sophistication on trends.
22 DR. APOSTOLAKIS: Speaking of that, that leads me
23 to the second point I wanted to make. I think you have to
24 develop some way of discriminating between random aleatory
25 occurrences of something and true changes in the

1 unavailability or whatever quantities of the epistemic type
2 because that's really what you want to know. You don't want
3 to know that for some random thing this unavailability goes
4 up for a short period of time. Now again, in quality
5 control, they have ways of handling that, and I think you
6 ought to spend some time thinking about doing something
7 similar or analogous to make sure that what you are -- the
8 changes you refer to in the definition were real changes and
9 not just something random.
10 MR. MAYS: Right.
11 DR. POWERS: I think that -- I think quality
12 control may not be the right discipline. I think it's
13 really time series analysis.
14 DR. APOSTOLAKIS: Okay, the mathematic -- well, in
15 quality control, they worry about that.
16 MR. MAYS: right.
17 DR. APOSTOLAKIS: You know, did they see three
18 defectives because of some random thing or is it and
19 underlaying cause?
20 MR. MAYS: Some systemic cause.
21 DR. APOSTOLAKIS: Yeah, systemic cause, that kind
22 of thing. Now, whether there are more sophisticated
23 methods, sure there are, but I think you have to address
24 that issue.
25 MR. MAYS: Well, that's an issue that's going to

1 come up when we talk about setting performance thresholds,
2 and one of the goals we had in the white paper was about the
3 false negative, false positive rate, which is somewhat along
4 the same lines as when you see variations in your quality
5 control, is it random or systemic.
6 DR. APOSTOLAKIS: Right --
7 MR. MAYS: Those are issues that deal with the
8 fact that the kinds of things we're going to be measuring
9 here are quantities that have some uncertainty associated
10 with them. Whenever you have a quantity with some
11 uncertainty and you set some sort of bright line limit,
12 you're always going to have that kind of a problem. I think
13 the approach taken in the oversight program is to take a
14 graded approach to response to each one of those areas so
15 that you don't have to be that terribly precise at, say, the
16 green, white interface. What you have to be precise about
17 is the fact that you're not indicating green when it's
18 really red or that you're not indicating red when it's
19 really green. That's more along a how precise do you need
20 to be kind of argument, and we'll talk about that in a
21 little bit.
22 DR. APOSTOLAKIS: Okay, so this is something
23 you're going to address?
24 MR. MAYS: We are thinking about that.
25 Let me put up, instead of the next slide, let me

1 go to the picture here because I think I want to talk --
2 DR. APOSTOLAKIS: How much time do we have? We
3 started a little late, and we're supposed to finished at
4 2:45.
5 DR. POWERS: Why don't you go ahead and take
6 another half hour?
7 MR. MAYS: Okay, let me go to figure 3 here and
8 we'll talk about some of the issues that are in some of the
9 intervening slides here. This picture was put together to
10 try to come up with a simple way to see where we are and how
11 this activity would fit in the reactor oversight process.
12 If you look at the bottom of the slide, you see there's a
13 lot of information that comes out of plant performance.
14 Some of that goes into the current reactor oversight PI's,
15 some of that goes into the information for the risk informed
16 baseline inspections. In the current process, information
17 going through the current PI's is compared to a threshold
18 value. If that change in performance is determined to be
19 significant, that information goes up into the action
20 matrix. If it's not, then it goes back into the plant's
21 corrective action program.
22 Similarly, with the inspection program, we have
23 inspection findings. Those inspection findings go through
24 the significance determination process. If they're found to
25 be significant, then those things go up into the action

1 matrix. If not, then they go back into the corrective
2 action programs. That's kind of the existing way that the
3 oversight process is designed to work.
4 DR. APOSTOLAKIS: This is your figure or theirs?
5 MR. MAYS: This is ours. So, what we're trying to
6 show in the bold areas is where the new things in part of
7 the risk based indicator program will potentially impact and
8 interact with that process. So, the first thing you see at
9 the bottom right-hand side is data information in terms of
10 EPIX and the rad systems. We're getting more information
11 through the EPIX information than we currently had available
12 in the past with LER's alone. That's being put together in
13 the RAD system to combine LER, monthly operating port, other
14 information, which will be the basis for our calculations
15 for the risk-based PI's
16 What we're showing here is that in a similar way
17 to the current PI's, risk based PI's will be compared to a
18 threshold and then have the opportunity to go into
19 significance and the action matrix. Over time, we would
20 anticipate the risk-based PI's and the current PI's would
21 basically be merged into one set so that that complication
22 in the drawing would eventually go away.
23 Coming out of the risk based PI's, there are two
24 key things that we talked about a little bit. One was the
25 integrated performance indicator, which was to say what was

1 the overall effect of these things potentially happening
2 concurrently, and that would involved not only the
3 indicators but also information from the inspection programs
4 as well.
5 We also have a block to show the development of
6 the industry trends and insights, and the key thing here is
7 that it provides a feedback mechanism to go back into your
8 risk informed baseline inspection or into your reactive
9 inspections at areas where you don't have necessarily a
10 plant specific indications and say okay, are my loss of
11 feedwater frequency or my steam generator tube rupture
12 frequency or my other things that I know to be risk
13 significant on the whole going up, down or sideways and
14 therefore, do I need to affect the frequency or the nature
15 of the kinds of risk informed inspections I do as I sample
16 the performance in those parts of the cornerstone.
17 So, that's kind of our concept of what we're going
18 to be doing and where these things fit.
19 MR. BONACA: Before you go forth, however, again I
20 keep coming to that because when I look at this process, the
21 foundation to it is data.
22 MR. MAYS: That's correct.
23 MR. BONACA: Now, the LER's, you know, you have
24 plenty of LER's out there, but it's always been skewed
25 information because certain data do not get reported just

1 because of regulatory quality or aspects of the information.
2 If you have a single train failure in a multiple train
3 system, it doesn't get reported.
4 MR. MAYS: Right.
5 MR. BONACA: It's a failure that doesn't get
6 counted.
7 MR. MAYS: Right.
8 MR. BONACA: Now, the only question I have, now
9 the EPIX system is going to provide ten times more
10 information than the LER system. However, again, I go back
11 to the issue, how do you deal with the fact that some of
12 this information still is voluntary? Therefore, some people
13 will not report it, or they will choose to report what they
14 want to report.
15 MR. BARANOWSKY: Tell him about the INPO.
16 MR. MAYS: Yeah, I think there are two things on
17 that. When we say it's a voluntary reporting system, I
18 don't think it means I report it if I feel like it. The way
19 this has been set up is that the EPIX system was put
20 together and proposed by the industry to the Commission as
21 an alternative to the reliability/availability data rule.
22 There was a commitment made that there was information that
23 would be put together to support giving the agency
24 information to move forward in risk informed regulations,
25 and there are definitions and processes and QA things that

1 are being put in place in that system so that we'll be able
2 to tell whether we're getting the right information. That's
3 part of the validation and verification phase as well.
4 Now, in addition, there has been a task force put
5 together through NEI with the agency and INPO to look at on
6 a more global level what kind of data and information ought
7 to be presented to the agency, what's the most efficient
8 ways to get it, what is the information going to be used
9 for, those kinds of things, so that we have a consistent
10 understanding of what this information is, what it's used
11 for and what the basis for it is so that we will get quality
12 voluntary reporting.
13 Now, if we don't get -- if we find the plant is
14 not doing that information or isn't producing, we'll have to
15 make up for anything we can't get from a data standpoint
16 through inspection. So, that's kind of the regulatory
17 hammer, if you will, that if you don't want to provide
18 information, then you have to be subjected to more
19 inspection.
20 MR. BONACA: Okay, but it's still an open issue.
21 We discussed this in December, and you recognized that you
22 had a concern yet -- and there were ways to close that issue
23 but I think, you know, we'd like to hear about it, maybe
24 tomorrow morning because I mean, it's very important. This
25 EPIX system is the foundation of much of what you're doing

1 right now in this area.

2 MR. BARANOWSKY: Yeah, why don't I cover that

3 tomorrow morning because I can tell you about some of the

4 interactions that we're having.

5 MR. SEALE: In that regard, though, if you have a

6 case where you have an -- I shouldn't say insufficient -- an

7 incomplete reporting from the particular plant, it seems to

8 me that that's a caveat that you can put on the quality of

9 the answer that you get, and to make that work, if you do

10 have a lack of data from the plant, that ought to be part of

11 the record for that plant, that you don't have that data.

12 Therefore, my answer is incomplete. Treat it with a grain

13 of salt.

14 MR. BARANOWSKY: You have the same issue with the

15 current set of performance indicators. It's voluntarily

16 provided information, and there's an approach to dealing

17 with when that information is not being provided. We

18 wouldn't change that approach. It's just that there's some

19 additional information being provided for this particular

20 set of indicators, but the rest of it is the same. We're

21 not going to a new regulatory approach.

22 DR. APOSTOLAKIS: Now, your impact on the process

23 should be more than you're showing there. It seems to me

24 that as you define RBPI's, there should be an impact on the

25 baseline inspection. As we said earlier, I mean, as you

1 defined those and you say this is what's covered here, then
2 maybe these guys should eliminate some of the areas the
3 inspect.
4 MR. MAYS: Let me go to what we talk about on the
5 industry performance trend, which is on the next slides
6 where we give some indication on the next few slides about
7 what we would be doing with that. I mentioned before we
8 wanted to be able to have a mechanism for answering the
9 Congressional question of how we're performing about no
10 statistically significant adverse trends.
11 We're also looking at industry trends to be able
12 to help the agency put together a fairly succinct statement
13 to Congress and public and other stakeholders of what our
14 view of where reactor safety is and where it's going. This
15 is something that NRR intends to use as a piece of the
16 measures of how successful the reactor safety program is in
17 general.
18 The next to the last bullet talks about areas and
19 specific aspects that should be improved or have resources
20 redirected, including reactor safety research. This is the
21 feedback mechanism because the industry trends will include
22 not only the individual plant specific PI's but the other
23 aspects of performance that we're able to measure, and that
24 feedback mechanism is where it would go back into the
25 process and say therefore, these inspection activities can

1 be changed, either in their frequency or in the nature of
2 how they're being done.
3 On the next slide where we talked about how they
4 could be used, we talk about in the third bullet, updated
5 risk informed inspection guidance and supporting analysis of
6 regulatory effectiveness. This is the mechanism by which if
7 you have an indicator in a particular area that covers
8 things that you used to have to do inspection on, you could
9 change the way you were doing inspection.
10 The other piece that we wanted to do with this
11 industry trend stuff in addition to providing general
12 statements to the public is deal with the issue of public
13 confidence because this information would be being generated
14 consistent with the general philosophy that AEOD had when it
15 was a separate organization, which was to provide an
16 independent look at operating experience and feed that back
17 to the operating -- the regulator so that those kinds of
18 things could be taken into account, and there would be an
19 enhancement, we hope, in the public confidence that the --
20 there was a group who was going to say that this is good or
21 this is bad independently of what the individual program
22 office would be doing, so there's a certain level of
23 independence there.
24 The actually ones that we're looking at doing, and
25 these will evolve over time as the risk based PI's get done

1 and we are able to make other measurements and calculations
2 in a more timely manner, is that we would be looking at
3 industry or group averages from the current reactor
4 oversight process, risk based PI's as they come along, and
5 other complimentary things which are some of the things that
6 we've done in some of the system studies, event studies and
7 the ASP program in this branch.
8 DR. APOSTOLAKIS: Now, the ASP again is another
9 one that really cannot be a performance indicator.
10 MR. BARANOWSKY: But it can be an industry trend
11 indication.
12 DR. APOSTOLAKIS: Yes.
13 MR. MAYS: And that's what we're talking about
14 here. On the last page, the next page after that, was
15 examples of trends which you have seen before in various
16 reports. These are the kinds of things that we could give
17 indications of that as a set would be able to say this is
18 what we think about where performance is going.
19 MR. BARANOWSKY: And we would not just show
20 figures, of course, as we were discussing with Dana. We
21 would try to understand why things are changing and where
22 they are in time and what the factors are.
23 DR. POWERS: Yeah, if you look at the one in the
24 lower right-hand corner, my eyes aren't good enough to tell
25 you what it is, but you see you got a nice downward trend

1 there, but in fact, if you look at it in detail, it was a
2 five-year cycle going through that. It's got to be
3 something that's causing a five-year cycle in there because
4 I get three cycles there. That must indicate some other
5 mechanism. Now, it may be a risk insignificant mechanism
6 and maybe the way corporate planning is done or something
7 like that, but it would be more detailed than just a
8 rudimentary plotting.
9 MR. BARANOWSKY: Correct.
10 MR. BONACA: It may be a different accounting
11 system. There is something.
12 DR. POWERS: Yeah, it may be every five years, NRC
13 counts it --
14 MR. MAYS: Yeah, it can happen. In the interest
15 of time, what I want to do is go over slide 16 next, and
16 I'll skip a couple after that.
17 DR. APOSTOLAKIS: You know, just an administrative
18 suggestion. For slide 8, I would change the heading, and
19 instead of saying what are RPBI's, give it a fancier name
20 --the guiding principles for development, and then make that
21 part of the process. There you should also mention that you
22 would like to make it as high as possible.
23 MR. MAYS: Okay.
24 DR. APOSTOLAKIS: We don't need 16, you say?
25 MR. MAYS: No, we'll do 16. I may skip a couple

1 of other ones. What we intend to do here is we're issuing
2 the white paper for stakeholder comment. We'll brief you
3 and the Commission, and then we want to get some agreement
4 that this is the right philosophy to go off and develop
5 these indicators. Then the phase 1 report will come in
6 which will be the first example of trying that process out
7 and we would have discussions as to how well that went. We
8 go back to the ACRS again, back to the Commission, and do
9 the same thing on phase 2.
10 MR. BARANOWSKY: The only thing you didn't mention
11 and we didn't put it in here, is that there would be also
12 substantial interaction with the public, which we would
13 either have workshops or at least meetings to go over this
14 stuff and get comments on it after the July report is
15 issued.
16 DR. POWERS: In that regard, one of the members of
17 this Committee has articulated a position on what the public
18 is that resonates with me a great deal. He has suggested
19 that there's a technical community that is part of the
20 public and that, in fact, if you cannot persuade that
21 technical community in one discipline or another and in this
22 particular discipline, I'm not sure which technical
23 community you would identify, but I'm sure there is a
24 technical community outside the reactor area that
25 constitutes a public that you have to persuade. Maybe it's

1 the guys that do time series analysis on the stock market.
2 I don't know.
3 When you say we're going to have stakeholder
4 meetings and meet with the public, are you going to
5 prostelitize this thing to the appropriate technical
6 institutions that represents that body of expertise that if
7 you don't persuade them, you're never going to get --
8 persuade the average guy on the street that you're doing the
9 right thing.
10 MR. BARANOWSKY: I think we plan on having a
11 pretty wide interaction through a public -- through Federal
12 Register notices and through targeting --
13 DR. POWERS: You would be surprised how few people
14 read the Federal Register. I mean, it may come as a shock
15 to you, but I bet you it really doesn't have the kind of
16 circulation in the rest of the country that it does here in
17 Washington.
18 MR. BARANOWSKY: Oh, I thought everyone reads it
19 at 5:00.
20 DR. APOSTOLAKIS: Even if they read it, they won't
21 come.
22 MR. BARANOWSKY: Also, targeting other
23 organizations, whether they're reactor groups or other
24 technical groups, public interest groups and so forth, that
25 have either shown an interest or that as best we can tell,

1 would have a good input to this process. It's not going to
2 get everybody in the world involved, but it's going to get
3 --
4 MR WALLIS: One thing you can do, though, is
5 instead of just meeting with what appears to be a meeting
6 between you and industry to sort of hash things out, call a
7 public meeting, you can make an effort to present a paper to
8 some tentacle society where other people are there and
9 convince them and get feedback from them. Go out of your
10 way to broaden this public reaction.
11 MR. MAYS: We have gone more than just meetings
12 with the industry in what we're intending to do. The
13 concepts of these risk based PI's and other things have been
14 presented through technical meetings and in other journals
15 as we've come along before, so that part of it's been done.
16 The people that we are primarily focusing on are the people
17 who have been actively involved in the reactor oversight
18 process, which is not just the industry. At the latest
19 Commission briefing on the reactor oversight process, there
20 were presentations from Dr. Lipoti from the state of New
21 Jersey, who had sent in concerns. There were presentations
22 from David Lochbaum from UCS. There have been other
23 workshops and meetings in which James Riccio from Public
24 Citizen has been involved. There's been the public
25 performance-based regulatory workshop in which other people

1 from Public Citizen and other groups have come. We're
2 sending this out to them and trying to get those people
3 involved.
4 MR WALLIS: Those are not the groups that Dr.
5 Powers was talking about.
6 DR. POWERS: Somehow I'm just not matriculating it
7 very well, Graham. I think we've got to -- I mean, I love
8 this idea, and I believe it's absolutely true, that if we
9 cannot persuade these people in professional organizations
10 outside the nuclear industry that the nuclear industry is
11 doing a good job, we'll never persuade the man down the
12 street.
13 MR WALLIS: Or even you give a seminar to Dr.
14 Apostolakis' students at MIT and let them have a go at you.
15 MR. MAYS: I've done that for the last two years.
16 MR WALLIS: Good, I'm glad. That's great.
17 MR. MAYS: I'm scheduled to go back again this
18 year.
19 DR. POWERS: The students at MIT are way too
20 reticent. You need to go up to Dartmouth. Dartmouth is
21 where they're really, really tough.
22 DR. APOSTOLAKIS: Well, let me -- I think there's
23 an important practical issue here, Graham, that --
24 MR. MAYS: As I get older, I go further and
25 further south.

1 DR. POWERS: -- the technical communities that
2 you're talking about as a rule will not come to what we call
3 public meetings.
4 MR. MAYS: Of course not. Of course not.
5 DR. APOSTOLAKIS: So, I can see two ways to get
6 them. Either you hire them and pay them as they view us.
7 I'm sorry, a statistician will not come to a Commission
8 meeting just to listen and express his views. They've got
9 to pay him.
10 DR. KRESS: They might be part of a National
11 Academy study.
12 DR. APOSTOLAKIS: Or you go to where they are
13 already, like technical meetings, their journals and so on.
14 So, I think you have to think about that, what would be the
15 best way to reach out to these communities. It's a fact of
16 life that even if you bring the Federal Register notice to
17 them, they're going to say well, you know, that's
18 interesting. They're not going to go out of their way to
19 fly to Washington, right? So, I mean, have that in mind.
20 MR. BARANOWSKY: I think there are probably fewer
21 highly technical and mathematical issues that need to be
22 resolved here than there are philosophical things.
23 DR. APOSTOLAKIS: Yeah, but for example --
24 MR. BARANOWSKY: But we would be willing for those
25 things that should have a high level technical review to get

1 it, because I'm convinced, as you are, that good quality
2 work that's been accepted is one of the keys to moving
3 forward with these kinds of things, and that's been one of
4 our philosophies for years.
5 DR. POWERS: I think you'll find a receptive
6 audience among the political economists. I mean, they're in
7 the business of doing this kind of stuff. It might be an
8 interesting way to go.
9 MR. BARANOWSKY: Yes. We might learn something.
10 DR. POWERS: Yes, but you'll never want to go to
11 another political economics meeting, I can say that.
12 DR. APOSTOLAKIS: Are you presenting this piece on
13 this one, or it's too recent?
14 MR. BARANOWSKY: We presented -- well, the charts
15 that you saw, the clocks, that was a paper I presented on
16 industry-wide trends.
17 MR. MAYS: And I made a presentation at PSA '99 as
18 well.
19 DR. APOSTOLAKIS: How about this coming November?
20 Are you going to the meeting?
21 MR. MAYS: I don't have a paper for that meeting.
22 DR. APOSTOLAKIS: Oh. I think you have to skip a
23 few of these.
24 MR. BARANOWSKY: I think we do. Let's go to the
25 schedule 1 -- well, we've covered the schedule.

1 DR. APOSTOLAKIS: No, tell us a little bit of the
2 roll of the integrated indicator, because that's a
3 relatively new concept. I'd like to understand.
4 MR. MAYS: Actually, the integrated indicator, we
5 can probably, if you will allow us, skip a little bit
6 because that's really a phase two process that's not going
7 to be something you're going to see in July anyway.
8 Basically the concept would be there, we would use a plant
9 specific model such as the SPAR 3 models of the plants to
10 combine the information about the indicators and inspection
11 findings, see what the overall implications were on core
12 damage frequency as a result of those. That's our initial
13 concepts on that, and we're not going to have anything more
14 for you to bite into for awhile yet. So, unless there's
15 something else you want us to talk about on that, I'd like
16 to skip that.
17 DR. APOSTOLAKIS: Okay, fine.
18 MR. MAYS: I'd like to go to the example
19 information on slide 2 about some of the stuff that we've
20 done, to give you kind of a taste of what's coming up. This
21 is not going to be a comprehensive statement of everything
22 that's being done. The July report will have a more
23 comprehensive work, but you'll see the examples includes six
24 bullets here, five of which you've already seen before,
25 because those are the things about how we develop a

1 particular PI going from the key attributes, the risk
2 elements, and the other one, which is on the next slide,
3 which a general risk perspective.
4 So, on slide 22 --
5 DR. APOSTOLAKIS: I can't believe you did this
6 here.
7 MR. MAYS: Yes, you can believe it.
8 DR. APOSTOLAKIS: So I have to count zeros now,
9 right?
10 MR. MAYS: You have to count zeros. Now, George,
11 I showed you this at your class --
12 DR. APOSTOLAKIS: Are you aware of the scientific
13 notation --
14 MR. MAYS: I'm aware of the scientific notation,
15 and I specifically did this with zeros for a reason, and we
16 shared this with your class last summer, so I wanted to --
17 DR. APOSTOLAKIS: That was the reason.
18 DR. POWERS: Ooh, Jack.
19 MR. MAYS: I wish I could take credit for being
20 that clever, but I can't. The purpose of this slide was to
21 do some perspective things because one of the things I've
22 seen in the workshops and discussions with public and the
23 discussions with the Commission and ACRS is there's two
24 things that tend to happen. One is there's the forest for
25 the trees problem. People start worrying about whether

1 something can actually count and whether something's 2.95
2 times 10 to the minus 6 or 3.27 times 10 to the minus 6, so
3 I think there's a perspective issue that needs to be done
4 there. There's also a perspective from a broader, more
5 global regulatory framework that I'll want to bring to bear
6 here.
7 Now, in doing this particular slide, there's a
8 couple caveats I'm going to start out with in the first
9 place, and one is this is talking about individual accident
10 death risk. This is not risk from cancer. This is not land
11 interdiction. This is not the complete and total picture of
12 what risk is, but it's a piece of it.
13 What we did here is we went back and looked at the
14 background risk for an individual in the United States dying
15 from an accident is, and as you can see here, in scientific
16 notation, that would be five 10 to the minus 4 per year. I
17 put the zeros on there because of another reason. The NRC's
18 quantitative health objective is for the risk to an
19 individual living near a nuclear power plant dying from an
20 accident should be less than .1 percent of the normal
21 background risk.
22 I put that on there to make sure that people didn't think
23 that 5E minus 4 and 5E minus 7 was just three. It's not
24 just 3. It's three zeros, okay, because people get confused
25 when you start talking logorhythmic from where we really

1 are.

2 DR. APOSTOLAKIS: A great communicator you are.

3 MR. MAYS: So, the next piece that I think is

4 important is okay, let's suppose a plant had a 10 to the

5 minus 4 core damage frequency from all causes, whatever that

6 was. We then looked at what the corresponding risk would be

7 using the worst NUREG 1150 containment and offsite

8 consequences calculations. When you take that kind of

9 approach, what you find is the risk to the individual, and

10 that case would be two 10 to the minus --

11 MR. BARANOWSKY: Eight.

12 MR. MAYS: Eight, which is a factor of 25 less

13 than what the qualitative health objective would be.

14 Therefore, a risk of 10 to the minus 5 delta CDF would be an

15 order of magnitude less than that and 10 to the minus 6 an

16 order of magnitude below that. So, if you happen to live

17 near a nuclear power plant with a 10 to the minus 4 core

18 damage frequency and a containment and offsite

19 characteristics like the worst of the 1150 plants, then the

20 individual risk would be .00050002. I think that's

21 important to know how many zeros are between the two of

22 those from a perspective standpoint.

23 MR WALLIS: Well, that's false because the

24 uncertainty in the five swamps any of the two.

25 MR. BARANOWSKY: That's excellent because what

1 we're really saying is we have to make sure we don't lose
2 our heads over that two when the real issue is at the five.
3 MR WALLIS: But the five should be rounded of. It
4 should be five two.
5 DR. APOSTOLAKIS: No, but that also tells you that
6 you have to have uncertainty that is so broad that the three
7 zeros there --
8 MR. MAYS: Exactly.
9 MR. BARANOWSKY: The three zeros, exactly, and
10 this perspective needs to come to play in talking about the
11 precision of the mathematics for any of the stuff we're
12 talking about. That's why he's showing it, not because
13 we're going to try and develop indicators at this level, but
14 how precise do we need to be.
15 DR. APOSTOLAKIS: Has the Commission seen this
16 slide?
17 MR. MAYS: I don't know if the Commission has seen
18 it. I do know the EDO has seen it.
19 MR WALLIS: Several times.
20 MR. MAYS: Several times. As a matter of fact,
21 earlier once again this morning. The issue here --
22 MR. BARANOWSKY: We will show this to the
23 Commission when we go in June.
24 MR. MAYS: Yes.
25 MR. BARANOWSKY: We'll probably modify the

1 presentation because there are certain sensitivities,
2 particularly about polar perception on land interdiction and
3 so forth, but nonetheless, I think this gives some risk
4 perspective that when people talk about being risk informed,
5 I hardly ever see them talk about risk. The next thing --
6 so therefore --
7 MR WALLIS: This has been around for -- since Wash
8 1400 and before.
9 MR. BARANOWSKY: Yes, but for some reason, we
10 stopped talking about it for ten years. I think the
11 important point from a standpoint of the reactor oversight
12 process, if you look at the last three lines, the reactor
13 oversight process is set up so that changes in performance
14 that will result in a 10 to the minus 4 increase in the CDF
15 for a plant which is basically the red zone, which has been
16 defined as the unacceptable performance range, means that
17 you would go from .00050002 to .00050004. That's the red
18 zone because that would be an addition one 10 to the minus 4
19 to what's already 10 to the minus four. It would be
20 doubling it. So, the red zone is still three orders of
21 magnitude down from the existing risk. That means the next
22 level down with yellow and the next level down from white --
23 DR. POWERS: Excuse me. Do you really think it's
24 necessary to explain the scientific notation to the
25 committee?

