# OFFICIAL TRANSCRIPT OF PROCEEDINGS

# NUCLEAR REGULATORY COMMISSION

## ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

**Title:** ACRS - ADVISORY COMMITTEE ON REACTOR SAFEGUARDS 478TH ACRS MEETING

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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

3 ***

4 478TH ADVISORY COMMITTEE ON

5 REACTOR SAFEGUARDS (ACRS)

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8 U.S. Nuclear Regulatory Commission

9 11545 Rockville Pike

10 Room T-2B3

11 Rockville, Maryland

12

13 Wednesday, December 6, 2000

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15 The above-entitled meeting commenced at 1:00 p.m.,

16 pursuant to notice, the HONORABLE DR. DANA A. POWERS,

17 chairman, presiding.

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1 ACRS COMITTEE:

2 DR. DAN A. POWERS, Chairman

3 DR. GEORGE APOSTOLAKIS, Vice Chairman

4 DR. THOMAS S. KRESS, ACRS Member

5 MR. JOHN D. SIEBER, ACRS Member

6 DR. GRAHAM B. WALLIS, ACRS Member

7 DR. ROBERT L. SEALE, ACRS Member

8 DR. WILLIAM J. SHACK, ACRS Member

9 DR. ROBERT E. UHRIG, ACRS Member

10 DR. MARIO V. BONACA, ACRS Member

11 DR. LEITSCH, ACRS Member

12 MR. PAUL A. BOEHNERT, ACRS Staff

13

14 APPEARANCES:

15 R. BARRETT, NRR

16 T. J. KIM, NRR

17 M. RUBIN, NRR

18 R. CARUSO, NRR

19 E. CARPENTER, NRR

20 F. ELTAWILA, RES

21

22 ALSO PRESENT:

23 MR. KARWWOSKI

24 MR. WERMIEL

25 DR. HOPENFELD

1 MR. STROSNIDER
2 MR. BALLINGER
3 MR. HOLAHAN
4 MR. CARPENTER
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1 P R O C E E D I N G S

2 [1:00 p.m.]

3 CHAIRMAN POWERS: The meeting will now come to
4 order. This is the first day of the 478th Meeting of the
5 Advisory Committee on Reactor Safeguards.
6 During today's meeting, the Committee will
7 consider issues associated with core power uprates, and a
8 differing professional opinion on steam generator tube
9 integrity.
10 We'll also have a report from the Subcommittee on
11 Thermal Hydraulics regarding the status of review of the GE
12 Nuclear Energy Track G Best Estimate Thermal Hydraulic Code.
13 We'll have a report from the Subcommittee on Plant
14 Systems regarding the ABB, CE, and Sieman's digital INC
15 applications.
16 The meeting is being conducted in accordance with
17 the provisions of the Federal Advisory Committee Act. Dr.
18 John T. Larkins is the Designated Federal Official for the
19 initial portion of the meeting. We have received no written
20 comments from members of the public regarding today's
21 sessions.
22 A transcript for portions of the meeting is being
23 kept, and it is requested that the speakers use one of the
24 microphones, identify themselves, and speak with sufficient
25 clarity and volume so they can be readily heard.

1 I'd like now to call the members' attention to
2 items of current interest. They have a package in front of
3 them.
4 There are two speeches by Chairman Meserve and a
5 speech by Commissioner Dicus that they might find of
6 interest. They'll also find of interest, a lessons learned
7 report on Indian Point Number 2 and their steam generator
8 rupture.
9 I also want to introduce to the members, Barbara
10 Whitaker. Barbara, can you stand up? Barbara comes to us
11 from the District Court in Rockville, where she was for 12
12 years, a long time in District Court, so she can keep you
13 guys in line.
14 [Laughter.]
15 CHAIRMAN POWERS: And she's coming here with an
16 eye towards working with the Federal Government and maybe
17 even moving up a little.
18 Well, welcome aboard, Barbara, we're glad to have
19 you here. I hope the members will take an opportunity to
20 introduce themselves as the meeting progresses today.
21 Are there any comments members would care to make
22 before we begin today's formal proceedings?
23 [No response.]
24 CHAIRMAN POWERS: Seeing none, I will to turn to
25 Professor Wallis and ask if he will -- I'm sorry, Mario.