1 MR. MAYS: But that's where the process interfaces
2 with that. That's what I wanted to make clear there.
3 When we go through this then, started looking at
4 how we were going to put together individual risk based
5 PI's. On slide 23, the -- what we're going to give you an
6 example here is for PWR and for internal events at full
7 power of the mitigating system cornerstones. So, this is
8 one slice of the entire process. The issue for us is how do
9 you pick up and identify what the significant attributes
10 were, and the approach we're going to use is we're going to
11 use insights from plant specific IPE's, ASP results, system
12 component and other studies to say which of these particular
13 attributes has the most risk significance.
14 On the next slide, we give you that attribute
15 slide again, and we bold, highlight in here the equipment
16 performance piece. It's a pretty good consensus that the
17 reliability and availability of mitigating systems is
18 important pieces to the risk. That's pretty simple to do.
19 The more difficult question is to go in and say okay, what
20 is it about design or procedure quality or human performance
21 that's risk significant if it changes from whatever its
22 baseline is, that we would need to capture, that isn't
23 reflected in reliability and availability of equipment.
24 DR. APOSTOLAKIS: Now, Steve, in this particular
25 issue, it seems to me that you need to explain a little bit

1 what you're doing on the figure. You're not really looking
2 at the equipment performance. You're looking at the
3 equipment performance under certain conditions.
4 MR. MAYS: That's correct.
5 DR. APOSTOLAKIS: Because later on, for example,
6 on slide 27, you separate out AC power, right? So, what
7 you're doing here is you're saying given that I have, for
8 example, AC power, due to other reasons, why is -- I would
9 have a performance indicator that would tell me what is the
10 reliability of this piece of equipment, given that certain
11 conditions exists, and for these conditions, I may have
12 something else. I have another performance indicator or put
13 them back into the baseline inspection program. That would
14 be consistent with the PRA, as you know very well. It comes
15 back to the idea, you know, what is the reliability of this
16 system. Well, the PRA's tell us that this is not a very
17 meaningful question because there are so many different
18 conditions under which that system may be demanded, and its
19 reliability will be different.
20 MR. MAYS: Right, and what we have to do is we
21 have to break the mitigating existing cornerstone up into
22 the particular areas for which things make sense to be
23 grouped together to see what the risk based PI's. That's
24 why I said starting out here, I'm talking about full power,
25 PWR, mitigating system, internal events only.

1 DR. APOSTOLAKIS: What I'm saying is make sure
2 there is somewhere in the figure here where these words
3 appear, that this is under these specified conditions.
4 MR. MAYS: That's correct.
5 DR. APOSTOLAKIS: Because slide 27 really is a
6 very important one.
7 MR. MAYS: And so we have to develop the
8 methodology and come back and show you why we think what
9 pieces are relevant for developing risk based PI's, and
10 that's part of our program.
11 On the next slide, we talked about we're going to
12 take the reliability block of that previous one, so we've
13 narrowed down a little bit further and said how do we
14 identify the risk significant system trains or components
15 with respect to the reliability attribute, and the approach
16 we're going to use is using a Fussell-Vesely risk
17 achievement worth features to look at the plant specific and
18 generic PRA's to see what particular things we can come up
19 with are the key systems that we need to look at. Then
20 we'll go down from the system to train or other levels in
21 accordance with the criteria that we had for what makes a
22 good indicator.
23 So, these are the ones we were looking at for this
24 particular PWR as the potential systems for which risk based
25 PI's might be developed.

1 DR. APOSTOLAKIS: Could you skip to 28?

2 MR. MAYS: Sure, we can do that. On 28, we talk
3 about, given that we've decided what level we're going to do
4 a particular indicator, or how are we going to do the
5 threshold determination. The approach we intend to use is
6 to use plant specific spar models and then go back and look
7 at what changes in the reliability model would produce
8 changes in the core damage frequency assessor at 10 to the
9 minus 6, 5 and 4. That's a little bit different from what
10 the current oversight process has, and the ACRS has raised a
11 concern about this in the past about why the green/white
12 interface was set at a 95 percentile of the average
13 performance.

14 There's lots of implications associated with that.
15 The first one is 95 percent may or may not be very risk
16 significant. The second one is if you're doing it on 95
17 percent of what the average is, as the performance improves,
18 what you've basically done is broaden the white zone as the
19 performance improves, unless you've set it at one particular
20 year and leave it there.

21 So, we want to address all those issues, and so
22 what we've done initially is put it on a risk basis because
23 this was risk based performance indicators, after all. We
24 believe we have the address, whether the 95 percent makes
25 any sense and why and what those are, and we need to lay

1 that case out.

2 Now, having said that, the 10 to the minus 6 one
3 also has some consistencies with respect to the significance
4 determination process, green/white interfaces, basically at
5 a 10 to the minus 6 delta CDF level as well. So, that helps
6 with some of the consistency issues.

7 So, going back to the last one, to give you an
8 example of what this might look like for this particular
9 plant under mitigating systems for internal events at power,
10 we have in the chart, for each one of these either systems
11 or trains, the baseline value, what the amount of change
12 would be necessary to get the delta CDF's as shown, and what
13 we're looking to see is is there a big enough spread
14 between, say, the green and the red to believe we have a
15 graded approach here, that we don't go from -- for example,
16 if we had the AFW went from 1.6 10 to the minus 4 nominal to
17 the red zone at 1.8 10 to the minus 4, you'd say that's a
18 pretty lousy indicator, and we wouldn't use that as an
19 indicator because there's no difference between red and
20 green. It's so small that it wouldn't make any sense.

21 So, we have to look to see if we have a spread in
22 those values and to do that. The case of that for this
23 particular plant is another example down here under power
24 operator relief valves. What you find at this plant is that
25 even if the PORV's are incapable of operating for the entire

1 year, are basically not there, you still can't make a delta
2 CDF with that alone, that 10 to the minus 4. You can
3 measure it at the lower levels, but not to that. So, this
4 helps us be able to figure out whether or not that's a good
5 indicator.
6 DR. APOSTOLAKIS: There's an important point here
7 that just occurred to me as you were speaking that I think
8 has to be made today, and then we'll start. When we -- I
9 don't know whether you read that ACRS letter where some
10 members said this and some members said that with regard to
11 the performance indicator and the threshold values. There
12 were two opposing viewpoints which come down to two
13 different views of the objectives of the reactor oversight
14 process.
15 In one, the plant is licensed, right. It's
16 allowed to operate. It has a certain risk profile. The
17 objective of the oversight process is to make sure that that
18 profile doesn't change significantly. The other is look at
19 the industry as a whole and do your oversight in a way that
20 the industry functions in an acceptable way.
21 You are really introducing a third view in your
22 slide 28, and maybe you can reflect a little bit on that.
23 You're saying with the second bullet yes, the plant is
24 licensed and so on, in slide 28, but all I care about is
25 really whether their CDF values, minus 4, 5 and 6, have been

1 exceeded. This is a third view, because you're not
2 referring now to the risk profile as it is now, and you know
3 you are interested in changes. You're saying fine, you can
4 even change, as long as these CDF values are not changed.
5 You have to think about it because we are running out of
6 time, but this is really an important point, and I don't
7 know whether this is the way we want to go.
8 MR. MAYS: Well, it was meant to be consistent
9 with 1.174.
10 DR. APOSTOLAKIS: You are making it risk based
11 now. Huh?
12 MR. MAYS: It was meant to be consistent with Reg
13 Guide 1.174.
14 DR. APOSTOLAKIS: I understand that.
15 MR. MAYS: Okay.
16 DR. APOSTOLAKIS: I understand that, but I'm tell
17 you, now three views of what the objectives of the process
18 are. All I'm saying is I want you to think about it before
19 July.
20 MR. BONACA: I'm not sure, however, because I
21 mean, there was a implication that consistency with Appendix
22 B requirements will give it a level of reliability. Now, it
23 was never measured, but this is the first time that I see an
24 interpretation in writing of what that would mean.
25 DR. APOSTOLAKIS: Well, that's a subject we

1 probably need to discuss in a separate meeting.

2 MR. BARANOWSKY: Our intent is to say that the

3 nominal performance should be acceptable, and that these

4 changes, 10 to the minus 6, 5 and 4, from that nominal

5 performance are the ones that we want to look at in terms

6 -- DR. APOSTOLAKIS: I understand that. Okay, we'll

7 have to discuss it in another forum because this is a big

8 subject. I take it you don't have anything else that is

9 really important to tell the Committee.

10 MR. MAYS: No.

11 DR. APOSTOLAKIS: Any members have a question or

12 comment?

13 MR. BARANOWSKY: Good work. Thank you.

14 MR. MAYS: Thank you.

15 DR. APOSTOLAKIS: Shall we invite the public or

16 the staff? Okay, back to you, Mr. Chairman.

17 DR. POWERS: Fine. I will recess us until 20

18 after the hour.

19 [Recess.]

20 DR. POWERS: Let's come back into session. We're

21 turning to the area of the human performance program plan,

22 and our cognizant member -- I don't know if he's available,

23 but I can introduce this subject. Here's Jack.

24 MR. ROSENTHAL: Thank you. I wore a jacket just

25 as a sign of respect to the ACRS, but now that -- it's hot,

1 so I'll take it off.

2 DR. POWERS: As a sign of good sense, you'll now

3 take it off, right?

4 MR. ROSENTHAL: And I'll be making somewhat less

5 than 40 minutes of the presentation, and we should allow for

6 NRR, which is both the user of the information and it is an

7 agency or attempt to be an agency program.

8 I'm going to talk about the plan itself, and then

9 Dave Tremble and Dick Echinrode are going to talk about the

10 reactor oversight process and the relationship of this to

11 the oversight process. Then I'll take the microphone back

12 and talk about where we go in the future.

13 We have been talking, slide 3, about plans for

14 years, and you know, there was National Academy of Science

15 reviews way back, and you know, this is pre-TMI. Then the

16 most recent round are really from about '95 where all that

17 happens was that three branch chiefs -- I was in AEOD, and

18 Mary Lee Slossen, I think, we in NRR. Dick was involved,

19 and I think it was Brian Coffman in RES. All we wanted to

20 do was get together and see that the programs didn't

21 overlap.

22 Well, that turned into a big plan which was

23 published and rejected, and then more recently there was a

24 SECY in '98 which the ACRS commented about heavily. Then

25 there was a presentation in February, '99. I sat in the

1 audience and Steve Arndt made that presentation. We took
2 what you said seriously.
3 DR. POWERS: We all jumped up and applauded that
4 presentation.
5 MR. ROSENTHAL: Yes, you did. You liked that
6 presentation very much on being more risk informed, but Dr.
7 Seale also tells us that we better be talking to INPO and we
8 should not be duplicative of the INPO efforts. We were to
9 see what other federal agencies were doing, as well as risk
10 informing. I think that we have, in fact, told us to do, so
11 I'll be talking mostly about the plan.
12 The plan is the staff's report because we continue
13 to work on risk informing it. It includes a mission
14 statement I want to talk a little bit about the basis for
15 the program elements and future directions. Ideally, one
16 would have a perfect PRA's and be able to do risk
17 achievement works or Fussell-Vesely on each element of the
18 plan and have this absolutely logical coherent instruction.
19 Well, even within the scope of PRA, I can talk
20 about human error, but I can't -- it's not at a state of
21 knowledge where you can separate out training from
22 procedures, et cetera, but we still try to do a fair amount
23 of risk work. The reality is that RES develops tools and
24 methods for user offices like NRR and NMSS, so user needs
25 are very, very important to us. In the plan, you'll see

1 that there are several specific elements with a mark of
2 anticipated user needs. Sam Collins signed that user need,
3 too. So, at this point, about 90 percent of my program in
4 fiscal 2000/2001 is user need based and specific
5 contemporaneous user needs.
6 We also looked at what the industry is doing where
7 fellows at FAA and NASA and Coast Guard, et cetera, as a
8 reality check to see that we're worried about the same
9 things that they are, and did they have data that might be
10 useful to us, et cetera. We also want to do our work within
11 the context of broader agency programs.
12 Okay, so now -- we did a fair amount of risk
13 reviews. Let me say that on March 15, we had a 4-1/2 hour
14 session with the subcommittee in which we went over the
15 stuff in detail, and I'll try to summarize here. There's
16 two sources of risk information that we would use. One is
17 from PRA's that have been performed and PRA risk insights,
18 and from the accident sequence precursor data. These don't
19 give you conflicting, they give you complementary views of
20 reality, but these complementary views are somewhat
21 different.
22 Brookhaven wrote a letter report which we did
23 provide to the Committee in which there's not a table of
24 employment human factors. There's a table of studies of PRA
25 effort, PRA, that did sensitivity studies said that human

1 performance, in whatever level of modeling that they did,
2 was important.
3 The things that you typically see in a PRA are
4 things like going to bleed and feed on a pressurized water
5 reactor, coping with a steam generator tube rupture, on a
6 boiler pumping with at atlas event, control of slick,
7 control of water level, et cetera. These are rare events
8 which one does not observe, fortunately, in every day
9 practice in the plant.
10 If you want to make conclusions about them or look
11 -- and you thought that was the total set of what you should
12 be looking at, then we should be looking at the simulator
13 and EEO PE's and procedures and training, and INPO does that
14 very well. So, our effort would then be modest. I'm not
15 proposing that we do that because INPO does it.
16 If one looks at the ASP data, one gets a somewhat
17 different view of reality. What did was we looked at the
18 last five years of accident sequence precursor events. It's
19 roughly ten a year -- I'm sorry, 10, 20 a year, looked at
20 those which were greater than 10 to the minus 5.
21 Conditional core damage probability, there's about 50 of
22 those events, and said we'll study those roughly 50 events
23 to say what's important. This becomes important when I talk
24 about -- and I will later on, about looking at the plant
25 oversight process. This was the focus and what could we

1 learn from these events.

2 In discussion with Dana at the subcommittee and
3 again in preparation just a few minutes before the official
4 meeting, he properly brought up I don't have -- I can't say
5 that 50 events greater than 10 to the minus 5 is no good or
6 good. I know that we've had there very many events. I know
7 that the mission goal is no single event in a year greater
8 than 10 to the minus 3 as a written stated goal, performance
9 measure, but the fact that we've had 50 might or might not
10 be acceptable, and what you have to do is somehow match that
11 up against --

12 DR. APOSTOLAKIS: You mean 1E-5? 10E-5 Is 10 to
13 the minus 4.

14 MR. ROSENTHAL: I'm sorry, 1E-5. Okay, now I'm
15 embarrassed.

16 DR. POWERS: Jack, let me ask you a question. You
17 go through and you look at these events and you see what's
18 the human contribution to this, and I have a tendency to go
19 back to the old inspector mentality. There are only four
20 possibilities on any event. The design was inadequate.
21 That means a human failing to anticipate the requirements.
22 There was no procedure -- that's a human failing to
23 anticipate the need for a procedure. The procedure was
24 inadequate -- a human failing to prepare a good procedure.
25 The procedure was not followed properly -- clearly a human

1 failure. Everything is human failure if you go back far
2 enough. Okay, so what do you do differently when you look
3 at these?
4 MR. ROSENTHAL: We took out the lightning strike
5 as, you know, the event that -- where, you know, within
6 milliseconds the plant's reacted. We took out the designer,
7 like a pressure locking of MOV's. Ultimately it was some
8 engineer who didn't listen to all the stuff. What we did is
9 we looked at those in which it was the operator or the
10 operating organization and the operating organization's
11 processes or procedures. Let me give some -- let me just
12 move to the next slide, and then I'll continue talking.
13 Okay, the most significant event that we've had in
14 the last few years was Wolf Creek event. It was a shutdown
15 event, 10 minus 3 conditional core damage probability. That
16 is an event in which the operating organization chose to do
17 multiple evolutions at the same time and caused that event
18 to take place. That was event in which they were under
19 pressures to do the fastest refueling outage ever. I think
20 that that's a legitimate look at how human performance in
21 the broadest scale could affect events. That's an event in
22 which the organization both caused the event and the
23 operators quickly closed the valves and ameliorated the
24 event so that they can do good as well as bad.
25 I throw -- okay, another important event was at

1 Oconee where they burnt up two high pressure safety
2 injection pumps. They actually caused damage to two pumps
3 and would have damaged the third pump if not for the
4 operators being swift enough to stop the third pump before
5 it autostarted and burnt up, too. Underlying that event was
6 -- it's a balance problem, and that is that you test high
7 pressure safety injection pumps quarterly and they worked,
8 and in today's speak, they'd be green and they'd have
9 adequate reliability, et cetera, et cetera, et cetera, but
10 you didn't include in your test boundary the sensors on the
11 refueling water storage tanks. So, if the refueling water
12 storage tank level is too low, then the pumps cavitated.
13 I consider that a human performance of the
14 operating organization. So, that's the kinds of things that
15 we put in and in contrast to the design of the pressure
16 locking valve. Now, I guess if I was more intellectual, I
17 would go from the specific examples to the general, but I
18 don't know how to quite say it.
19 Okay, so we do this work, and it tells us,
20 depending on the event, that the contribution of the human
21 is very important, only in these 50 events -- I'm sorry, in
22 these events, I think that we only have six that involve
23 some aspect of the operators in the control room which is
24 the typical focus of the PRA. Then we have many, many, many
25 events involved the operating organization to include a lot

1 involving maintenance and the ratio of what I call latent
2 errors -- it's like four to one. What I mean by latent
3 errors is the Jim Reason sense of the definition of latent
4 error, this thing that has escaped your ISI, IST,
5 reliability studies, et cetera. It's something waiting
6 there to grab you.
7 That is not to say that this is not an acceptable
8 number for the industry as a whole over time.
9 DR. POWERS: What you're telling me --
10 MR. ROSENTHAL: And that's work to be done.
11 DR. POWERS: I mean, when we do a PRA, there is
12 certain unreliability due to maintenance failures. It's a
13 maintenance failure, not a human error probability built
14 into there, and that's what you're looking at when you look
15 at these things. You're looking at human a little more
16 broadly than you would in any risk achievement worth going
17 into analysis where I said the operator was either dead or
18 infallible, depending on which way I did it. You're looking
19 a little broader than that.
20 MR. ROSENTHAL: Yes, and now this affects the how
21 is human considered within the overall plant assessment
22 process, where if I base it solely on the PRA insights, then
23 I'm going to use the plant assessment process and look at
24 things like recall exams, and if I'm worrying about all
25 these latent errors, then I should look more broadly. Then

1 ultimately what I'm going to do is see if the plant
2 assessment process is or is not considering this.
3 DR. APOSTOLAKIS: The other very important reason
4 why you look for latent errors is that some of those may
5 introduce dependencies that we're not aware of. For
6 example, if the work prioritization process has some
7 problem, okay, that may result in a coupled failures of
8 equipment that are not even similar, which is a usual common
9 cause failure analysis in the PRA. Now, that doesn't mean
10 that if you look you're going to find that for sure, but
11 there is a suspicion that this may happen, and at this stage
12 of the game, what we're saying is let's try to understand it
13 a little better to make sure that these things will not
14 happen because that's the problem with latent errors. They
15 may not lead to a single active failure. They may actually
16 lead to a number of them at the time when you don't want
17 them to happen. By the way --
18 MR. ROSENTHAL: We have a test to look at
19 corrective actions, and we've been doing some work with Bill
20 Veseley, and I'll give a hypothetical example of what Dr.
21 Apostolakis is talking about, or a pretty concrete one.
22 There's probably like one or two guys at a plant that are
23 MOVATS qualified now, you know, and they go around to all
24 the safety related valves over time, and they set up the
25 valves. So now if you have an error in the procedures that

1 they're following or an error in the MOBAT software, I mean,
2 whatever, then they're systematically marching through the
3 plant messing it up, and it is not revealed through normal
4 operation because you don't demand the valves. It is not
5 revealed during the current IST which is typically done
6 under zero delta P, and it's sitting there latent to catch
7 you when the real event takes place. So, I think that's a
8 concrete example of the kind of thing we might we talking
9 about, and we do intend to explore that in my branch,
10 although maybe not as part of this.
11 DR. APOSTOLAKIS: As part of what? It should be
12 part of the program.
13 MR. ROSENTHAL: Because I have another task I'm
14 looking at. It's a research task. Okay, so in any case, if
15 you take the events, you can split them apart. There's --
16 among slide 8, there's a zillion ways of cutting and
17 parceling it. I know that some people like program, some
18 people like processes, and you can cut it any number of
19 ways, but the point is that this is the sort of issues that
20 you see, and you see the latent errors rather than the
21 so-called active control room errors.
22 So now I'm supposed to use this information to
23 risk inform my human performance plan, and we should
24 continue doing this work because we want to mind this more,
25 and I think it's -- and my intent is to independently

1 publish this in depth look at ASP because I think it has
2 lots of utility.
3 Now let me get to the element -- the oversight
4 process. I'm sorry, the human performance plan elements,
5 and there's essentially four elements of the oversight
6 process. Licensing and monitoring are really NRR functions,
7 and we'd be occasionally provide some assistance. There's
8 risk informing the regulations in an area which we call
9 emerging technologies. Jay Persinsky has I think ABC flow
10 charter on his machine, so he's able to make fancier slides
11 than Steve.
12 The top block is the vector, really, is the
13 maintained safety factor, and we decided this is not a
14 burden reduction of public confidence, though really it
15 should be labeled maintain safety.
16 The squares and wigglies are current ongoing
17 programs within the NRC, and then the wide background boxes
18 are things that we're doing. The first one, and we just
19 got, as I say, the signed letter from Sam Collins now, is
20 characterizing the effects of human performance within the
21 overall plant oversight process. I think that that, at
22 least in part, will attempt to answer some of the questions
23 that the ACRS has raised on how you consider human
24 performance a cross cutting issue.
25 Let me give a specific example that we discussed

1 again at the subcommittee. One might argue that if you have
2 .96 diesels and you wanted .95 diesels and you have 0001
3 high pressure safety injection and that's what's in your
4 PRA, so you're meeting all your hardware goals, why should
5 you even look at human performance? It's covered within the
6 hardware, and there is some merit to that.
7 If I know that the unreliability contribution due
8 to the human is important for diesels and HPSI and low
9 pressure injection, whatever it is, if I know in these
10 several areas that it's important, then I have a cross
11 cutting issue that may be greater than the individual
12 elements. To the extent that I'm only monitoring about 20
13 percent of the risk by looking at the current generation of
14 PI's, then I want to look at this cross cutting to see these
15 other issues. So, that's why I think it's important to look
16 -- what?
17 DR. APOSTOLAKIS: Why are you limiting yourself to
18 human performance? It seems to me the problem can
19 accommodate all three cross cutting issues. The second one
20 is a safety conscious work environment, and I look at the
21 inspection manual that you have prepared, and you're asking
22 questions, you know, about the questioning attitude of
23 people -- I mean, safety, cultural kind of stuff. Safety
24 culture. Safety culture. So, why is this limited to human
25 performance? Corrective action certainly is a human

1 activity that, you know. It seems to me that your program
2 should be focusing on all three.
3 MR. ROSENTHAL: We're surely looking at corrective
4 actions. We're surely looking at human performance. I have
5 no specific activity on a safety conscious workplace, but
6 maybe NRR can think about what they might say about it.
7 DR. APOSTOLAKIS: You are asking the right
8 questions, or some of the right questions in the inspection
9 manual.
10 MR. ROSENTHAL: Okay, good.
11 DR. APOSTOLAKIS: I mean, this questioning
12 attitude, I thought I would never see, but you know, you
13 have it there. There is a question about that. So, why did
14 you say you received from Mr. Collins, what was it, a
15 memorandum or something?
16 MR. ROSENTHAL: User needs.
17 DR. APOSTOLAKIS: User need, the specifically
18 mentioned human performance and not the other two?
19 MR. ROSENTHAL: Right, and we can -- okay. The
20 NRC currently hypothesizes that the current generation of
21 PI's and the current inspections are adequate and that human
22 performance will be revealed in the equipment reliability.
23 That was given as a statement of fact, and I would say that
24 that's a hypothesis or an assumption, and now we've been
25 charged with the opportunity to explore to what degree that

1 assumption is or is not true.

2 DR. APOSTOLAKIS: Well, it's not clear what their

3 assumption is. I think you're right that the original 007

4 report said that, although what confused me a little bit was

5 at the subcomittee meeting. It was stated by the staff that

6 the performance indicators and inspection findings will

7 reflect poor performance in any of the cross-cutting issues.

8 Now, given that you are submitting this manual for part of

9 the base lying inspection problem, this is a true statement.

10 We will be reflected somewhere. I mean, you're asking

11 questions of the safety culture. So, it's not going to

12 session anymore, and I'm a bit confused now as to whether

13 this hypothesis be tested, or it's a thing of the past.

14 MR. ROSENTHAL: I mean, surely we should get on

15 with the oversight process, you know, let that go. I do

16 think it appropriate and what we intended to do was to go

17 back to the operational data with emphasis on these 50 top

18 ASP events and match it up against the current generation of

19 PI's and the current plant baseline inspection and ask very

20 systematically, are the kinds of -- what?

21 DR. APOSTOLAKIS: You said the current, not the

22 one that would be enlarged by what you are proposing. When

23 you say current, do you include the manual you have

24 prepared?

25 MR. ROSENTHAL: Double 0 seven.

1 DR. APOSTOLAKIS: Oh, double O seven is current?
2 MR. ROSENTHAL: Right.
3 DR. APOSTOLAKIS: See, with this manual, we're
4 deceived.
5 MR. TRIMBLE: We are going to talk about the
6 supplemental inspection.
7 DR. APOSTOLAKIS: Yeah, the supplemental
8 inspection. Is that part of the current process or not?
9 MR. TRIMBLE: It's part of the new oversight
10 process.
11 DR. APOSTOLAKIS: So there is no hypothesis then.
12 I think the claim is true because you have questions there
13 that refer to the cross cutting issues. Yes, the baseline
14 inspection and we've got you. The big question was whether
15 the component performance -- I mean, you know --
16 MR. SEALE: I guess I'm totally lost. Are we
17 discussing the human performance plan or something else?
18 DR. APOSTOLAKIS: Yes, yes, because there's a big
19 question whether they are supporting the oversight process.
20 MR. TRIMBLE: What I'm proposing to do is to take
21 what we've learned from the PRA's and the ASP work and match
22 it up against the currently, you know, what we're going to
23 implement, not the prior lecture that you heard on risk
24 based PI's, but what we're currently implementing, match
25 that up against those 50 events, match that up against what

1 we know from PRA and see if either the PI's or the baseline
2 inspection process picks up the issues that I'm talking
3 about.
4 If they do find, then that's a very interesting
5 finding. If they don't -- if there are holes, let's
6 identify the holes, and then you might find out how you
7 would go about fixing those holes.
8 DR. APOSTOLAKIS: I guess the question is which
9 baseline inspection process?
10 MR. SEALE: The one they're currently
11 implementing.
12 DR. APOSTOLAKIS: Not the one that includes this
13 particular supplemental --
14 MR. ECKENRODE: First of all, that supplemental
15 inspection that you're looking at is just that, it's a
16 supplemental. It's -- in fact, it's probably going to be
17 used about three levels down from the baseline, two levels
18 down, at least from the baseline.
19 DR. POWERS: By the way, the direction down
20 doesn't mean anything to me.
21 MR. ECKENRODE: Okay, The inspection program,
22 first of all, has a baseline -- a group of baseline
23 inspections. They're done every year or every -- on a
24 periodic basis. When you find some significant issues that
25 cause you to have, I believe, it's two whites in a

1 particular area, and this is the baseline inspection, you do
2 a supplemental inspection. That's the next level down,
3 okay?
4 DR. POWERS: Okay, yeah. The supplemental
5 inspection, I didn't understand. Okay, from that, you've
6 got to have a significant number of issues in there. Then
7 you may use, if they happen to be human performance issues,
8 you would use the inspection procedure that you're looking
9 at now.
10 DR. APOSTOLAKIS: And this is part of the current
11 revised reactor oversight process?
12 MR. ECKENRODE: That's correct. By the way, it is
13 a draft. It's not been approved yet. It's out to the
14 regions for comment. That's it.
15 MR. TRIMBLE: So, that's a new process.
16 DR. APOSTOLAKIS: So, there is a staged approach,
17 plus the baseline must find it, in which case Jack is right.
18 You should be testing this.
19 MR. TRIMBLE: Correct.
20 DR. APOSTOLAKIS: Yes.
21 MR. ROSENTHAL: Okay, the second leg is primarily
22 NRR activities, and I'll let them speak for themselves. I
23 would point out that policy review includes things like what
24 we might do on fatigue or staffing or hours worked, that
25 sort of thing, and that would be an effort in which I would

1 hope both offices would work together.

2 DR. POWERS: Well, that's one of the areas that I

3 didn't quite understand in the plan. It seems to me that

4 there's been a hypothesis, I guess, if you will, that no

5 need to worry about these things, that if, in fact, fatigue,

6 for instance, is a problem, it will surely show up in the

7 other performance indicators.

8 Now does the plan work to test the hypothesis or

9 something else?

10 MR. ROSENTHAL: You know, there is an active 2206

11 petition on this and there's been staff meetings, and we've

12 met with NEI, and I think that it's -- I'm just -- I'm

13 hesitant to speak too much right now.

14 MR. TRIMBLE: Let me just speak to the fatigue

15 issue. We haven't been thinking of it in --

16 DR. APOSTOLAKIS: Use the microphone.

17 MR. TRIMBLE: I'm sorry. I'm Dave Trimble,

18 section chief over at NRR, License and Human Performance.

19 We have been thinking about the fatigue issue. We haven't

20 been thinking about it in the context really of the

21 oversight issue or as perhaps you may be alluding to. It's

22 been on a separate track. And, as Jack referred to, we have

23 a petition for ruling that's been sent in, basically, where

24 the petitioner --

25 DR. POWERS: We're familiar with it.

1 MR. TRIMBLE: Right. And so, we're basically
2 looking at a couple of options how to deal with that. But,
3 again, we have not been associating it particularly with the
4 oversight process.
5 DR. POWERS: But when I look at the plan, I just
6 can't -- I can't make that disassociation and there are
7 three or four of those similarly on conduct of operations
8 and human factors engineering. It seemed to me that if I
9 were to follow the oversight philosophy, after a while, I
10 just don't need to worry about these things, because -- I
11 mean, to say not worry about is over stated. I don't have
12 to worry about it at the baseline level. I have to worry
13 about it at one or two levels down, okay. Whichever
14 direction we go, I worry about it when I find -- when I have
15 findings. And so, it's not that I don't worry about it at
16 all; it's that I don't worry about it at the baseline level,
17 okay.
18 That, by section, does not come across in the
19 plan. I think what you're telling me is, yeah, it doesn't.
20 But, I think it should. I think it should be explained in
21 the plan, that we're looking at working hours, we're looking
22 at conduct of operations, we're looking at human factors
23 engineering; not to do something day-to-day to the poor guy
24 that's running the plant, but rather when we have findings
25 and we're trying to understand what the cause of these

1 multiple findings are, and it does have to be multiple, but
2 we need to understand working hours, conduct of operation
3 and human factors engineering. That would make it more
4 comprehensible to me why we're going into those.
5 DR. APOSTOLAKIS: Well, that, again, relies on the
6 untested hypothesis.
7 DR. POWERS: That we will pick these things up --
8 DR. APOSTOLAKIS: We will pick these things up.
9 DR. POWERS: -- in the performance indicators?
10 DR. APOSTOLAKIS: And the baseline inspection.
11 DR. POWERS: And/or the baseline inspection.
12 MR. ROSENTHAL: You've had separate briefings on
13 the risk-informing regulations. Let me just give examples
14 of a -- currently, a -- is not a design basis event, but
15 your PRA would say that they -- on a PWI is an important
16 sequence, so -- as well as things where you would reduce the
17 burden. That would be an example where your observations
18 would drive you to perhaps do more. So that we see that a
19 contemporaneous look at human performance ought to drive --
20 or be an input to risk informing the regulations. And then
21 the other thing is that we see this as a source of data to
22 provide information for HRA to drive PRA.
23 The last area, emerging technologies, let me give
24 a specific example. Beaver Valley, within the last six
25 months, they lose an electrical bus and they had 130 some

1 odd alarms come in at the same time. And I would say that
2 that is unfair to the operator and that -- I will, okay.
3 DR. POWERS: Well, that's not news. We had TMI,
4 where we had literally thousands alarms coming in at the
5 same time.
6 MR. ROSENTHAL: Okay. So, it is time to do alarm
7 prioritization. And it's going on, to some extent and
8 that's good. And I'll surely will take advantage of Steve's
9 smart sensors and AI, you know, all different sorts of
10 things. And it's a good thing. You just have to do it
11 carefully. So, if there's definitely an interface between
12 the digital INC plan and what we would know about human
13 performance --we've already looked at some things like alarm
14 -- and provided -- we've written NUREG CRS on alarm
15 prioritization and how do you do -- I've got lost on the NRC
16 Webpage yesterday, looking for generic issues, which is
17 another one of my responsibilities, no less an outsider.
18 Well, if you have somebody then responding to an event on a
19 -- will they be -- they have to be able to navigate through
20 their multiple pages on their CRT and what not. So, there
21 are issues.
22 DR. POWERS: My guess off hand is that the average
23 operator would be better trained on a CRT --
24 MR. ROSENTHAL: Absolutely.
25 DR. POWERS: -- than you were on NCR's Webpage.

1 MR. ROSENTHAL: Yes, sir.

2 DR. POWERS: That's my guess. I don't know how

3 well trained you are on NRC's Webpage.

4 MR. ROSENTHAL: Yes, sir.

5 DR. APOSTOLAKIS: Isn't there an untested

6 hypothesis here again, that the fact that they had 150

7 alarms is bad? How do you know it's bad? And doesn't it go

8 against the current regulatory philosophy that the

9 Commission is promoting, at looking at results, performance?

10 I mean, why shouldn't we expect that an the oversight

11 process, with its performance indicators and baseline

12 oversight process pick up failures that would lead us to the

13 conclusion after we broke down one level, that the number of

14 areas was bad -- was high, too high? What is so special

15 about these that needs to have a separate item? In other

16 words, shouldn't this problem really focus on the first and

17 third key program areas: reactor oversight and risk

18 informing the regulations, and really go out of its way to

19 support these two activities that are, I think, the two

20 major initiatives the Commission has stated? And everything

21 else should be justified, in the context of these two, as

22 opposed to --

23 MR. ROSENTHAL: I don't -- I don't know if I'm

24 doing semantics or what. The reason that we measure this

25 emerging technology and put it out separately is that this

1 is work that's going to be done far in advance of stuff that
2 we're going to see in the oversight process.
3 DR. APOSTOLAKIS: Which is an untested hypothesis.
4 MR. ROSENTHAL: And I -- I would -- I'm going to
5 live to regret that phrase. I would assert that stuff is
6 going on at real plants, okay. Calvert Cliffs, I know,
7 would go into its life exemption with pistol grip controls
8 and fancy flat screen digital displays, of new information
9 systems and all controls. And then at some point, we ought
10 to be able to understand and review it. If we're not going
11 to review it, because it's an information system, then we've
12 given tacit approval. That is okay, if we know what we're
13 doing. So, we ought to be able to get out in front on the
14 emerging technology, so that at a minimum, we understand
15 what's going on and we shouldn't be an impediment to the
16 plant modification. So, at least in my mind, I break that
17 off from the oversight process, which is on a different time
18 scale.
19 DR. APOSTOLAKIS: Wouldn't that -- wouldn't it be
20 better, though, to have ATHEANA out there, say, you know, on
21 the risk informing the regulations? Right.
22 MR. ROSENTHAL: That's --
23 DR. APOSTOLAKIS: Yeah, I know that's what you
24 mean.
25 MR. ROSENTHAL: Well --

1 DR. APOSTOLAKIS: ATHEANA tells us that we have to
2 worry about the error forcing context and that this
3 particular issue may be an important element of the error
4 forcing context. But, at least, you're going through in
5 logic here that is forcing you to think about how important
6 is this issue or how important could it be. And, at the
7 same time by doing this and having those fellows interact
8 with you -- this is another untested hypothesis, but I think
9 the ATHEANA guys will be able to limit bit this motion of
10 things that form an error forcing context, which his
11 something that this committee complained about last time.
12 And some of us on the committee don't see this
13 close collaboration between your group and ATHEANA, so that
14 both of you will benefit from each other. Because, you
15 know, you read ATHEANA and so many things -- anything that
16 anybody can thing about is something that can affect the
17 error forcing context. And then Jack's group can come in
18 and say, wait a minute now, here's what the data says, the
19 evidence, right?
20 MR. ROSENTHAL: Nathan and I met -- have met a
21 couple of times. And I just have to give you an IOU
22 standing up here right now, that, in fact, the intent is
23 that we work close together.
24 DR. POWERS: Well, that is one of the things that
25 I persist in not understanding about the human -- about this

1 plan is the disassociation between this set of activities
2 and this ATHEANA development activity. I mean, why isn't it
3 all part of the same -- or maybe it is, and just does never
4 get mentioned or hidden under PR model development?
5 MR. SIU: Yeah. This is Nathan Siu, Office of
6 Research PRA Branch, in charge of the ATHEANA program. The
7 -- you're right, Dr. Powers, PRA model development doesn't
8 cover ATHEANA. It covers HRA, in general. One of the
9 things that we have to look at is -- one of the things that
10 you have to do is develop the plan for the HRA model
11 development that addresses issues that are covered by other
12 methodologies. I think the question came up this morning
13 about, for example, the ASP HRA. Then when you get --
14 DR. POWERS: It came up with SPAR HRA.
15 MR. SIU: SPAR, sorry.
16 DR. POWERS: That is identical --
17 MR. SIU: That's right, okay. But the point is
18 that we have to come up with a program plan that addresses
19 the variety of activities going on within HRA, within the
20 agency, how they look together. And, obviously, part of
21 that, also, is how we interact with the human performance
22 program. You're right, we have not done a good job of that
23 in the past and Jack and I have spoken about that and sworn
24 internal brotherhood and stuff like that.
25 [Laughter.]

1 MR. SIU: We will work on that and get better.
2 It's obviously not perfect right now.
3 DR. POWERS: Well, I mean there are other things
4 that discuss it. For example, the plan discusses the
5 collection of data. And -- but, we've been collecting data
6 a long time about human performance and things like that.
7 It never seems to do anything. And my example of that is
8 just what we heard about earlier this morning, the same
9 thing that brought up ASP HRA is that they go through and
10 they see -- frequently, they do things with THERP tables and
11 the THERP tables -- the publication date was 17 years ago.
12 I happen to know that much of them was made up from
13 information gathered in the 19 -- late 1960s.
14 MR. ROSENTHAL: It was the early 1960s. I was
15 there.
16 DR. POWERS: You were there. This data never
17 seems to result in any changes in the way we do human
18 reliability analysis. So, why are we collecting it?
19 DR. APOSTOLAKIS: Put another way, would it be
20 time now to revisit the human reliability conduct?
21 MR. ROSENTHAL: It's time to revisit human
22 reliability.
23 MR. SIU: Yeah, and that's -- that's, again, what
24 we have to do in the development of this plan. Let me
25 address this point about the data not telling us that we

1 should change the way we do HRA. Actually, the data have
2 told us that we should change the way we do HRA and that's
3 why we are working on ATHEANA, because it is this notion of
4 looking at the severe accidents -- not severe accidents,
5 excuse me, the major events that have occurred, what are the
6 driving factors underlying those events and, therefore, what
7 are the things that we should be including in the models.
8 Now, I'm using data in a broader sense than just,
9 say, the number of successes and failures. We're looking
10 at, again, what are the factors that have been observed for
11 these different events and trying to develop a way to tie
12 those -- that information from those events into the
13 analysis. Right now, as the committee has noted, our
14 quantification process is -- what shall I say -- it needs
15 improvement and --
16 DR. POWERS: It's geriatric.
17 [Laughter.]
18 MR. SIU: We recognize that we have to do
19 something about that and that's one of the things that we
20 hope to address as part, frankly, of some of the
21 applications work we're doing, for example, in PTS.
22 DR. POWERS: I mean, don't you think that you can
23 make a more persuasive case in your plan to come in and say:
24 my THERP tables are geriatric; I've got better data; please,
25 Commission, give me the money and resources to allow me to

1 bring these into the 21st century? I honestly don't believe
2 the Commission understands that the THERP is fine. I mean,
3 it's been fine for a long time. It's a good way of doing a
4 lot of things. But, you have the database now to take THERP
5 out of the weapons community, where it was defined, and make
6 it specific to the reactor community, and you've got a good
7 database to do that updating. That seems like it ought to
8 appear in the plans somehow.
9 DR. APOSTOLAKIS: Let me give you an example of
10 that. There is a statement in the human reliability
11 handbook that human actions separated in time tend to be
12 independent. Now, with all this evidence about latent
13 errors, I'm not sure that true anymore. It depends on the
14 nature of the latent error. And, yet, we are using that.
15 We have gone to staggered testing of redundant trains now,
16 as opposed to consecutive test. I'm not saying go back to
17 consecutive test, but is that an assumption that is still
18 valued, in light of the evidence of the last 20 years, or
19 should we do something about it? Okay, I'm not particularly
20 concerned about the distributions that Alan Swain put there
21 about individual human actions, because I don't think anyone
22 can really do much better than that; but, there are some
23 assumptions there in the model that I think need
24 questioning.
25 And then, of course, the other point that we made

1 in one of the recent letters is the humans, during normal
2 operations, starting an initiating event, because ATHEANA
3 has focused on recovery actions and as of commission given
4 the initiator.
5 Now, these are issues that, it seems to me, are
6 really important and should be prominent in this. By the --
7 another question, Jack. Plant licensing and monitoring,
8 these are activities that you have to do, you don't choose
9 to do, because you're supporting other offices?
10 MR. ECKENRODE: They're NRR activities.
11 MR. ROSENTHAL: No, these are -- yeah, these are
12 NRR -- most of this whole leg is NRR.
13 DR. APOSTOLAKIS: But the "Y" boxes, rectangles,
14 human factors information system.
15 MR. ROSENTHAL: That's NRR. No, we'll give him
16 the floor in a minute.
17 MR. PERSENSKY: Excuse me, George, this is an
18 agency-wide plan. It is not a research plan. So, their
19 activities are, also, included. So, their activities are
20 included in here and that's where the -- a lot of them are.
21 The first two boxes are really NRR activities, except for
22 some things that we're doing under user need.
23 MR. ROSENTHAL: Let me just pick out one more
24 bubble and then give it to NRR and then take the floor back
25 quickly, and that is that -- and it's a very small effort,

1 but I find it interesting, and that we wanted -- we are
2 doing some small modest effort on econmic deregulation,
3 industry consolidation, and we're trying to get out in
4 front, not waiting for -- to monitor equipment reliability.
5 And there are issues like: what will this industry look
6 like with six or eight generators, rather than utilities,
7 owning multiple plants; what kind of pressures will they be
8 under; what resources will there or not there be to maintain
9 safety.
10 The whole paradigm of a base loaded plant may
11 change, when in the Midwest on a Saturday August afternoon
12 at $2,000 per megawatt hour, you make all the profit for the
13 year on that afternoon. Well -- so, will the very paradigms
14 for how you run a plant change? And if that's true, then
15 what are there --
16 DR. SEALE: Make Shack pay for it.
17 MR. ROSENTHAL: -- are there technological issues
18 that we ought to be addressing? And what we'd like to do is
19 just do a modest amount of thinking, a little bit of
20 research, to get out -- to try to get out in front of what
21 these things would be, rather than waiting.
22 DR. POWERS: You know, it's hard -- hard to be
23 opposed to thinking and getting out in front. On the other
24 hand, in this area -- this is another one of those areas
25 that I say, gee, no matter what they find out, there's

1 nothing they can do with it, because -- suppose a licensee
2 says, I am becoming economically competitive; I don't want
3 all my profit to be on Saturday afternoon in the Midwest in
4 August; and so, I'm cutting my manpower by 50 percent with
5 this plan. And the NRC can say, yeah, and let's look at
6 your performance indicators and they all stay good. They
7 don't do anything about it. Then, how do you act upon this
8 information that you get?
9 MR. ECKENRODE: We're doing a little bit of that
10 in the license transfer area right now --
11 DR. POWERS: Yeah.
12 MR. ECKENRODE: -- in NRR. We're basically
13 approving the organization charts. We have one now that's
14 going to have -- one organization is going to have 20 plants
15 under it and we find that a problem. So, we're doing
16 licensing reviews now, from that point of view.
17 MR. ROSENTHAL: It's an area where I think --
18 before you tell me how I'm going to use the information, I
19 have to invest at least enough to understand what -- to try
20 to get a handle on what -- even what are the issues.
21 DR. APOSTOLAKIS: Let me -- I've got another one.
22 I'm trying to understand what it is we're trying to do here.
23 This is an agency-wide problem, so what is NMSS?
24 MR. ROSENTHAL: I really --
25 DR. APOSTOLAKIS: They don't involve humans in

1 their activities or are they involving --

2 MR. ROSENTHAL: Ideally -- ideally, NMSS would

3 play -- NMSS is, at this point, too busy reinventing itself

4 to participate. My assistant branch chief, John Flack, who

5 is a PRA practitioner is on loan to NMSS, to help them risk

6 inform NMSS activities. I would anticipate that in future

7 years --

8 DR. APOSTOLAKIS: Years.

9 MR. ROSENTHAL: -- years, they would be more --

10 they would be part of an agency-wide plan.

11 DR. POWERS: When we asked this question a

12 year-and-a-half ago, we were told the same thing. So, years

13 is apparently the right time frame.

14 MR. ECKENRODE: Originally, they were players in

15 this. Yeah, they showed up once.

16 DR. POWERS: And then they bowed out quickly.

17 DR. APOSTOLAKIS: Okay. So, that's one

18 observation. The second observation is: is this supposed

19 to be a picture -- a figure of the way things are and there

20 isn't really much we can do about them, or we will try to --

21 we can try to improve these? And if so, who is the

22 decisionmaker that will change this? Is it EDO or is just

23 the three of you? If you agree, then we can change this.

24 I'd like to understand how much flexibility do I have here.

25 If you don't --

1 MR. ROSENTHAL: You have no flexibility.

2 DR. APOSTOLAKIS: No, no, no. These boxes here

3 are there, because Congress said that.

4 MR. ROSENTHAL: No, no, no, no.

5 DR. APOSTOLAKIS: Comment on that.

6 MR. ROSENTHAL: You have no flexibility for my

7 fiscal 2000 efforts. They are being executed right now.

8 DR. APOSTOLAKIS: Okay, right.

9 MR. ROSENTHAL: You have influence over 2001. And

10 your questions that I stood up here and sweated over, we're

11 going to try to address them. I mean, yeah, we really have

12 been responsive on the --

13 DR. APOSTOLAKIS: Who is "we?"

14 MR. ROSENTHAL: In this case, I know that I can

15 affect my -- I know that I can affect my fiscal 2001 and I

16 know that the prodding that you're giving me here will

17 affect the details of what we do in 2001, and you'll have

18 more freedom yet for 2002.

19 DR. APOSTOLAKIS: No, but, the point is --

20 MR. ROSENTHAL: So, we really do pay attention.

21 DR. APOSTOLAKIS: -- if NRR is determined to do

22 some of these things, then it's not entirely up to you to

23 change your program. So, I'm trying to understand who has

24 the final authority here to say, yeah, this is a good idea;

25 we're going to change it. If the three of you agree, it's

1 going to happen or it has to go higher?

2 MR. ECKENRODE: Higher.

3 DR. APOSTOLAKIS: Higher, where?

4 MR. ECKENRODE: It definitely has to go higher.

5 This was going to the Commission.

6 DR. APOSTOLAKIS: All the way to the Commission?

7 MR. ECKENRODE: This plan was presented to the

8 Commission.

9 DR. APOSTOLAKIS: Okay, that's good to know.

10 MR. ROSENTHAL: Okay, NRR?

11 MR. TRIMBLE: Yeah, again, our remarks are limited

12 in nature. And we were going to focus on the elements of

13 the performance plan that relates to the oversight process

14 and we are speaking in a support role to that process. And

15 we've already touched on what I would say our flagship

16 effort, which was to test this hypothesis through the user

17 need that we've been talking about. Steve has finally

18 gotten over to research here, so we can get rolling on that.

19 The second area is -- again, we've touched on the

20 supplementary procedure and all these areas, Dick is going

21 to make a couple additional comments. And that was

22 developed. As we mentioned earlier, it's in draft form and

23 it's to be used two levels down or two levels up. We want

24 to think about it. And that -- the thrust of that is more

25 for an understanding, if the licensee is not to do the work

1 for them, but to understand if they are going about it in
2 the right way.
3 The third area, we've had some sort of hesitating
4 starts in the -- coming up with the significance
5 determination process. We're just -- we came up with a
6 concept. We were kind of presenting it to the oversight
7 folks, getting -- the processing of getting beaten back a
8 little bit and then trying to make advances from a slightly
9 different direction. One area they certainly want us to
10 focus on is what to do with multiple problems across the
11 board. And I have to say that, initially, we were taking
12 the tack of more of the broken operator. What happens if
13 somebody returns? In a requalification setting, if they're
14 found to be lacking in a significant -- risk significant
15 action, they return to shift unremediated. And,
16 particularly, if multiple crews do, then you're sort of set
17 up for failure and you wouldn't pick that up until the event
18 happens.
19 DR. POWERS: Yes.
20 MR. TRIMBLE: So, that was one of the thrusts we
21 were going down. But, again, we're running into, you know,
22 the kinds of things we have to deal with: was that already
23 considered and through some of these other assumptions in
24 the PRAs. And so, we're starting to interface with the PRA
25 people on that.