1 I'll turn to Dr. Bonaca, and ask him if he would like to
2 introduce us to the subject of Issues Associated with Core
3 Power Uprates.
4 DR. BONACA: Okay. Mr. Chairman, as you know,
5 many plants are planning significant power uprates. And
6 today we will learn actually that that's a significant
7 number.
8 These power uprates are of the order of up to 15
9 percent or even more. ACRS members and also ACRS staff
10 members have expressed concerns with proposed licensing
11 actions of this type in several ways:
12 One is concerns with the adequacy and the
13 consistency of NRC review in the absence of a Standard
14 Review Plan to looking at power uprates.
15 Also, concerns have been expressed with
16 synergistic effects with other licensing actions that may
17 come separately and may compete for the same margins.
18 Some discussion has been taking place within ACRS
19 that was prompted by a paper that some of the Staff have
20 seen, regarding the fact that some of these licensing
21 actions, if looked at from a risk perspective, would tend to
22 increase risk by some degree.
23 But that deterministic regulation being used right
24 now to approve these individual actions, will not recognize
25 those risk increases because they simply defend a regulatory

1 margin which is not being affected by this licensing action.
2 Because of that, we expressed this concern to the
3 Staff and expressed our interest in hearing from the Staff,
4 what they are planning to do, first from a perspective of
5 just looking at the specific issue of power uprates; and,
6 second, other risk considerations that they may have looked
7 at in conjunction with parallel licensing actions.
8 With that, I will pass it on to the staff, I
9 believe, to Mr. Barrett. You have some introductory
10 statement to make, and we'll hear from the staff.
11 DR. BARRETT: Thank you, Mr. Chairman. I'm
12 Richard Barrett with the NRR staff, the NRC Staff, with the
13 Office of Nuclear Reactor Regulation.
14 We anticipate a somewhat unusual session today.
15 Most often when we come to the ACRS, you have a specific
16 question that we are trying to answer.
17 Today I think it's fair to say that you have more
18 of a general concern about the question of synergism and how
19 we are dealing with that question in power uprates and
20 perhaps in other arenas.
21 With that in mind, we have three goals for today
22 for these two hours: Our first goal is to describe to you,
23 what we have considered in our power uprate reviews, and
24 what we will consider, both from a deterministic perspective
25 and from a risk perspective.

1 We would like to convey to you that we consider in
2 our reviews, a range of potential impacts from these
3 proposals, and that we look at the implications of past
4 decisions as we go into these reviews.
5 We'd also like to convey to you that we consider
6 risk. We have considered risk in the past, and that we
7 intend to continue to keep our eye on that ball.
8 Also as part of our presentations, we want to give
9 you the benefit of the perspective of the Office of
10 Research, and Farouk Eltawila from the Office of Research
11 will take the opportunity to give you some views from his
12 reading of some of the work that NRR has done.
13 Our second goal is to, through an open dialogue,
14 to gain a better understanding of where these synergisms
15 might exist, and by a synergism, I think you might simply
16 define a synergism as a case where two plus two is equal to
17 more than four, and to understand whether there is reason
18 for us to be concerned about these synergistic effects.
19 And we hope to do that through an open dialogue.
20 So our presentations are put together in a way that
21 hopefully will elicit that.
22 And finally, our third goal is to understand
23 whether course corrections are justified in our review
24 process, and also to understand whether it would be
25 advisable to initiate an effort, a research effort, related

1 to any of these issues.

2 Those are our goals for today. If you have no

3 questions about those goals, I'd like to introduce Mr. T.J.

4 Kim, who is the Project Manager for this effort. And he

5 will describe to you, some of the background and the

6 structure of today's presentations.

7 MR. KIM: Thank you, Rich. Mr. Chairman, members

8 of the Committee, my name is T. J. Kim, and I'm the Lead

9 Project Manager in the Office of Nuclear Reactor Regulation.

10 Let me put up the agenda for today's briefing. As

11 Rich mentioned, I'll be going over the program overview, and

12 I'll talk a little bit about the Standard Review Plan, the

13 needs thereof.