1 But, enough said on the general overview. Dick's
2 got a little bit more detail for you.
3 MR. ECKENRODE: I'll give you this little
4 presentation. Dave is going to answer all the questions.
5 DR. POWERS: We hardly ever ask any, so.
6 MR. ECKENRODE: I know. Back on the user need
7 that went over to research, the precise words of the
8 assumption that were in that user need are on the top here.
9 The effect of human performance in plant safety will be
10 largely reflected in plant performance indicators and
11 inspection findings. We agree that it's not -- you're not
12 going to get them all, but they expect it will be largely.
13 We are going to try to test that assumption, first
14 through the research user need from their direction, and NRR
15 is going to look at it from -- through our human factors
16 information system program. We intend to -- in that area,
17 we intend to record information from the inspection reports
18 that are going to come out in the new process. And assuming
19 there is sufficient data -- and we're not sure of that yet,
20 because that process is being changed, also, the 50.72
21 process -- if there is sufficient data, we intend to attempt
22 to compare it with the last historic data we have in HFIS
23 for the last five years.
24 DR. SEALE: Could I ask you something about your
25 assumption? I read that and I have difficulty. I don't

1 know whether you're telling me that superior human
2 performance will result in green performance indicators and
3 positive inspection findings, or that efficient human
4 performance will result in white or yellow performance
5 indicators and deficiencies in performance -- in inspection
6 findings.
7 MR. TRIMBLE: I believe the latter is the case,
8 that poor performance would show up --
9 DR. SEALE: Okay.
10 MR. TRIMBLE: -- in these indicators.
11 DR. SEALE: Okay.
12 DR. POWERS: You know, I mean, this is -- I can't
13 tell you how enthusiastic I am about this idea of testing
14 hypothesis and what not, and I think that needs to come
15 across clearly in the plan, that the agency is going back
16 and testing its hypothesis here. Because, I think -- I
17 mean, that's the mark of a really first-rate operation here,
18 and that sense needs to get across.
19 DR. SEALE: Yes.
20 DR. POWERS: And then here, you're telling me,
21 yeah, we're actually going to go use this data for something
22 that we've been collecting. You know, that makes me excited
23 about it, too, and I think that's -- I think it's a --
24 MR. ECKENRODE: We've been using this for a long
25 time, for a lot of different things. This is the first time

1 for this kind of a thing.

2 DR. POWERS: Yes.

3 MR. ECKENRODE: We don't know if it's going to

4 work or not, because, frankly, the new reporting process is

5 going to reduce the amount of data we're going to have and

6 that's can be a problem.

7 DR. POWERS: If you knew it was going to work, it

8 wouldn't be research; it would just be go do it.

9 MR. ECKENRODE: We don't do research in NRR.

10 DR. POWERS: I know. But, you would do this. If

11 you knew this was going to work, you wouldn't have sent it

12 over to research. You would have just sat down and done it,

13 right?

14 MR. ECKENRODE: That's right; sure. The

15 supplemental inspection procedures that you have copies of,

16 it's based on this hierarchy of baseline and supplemental,

17 and then this is a sub-supplemental. So, you understand --

18 we went through that. I don't think I have to talk about

19 that at all.

20 These are the objectives of that. And, again, the

21 purpose is not for us to do the root cause analysis; it's

22 for us to do -- to look at the licensee's root cause

23 analysis process and make sure they're doing it right. Now,

24 obviously, to do that, we're going to have to go down and

25 find out ourselves pretty much what happened, and that's why

1 the detailed procedure that you've seen. As I say, this is
2 a draft procedure. It's gone through NRR. It's out now to
3 the regions for comment. We haven't heard anything yet at
4 all from them. They were quite -- the region were quite
5 happy to see one. They're interested in seeing one, because
6 they feel that their human performance is being given sort
7 of the short shrift in their reports. So, this is the area
8 we're --
9 DR. POWERS: And you can't underestimate how
10 important the corrective action program is. And you've read
11 more AITs than I have, but I can't remember one that comes
12 back and doesn't say something about that the licensees
13 really didn't do this corrective action in the past well, or
14 something like that. I mean, it's a very common thing in
15 AIT.
16 MR. ECKENRODE: Right. These are the areas that
17 you see in the inspection procedure. We looked at the -- in
18 the human system interface area, we looked at both the
19 visual information annex and some mechanization, same as the
20 control function. We look for whether the control function
21 is available and whether it's -- the hardware is there to do
22 the job.
23 The only other two that we said anything about, I
24 guess procedure use and adherence is talked about there, but
25 procedural quality is not. And the reason for that is that

1 the two inspection procedures are still in place for EOPs
2 and for plant procedures. It's IP 42001 and 42700 are still
3 in existence and they would be used for that particular
4 thing.
5 Similarly, training and qualifications, we don't
6 look at all in this procedure. It slipped out, IP 41500.
7 That's why those two are --
8 DR. APOSTOLAKIS: What are work practices?
9 MR. ECKENRODE: Pardon me?
10 DR. APOSTOLAKIS: Work practices?
11 MR. ECKENRODE: This has got to do with all of
12 your work plans and work -- you know --
13 DR. POWERS: Plan the day sort of thing.
14 MR. ECKENRODE: Plan a day; yeah, discussions of
15 -- what do they call them -- tail --
16 MR. BARTON: Pre-job briefings.
17 MR. ECKENRODE: Pre-job briefings, right.
18 DR. APOSTOLAKIS: Where is the work
19 prioritization?
20 MR. ECKENRODE: That's in there, too.
21 DR. APOSTOLAKIS: It's in there?
22 MR. ECKENRODE: Yes. It's part of it.
23 DR. APOSTOLAKIS: I don't know, what -- are we
24 going to have the opportunity to understand the logic behind
25 this, at some point at the subcommittee meeting? Jack, do

1 you plan to have a -- oh, no, it's not Jack. I think we
2 should discuss -- I would like to understand the logic that
3 led you to this set, as opposed to some others.
4 MR. ECKENRODE: This set of areas?
5 DR. APOSTOLAKIS: Yes. I am not saying that --
6 MR. ECKENRODE: This is a common set of human
7 performance areas. And, you know, we talked earlier about
8 safety culture. Yes, there's some of that in here. But,
9 the whole human performance area has -- you know, is
10 involved here. It covers just about everything, except
11 getting into upper management.
12 DR. POWERS: We don't do that.
13 DR. APOSTOLAKIS: I would like to understand this,
14 sir, so maybe in a future subcommittee --
15 MR. ECKENRODE: I'm not sure I understand your
16 misunderstanding or your --
17 DR. APOSTOLAKIS: Why these --
18 MR. ECKENRODE: What other material --
19 DR. POWERS: What's missing. What would you put
20 in?
21 DR. APOSTOLAKIS: Resource allocation, I don't
22 know, where is that?
23 MR. ECKENRODE: Resource allocation is -- it's
24 there.
25 DR. POWERS: That's in there, yes.

1 MR. BARTON: It's not called that, but there's
2 something else that would go and pick that up in here.
3 DR. APOSTOLAKIS: Well, I'd like to understand
4 that. I can replace this by --
5 MR. BARTON: More sufficient workers assigned,
6 appropriate materials available, sufficient time allocated
7 for a job.
8 MR. TRIMBLE: Well, we are certainly willing to
9 talk about it in the future.
10 DR. APOSTOLAKIS: Yeah, I think we should discuss
11 it. I'm not saying it's bad. All I'm saying is I want to
12 understand it.
13 DR. POWERS: We'd be glad to hear your thoughts on
14 it, because we --
15 MR. ECKENRODE: Oh, yes.
16 DR. APOSTOLAKIS: Is this consistent with the
17 Commission's decision a year ago to stop all work on
18 organizational?
19 MR. ECKENRODE: There are no organizational issues
20 in here.
21 DR. APOSTOLAKIS: There are no organizational
22 issues in coordination or work practices.
23 DR. POWERS: They are all here, George, they're
24 just not called organizational issues.
25 MR. TRIMBLE: Let me characterize this. This is,

1 again, a boundary between the old and the new approaches
2 here, and it may be dangerously on that boundary. It's --
3 it is -- actually, it's draft. It was viewed as how on
4 earth do we check and see if licensees -- at some point,
5 they're having problems; at some point, you need to make
6 sure that they are looking at the right spots. You have to
7 satisfy yourself. So, it's a way of providing guidance to
8 the inspectors in an easy to use format.
9 DR. POWERS: Now, my understanding is that I don't
10 think it's on dangerous -- dangerously on the boundary
11 there. This is the sub-sub-supplemental -- I mean, this is
12 after you found things in the new system and you've reached
13 the point where NRC feels it has to do something.
14 MR. ECKENRODE: Okay. The next theory is the
15 significance determination process. This is sort of our
16 objective, is to be able to cover these functional areas.
17 It's -- we may not be successful in it, but we're hoping to.
18 And, again, on the issue areas, the same thing, the seven or
19 eight issue areas there, we'd like to be able to cover all
20 of these through the significance determination process, and
21 to be able to show significance.
22 We're operating on what we consider to be a very
23 basic premise in human factors, which is every human action
24 requires information to initiate the action and control
25 capability to accomplish the action. It gets pretty simple,

1 the idea being that we're going to look at all of the kinds
2 of things that we find and the issues in the expected list.
3 DR. APOSTOLAKIS: So that's interesting
4 information. There's nothing else?
5 MR. SIEBER: Like brain?
6 DR. APOSTOLAKIS: Yes.
7 MR. ECKENRODE: Pardon me?
8 DR. WALLIS: Well, there must be.
9 DR. APOSTOLAKIS: There must be something there.
10 DR. WALLIS: There must something that tells you
11 what to do with the information, in order to initiate it.
12 DR. APOSTOLAKIS: Yeah. I mean, they operators,
13 themselves --
14 MR. ECKENRODE: Not defined through inspections or
15 PI.
16 DR. APOSTOLAKIS: I thought the basic premise was
17 going to be the standard model of your information --
18 processing information and then action. You seem to be
19 skipping the processing of information.
20 MR. ECKENRODE: That's true.
21 DR. APOSTOLAKIS: And you are doing that
22 consciously?
23 DR. WALLIS: He regards that as part of the
24 information, I think.
25 DR. APOSTOLAKIS: No, because there is an

1 assumption that the procedures tell you what to do.

2 MR. ECKENRODE: Yeah, the response to the

3 information, as far as training.

4 DR. APOSTOLAKIS: And I was noticing behavior is

5 not covered by this.

6 MR. ECKENRODE: Right.

7 DR. APOSTOLAKIS: Unusual circumstances that would

8 require some creative thinking is not covered by this.

9 MR. ECKENRODE: That's true.

10 DR. POWERS: This gets -- the significance in

11 determination process gets triggered when there's a -- I

12 mean, they have to find a -- it has to be a finding.

13 MR. ECKENRODE: That's right.

14 DR. POWERS: And a guy saving the plant is going

15 to be in somebody else's bailiwick, because it was initiated

16 by something else.

17 DR. APOSTOLAKIS: So, if it's in low power

18 shutdown, in a situation that the operators understand and

19 they made a mistake, wouldn't go through the SDP?

20 DR. POWERS: Sure, it would. I mean, if they had

21 a fault there, they would come back and say the operators

22 didn't understand that. So, it must be there's inadequate

23 procedures, procedures weren't followed, they didn't have

24 the right information, something like that. That's what

25 he's going to do when he looks at those.

1 DR. SEALE: Training didn't cover the case.

2 MR. ECKENRODE: Right.

3 DR. WALLIS: So, all eventualities are foreseen

4 ahead of time, you're saying.

5 MR. ECKENRODE: Well, we would hope so.

6 DR. POWERS: So, they did not, because the

7 procedure wasn't written for them. So, in essence --

8 DR. APOSTOLAKIS: In essence what they are saying

9 is in this parenthesis up there, display and so on, they

10 define the context for ATHEANA.

11 DR. POWERS: Yeah, they do.

12 DR. APOSTOLAKIS: So, they should stop

13 investigating the context and take these and run with them.

14 You need display, training, procedures, and supervise the

15 action.

16 MR. TRIMBLE: Yes. One of the things -- part of

17 the feedback we were getting on this when we first did this,

18 we sort of thought you need to kind of understand -- go

19 through the process and understand what was missing, so the

20 operator couldn't do the function, and then that would

21 somehow give us a feel for the significance of the problem.

22 One of the bits of feedback we've gotten is, well, maybe

23 this approach -- maybe we're getting into trying to step

24 into the licensee's business too far, too early, and

25 understand the root cause -- getting to a root cause,

1 opposed to limiting ourselves to deciding what the
2 significance is. And that's where we -- we need to go back
3 and -- maybe we're filing the philosophy here and I think --
4 DR. APOSTOLAKIS: I don't think this is accurate
5 what you have there. Training is not information.
6 MR. ECKENRODE: Well, you get the information out
7 of training.
8 DR. APOSTOLAKIS: Yeah.
9 DR. POWERS: I can see what your problem is; but,
10 I guess I'm more supportive than maybe your critics are on
11 this.
12 MR. ECKENRODE: There's two more you can shoot at
13 them. We have -- this is where we're getting -- trying to
14 get into -- we're trying to get into a little bit more of
15 the significance. And the first one, of course, is that no
16 information or control capability is better than incorrect
17 information. You have an incorrect procedure, it's worse
18 than not having a procedure at all, for instance.
19 DR. POWERS: I guess I have troubles believing
20 that this is true, because there are levels of
21 incorrectness.
22 MR. ECKENRODE: Yes, of course.
23 DR. POWERS: There's a minor error and then
24 there's flat -- completely -- it says right, it should have
25 been left, okay. When it's that bad, yeah, I agree with

1 you. When it's a minor incorrectness, then maybe it's not
2 so bad. And I think no is, therefore, incorrect, has
3 gradations.
4 MR. ECKENRODE: Yeah, and the same with the second
5 one.
6 DR. APOSTOLAKIS: How does this affect the SDP?
7 We're talking about the --
8 MR. ECKENRODE: Well, what we're trying, what
9 we're hoping to do, and we -- again, we're very preliminary
10 on this. We haven't gone very far. We're hoping to be able
11 to identify those kinds of things that -- in other words,
12 where information is missing, it's less significant, than if
13 it's incorrect.
14 MR. TRIMBLE: In one case, you might come out with
15 no color, and in the other case, a color.
16 MR. ECKENRODE: Yes.
17 DR. APOSTOLAKIS: So, the SDP would assign the
18 weight --
19 MR. ECKENRODE: Yes.
20 DR. APOSTOLAKIS: -- and make correct --
21 DR. WALLIS: So, what you're really implying is a
22 measure of control capability and its correctness and the
23 correctness -- it's a measure of this. And you're saying
24 that on a scale, plus is better than minus, and zero is in
25 between.

1 MR. ECKENRODE: Yes.

2 DR. WALLIS: But, you're implying there's a

3 measure of these things. So, you have to have that measure.

4 MR. ECKENRODE: Well, that's what we're trying to

5 hope to get. The second one is the -- anything less than a

6 complete failure to perform an action may not be a risk

7 significant as a complete failure.

8 DR. POWERS: I wish you would explain to those

9 people that do severe accidents that there is that

10 possibility, because they keep analyzing accidents that the

11 operator seemed to have died or done something, and don't

12 turn on water unless there's a complete possibility of

13 saving the core. And I think I'm very much -- I would like

14 to see it tested.

15 MR. ECKENRODE: And then, finally, we're hoping to

16 use the information from -- actually from the second view

17 graph, the guidance there from Brookhaven changes the risk

18 important human actions, which is based on Reg Guide 1.174.

19 They have defined a series of significant risk -- they call

20 them risk important actions -- human actions and this is all

21 in the operator area -- well, no, I guess not totally

22 operator area. It defines certain risk important human

23 actions and we basically have said if they fail to do these,

24 they are more significant than others. And we're looking

25 into this as a possibility to feed into the other part here.

1 DR. POWERS: Have we gotten that Brookhaven
2 report?
3 MR. ECKENRODE: We have the draft. I don't know
4 where it stands.
5 DR. POWERS: We haven't seen it.
6 MR. ROSENTHAL: Would you like it?
7 MR. ECKENRODE: I have one more --
8 MR. ROSENTHAL: I'm sorry.
9 MR. ECKENRODE: I bet we're tolling here.
10 MR. ROSENTHAL: I'm sorry; I apologize. I
11 apologize, Dick.
12 MR. ECKENRODE: That's okay. Finally, we have
13 been asked to make sure we consider requal -- or a requal
14 problem, because you actually have a requal inspection
15 procedure. And this is one we're actually are doing fairly
16 well at the moment. We decided these are the qualities we
17 want to look at or the areas we want to look at, both the
18 written JPM and the simulator, but somewhat different
19 things. The quality of the exam, itself, would be looked
20 at, and that's one of the things that's inspected in the
21 requal inspection. Security problems, we've had these with
22 the written exams and have some significance. And, then, of
23 course, the number of failures, one person fails is not as
24 significant as 20 of them failing. We're using this as one.
25 And the same with the JPMs.

1 In the simulator area, actually, the simulator,
2 itself, the quality of scenarios that are being written for
3 the simulator tests. And then in the operational test,
4 itself, whether it's just a single crew that fails or it's
5 mobile crews. You consider -- obviously, you consider
6 mobile crews being more significant than a single crew. And
7 then, as David mentioned earlier, remediation, we're going
8 to go back on shift with or without remediation. We
9 consider it to be quite serious.
10 DR. WALLIS: You use the word "quality" three
11 times here. I wondered if you know what that means, in
12 terms of some explanation, or is it just implied that
13 everybody knows that quality is.
14 MR. ECKENRODE: The requal exams, of course, are
15 written by the licensee. We review the exams before they
16 are given. And in quality there, you can have quality both
17 from the content and from the psychosometric --
18 DR. WALLIS: Quality is somebody's judgment.
19 MR. ECKENRODE: Yes.
20 MR. BARTON: Eyes of the beholder.
21 MR. ECKENRODE: Well, it's not quite in the eyes
22 of the beholder. Some of them are actually incorrect
23 questions or incorrect, and it's how much we have in that.
24 So --
25 MR. TRIMBLE: There certainly is a degree of --

1 degree of subjectivity. What we were trying to capture is
2 what -- if the processes for assessing the operators are
3 broken, then your assurance that their -- is, therefore,
4 reduced, that they're going to take the right actions on
5 shift and post accident initiation. So, we thought that's
6 --
7 DR. WALLIS: I think in terms of these qualities,
8 particularly the second one, it might be worthwhile to break
9 it down, what is it you're trying to measure.
10 MR. ECKENRODE: Well, I'm sure we will. We just
11 haven't gotten that far yet.
12 DR. POWERS: I wonder if you thought about --
13 well, you call that failure, especially with respect to the
14 multiple crew failures under the simulators. Suppose I
15 didn't have any failures, but all my crews kind of get -- I
16 mean, they weren't really sharp. Is there a gradation in
17 there that need to be looked at, especially when you talk
18 about multiple crews. You know, they all get barely passing
19 versus all of them being very good. That usually doesn't
20 happen though.
21 MR. TRIMBLE: When we first started down this
22 track, we were saying, well, you know, if you find
23 performance issues in training, then that might have been --
24 indicate that people that were on shift, there was a risk.
25 They didn't know how to do things while they were on shift.

1 Then the comment came out, wait a minute, that's what
2 training is for. You're supposed to find these things and,
3 therefore, the discussions began to turn towards -- the
4 problem really is if they return to shift with the problem
5 uncorrected, and that's why we got focused in that
6 direction.
7 MR. BARTON: The training program is pretty solid.
8 The licensee offered it in its program. When you get the
9 scenario you just described, I would start looking at the RC
10 examiners.
11 DR. POWERS: Well, I mean that -- I presume that's
12 an outcome --
13 MR. BARTON: sure.
14 DR. POWERS: -- on this. Not holding your feet to
15 the fire is the right way or something. I mean, I think
16 that's -- that is a legitimate outcome in the significance
17 determination process.
18 MR. ECKENRODE: And those are the things that
19 we're doing in the assessment process.
20 DR. POWERS: I am quite excited about your testing
21 the hypothesis that you've settled on and I sympathize with
22 your struggling with this significance determination
23 process, because I sure don't know it.
24 DR. APOSTOLAKIS: Let me ask two questions before
25 you go onto the future activities. We were told this

1 morning that the human performance, in the context of spent
2 fuel pool liability, is different from other things that we
3 study now, because it involves long periods of time,
4 seven-hour shifts, and it's primarily due to organizational
5 failures, the speaker speculated. Where, in this program,
6 are you investigating this? In other words, a similar
7 situation is during the transitions doing low power and
8 shutdown operations, where our colleagues hear from the
9 utility sub telling us there are multiple human actions,
10 sometimes without guidance, and it's public information and
11 so on. Is there a methodology within the program that
12 identifies this different areas, so that proper attention
13 will be paid to them? It seems to me, we have, all of us,
14 jumped onto the ATHEANA bandwagon without realizing, at the
15 time, that this is an important class of human actions, but
16 it's just one class. There are other classes, where perhaps
17 we should do other things. Is there a mechanism within the
18 program for identifying those areas or we'll find them as we
19 go?
20 MR. ECKENRODE: I don't know what inspection
21 procedures are out there. There must be some in that area.
22 I'm not aware of -- you know, I can't identify them. But,
23 there must be inspection procedures in the area.
24 DR. APOSTOLAKIS: Or transition. Jack, are you
25 aware of any during transition periods?

1 MR. ROSENTHAL: We need to get back to -- about
2 the time of the -- Millstone was very popular. We did a --
3 mailed a -- DSEF did a report on spent fuel pool cooling and
4 there are two classes of events: one was loss of heat
5 removal and the other was loss of inventory due to actions,
6 deflate a seal or open -- and we thought that the inventory
7 ones had received -- perhaps received less attention than
8 they might have and that the ones with loss of heat removal,
9 yeah, that was multiple days long. And that report got a
10 fair amount of reviews. So, we'll have to figure out where
11 it falls.
12 The other question, I think, Nathan and I have to
13 work together and get back to you.
14 MR. SIU: Yeah, it's a fair question. One of the
15 things that we're planning to do this summer is to put
16 together a white paper that talks about what are the
17 different methods that have been developed, where do they
18 stand, and some sort of framework. I'm not sure what that
19 framework would be. Obviously, we have to cover different
20 modes of operations, one way of looking at the problem.
21 Yeah, we have to get back to you, in terms of
22 identifying a -- part of a program that would regularly
23 examine these areas and make sure that we're doing things
24 that we need to do.
25 DR. APOSTOLAKIS: But shouldn't the program,

1 though, have some sort of an activity that would search for
2 these different situations and -- as part of something?
3 Participatory or imagination or something, while you're
4 trying sort of a systematic approach -- not a systematic
5 approach -- but identify those different things. And maybe
6 you ought to put some box there. The inputs to the box can
7 be somebody's analysis or can be something from the ASP
8 work. I don't know. But, there ought to be, I think, for
9 identifying these, because we can't have this. We can't be
10 not surprised, but be faced with a new situation, where the
11 guys who did the analysis tell us, you know, we can't use
12 ATHEANA, because ATHEANA is not for this thing. My God, how
13 much money have we spent on ATHEANA? And now you're telling
14 me we can't use ATHEANA? You see, that's the -- anyway,
15 enough said.
16
17 DR. WALLIS: Can I ask a question for you?
18 MR. ROSENTHAL: Yes, of course.
19 DR. WALLIS: I'm a little puzzled. I've heard two
20 very interesting presentations and I was asking myself, do
21 these complement each other? Does one fit in with the other
22 and provide something, which is missing in the other? I
23 don't see how they fit together.
24 MR. ECKENRODE: We -- in the areas that we work
25 in, if we need research done, basically, we send a user need

1 over. And we just did, as a matter of fact, this past
2 weekend in the oversight area.
3 DR. WALLIS: When you made your presentation, you
4 didn't emphasize how it fitted in, in some key way, to --
5 MR. ECKENRODE: No, I did not.
6 DR. WALLIS: -- what you were doing.
7 MR. ECKENRODE: What I saw, the gentleman that was
8 sent to me said they wanted to hear -- they wanted to hear
9 about the oversight activities in NRR and that's why --
10 DR. WALLIS: These are some -- two independent
11 presentations?
12 MR. ECKENRODE: They're connected by that chart.
13 Now, you have to understand, the -- some of the areas of the
14 emerging issues that you're talking about, those are all
15 human needs within NRR, request for none.
16 DR. WALLIS: I know.
17 DR. POWERS: Let me ask a question about user
18 need, in connection with areas. Episodically, NRR has to
19 make the decision on whether to allow manual actions on some
20 safety system, where it has to be automated and to make that
21 decision, presumably you have to know how much time is
22 available. I understand that in your plan, you have an
23 issue in that area?
24 MR. ECKENRODE: Yes, they do.
25 DR. POWERS: Can you tell me what that is? Are we

1 collecting some data on this? I mean, we've had data, but
2 it's been proprietary.
3 MR. ROSENTHAL: You want to get back to 58.8. I'm
4 going to ask Jay -- we have a study going on and to tell you
5 the truth, I'm a mere puppet. And Jay Persinsky is my
6 expert.
7 MR. BARTON: Jay pulls the strings?
8 MR. ROSENTHAL: Yes.
9 MR. PERSENSKY: Not very effectively at all times,
10 unfortunately. The initiative that's mentioned in the
11 program, I mentioned briefly when we were talking about 58.8
12 and B-17 and the closure of B-17. That particular program
13 is one that is addressed right now more at methodology,
14 rather than data. The intent is not, as I indicated, at
15 this point, to endorse 58.8 or the data within it. It's
16 primarily to come up with a risk informed method for the
17 plants to, in fact, determine the times that would be used
18 in the -- for their situation. So, it's very plan specific;
19 but it's more in that a methodology, as opposed to a --
20 collecting a lot of data on that.
21 DR. POWERS: You told me the times had passed us
22 by, but now we're getting to a realistic point --
23 MR. PERSENSKY: Correct. And, in fact, Dick
24 mentioned in the SDP process, the use of a method developed
25 by BNL for -- based on Reg Guide 1174, for the SDP process.