14 And following me, following my discussion will be

15 Mark Rubin, who will be talking about application of

16 risk-informed decisionmaking for power uprates.

17 And Ralph Caruso will talk about realistic

18 analyses applicable to power uprate reviews, and he will

19 also be talking about synergistic effects relative to high

20 burnup fuel and power uprated conditions. And we'll also be

21 talking about accelerated erosion/corrosion issues relative

22 to power uprate, and then you'll hear from Mr. Farouk

23 Eltawila regarding the Research perspective on power uprate

24 programs, and then Mr. Barrett will wrap it up for us.

25 Okay, in terms of power uprate program overview,

1 I'm going to be basically going over the historical
2 perspectives on how the Staff has approached power uprates
3 in the past, and how the program has evolved over the years,
4 and where we are at now in terms of the program, and where
5 we think we're headed in the future.
6 DR. SEALE: What does the word, recapture, there,
7 mean?
8 MR. KIM: Okay, that's a good leadin to the next
9 slide, by the way.
10 Okay, some time ago, the Staff had tabulated all
11 the power uprates that have been granted since the early 70s
12 or late 60s. And we noticed that for a handful of plants,
13 the number of percentage of power uprates granted were
14 rather significant.
15 So we did a little bit of research into what that
16 all meant, and we found out that these large power uprates
17 in the old late 60s and 70s timeframe were granted to a
18 handful of old plants, early-licensed plants, and I think we
19 used to call them provisional operating licensed plants
20 where these are the first group of large plants at that time
21 where I think the AUC has decided that we would license
22 these plants at a derated power level, if you will.
23 And these plants have subsequently come in for
24 recapturing those power levels after five or six years of
25 successful operation.

1 DR. SEALE: Did these plants ever operate at the
2 -- before they were upgraded, did they ever operate at that
3 level?
4 MR. KIM: These plants were originally licensed at
5 derated power levels. What I mean by derated is that 15-20
6 percent less than what the plant was designed for.
7 DR. UHRIG: But the safety analysis is performed
8 on the --
9 MR. KIM: The design power level.
10 DR. UHRIG: The designed power level.
11 MR. KIM: Right.
12 DR. BONACA: So they were designed to the higher
13 power level?
14 MR. KIM: Right.
15 DR. BONACA: And the FSAR would have said that?
16 MR. KIM: Strictly from a licensing perspective,
17 we issued the operating license at a much lower power level,
18 and after five or six years of successful operation, these
19 plants, these licensees --
20 DR. APOSTOLAKIS: Why did this happen?
21 MR. KIM: There's lack of documentation on this,
22 by the way, but my understanding, talking with some of the
23 old timer's, if you will, was that the AEC has decided that
24 after Yankee Rowe and Big Rock Point, Yankee Rowe being the
25 first PWR and Big Rock Point being the first BWR plant that

1 was licensed, these were relative -- you know, very small
2 plants in terms of the core size and everything else.
3 Indian Point II, and Hadham Neck, and -- you know,
4 this group of plants represent a quantum leap, if you will,
5 from the size of Yankee Rowe and Big Rock Point, so the AEC
6 has decided that rather than grant a full operating license
7 at the full design power level, we rather approach it in a
8 step-wise fashion, if you will.
9 DR. BONACA: Hadham Neck was the first four-loop
10 --
11 MR. KIM: PWR.
12 DR. BONACA: -- PWR with a known -- pumps. I
13 mean, with flywheel pumps, so it was truly an unproven
14 design.
15 MR. KIM: Right.
16 DR. WALLIS: But the idea presumably was a safety
17 margin, if you operated at a lower power.
18 MR. KIM: That's right.
19 DR. WALLIS: So the implication of that is that if
20 you go to higher power, it becomes more challenging to
21 safety.
22 MR. KIM: Sure.
23 DR. WALLIS: That would be the reason.
24 MR. KIM: I'd be speculating.
25 DR. WALLIS: If they were operating at a lower

1 power, this is in order to achieve some safety margin.

2 MR. KIM: My understanding is that the AEC's

3 decision at the time was purely based upon the fact that,

4 well, neither the industry nor the AEC at the time had

5 enough experience with this so-called large reactor.

6 So, they wanted to approach it in a step-wise

7 fashion.

8 DR. WALLIS: So they said it's safe to operate it

9 at this reduced power, 80 percent power, but we're not sure

10 it's safe to operate at 100 percent power.

11 MR. KIM: Again, I would be speculating.

12 DR. WALLIS: But there was a safety connection to

13 power level. That's all I'm trying to make a point on.

14 DR. BONACA: I think there is a very important

15 point to make in there. And it's worthwhile to pursue this

16 now, just to put it in perspective.

17 Hadham Neck was a 600 megawatt electric that was

18 being run at 485 or something like that. If you take the

19 latest generation of Westinghouse PWRs like Seabrook Plant

20 which generates 1250 megawatt electric, the volumes are only

21 about ten percent larger than Hadham Neck, but it has a much

22 larger core.

23 It's important because now we're talking about

24 increasing power for newer plants, the most recent plants,

25 which are already a significantly stretched design over the

1 earlier one at Hadham Neck.

2 DR. APOSTOLAKIS: So the 24 percent there for

3 Hadham Neck means it was a licensed to operate at 24 percent

4 less power than designed?

5 MR. KIM: Originally, yes, and then later, they

6 had recaptured, if you will.

7 DR. APOSTOLAKIS: When did they recapture?

8 MR. KIM: In 1969.

9 DR. APOSTOLAKIS: That's when they did, which is a

10 year --

11 MR. KIM: Year -- they have obtained the full

12 recapture.

13 DR. APOSTOLAKIS: When was it licensed?

14 MR. KIM: I don't have that figure with me. '66

15 or '67 is what --

16 CHAIRMAN POWERS: When I look at this list of

17 plants, they are not plants that have been trouble-free.

18 I'm wondering if there is any -- if you've looked for any

19 connection between the decision to increase those powers and

20 the events that have occurred at those plants.

21 MR. KIM: The question is, have we looked at?

22 CHAIRMAN POWERS: Looked at the history of the

23 plants and seen if there is any change in their performance

24 over time, any changes that could be attributed to the power

25 uprate.

1 MR. KIM: As you know, Mr. Chairman, back in the
2 '95 and '96 timeframe, the Staff had done an extensive study
3 into Maine Yankee lessons learned issues. And I'll be
4 talking about that a little bit later.
5 But the purpose of this slide here is to simply
6 show that when you see a list of plants that have obtained
7 power uprates, you might see a large number in terms of
8 percentage of power uprates, and that they are not truly
9 power uprates in today's definition; these are what I would
10 call power recaptures. That's all I'm trying to show in
11 this slide.
12 DR. SEALE: I think the reason behind the
13 Chairman's question, though, is that every time he looks at
14 one of those names on that list, he can legitimately wince.
15 [Laughter.]
16 DR. SEALE: And you wonder if the density of
17 winces is as high for a randomly-selected group of plants as
18 it is for that group.
19 There's another point here that I'd like to make,
20 and that is that these plants, when they first went into
21 operation, operated at the capacities or at the values for
22 the various parameters that influence power output,
23 represented by these initial power levels.
24 And to a degree, the so-called design value of 24
25 percent higher or 14 or whatever it was, was a static safety

1 analysis kind of value, among other things, and there still
2 were questions as to whether or not, for example,
3 flow-induced vibration might not occur when you raised the
4 flow rates through the cores involved in these now. I don't
5 think you did, or maybe you did. Maybe that's what has
6 caused some of the problem; I don't know.
7 It wasn't a lead pipe cinch whenever you raised
8 those power levels. There were still some uncertainties
9 that might have occurred, might reasonably rear their head,
10 and may very well rear their heads in some of these other
11 things we have got in the works. Just a comment.
12 MR. KIM: Okay. The comment is noted, sir.
13 Let me move on to the next slide.
14 On this slide I am showing all the five percent
15 so-called stretch power uprates that have been granted in
16 the past.
17 The first one on the list is Calvert Cliffs, Units
18 1 and 2, 1977, and most recently River Bend and Diablo
19 Canyon Unit 1 in this year.
20 DR. UHRIG: In these cases the original safety
21 analysis was performed on the higher power?
22 MR. KIM: No, in these cases --
23 DR. UHRIG: Well, I know there was the case in St.
24 Lucie 1.
25 MR. KIM: Actually, there were some mixed bags