1 Well, that method, in fact, was determined and developed for
2 this operation action time project. So, in fact, there is a
3 lot of interaction.
4 The supplemental inspection that Dick talked
5 about, in fact, we sat around the table for several days
6 working together, to develop that, as an in-house effort.
7 So, there is interaction in that sense. Dr. Apostolakis
8 asked a question about, you know, why these particular
9 topics. Well, these particular topics have shown up in
10 various other activities that we've done, either through our
11 various research topics, our interactions with other
12 agencies, in terms of these are standard -- very standard
13 human factors, categories, or whatever term you want to
14 assign to those topics, as far as what it is that affects
15 human performance. So, these are all things that come out
16 of our interaction with the user.
17 DR. POWERS: Well, in response to your response, I
18 think it's exciting what you're doing to a risk informed
19 selection between manual and automatic operations. That
20 helps a lot in their -- I think when you -- a paragraph to
21 that affect in the plan would make other people
22 enthusiastic, as well.
23 MR. ROSENTHAL: I just want to pick up a couple of
24 points. ACRS review, yes, the ACRS does influence course of
25 actions. They are great proponents for us and more risk

1 informed and I think we're going in the direction that
2 you've -- that you've indicated in the past. We have not
3 achieved the level of being as risk informed as we would
4 like, but we will continue on.
5 The last thing I want to bring up is actually an
6 idea that -- of Jay Persinsky's and it's in the plan. Just
7 like you have thermal hydraulic PIRT meetings, I think we
8 recognize, with some modesty, that we could use some expert
9 assistance and we intend to have actually this fiscal year
10 an experts meeting, to help guide the details of future
11 human performance work. We would, also, plan to have a
12 stakeholders meeting; but, in my mind, you know, a public
13 meeting. Those are -- both would be public. But the
14 stakeholder meeting and the expert meeting would be
15 different meetings.
16 DR. POWERS: With the intention of the expert
17 meetings to deal with things -- apparently what you've got
18 or suggest other things that --
19 MR. ROSENTHAL: Actually, I'm more interested in
20 where should we go in the future. Ideas are precious
21 things.
22 DR. APOSTOLAKIS: Who owns this program?
23 MR. ROSENTHAL: We.
24 [Laughter.]
25 MR. ECKENRODE: The NRC.

1 DR. APOSTOLAKIS: Yeah, the American taxpayer.
2 Who is the guy, who would say, hey, I'm not doing anything
3 here or should, because I would be embarrassed when I have
4 to defend this? If it's a committee, that doesn't help. Is
5 it Jack? I think -- years ago, we hold the letter that it
6 was critical for the human performance program to have a
7 guiding charge. We've gone there. So, it's you.
8 MR. ECKENRODE: Yes, it definitely is.
9 [Laughter.]
10 DR. APOSTOLAKIS: Okay. I have no more questions.
11 MR. TRIMBLE: I can't leave Jack hanging out
12 there.
13 MR. ROSENTHAL: It's fine; that's fine. The
14 refitness program has been in NRR one time. Currently, the
15 DRS -- for the program are taken and we would like a -- we
16 would appreciate a letter.
17 DR. WALLIS: I think it's being thrust upon you.
18 DR. POWERS: Without debating that any further,
19 thank you, Jack. Thank you, John. We have a lot of work to
20 do ahead in the time, because -- because Apostolakis is not
21 going to be with us tomorrow afternoon.
22 DR. APOSTOLAKIS: No. So, I have to be here when
23 you discuss the first two items.
24 DR. POWERS: And that is the intention, is to do
25 the first two items. What I'd like to do, I think, is to

1 take a recess for 10 minutes and then come back and have a
2 first reading and discussion of the joint letter, and then
3 discuss --
4 DR. APOSTOLAKIS: I have some preliminary stuff.
5 DR. POWERS: Okay, discuss the -- we have a
6 performance issue. And then as time available, we will
7 discuss the spent fuel pool risk assessment. And Don has a
8 fourth draft of his safety policy letter, so maybe we can
9 get a first reading on that, as well. Okay, yes -- and we
10 no longer need the transcription.
11 [Whereupon, the recorded portion of the meeting
12 was recessed, to reconvene at 8:30 a.m., Thursday, April 6,
13 2000.]
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REPORTER'S CERTIFICATE

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

NAME OF PROCEEDING: 471ST ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

CASE NO:

PLACE OF PROCEEDING: 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.

Mark Mahoney

Official Reporter

Ann Riley & Associates, Ltd.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D. C. 20555

**March 14, 2000**

**SCHEDULE AND OUTLINE FOR DISCUSSION**
**471st ACRS MEETING**
**APRIL 5-7, 2000**

**WEDNESDAY, APRIL 5, 2000, CONFERENCE ROOM 2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND**

1) 8:30 - 8:35 A.M. Opening Remarks by the ACRS Chairman (Open)
   - 1.1) Opening statement (DAP/JTL/SD)
   - 1.2) Items of current interest (DAP/NFD/SD)
   - 1.3) Priorities for preparation of ACRS reports (DAP/JTL/SD)

2) 8:35 - 10:30 A.M. Spent Fuel Pool Accident Risk for Decommissioning Plants (Open) (TSK/MME)
   - 2.1) Remarks by the Subcommittee Chairman
   - 2.2) Briefing by and discussions with representatives of the NRC staff regarding the proposed final report of a technical study associated with the spent fuel pool accident risk for decommissioning plants, public comments received on the proposed report, and the staff's resolution of public comments.

   Representatives of the nuclear industry will provide their views, as appropriate.

**10:30 - 10:45 A.M. ***BREAK*****

3) 10:45 - 12:15 P.M. Proposed Research Plan for Digital Instrumentation and Control (Open) (REU/AS)
   - 3.1) Remarks by the Subcommittee Chairman
   - 3.2) Briefing by and discussions with representatives of the NRC staff regarding the proposed research plan for digital instrumentation and control.

**12:15 - 1:15 P.M. ***LUNCH*****

4) 1:15 - 2:45 P.M. Proposed White Paper on Risk-Based Performance Indicators (Open) (GA/MTM)
   - 4.1) Remarks by the Subcommittee Chairman
   - 4.2) Briefing by and discussions with representatives of the NRC staff regarding the proposed white paper on risk-based performance indicators.

   Representatives of the nuclear industry will provide their views, as appropriate.

**2:45 - 3:00 P.M.** *****BREAK*****

5) 3:00 - 4:00 P.M. Human Performance Program (Open) (GA/NFD)
   5.1) Remarks by the Subcommittee Chairman
   5.2) Briefing by and discussions with representatives of the NRC staff regarding the revised version of the human performance program.

6) 4:00 - 5:00 P.M. Break and Preparation of Draft ACRS Reports
   Cognizant ACRS members will prepare draft reports for consideration by the full Committee.

7) 5:00 - 7:00 P.M. Discussion of Proposed ACRS Reports (Open)
   Discussion of proposed ACRS reports on:
   7.1) Spent Fuel Pool Accident Risk for Decommissioning Plants (TSK/MME)
   7.2) Proposed Research Plan for Digital Instrumentation and Control (REU/AS)
   7.3) Proposed White Paper on Risk-Based Performance Indicators (GA/MTM)
   7.4) Human Performance Program (GA/NFD)
   7.5) Proposed Revision of the Commission's Safety Goal Policy Statement for Reactors (TSK/GA/PAB)
   7.6) ACRS/ACNW Joint Report on Defense in Depth in a Risk-Informed Regulatory System (TSK/JS/MTM)

**THURSDAY, APRIL 6, 2000, CONFERENCE ROOM 2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND**

8) 8:30 - 8:35 A.M. Opening Remarks by the ACRS Chairman (Open) (DAP/SD)

9) 8:35 - 9:45 A.M. Special Studies for Risk-Based Analysis of Reactor Operating Experience (Open) ( MVB/MTM)
   9.1) Remarks by the Subcommittee Chairman
   9.2) Briefing by and discussions with representatives of the NRC staff regarding special studies of the staff associated with the risk-based analysis of reactor operating experience.

**9:45 - 10:00 A.M.** *****BREAK*****

10) 10:00 - 11:15 A.M. Operating Event at Indian Point Unit 2 (Open) (JJB/PAB)
   10.1) Remarks by the Subcommittee Chairman
   10.2) Briefing by and discussions with representatives of the NRC staff regarding the findings and recommendations of the Augmented Inspection Team, which investigated the reactor trip and partial loss of AC power event that occurred at Indian Point Unit 2 on August 31, 1999.

Representatives of the Indian Point Licensee will provide their views, as appropriate.

11) 11:15 - 11:45 A.M. Reports of the Materials and Metallurgy and Thermal-Hydraulic Phenomena Subcommittees (Open) (WJS/GBW/NFD/PAB)
Discussion of the reports by the Chairmen of the ACRS Subcommittees on Materials and Metallurgy and on Thermal-Hydraulic Phenomena regarding the status of activities associated with the development of a revised Pressurized Thermal Shock Screening Criterion.

Representatives of the nuclear industry will provide their views, as appropriate.

**11:45 - 1:00 P.M.** ***LUNCH***

12) 1:00 - 1:15 P.M. Future ACRS Activities (Open) (DAP/JTL/SD)
Discussion of the recommendations of the Planning and Procedures Subcommittee regarding items proposed for consideration by the full Committee.

13) 1:15 - 1:45 P.M. Report of the Planning and Procedures Subcommittee (Open) (DAP/JTL)
Report of the Planning and Procedures Subcommittee on matters related to the conduct of ACRS business.

14) 1:45 - 2:00 P.M. Reconciliation of ACRS Comments and Recommendations (Open) (DAP, et al./SD, et al.)
Discussion of the responses from the NRC Executive Director for Operations to comments and recommendations included in recent ACRS reports and letters.

15) 2:00 - 3:00 P.M. Break and Preparation of Draft ACRS Reports
Cognizant ACRS members will prepare draft reports for consideration by the full Committee.

16) 3:00 - 7:00 P.M. Discussion of Proposed ACRS Reports
Discussion of proposed ACRS reports on:

16.1) Spent Fuel Pool Accident Risk for Decommissioning Plants (TSK/MME)
16.2) Proposed Research Plan for Digital Instrumentation and Control (REU/AS)
16.3) Proposed White Paper on Risk-Based Performance Indicators (GA/MTM)
16.4) Human Performance Program (GA/NFD)
16.5) Special Studies for Risk-Based Analysis of Reactor Operating Experience (MVB/MTM)

16.6) Proposed Revision of the Commission's Safety Goal Policy Statement for Reactors (TSK/GA/PAB)
16.7) ACRS/ACNW Joint Report on Defense-in-Depth in a Risk-Informed Regulatory System (TSK/JS/MTM)

**FRIDAY, APRIL 7, 2000, CONFERENCE ROOM 2B3, TWO WHITE FLINT NORTH, ROCKVILLE, MARYLAND**

17) 8:30 - 2:00 P.M. **(12:00-1:00 P.M. LUNCH)**
Discussion of Proposed ACRS Reports (Open)
Continue discussion of proposed ACRS reports listed under Item 16.

18) 2:00 - 2:30 P.M.
Miscellaneous (Open) (DAP/JTL)
Discussion of matters related to the conduct of Committee activities and matters and specific issues that were not completed during previous meetings, as time and availability of information permit.

NOTE:

- **Presentation time should not exceed 50 percent of the total time allocated for a specific item. The remaining 50 percent of the time is reserved for discussion.**
- **Number of copies of the presentation materials to be provided to the ACRS - 35.**

# ADVISORY COMMITTEE ON REACTOR SAFEGUARDS BRIEFING

ON

# Draft Final Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants

Glenn B. Kelly
Probabilistic Safety Assessment Branch
Office of Nuclear Reactor Regulation

April 5, 2000

## TECHNICAL CONTRIBUTORS

| | NRR | RES |
|---|---|---|
| Coordination: | Diane Jackson<br>Tanya Eaton<br>George Hubbard | |
| Risk Assessment: | Glenn Kelly<br>Michael Cheok,<br>Gareth Parry<br>Mark Rubin | Nathan Siu |
| Seismic: | Goutam Bagchi<br>Robert Rothman | Nilesh Chokshi<br>Robert Kennedy (consultant) |
| Criticality: | Larry Kopp<br>Anthony Ulses | |
| T-H: | Joseph Staudenmeier | Christopher Boyd |
| Consequences: | | Jason Schaperow |

## TECHNICAL CONTRIBUTORS
## (Cont.)

| | |
|---|---|
| **Heavy Loads:** | **Edward Throm** |
| **Safeguards:** | **Robert Skelton** |
| **EP:** | **James O'Brien** |

# BACKGROUND AND STATUS

- June 1999 preliminary draft report concluded that:

  - Zirconium fires can occur for several years after shutdown

  - The offsite consequences are very high

  - Frequency about 2E-5 per year. Dominated by human error

- Extensive scrutiny by industry and other stakeholders; NRC sponsored technical review of preliminary draft

- Industry committed to design and operational actions, and proposed a seismic checklist

- Risk has been requantified and draft report prepared

- Draft-for-comment issued 2/15/00

# TECHNICAL RESULTS

- In current draft report, risk is reduced significantly due primarily to industry commitments

  - Human-error driven sequences reduced to about 2E-7 per year

  - Heavy load sequences reduced to about 2E-7 per year

# TECHNICAL RESULTS
(Cont.)

- Seismic failure frequency bounded by 3E-6 per year, but not fully quantified due to seismic checklist approach

- Overall risk estimate reduced by about an order of magnitude

- Criticality issue and most stakeholder comments addressed

# TECHNICAL RESULTS
(Cont.)

- NRC analysis to date shows that zirconium fires will generally not be possible after 5 years. Acceptance of shorter times would require plant-specific analysis

# COMPARISON WITH OTHER RISK MEASURES AND RESULTS

- Decommissioning reactor large release frequency: <3E-6
- RG 1.174 large early release (LERF) baseline guideline (below which only a small increase in risk will be allowed): 1E-5
- Range of IPE LERF estimates: 2E-6 to 2E-5
- Pool Performance Guideline: 1E-5

# THREE PHASES OF A SPENT FUEL POOL

- **IMMEDIATELY AFTER PLANT SHUT DOWN:**

  **Large early offsite release due to zirconium fire possible.**

  **Design basis systems and operating practices retained. Full requirements for EP, indemnification, and security in place**

- **EARLY DECOMMISSIONING PHASE**

  **Large late releases possible. Relaxation of EP requirements justified technically.**

  **Meeting industry commitments, seismic checklist, and staff assumptions required.**

Frequency of large releases within RG 1.174 guidance that allows for small increases in risk. NRC might consider insurance relief.

Staff analyzed pools with one year of cool down, but shorter times might be justified.

- ZIRCONIUM FIRES NO LONGER POSSIBLE:

  Report justifies 5 years. Shorter times might be justified plant-specifically

  There may be technical justification for elimination of Offsite EP and insurance requirements in this phase

# RISK INFORMED-DECISION MAKING

- **Baseline risk and changes to risk**

  **The results of the risk assessment show that the estimated risk from operating decommissioning spent fuel pools is within the PPG guidelines that are based on RG 1.174.**

- **Margin**

  **Thermal inertia of fuel and SFP volume give significant time for heat up to a zirconium fire.**

- **Defense in Depth (DID)**

  **Given the margin in SFPs, DID is not a major issue. However, given risk analysis findings including uncertainties, the technical results provide justification for retaining a baseline level of EP, including procedure to classify accidents and notify offsite authorities.**

  **In the late decommissioning phase, there is no technical basis for retaining EP.**

- **Monitoring performance**

  **Licensees should monitor characteristics important to controlling risk, including industry commitments, staff assumptions, and seismic checklist.**

# IMPACT ON RULE MAKING

- Slow evolution of release justifies reduction in EP requirements. Risk insights and defense-in-depth considerations indicate need for retaining a baseline EP capability.

- Risk analysis does not justify reduction in security function. Reduction of requirements might be justified on the basis of reduced complexity

- Current report does not take a position on indemnification. The frequency of zirconium fire is not "incredible," but may be low enough for the commission to conclude that licensees could be relieved from insurance requirements. However, some operating plants have comparably low frequencies of large releases.

- **Rule making should include requirement to monitor performance in areas important to risk.**

- **In the late decommissioning phase, there is no technical basis for retaining EP. The draft report did not directly address indemnification issues.**

# Consequence Evaluation for Spent Fuel Pool Accidents

## Presentation to the Advisory Committee on Reactor Safeguards

**Jason Schaperow**
**Safety Margins and Systems Analysis Branch**
**Division of Systems Analysis and Regulatory Effectiveness**
**Office of Nuclear Regulatory Research**

**April 5, 2000**

# Consequence Assessment

## Object of the analysis

Assess effect of 1 year of decay on offsite consequences
Assess effect of early vs. late evacuation

## Summary of approach

Use the MACCS code with fission product inventories for 30 days and 1 year after final shutdown

## Conclusion

Short-term consequences (early fatalities) reduced by a factor of 2 from 30 days to 1 year. Early evacuation reduces early fatalities by up to a factor of 100.

Long-term consequences (cancer fatalities and societal dose) less affected by additional decay and early evacuation

## Results

| Mean Consequences for Surry Population Density | | | | |
|---|---|---|---|---|
| Decay Time Prior to Accident | Distance (miles) | Early Fatalities | Societal Dose (person-rem) | Cancer Fatalities |
| 30 days | 0-100 | 1.75 | $4.77 \times 10^6$ | 2,460 |
| 1 year | 0-100 | 1.01 | $4.54 \times 10^6$ | 2,320 |
| 1 year[1] | 0-100 | .0048 | $4.18 \times 10^6$ | 1,990 |

[1]Based on evacuation before release.

## Effect of Ruthenium

**Small-scale Canadian tests with an air environment show significant ruthenium release following cladding oxidation.**

**MACCS calculations show that release of all ruthenium increases early fatalities by up to a factor of 100, because the assumed form (oxide) has a large dose per Ci inhaled due to its long clearance time from the lung.**

**Mitigating factors for ruthenium releases in spent fuel pool accidents**

- **rubbling of the fuel may limit air ingression**
- **1 year half-life of ruthenium**

**PHEBUS test planned to examine effect of air ingression on a larger scale in an integral facility**

# Results

| Mean Consequences for Surry Population Density | | | | |
|---|---|---|---|---|
| **Decay Time Prior to Accident** | **Distance (miles)** | **Early Fatalities** | **Societal Dose (person-rem)** | **Cancer Fatalities** |
| 1 year | 0-100 | 1.01 | $4.54 \times 10^6$ | 2,320 |
| 1 year (100% ruthenium release) | 0-100 | 95.3 | $9.53 \times 10^6$ | 9,150 |
| 1 year (100% ruthenium release)[1] | 0-100 | .13 | $6.75 \times 10^6$ | 6,300 |

[1]Based on evacuation <u>before</u> release.

**Conclusion: Effect of ruthenium release can be very significant, but can be offset by early evacuation.**

# Research Plan for Digital Instrumentation and Control (I&C)

ACRS Meeting

April 5, 2000

Steven Arndt , SMSAB/DSARE/RES
Sher Bahadur, ERAB/DET/RES
Matthew Chiramal, EEIB/DE/NRR

# Presentation Outline

- Introduction - Sher Bahadur, Chief, ERAB/DET/RES
- Regulatory Review - Matthew Chiramal, EEIB/DE/NRR
- Research Plan - Steven Arndt, SMSAB/DSARE/RES
- Conclusion - Sher Bahadur, Chief, ERAB/DET/RES

# Introduction

- Purpose
  - To Present the Digital I&C Research Plan for ACRS Review.
- Basis for the Plan
  - Input From Various Organizations
    - Workshop on Man-Machine Interface (NUREG/CR-5348), 7/1989
    - Workshop on Digital Systems Reliability (NUREG/CP-0136), 9/1993
    - NRC/NAS Report on Digital Instrumentation and Control Systems in Nuclear Power Plant: Safety and Reliability Issues, 1/1997
    - ACRS Report on Research Programs, 1998
    - Expert Panel on Digital Systems Research, 9/1999
  - NRR Needs to Respond to Industry Efforts
  - Agency's Need to Get Prepared for Future
- Briefing Include two parts:
  - (i) Regulatory Framework and
  - (ii) Description of the Digital I&C Research Plan

# Digital I&C System Review Process

- Guidance for review in sections of SRP Chapter 7 Review of digital systems based on IEEE Standards 603 (10 CFR 50.55a(h)) and 7-4.3.2 (RG 1.152)
- Topical Report reviews and Plant Specific reviews (To Be Completed in FY2000)
  - Five topical reports: (1) Siemens Teleperm XS, (2) ABB-CE Common Q, (3) Westinghouse ASIC, (4) Triconex PLC, and (5) Westinghouse Ovation (E-3)
  - Expect plant-specific applications using approved platforms

# NRR User Need for RES

- **SRP Chapter 7 guidance adequate for review of digital I&C**
- **Based on the combination of meeting NRC Goals** (maintain safety, increase public confidence, reduce unnecessary regulatory burden, and make NRC activities and decisions more effective, efficient, consistent, and practical) **and keeping pace with the rapid changes in digital technology and assessment practices**, **NRR requested RES conduct research in support of new user needs for digital I&C**
- **With the primary goal of maintaining safety, the user needs aim to:**
  - **Improve efficiency of the review of plant-specific applications using approved platforms**
  - **Address reliability and risk considerations**
  - **Reflect evolving technology aspects**
  - **Keep current with industry standards and practices**

# Program Goal and Outputs

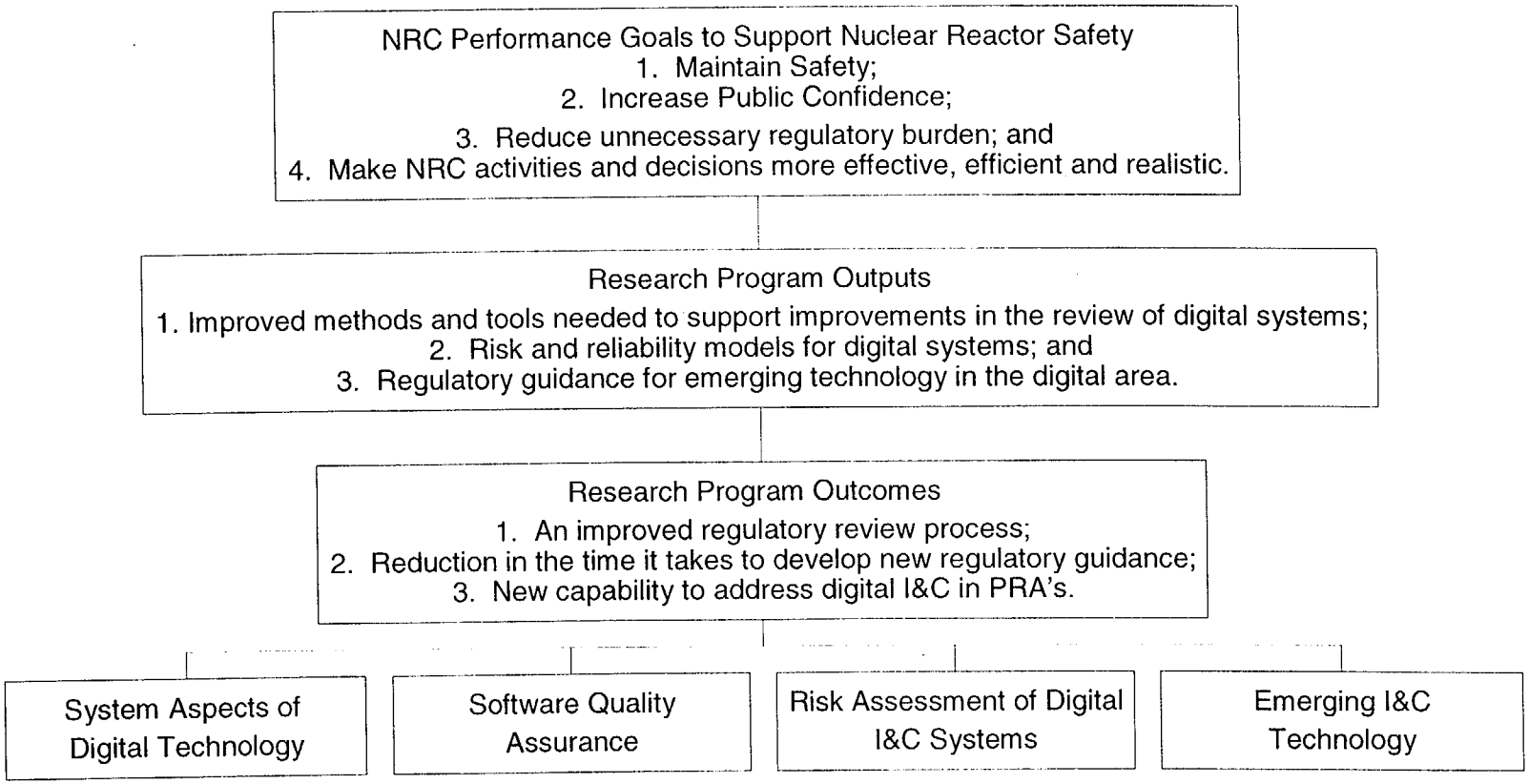
- Program Goal
  - Continue to assure, no unanticipated failures on digital system in the face of implementation of ever changing technology.