1 where for some of these plants the original SER, safety
2 analyses, were performed at 5 percent higher than what was
3 originally licensed as well as the environmental assessment
4 and some of the later plants that were licensed were not,
5 so --
6 DR. UHRIG: So you have not differentiated?
7 MR. KIM: I have not differentiated those, that is
8 correct, sir.
9 From 1977 to 1992 these power uprate reviews were
10 done on an ad hoc basis until 1990-1991 timeframe when
11 General Electric has put forward a generic approach in doing
12 these 5 percent power uprates for boilers and subsequent to
13 that time -- well, let me take a step back.
14 In 1992 the Staff has approved with the ACRS's
15 blessing, if you will, the Staff has approved GE's Topical
16 Reports on 5 percent power uprates and subsequent to that
17 Fermi, Susquehanna, and Peach Bottom and subsequent BWR 5
18 percent uprates were all modelled after GE's topical
19 reports.
20 BWR 5 percent power uprates will continue to be
21 done on an ad hoc basis, lacking any generic guidance.
22 Any questions on this slide?
23 [No response.]
24 MR. KIM: After having a number of years of
25 experiences doing 5 percent power uprates, GE had proposed

1 in 1995 to pursue what they call extended power uprates and
2 by GE's definition extended power uprate means power uprates
3 between 5 percent and 15 percent.
4 GE had submitted a set of topical reports
5 addressing the extended power uprate program and Monticello
6 and Hatch were the lead plants that followed GE's topical
7 reports and the Staff has granted 6.3 percent power
8 uprate -- that is on top of 5 percent -- for Monticello, and
9 Hatch, Units 1 and 2 the Staff has approved 8 percent power
10 uprates. Again, that is on top of 5 percent.
11 DR. WALLIS: Could you give me in three or four
12 sentences what the criteria are for accepting these
13 applications?
14 MR. KIM: I think we will be covering that in a
15 later slide, so if you could --
16 DR. WALLIS: Yes.
17 MR. KIM: Down at the bottom on a footnote, I just
18 wanted to point out that the GE Topical Reports for extended
19 power uprates as well as the lead plant reviews, Monticello
20 and Hatch, were all reviewed by the ACRS back in 1998.
21 Okay, so now I think that brings up to date in
22 terms of where we are in the power uprate program --
23 DR. WALLIS: I'm sorry, could you tell me -- I
24 asked for criteria. What was it that made this possible, to
25 uprate? Was it initial margin or was it changes in design?

1 MR. KIM: It is initial margins.

2 DR. WALLIS: Initial margins. Up to now it's

3 initial margins.

4 MR. KIM: In a very big picture perspective, for

5 NSSS systems it is --

6 MR. CARUSO: It's initial margin and design plus

7 new fuel designs.

8 DR. WALLIS: I guess in the case of Hatch there

9 was also a new fuel design.

10 MR. CARUSO: That's correct.

11 MR. KIM: But one thing I wanted to find out

12 though, for extended power uprates, that's power uprates

13 above 5 percent. These utilities are doing significant

14 balance of plant modifications to support these uprates.

15 When I say significant I am talking about

16 replacing the high pressure turbines, doing significant work

17 to main generator transformers, as well as the condensate

18 system. It's a lot of capital investments in the orders of

19 200, 300 million dollars.

20 DR. WALLIS: How do you explain to the public that

21 as these things get older it is safer to uprate them at

22 higher power?

23 MR. KIM: I think that's really the focus of our

24 discussion today and I think we will get back to that

25 question at the end, I think.