<u>Outputs</u>

- Improved methods and tools needed to support improvements in the review of digital systems;
- Risk and reliability models for digital systems;
- Regulatory guidance for emerging technology in the digital area.

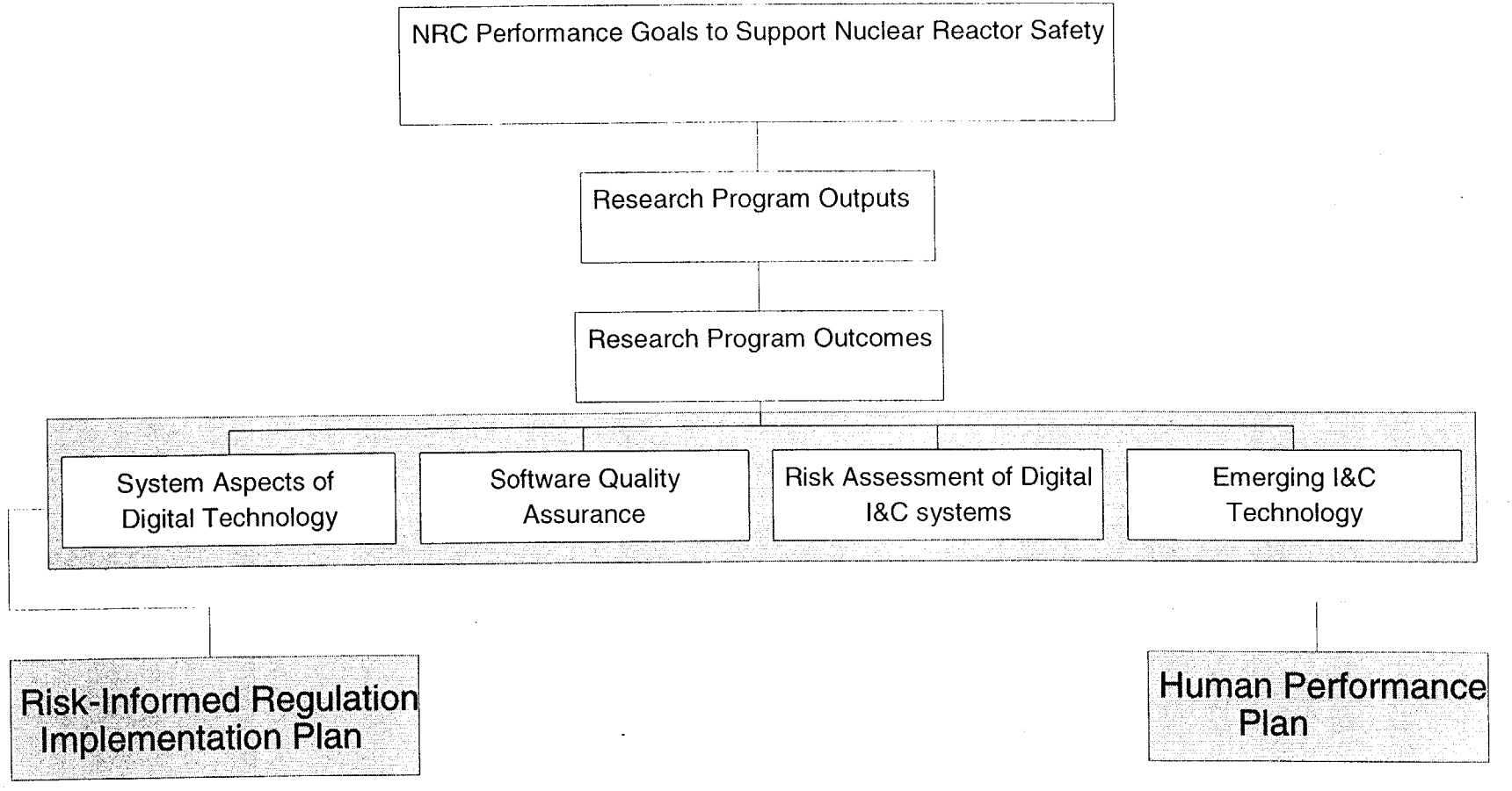
# Outcomes

- An improved regulatory review process;
- Reduction in the time it takes to develop new regulatory guidance;
- New capabilities to address digital I&C systems in PRA's and other tools.


NRC Performance Goals to Support Nuclear Reactor Safety
1. Maintain Safety;
2. Increase Public Confidence;
3. Reduce unnecessary regulatory burden; and
4. Make NRC activities and decisions more effective, efficient and realistic.
Research Program Outputs
1. Improved methods and tools needed to support improvements in the review of digital systems;
2. Risk and reliability models for digital systems; and
3. Regulatory guidance for emerging technology in the digital area.
Research Program Outcomes
1. An improved regulatory review process;
2. Reduction in the time it takes to develop new regulatory guidance;
3. New capability to address digital I&C in PRA's.
System Aspects of Digital Technology
Software Quality Assurance
Risk Assessment of Digital I&C Systems
Emerging I&C Technology

# Research Areas

- System Aspects of Digital Technology
- Software Quality Assurance
- Risk Assessment of Digital I&C Systems
- Emerging I&C Technology and Applications


NRC Performance Goals to Support Nuclear Reactor Safety
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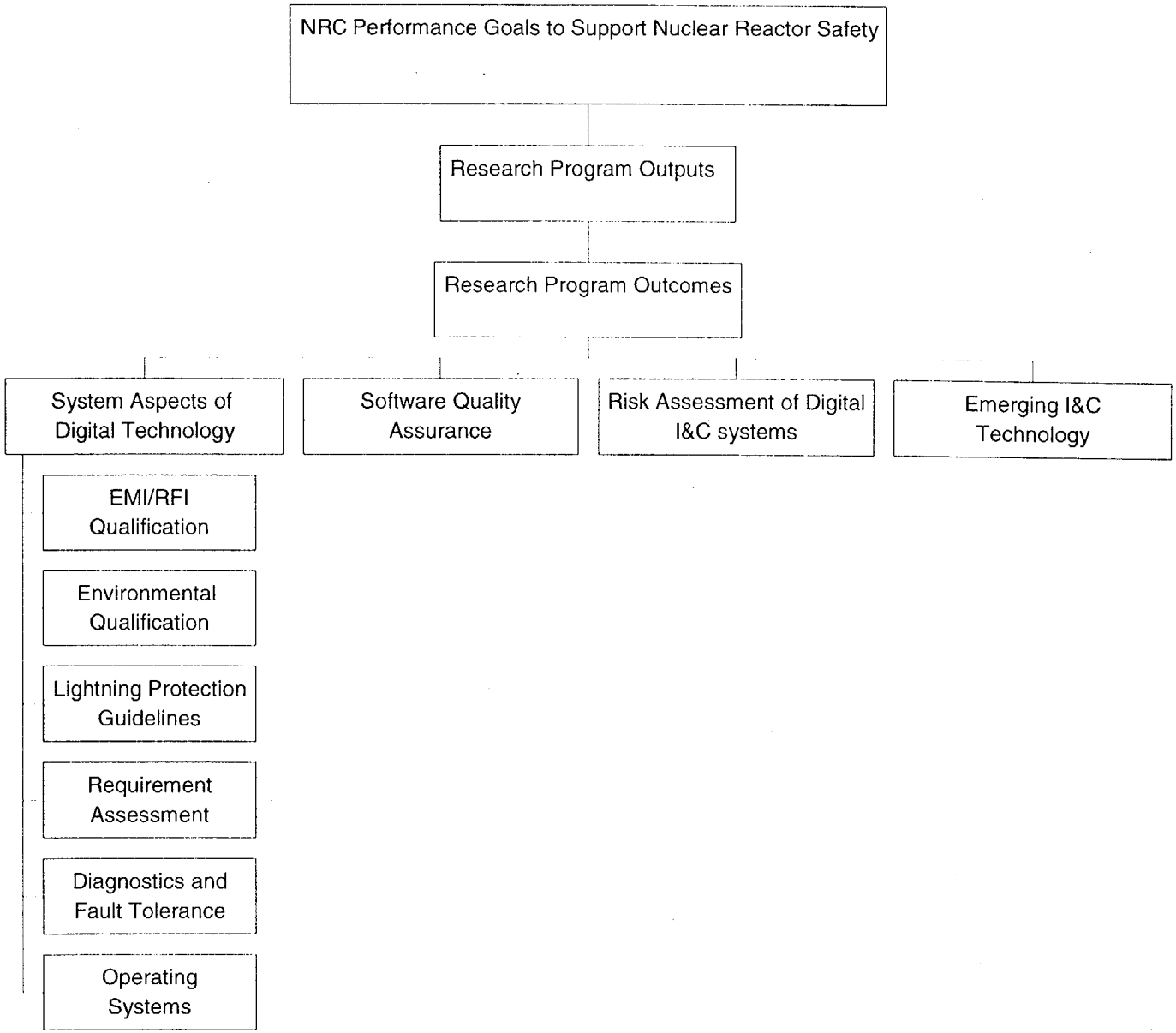
Risk-Informed Regulation Implementation Plan
Human Performance Plan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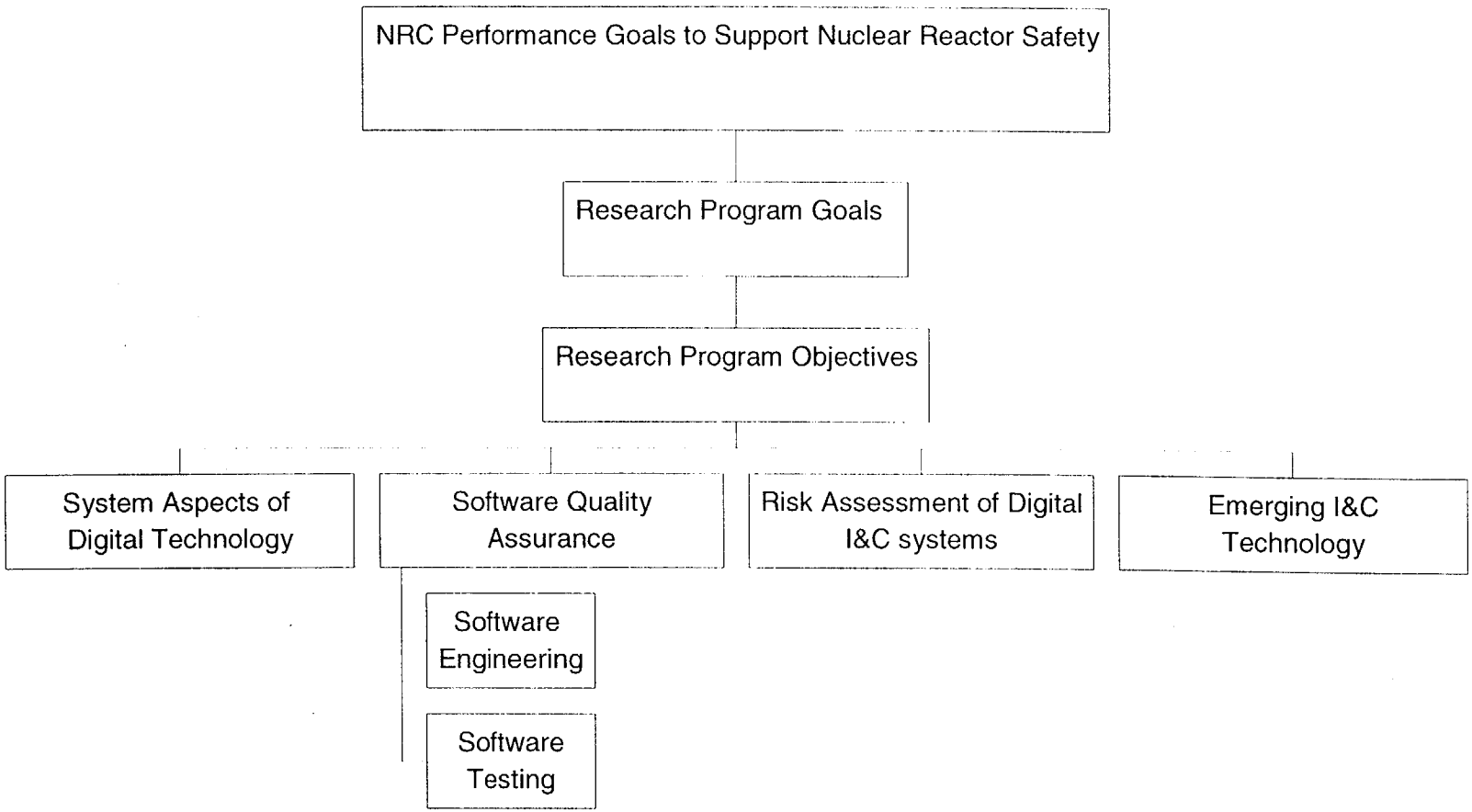
EMI/RFI Qualification
Environmental Qualification
Lightning Protection Guidelines
Requirement Assessment
Diagnostics and Fault Tolerance
Operating Systems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Research Program Goals
Research Program Objectives
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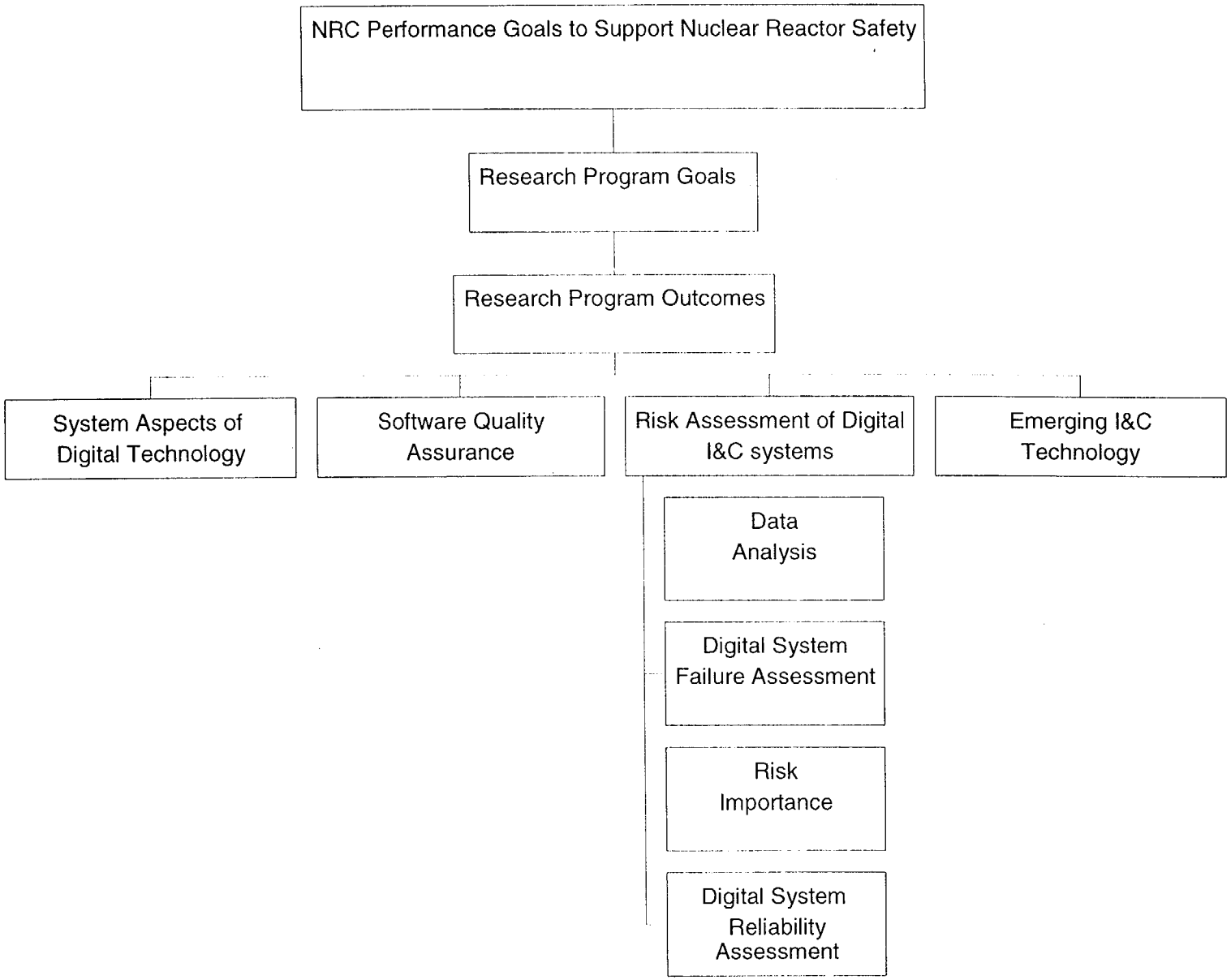
Software Engineering
Software Testing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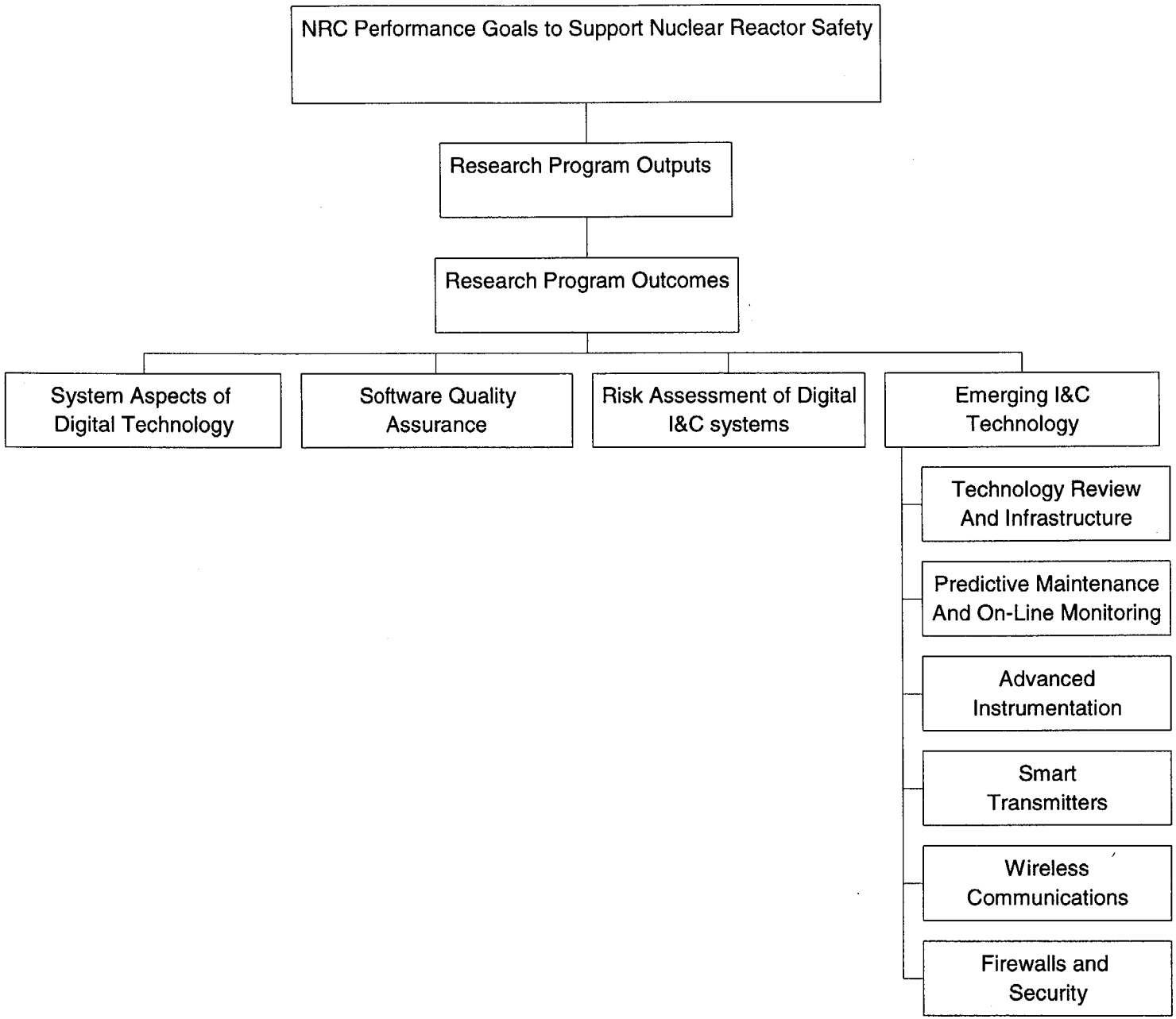
Data Analysis
Digital System Failure Assessment
Risk Importance
Digital System Reliability Assessment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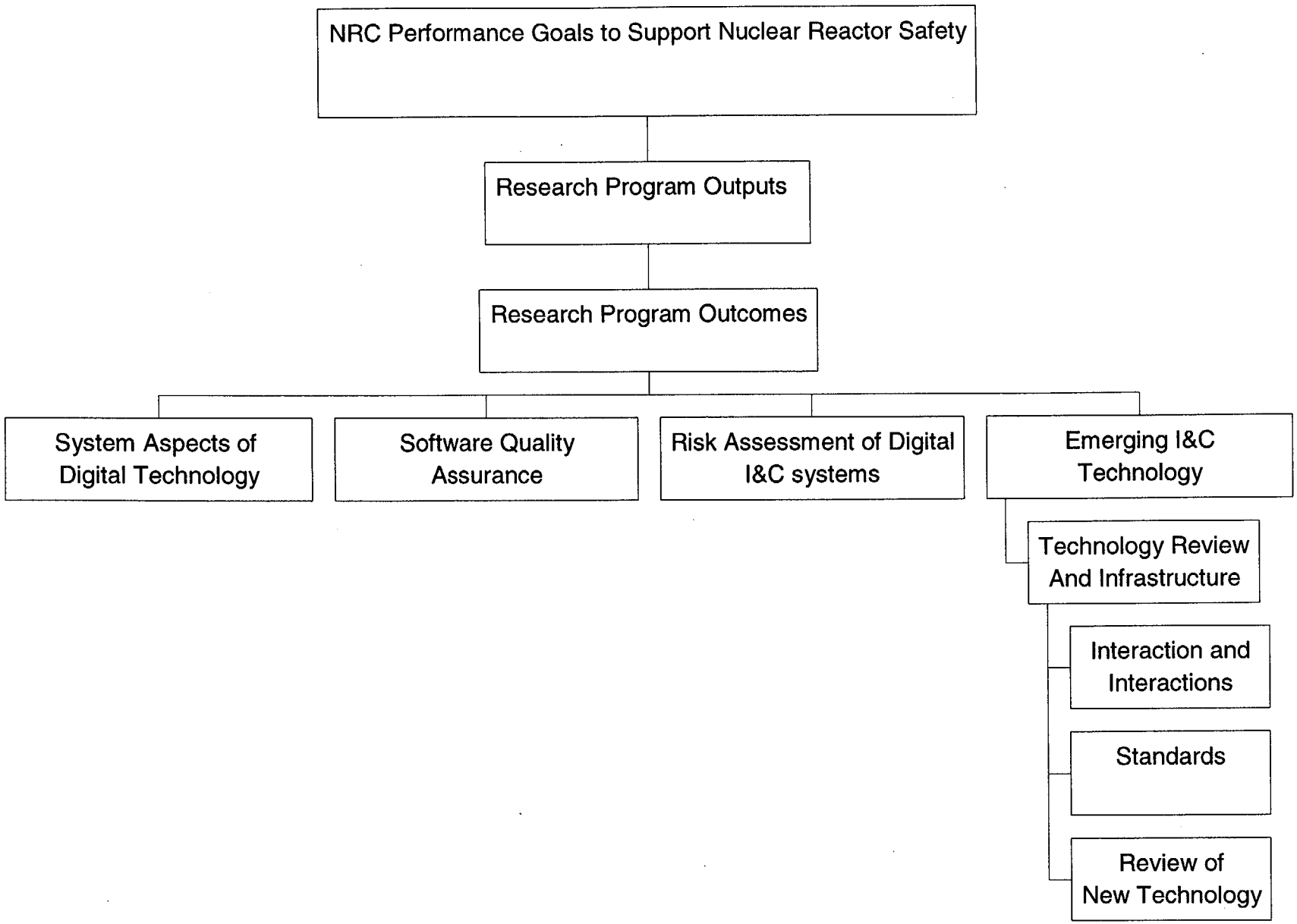
Technology Review And Infrastructure
Predictive Maintenance And On-Line Monitoring
Advanced Instrumentation
Smart Transmitters
Wireless Communications
Firewalls and Security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Technology Review And Infrastructure
Interaction and Interactions
Standards
Review of New Technology

# Conclusions

- Forward looking five year Research Plan
- Plan includes NRR user needs
- Plan also addresses emerging technology
- Implementation of the Plan would involve in-house research, contractor assistance, cooperative programs at universities, and participation in International programs.
- Schedule

# Back-up slides

# Topical Report Reviews and Issues

- Issues associated with the digital equipment under review:
  - Commercial-grade dedication process
  - Environmental qualification
  - Defense-in-depth and diversity
  - Verification and validation activities
  - Configuration management
  - Interface with plant equipment
  - Real-time performance

# Topical Report Reviews and Issues (contd.)

- Plant-specific issues:
  - System requirements
  - Hardware differences and existing plant equipment interfaces
  - Application-specific software integration with qualified platform
  - Technical specification modifications
  - Defense-in-depth and diversity determination
  - Implementation of design
- Topical Report reviews expected to be completed this year

# Systems Aspects of Digital Technology

- *Environmental Stressors*
  - Includes electromagnetic interference/radio-frequency interference (EMI/RFI), temperature, humidity, smoke, and lightning. Research efforts will provide appropriate acceptance criteria for the qualification of digital equipment against these stressors.
- *Digital Requirement Specifications*
  - Currently, it is difficult to review requirement specifications for correctness and completeness. Research efforts will provide the best methods and tools for the review of requirements specifications.

# Systems Aspects of Digital Technology

- *Diagnostics and Fault-Tolerance*
  - Special features that enable the system to detect internal problems and either avoid, handle, or alert the operator to the problem. Research efforts will investigate both positive and negative safety impacts and determine the amount of credit that should be given to them in a review.
- *Operating Systems*
  - Controls communication functions, memory management, and processor scheduling. These systems are becoming larger and more complex, making the review of such systems difficult. Research efforts will identify the aspects of operating systems that may adversely impact safety.

# Software Quality Assurance

- *Objective software engineering criteria*
  - Research results from academia and other industries show potential software measures that could be used to establish minimum software quality acceptance levels. Research efforts will investigate the potential of using such measures for NRC regulatory purposes.
- *Criteria for software testing*
  - Software tests and testing criteria are important to the assessment of software quality. Research efforts will support software quality assessments by analysis of software test criteria.

# Risk Assessment of Digital I&C Systems

- *Digital I&C failure data*
  - Research efforts will gather and assess digital failure data from domestic/foreign nuclear power plants and other industries having digital systems that are critical to safety. Particular attention will be paid to commercial off-the-shelf digital I&C equipment.
- *Digital failure assessment methods*
  - Used by defense and aerospace industries to determine types of failures and their impact on overall safety, these methods can be useful in nuclear application. To ensure the quality of digital failure assessments, research efforts will provide criteria outlining the use of failure assessment methods.

# Risk Assessment of Digital I&C Systems

- *Risk-importance of digital I&C systems*
  - Risk-importance can help NRC determine the required level of regulatory review for digital upgrades and focus research efforts on those aspects of digital I&C systems having a significant impact on plant safety. This research will focus on the development of methods to support this.
- *Digital reliability assessment methods*
  - Several reliability assessment methods have been used by other industries and show potential for use in the nuclear industry. Research efforts will identify digital reliability assessment methods that are applicable to the nuclear industry and provide criteria for their proper use.

# Emerging I&C Technology and Applications

- *Predictive maintenance and on-line monitoring systems*
  - Provide the automatic capability to determine system/component failure or the need for maintenance. Research efforts will analyze the positive and negative safety impacts of this technology.
- *Advanced instrumentation*
  - Measuring flow, temperature, pressure, neutron flux, and other plant variables hold the potential to improve upon plant efficiency, safety, or both. To make timely and informed regulatory decisions involving advanced instrumentation the NRC will develop the technical bases surrounding this emerging technology.

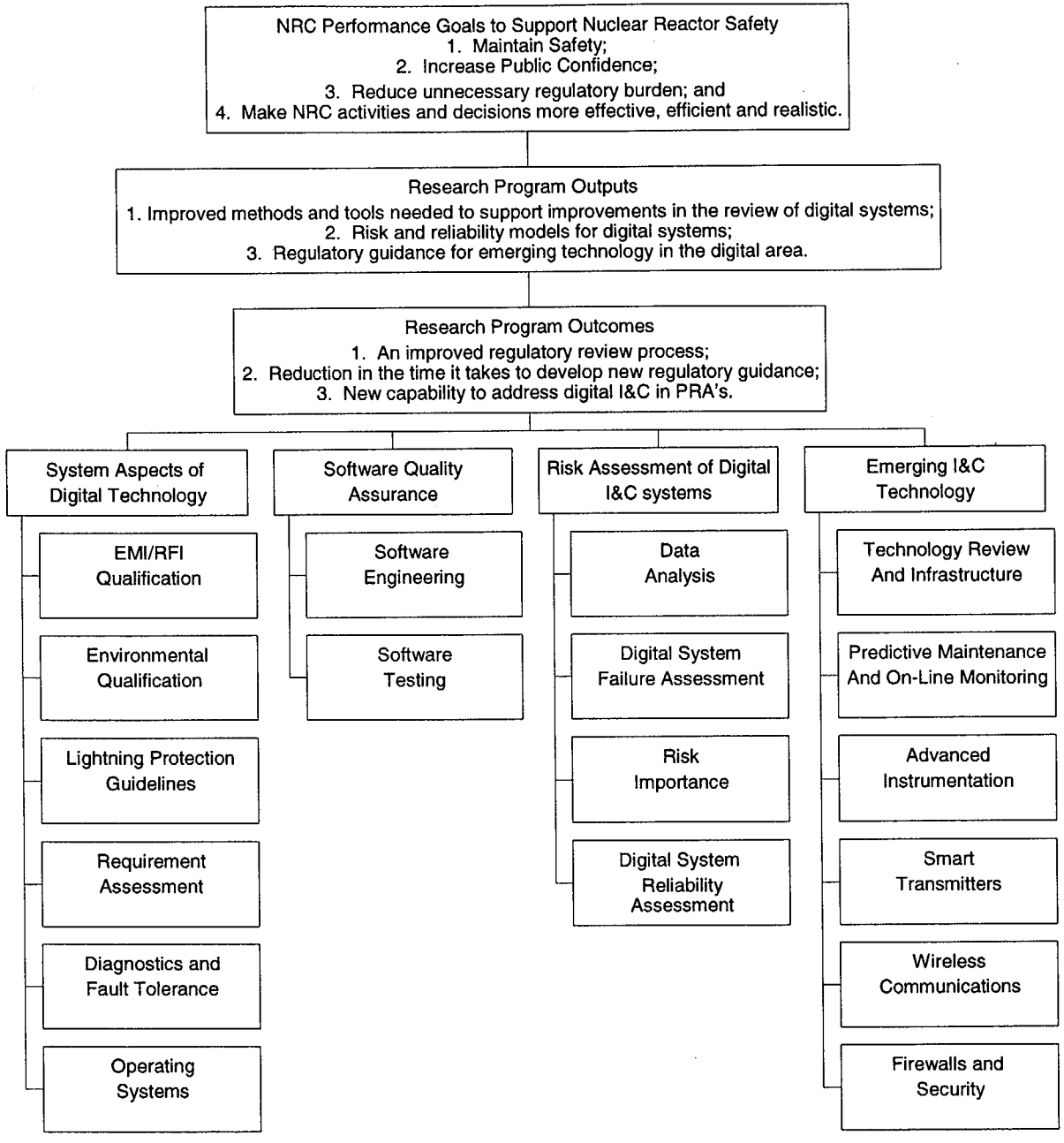
# Emerging I&C Technology and Applications

- *Smart transmitters*
  - Smart transmitters can provide additional information and capabilities for providing compensating measures for instrument error or control functionality. Research efforts will provide information on this technology.
- *Wireless communication*
  - This technology can eliminate some of the problems associated with cables, it also has its own inherent problems which will be identified by the digital I&C research program.
- *Firewalls*
  - Research will be conducted to assess the potential for corruption/degradation of computers in nuclear power plants.

# Emerging I&C Technology and Applications

## Technology Review and Infrastructure

- *Develop and maintain interactions and interfaces*
  - Formal and informal interactions with the industrial, academic and regulatory communities with relevant digital I&C applications as recommended by the National Academy of Science report.
- *Standards*
  - Revise existing regulatory guides, as appropriate to include updated standards.
- *Review new technology*
  - Review new technology; attend professional meetings; and develop new technical capabilities.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1. Maintain Safety;
2. Increase Public Confidence;
3. Reduce unnecessary regulatory burden; and
4. Make NRC activities and decisions more effective, efficient and realistic.
Research Program Outputs
1. Improved methods and tools needed to support improvements in the review of digital systems;
2. Risk and reliability models for digital systems;
3. Regulatory guidance for emerging technology in the digital area.
Research Program Outcomes
1. An improved regulatory review process;
2. Reduction in the time it takes to develop new regulatory guidance;
3. New capability to address digital I&C in PRA's.
System Aspects of Digital Technology
EMI/RFI Qualification
Environmental Qualification
Lightning Protection Guidelines
Requirement Assessment
Diagnostics and Fault Tolerance
Operating Systems
Software Quality Assurance
Software Engineering
Software Testing
Risk Assessment of Digital I&C systems
Data Analysis
Digital System Failure Assessment
Risk Importance
Digital System Reliability Assessment
Emerging I&C Technology
Technology Review And Infrastructure
Predictive Maintenance And On-Line Monitoring
Advanced Instrumentation
Smart Transmitters
Wireless Communications
Firewalls and Security

# RISK-BASED PERFORMANCE INDICATORS
# and
# INDUSTRY-WIDE PERFORMANCE MEASURES DEVELOPMENT PROGRAM

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PRESENTATION TO ACRS
APRIL 5, 2000

# RISK-BASED PERFORMANCE INDICATOR DEVELOPMENT

- Purpose of the risk-based performance indicator white paper:

  To provide an overview of the current effort to develop risk-based performance indicators (RBPIs)

- Briefing includes:
  - Background
  - What are RBPIs?
  - Benefits of RBPIs
  - Where RBPIs potentially fit into revised reactor oversight process (RROP)
  - Process of developing RBPIs

# BACKGROUND

| | |
|---|---|
| • RBPI concept presented to Commission | August 1995 |
| • Plan revised for risk-based analysis of reactor operating experience | December 1995 |
| • RBPI concept presentations to ACRS | 1995 to present |
| • EDO tasking memorandum Task III.A | August 1998 |
| • AEOD RBPI program plan memorandum to NRR and RES | October 1998 |
| • Revised Chairmans' tracking memorandum Task III.B | January 2000 |
| • Draft RBPI white paper | February 2000 |

# WHAT ARE RBPIs?

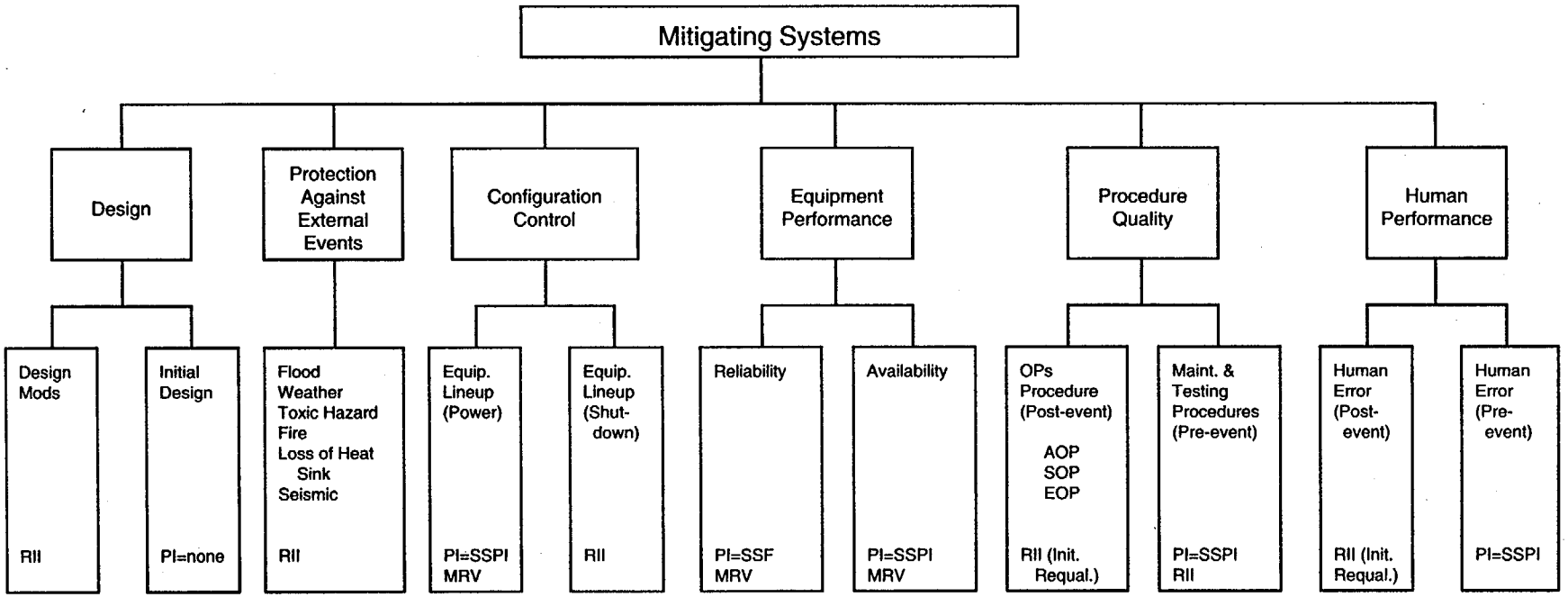
- RBPIs reflect changes in licensee performance logically related to risk and associated models

- "Performance" refers to those activities in design, procurement, construction, operation and maintenance that support achievement of the objectives of the cornerstones of safety in the revised reactor oversight process

# WHAT ARE RBPIs?

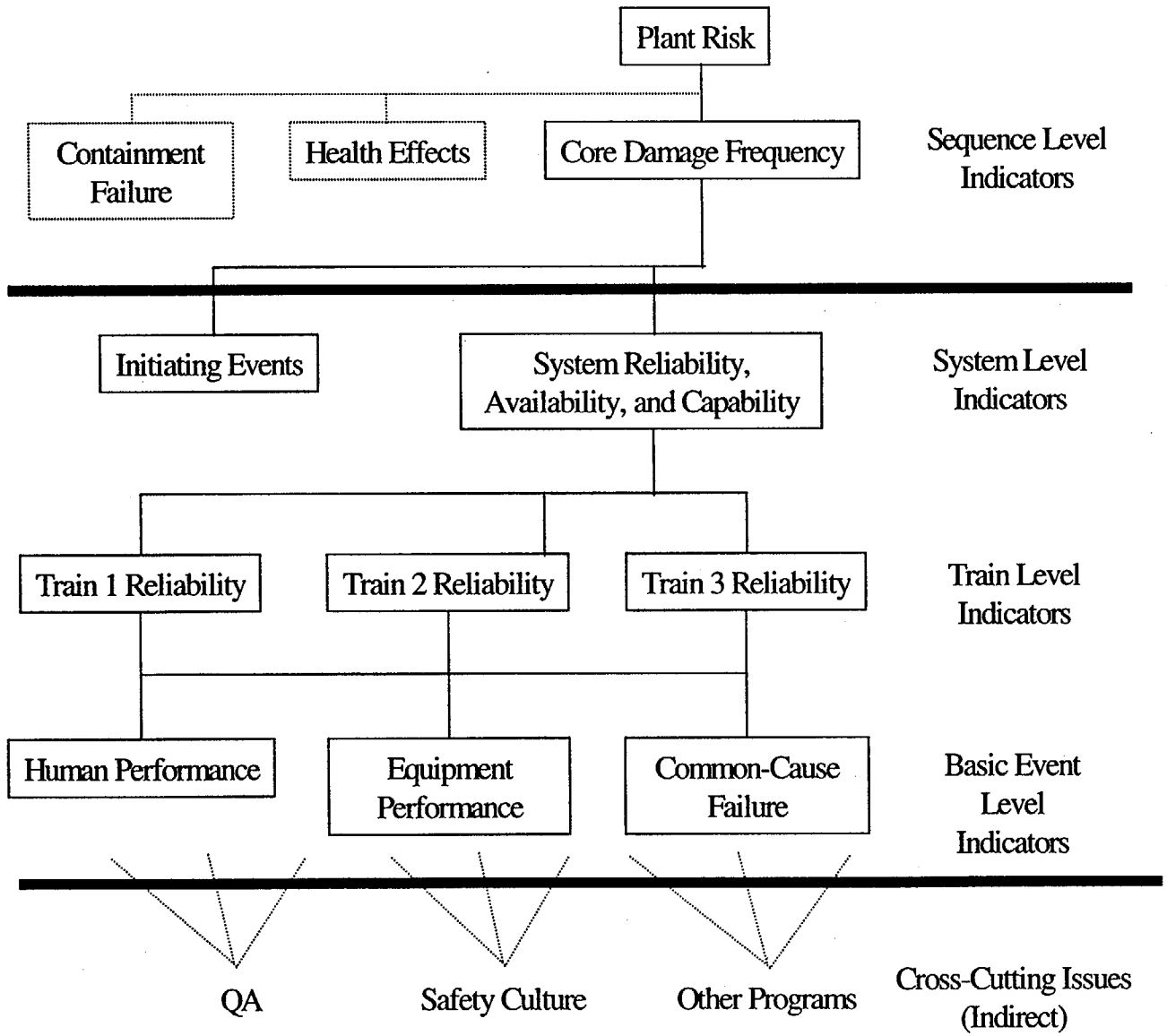
- RBPIs are developed by:
  - Determining risk-significant key attributes of each cornerstone of safety (e.g., design, configuration control, human performance) [see Figure 1]
  - Determining risk-significant elements of each risk-significant key attribute (e.g., system train reliability/availability, CCF) [see Figure 2]
  - Obtaining performance data for each of these elements
  - Identifying indicators from data that are capable of detecting performance changes in a timely manner
  - Identifying performance thresholds from data consistent with a graded approach to performance evaluation outlined in SECY 99-007

# FIGURE 1. KEY ATTRIBUTES




| | |
|---|---|
| SSPI | = Safety System Performance Indicators |
| Init | = Initial Operator Exam |
| Requal | = Operator Requal |
| RII | = Risk Informed Inspections |
| MR | = Maintenance Rule |
| V | = Verification and Validation |
| SSF | = Safety System Failures |

# FIGURE 2. ELEMENTS OF RISK



# WHAT ARE RBPIs?

- How do RBPIs fit into the revised Reactor Oversight Process?
  - RBPIs should be compatible with, and complementary to, risk-informed inspection activities of the RROP
  - RBPIs should cover all modes of plant operation
  - Within each mode, RBPIs should cover risk-important structures, systems and components (SSCs) to the extent practical
  - RBPIs should be capable of implementation without excessive burdens to licensees or NRC in areas of data collection and quantification
  - To the extent practical, RBPIs should identify declining performance before performance becomes unacceptable without incorrectly identifying normal variations as degradation
  - RBPIs should be amenable to establishment of plant-specific thresholds consistent with the RROP

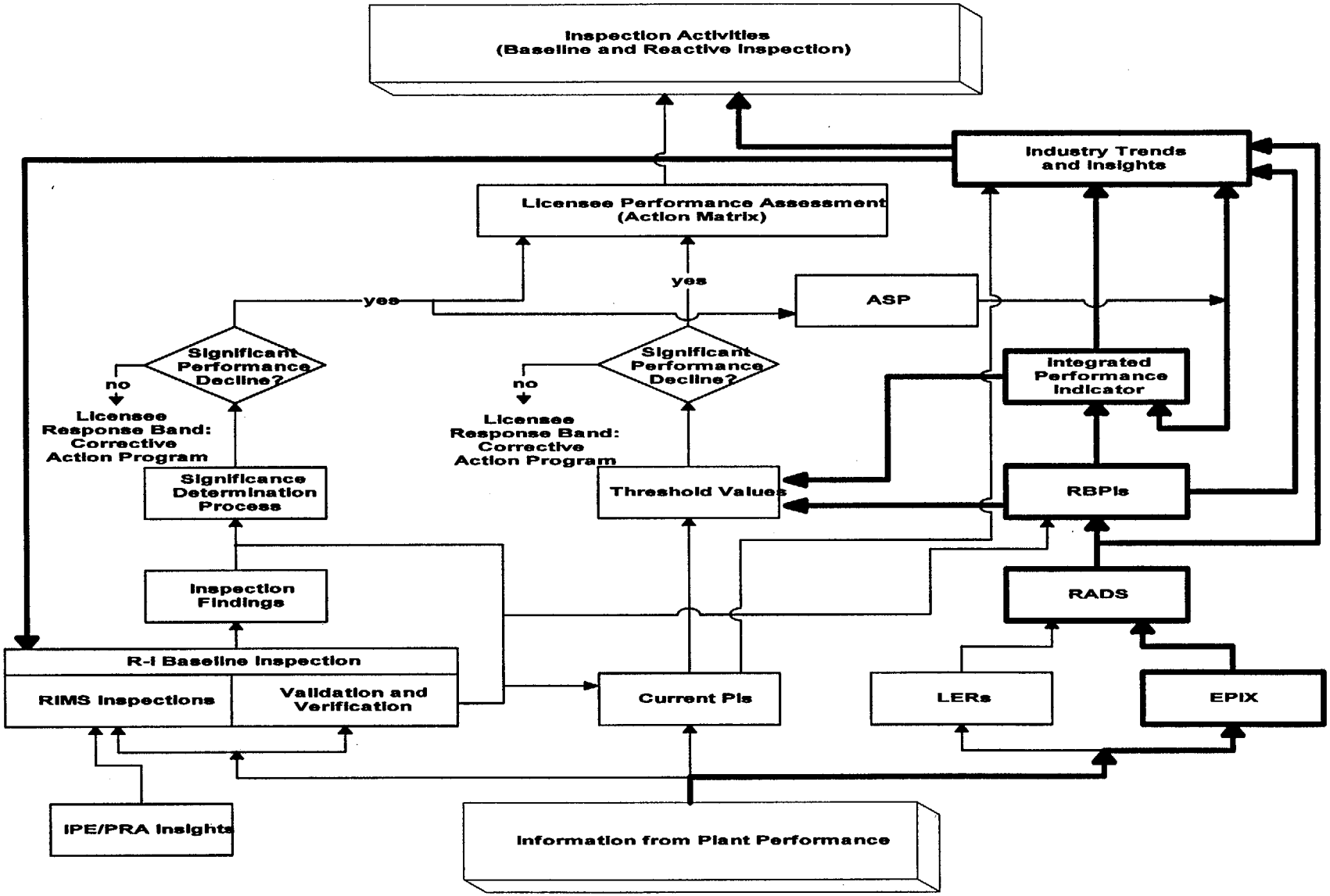
# BENEFITS OF RBPIs

- **Potential benefits of RBPIs to the RROP:**
  - Reliability indicators will be developed at the component/train/system level to provide both safety cornerstone and cross-cutting issue performance indication
  - RBPIs for shutdown modes and fire events will be developed consistent with available models, data and methods
  - RBPIs and their thresholds will be more plant-specific to reflect risk-significant differences in plant designs
  - An integrated indicator will be developed to identify and assess risk-significant changes in multiple performance areas at the same time
  - Trending of risk-significant performance at an industry-wide level, including insights and identification of key contributors to any observed trends, will be provided. This will include trending of existing indicators and other performance data such as ASP events and common-cause failure events that cannot be tracked at a plant-specific level

# WHERE RBPIs POTENTIALLY FIT INTO REVISED REACTOR OVERSIGHT PROCESS

- The potential integration of RBPIs into the RROP involves development activities in the following major areas:
  - Data
  - RBPIs
  - Industry trends and insights
  - Integrated perfomance indicator
- The potential relationship of these activities to the RROP is shown in Figure 3

# FIGURE 3. WHERE RBPIs POTENTIALLY FIT INTO REVISED REACTOR OVERSIGHT PROCESS



# WHERE RBPIs POTENTIALLY FIT INTO REVISED REACTOR OVERSIGHT PROCESS

- **Purpose of industry-wide performance measures:**
  - To determine whether the industry continues to maintain safe operations per the Draft FY 2000-2005 Strategic Plan - "No statistically significant adverse industry trends in safety performance"
  - Provides a succinct statement on reactor safety performance to Commission and public
  - Provides a measure of success of reactor safety program (RSP) [RROP performance indicators, RBPIs, other indicators]
  - Helps identify broad areas and specific aspects of the RSP that should be improved or have resources redirected to them, including reactor safety research
  - Relates to independent role of RES in preparing analysis of industry-wide reactor safety performance - Monitor/analyze data and provide insights independent from, but closely coordinated with, NRR assessment of RROP

# WHERE RBPIs POTENTIALLY FIT INTO REVISED REACTOR OVERSIGHT PROCESS

- How would industry-wide performance measures be used?
  - Determine whether safety is improving, deteriorating, or remaining constant by providing performance trends on risk-significant industry indicators and identifying performance insights
  - Provide timely, continuous, useful operating experience feedback to RROP which NRR could use to adjust oversight activities in a predictable and orderly manner
  - Support risk-informed regulatory activities, such as updating risk-informed inspection guidance and support analysis of regulatory effectiveness
  - Support Increasing public confidence with "independent" and succinct source of information on industry reactor safety performance
  - Support other resource planning, budgeting, and redirection activities

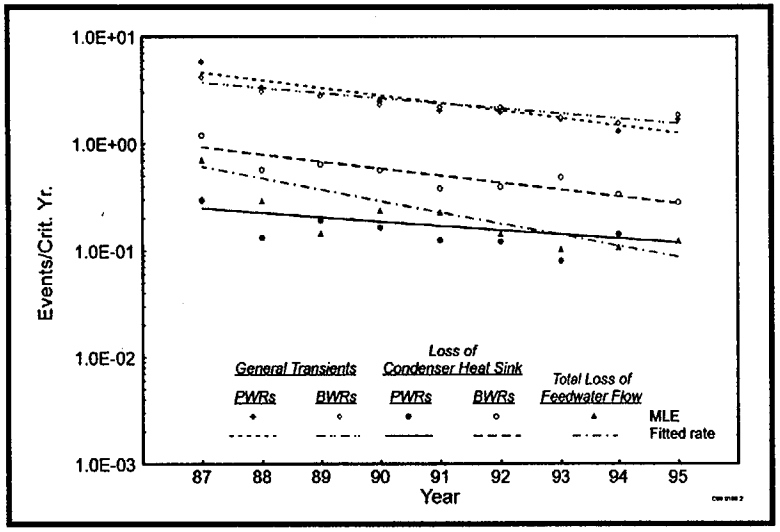
# WHERE RBPIs POTENTIALLY FIT INTO REVISED REACTOR OVERSIGHT PROCESS

- What are industry-wide performance measures? [see Figure 4]
  - Industry or group averages for the RROP performance indicators
  - RBPIs following review and approval
  - Other complementary, indicators of risk-significance performance that can not track plant-specific performance due to sparseness of data

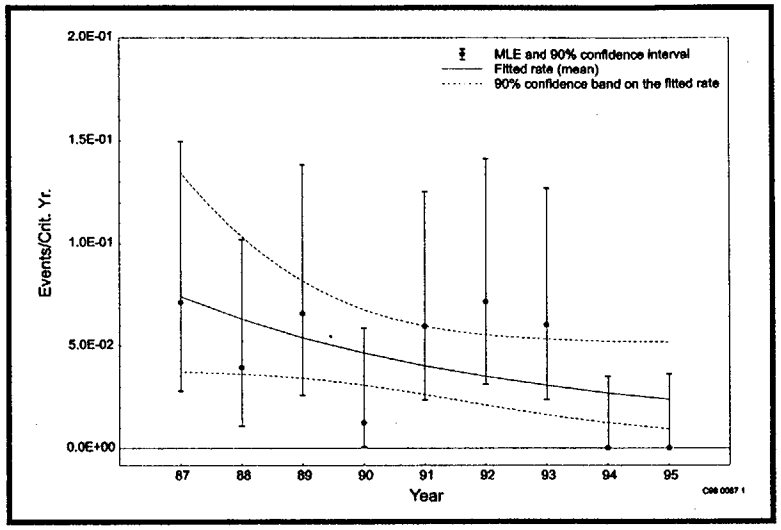
| | |
|---|---|
| ASP trends | LOSP frequency |
| SGTR frequency | LOCA frequency |
| CCF trends | Collective RAD exposure |

# FIGURE 4. EXAMPLES OF INDUSTRY TRENDS

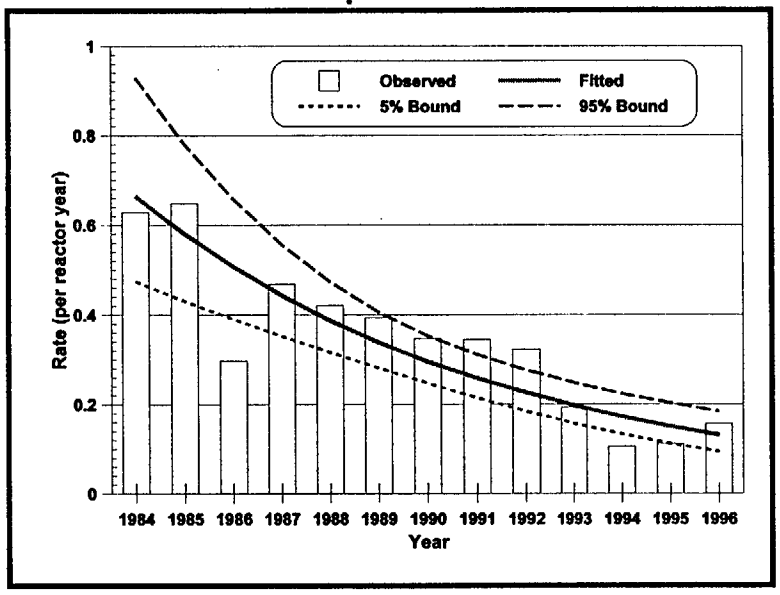
## Reactor Transients



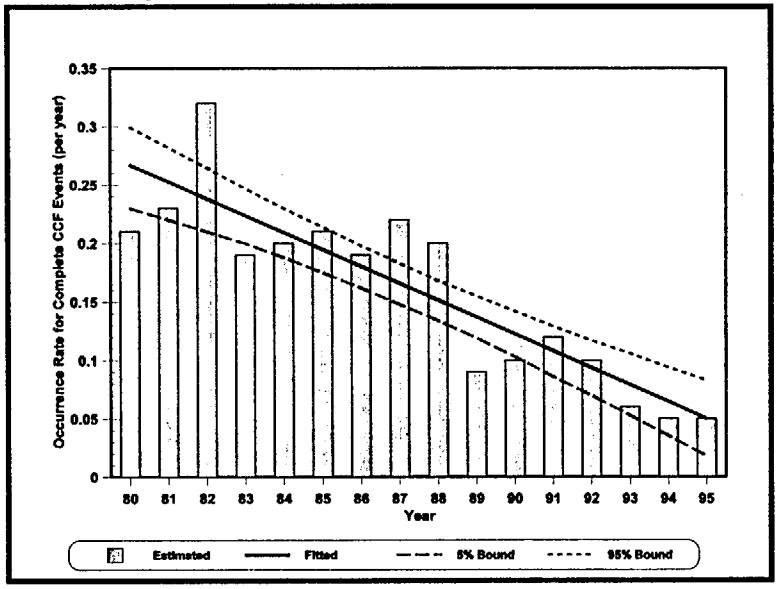

## Loss-of-Offsite Power




## Accident Sequence Precursors




## Complete Common-Cause-Failure Events



# PROCESS OF RBPI DEVELOPMENT

- Steps to accomplish RBPI development are:
  - Issue RBPI program overview white paper for stakeholder comment
  - Brief ACRS and Commission on RBPI development plan outlined in program overview white paper
  - Issue Phase 1 RBPI development progress report including example RBPIs for stakeholder comment
  - Brief ACRS and Commission on Phase 1 RBPI development progress
  - Issue Phase 2 RBPI development progress report, including example of RBPIs, for stakeholder comment
  - Brief ACRS and Commission on Phase 2 development progress

# PROCESS OF RBPI DEVELOPMENT

- Industry-Wide Performance Measures
  - Use ASP, existing PIs, system, component, and initiator trends to the extent possible
  - RES will systematically identify, develop, test, and document bases for additional industry-wide reactor safety performance indicators
  - RES will work with NRR (possibly through task group arrangement to assure plan and products meet NRR needs)
  - Several management (and ACRS) briefings during the project
  - RES will prepare SECY
    - To explain concepts, needs and uses of work
    - To obtain endorsement to go forward
  - Management briefings and SECY on industry-wide performance measures could be in conjunction with or part of briefings and SECY on RBPIs

# PROCESS FOR RBPI DEVELOPMENT

- **Phase 1 of RBPI development will include:**
  - Containment Barrier cornerstone
  - Reliability indicators for the Mitigating System cornerstone
  - Fire events
  - Shutdown modes
  - Industry trends

# PROCESS FOR RBPI DEVELOPMENT

- Additional phases of RBPI development will include:
  - An integrated indicator
  - Improvements to indicators based on advances in models, methods, and data (e.g., fire, shutdown, and plant-specific availability)
  - Follow-up work to improve existing indicators in response to NRC/industry lessons learned from the RROP
  - Other external event indicators (e.g., seismic and wind)
  - Follow-up development of new or improved industry-wide performance measures

# PROCESS OF RBPI DEVELOPMENT

## Schedule

| | |
|---|---|
| • Issue RBPI program overview white paper for comment | March 2000 |
| • Brief ACRS on RBPI program overview white paper | April 2000 |
| • Brief Commission on RBPI program overview white paper | June 2000 |
| • Issue SECY on industry-wide performance measures | June 2000 |
| • Issue Phase 1 RBPI development progress report for comment | July 2000 |
| • Brief ACRS on Phase 1 RBPI development progress | October 2000 |
| • Brief Commission on Phase 1 RBPI development progress | December 2000 |
| • Issue Phase 2 RBPI progress report for comment | July 2001 |
| • Brief ACRS on Phase 2 RBPI development progress | October 2001 |
| • Brief Commission on Phase 2 RBPI development progress | December 2001 |

# EXAMPLE OF PRELIMINARY RBPI DEVELOPMENT RESULTS

- Example includes:
  - General risk perspective
  - Identification of risk-significant key attributes
  - Identification of risk-significant elements
  - Collection and review of performance data
  - Selection of risk-based performance indicators
  - Determination of performance thresholds

# GENERAL RISK PERSPECTIVE

## Individual Accidental Death Risk (per year)

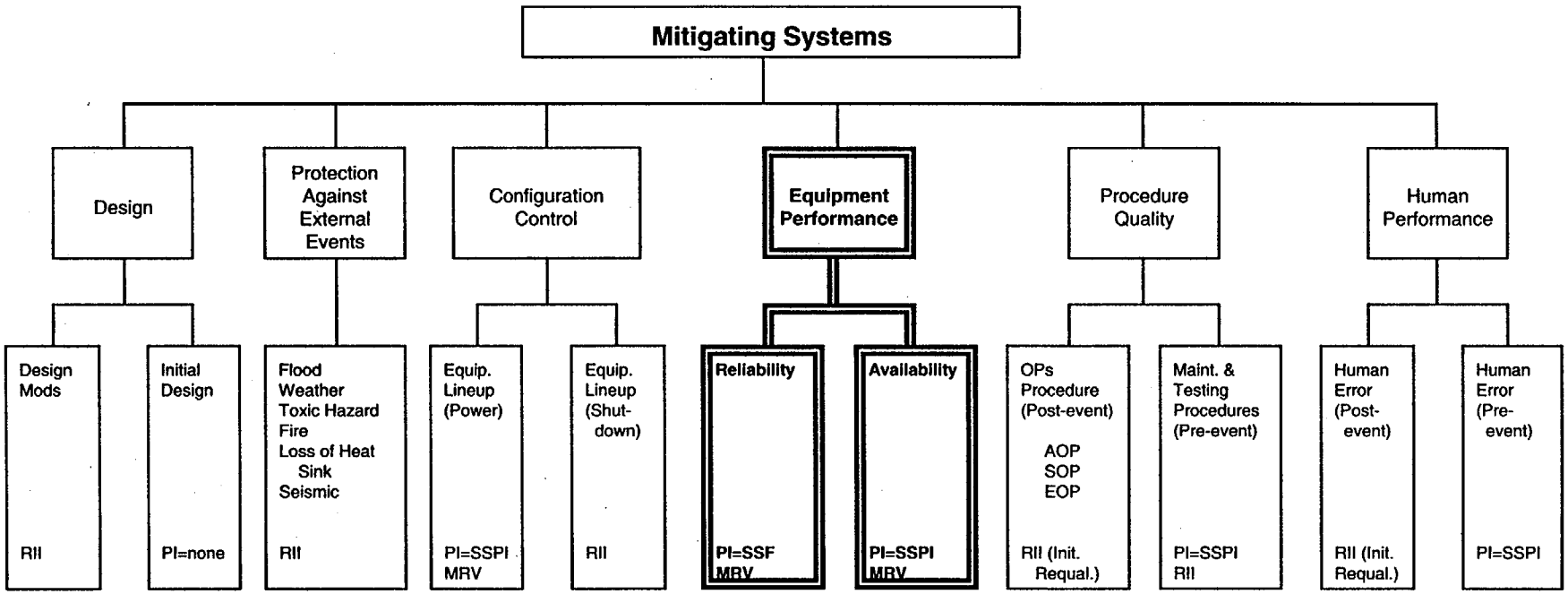
| | |
|---|---|
| Background risk from accidents | 0.000 5 |
| NRC Quantitative Health Objective | 0.000 000 5 |
| Risk from $10^{-4}$ CDF* | 0.000 000 02 |
| Risk from $10^{-5}$ ΔCDF | 0.000 000 002 |
| Risk from $10^{-6}$ ΔCDF | 0.000 000 000 2 |
| Risk near nuclear power plant (NPP) with $10^{-4}$ CDF | 0.000 500 02 |
| Risk near NPP with $10^{-4}$ CDF + $10^{-5}$ ΔCDF | 0.000 500 022 |
| Risk near NPP with $10^{-4}$ CDF + $10^{-6}$ ΔCDF | 0.000 500 020 2 |

*Derived from NUREG 1150 comparisons to safety goals

# IDENTIFICATION OF RISK-SIGNIFICANT KEY ATTRIBUTES

- Example: For a PWR plant - full power internal events for Mitigating System cornerstone
- Issue: How to identify the risk-significant key attributes
- Approach: Use insights from plant-specific IPEs, ASP results, and system/component/event studies
- Preliminary results: (Figure from SECY-99-007)

# KEY ATTRIBUTES

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| SSF | = Safety System Failures |

# IDENTIFICATION OF RISK-SIGNIFICANT ELEMENTS

- Example is for reliability attribute
- Issue: How to identify risk-significant systems, trains and/or components
- Approach: Use Fussell-Vesely and Risk Achievement Worth importance measures
- Preliminary Results:
  - Auxiliary Feedwater system (AFW)
  - High-Pressure Injection system (HPI)
  - Component Cooling Water system (CCW)
  - Emergency AC Power
  - Power-Operated Relief Valves (PORVs)
  - Residual Heat Removal system (RHR)
  - Service Water system (SSW)

# COLLECTION AND REVIEW OF PERFORMANCE DATA

- Issue: What data is available to assess risk-significant system reliability performance?
- Approach: Available data included EPIX, LERs, MORs, CCF and SSPI
- Preliminary Results: RADS was used for the period January 1997 through September 1999 (2.75 years)

# SELECTION OF RISK-BASED PERFORMANCE INDICATORS

- Issue: Which performance indicators and at what level of performance (system, train, or component) would be capable of detecting performance changes in a timely manner?

- Approach: Used statistical methods and models developed in system, component and event studies to assess the appropriate monitoring level and monitoring interval.

- Preliminary Results:

| System-Level | Train-Level | Component-Level |
|---|---|---|
| Auxiliary Feedwater<br>High-Pressure Injection<br>Residual Heat Removal<br>PORVs | Emergency AC Power<br>Component Cooling Water<br>Service Water | Motor-driven pumps<br>Turbine-driven pumps<br>Motor-operated valves<br>Air-operated valves |

# DETERMINATION OF PERFORMANCE THRESHOLDS

- Issue: How to set performance thresholds so that a graded approach described in SECY-99-007 can be achieved
- Approach:
  - Used plant-specific SPAR models and performance indicators identified in the previous steps
  - Reliability values for each performance indicator were increased to reach a change in CDF of 1.0E-6, 1.0E-5, and 1.0E-4
  - Results were reviewed to determine whether they met the required performance indicator characteristics
  - 95% for Green/White threshold will also be looked at
- Preliminary Results: (See following table)

# MITIGATING SYSTEMS THRESHOLD SUMMARY

| System | Baseline Unreliability | Green/White Threshold (ΔCDF =1E-6/yr) | White/Yellow Threshold (ΔCDF =1E-5/yr) | Yellow/Red Threshold (ΔCDF =1E-4/yr) |
|---|---|---|---|---|
| Auxiliary Feedwater (No CCW or SSW supports modeled) | 1.6E-4 (System-Level) | 1.7E-4 | 3.0E-4 | 2.1E-3 |
| Component Cooling Water (CCW) | 2.0E-4 (Train-Level) | 8.9E-3 | 1.0E-1 | 5.5E-1 |
| Emergency AC Power | 4.2E-2 (Train-Level) | 4.3E-2 | 5.5E-2 | 1.3E-1 |
| High-Pressure Injection (Includes CVCS trains) | 3.3E-6 (System-Level) | 4.0E-4 | 1.2E-2 | 2.0E-1 |
| Power Operated Relief Valves | 3.2E-2 (System-Level) | 5.7E-2 | 2.6E-1 | 1E-4 Not Reached Even with System Failed |
| Residual Heat Removal | 7.3E-3 (System-Level) | 1.1E-2 | 3.4E-2 | 2.6E-1 |
| Service Water (SSW) | 1.6E-4 (Train-Level) | 1.6E-3 | 5.5E-3 | 1.7E-2 |

# NRC Program on Human Performance in Nuclear Power Plant Safety

## ACRS

## April 5, 2000


**Jack Rosenthal**
**Office of Nuclear Regulatory Research**

**David Trimble**
**Richard Eckenrode**
**Office of Nuclear Reactor Regulation**

# PRESENTATION OUTLINE

- SECY-00-0053 - J. Rosenthal, RES
- NRR Activities - D. Trimble, NRR
  With Reactor R. Eckenrode, NRR
  Oversight
  Process
- Future Planning Activities - J. Rosenthal, RES

# Background

- Initial Version of Human Performance Program - 1995
- SECY-98-244, October 1998
  - Work in Progress
  - Described Risk-Informed Process
- ACRS Review, February 1999
  - Agreed with Process
- SECY-00-0053, February 2000

# SECY-00-0053

- Status Report
- Mission
- Basis for the Program
- Program Elements
- Future Activities

# Basis for the Program

- User Needs
- Risk Reviews
- Industry and International Activities
- Activities at Other Agencies
- Related NRC Programs

# Risk Reviews

- Evaluated Human Reliability Sensitivity Studies -BNL
- Qualitative Review of ASP Data - RES
  - 5 Years of Events
  - Events with CCDP > 10 E-5
  - Reviewed LERs and Inspection Reports
- Quantitative Review of ASP Data -INEEL
  - Same Events
  - Isolated Human Performance Contribution
  - Reviewed LERs and Inspection Reports

# INEEL STUDY

**Objective** - Study how human performance influences risk at commercial nuclear plants to provide a basis to support development of Human Performance Program

**Method** - Review Events to determine specific human and process related influences.

**Results** -

- Range of Human Performance Contribution = 10% to 100% (16 events)
- Ratio of latent to active errors = 4:1

| Category (followed by human performance influence) | Latent Errors | Active Errors |
|---|---|---|
| Operations | | |
| Command and control issues including crew resource management | 6 | 5 |
| Failure to follow safe procedures | 1 | |
| Improper diagnostics | 1 | 1 |
| Inadequate knowledge or training | 7 | 3 |
| Design and Design Change Work Process | | |
| Design deficiencies | 7 | |
| Inadequate design and design change testing | 2 | |
| Inadequate engineering evaluation | 3 | |
| Ineffective indications for abnormal condition | | 1 |
| Inadequate knowledge during design process | 1 | |
| Drawing configuration management | 1 | |
| Maintenance Work Process | | |
| Poor work package preparation, QA and use | 3 | |
| Inadequate maintenance practices | 4 | |
| Inadequate technical knowledge | 2 | |
| Procedural Design and Development Process | | |
| Inadequate procedures | 6 | |
| Inadequate alarm response procedures | 1 | |
| Organizational Learning and Corrective Action Program | | |
| Failure to respond to industry and internal notices | 8 | |
| Failure to follow industry operating practices | 2 | |
| Failure to identify by trending | 2 | |
| Failure to validate vendor reports | 1 | |
| Work Prioritization | | |
| Failure to correct known deficiencies | 5 | |
| Continue to operate during unstable conditions | | 1 |

# Program Elements

- Reactor Oversight Process
- Plant Licensing and Monitoring
- Risk-informed Regulation Implementation Plan
- Emerging Technology/Issues

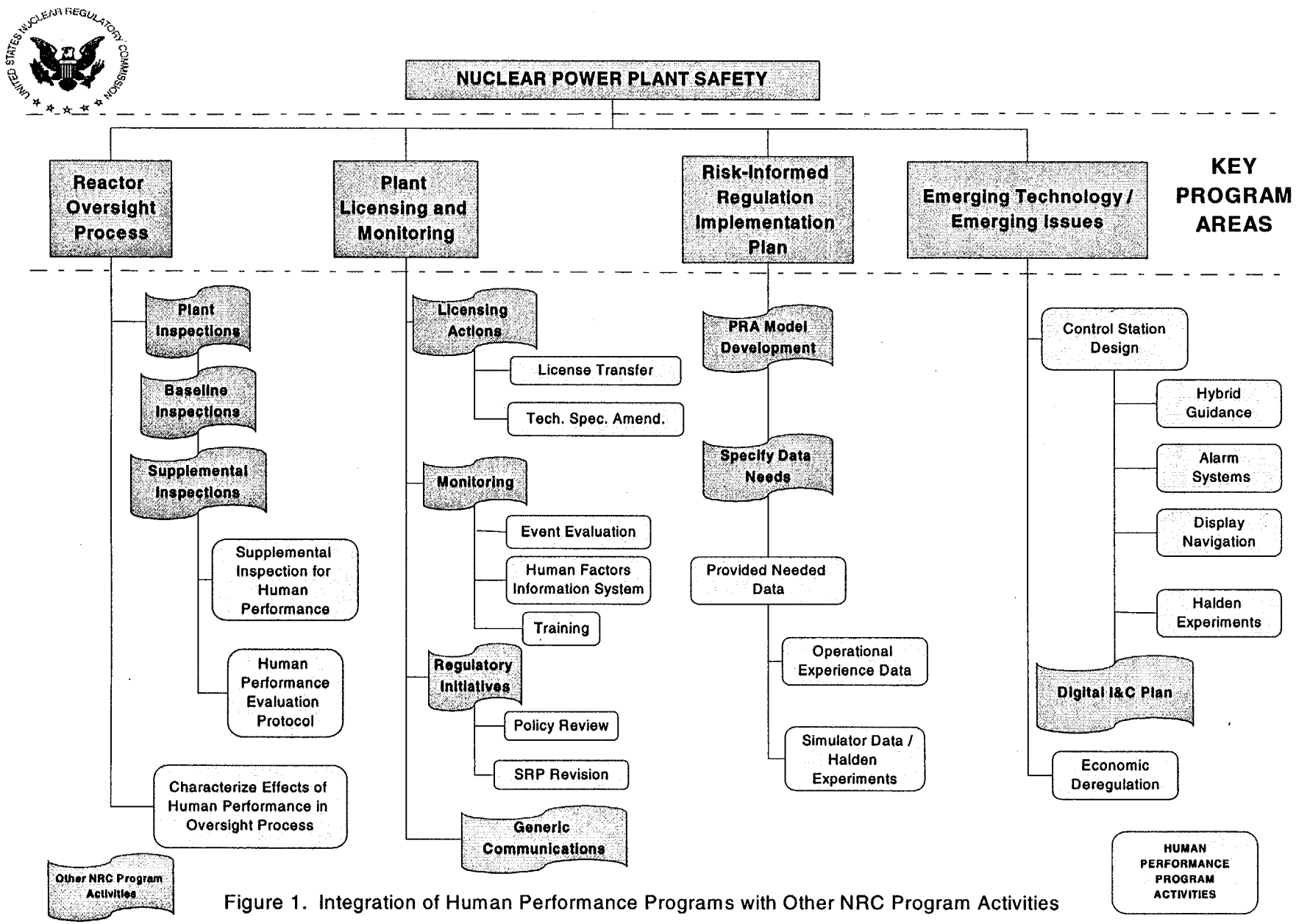


Figure 1. Integration of Human Performance Programs with Other NRC Program Activities

# NRR Activities With the Reactor Oversight Process

David Trimble
Richard Eckenrode

# Future Activities

- Budget Prioritization
- ACRS Review
- Continued Data Assessment
- Peer/Stakeholder Review
- International Cooperation
- Standards Support

Presentation To:

# Advisory Committee On Reactor Safeguards

April 5, 2000

Subject:

# NRR Human Performance Activities In Reactor Oversight Process

David Trimble
Richard Eckenrode

# Human Performance Areas Of Interest
# In
# Reactor Oversight Process

- Cross Cutting Issue
- Performance Indicator
- Inspection Procedure
- Significance Determination Process

# Human Performance
# in
# Reactor Oversight Process

Assumption:

Effects of Human Performance on Plant Safety Will Largely Be Reflected in the Plant Performance Indicators and Inspection Findings

Two-pronged Effort of Proof:

- Research - Insights - Operating Experience
  - Past Human Performance Analyses
  - Risk Studies
- HFIS - Comparison - Historical Data (5 Years)
  - New Process Data

# Supplemental Inspection Procedure for Human Performance

IP-71841

Objectives: With Respect to Human Performance,

1. Assess Licensee's Root Cause Evaluation and Corrective Actions.

2. Assess Extent of Condition.

# IP-71841 Topic Areas

Human System Interface
- Visual Information/Display
- Control Function/Control Device
- Alarm/Annunciation

Environment

Communication

Coordination of Work/Supervision

Work Practices

Procedure Use/Adherence

Training and Qualifications (IP-41500)

Fitness for Duty

# Human Performance Significance Determination Process

Functional Areas:
- Operations
- Maintenance
- Surveillance
- Testing
- Health Physics
- Security

Issue Areas:
- Training
- Procedures
- Human/System Interface
- Environment
- Supervision
- Communication
- Staffing
- Fitness for Duty

## SDP
## Basic Premise

Every Human Action Requires Information (e.g. Display Parameters, Training, Procedures, Supervisory Direction) to Initiate the Action and Control Capability (e.g. Switch, Keyboard, Wrench, Test Equipment) to Accomplish the Action.

## Second Premise

No Information or Control Capability Is Better Than Incorrect Information or Control Capability.

## Third Premise

Anything Less Than Complete Failure to Perform an Action (e.g. Untimely, But Completed), May Not Be As Risk-Important As Complete Failure.

# Risk Importance

Regulatory Guide 1.174 - An Approach for Using Probabilistic Risk Assessment In Risk-Informed Decisions On Plant-Specific Changes to the Licensing Basis

Draft - Guidance for the Review of Changes to Risk-Important Human Actions - Brookhaven National Laboratory

# Operator Requalification SDP

- Written Exam
  - Quality
  - Security
  - Number Of Failures

- Job Performance Measures
  - Quality
  - Number Of Failures

- Simulator
  - Fidelity
  - Scenario Quality
  - Operational Test
    - Single/Multiple Crew Failures
    - Remediation