1 Like I said, the Staff has received an application
2 for 15 percent power uprate for Duane Arnold on November
3 17th and the Licensee has requested Staff's approval by
4 mid-2001, so we are on a rather tight schedule to review
5 that.
6 DR. APOSTOLAKIS: Excuse me. I don't understand
7 what that means. You are under a tight schedule because the
8 Licensee requested an answer by a certain date?
9 Can you explain that to me?
10 MR. KIM: Yes. To the extent possible we will try
11 to accommodate the Licensee's schedule. That doesn't
12 mean -- I want to make that very clear that doesn't mean
13 that --
14 DR. APOSTOLAKIS: I haven't heard that before,
15 that the Licensee sets a schedule. So they just expressed a
16 wish perhaps?
17 MR. KIM: I beg your pardon?
18 DR. SEALE: George, they are spending $200 million
19 and the banker never sleeps.
20 [Laughter.]
21 DR. APOSTOLAKIS: They can still express a wish.
22 DR. SEALE: Yes.
23 DR. BARRETT: That is correct. They can express a
24 wish and we need to take that into account and their
25 schedules, but we obviously have to make sure there is

1 enough time available to do a proper review.

2 DR. APOSTOLAKIS: Good.

3 DR. BARRETT: Absolutely.

4 MR. KIM: As it stands now, a number of other

5 plants have made their intentions known, intention to file

6 their applications for extended power uprates within the

7 near future at Dresden and Quad, for example, plans to

8 submit their application some time this month in fact, and

9 Brunswick and Clinton will follow shortly thereafter.

10 DR. UHRIG: These are all BWRs?

11 MR. KIM: These are all BWRs.

12 DR. UHRIG: Do you expect comparable submissions

13 in the PWR area?

14 MR. KIM: No, sir and the reason for that is for

15 Ps, even with the replaced steam generators I believe to

16 accommodate a significantly higher level of power uprate the

17 plant will have to operate at a significantly higher T

18 average and my understanding is that that is detrimental to

19 the longevity of the steam generators, so there would be a

20 tradeoff there.

21 MR. SIEBER: It is either that or fix pH and lower

22 TF to get the delta which is what any of them have

23 considered doing.

24 DR. SEALE: Which means increased flow rates.

25 MR. SIEBER: That is increased flow rates,

1 increased moisture separation capability. It makes a lot of
2 changes to the balance of plant.
3 MR. KIM: Okay. On this slide I want to summarize
4 for you the issues that were associated with Maine Yankee
5 lessons learned issues.
6 As I said before, back in '95-'96 timeframe, the
7 Staff has done extensive work to study what happened or what
8 went wrong at Maine Yankee relative to their power uprate
9 program and the team, the Maine Yankee lessons learned team,
10 has developed a number of action items and I have listed
11 some of those here, or what I thought were more important
12 ones.
13 The first one deals with Staff ensuring
14 appropriate use of analytical models and tools that the
15 Licensee has used to support power uprate analyses.
16 DR. WALLIS: There are a lot of -- as I read Reg
17 Guides and so on -- there are a lot of words like
18 "appropriate" used, which seems to be somewhat vague. Do
19 you have a good idea of what appropriate use would mean?
20 MR. KIM: Yes. Let me try that, sir.
21 What I mean by appropriate use in this case is for
22 the Staff to ensure that the Licensee has used analytical
23 tools and computer codes and models that have been
24 previously approved by the Staff in other previous licensing
25 actions, and also -- either that or the Licensee has done

1 adequate benchmark analyses with their current licensing
2 base codes and analyses to make sure there are no --
3 DR. WALLIS: You always get some other words like
4 "adequate benchmark" and you always put it off to some other
5 term. Maybe it has to be. I don't know if it has to be
6 like that, but every time you can be a little more specific
7 it constrains the sort of freedom to maneuver perhaps in a
8 detrimental way.
9 MR. KIM: Ralph, do you want to take a stab at it?
10 MR. CARUSO: Dr. Wallis, I am going to talk about
11 this a little bit later.
12 DR. WALLIS: Great, thank you. I shall be quiet.
13 [Laughter.]
14 MR. KIM: Another area that the Maine Yankee
15 Lessons Learned Task Force has touched upon was what they
16 considered inconsistencies in the areas that were covered in
17 Staff's safety evaluation for various power uprate
18 amendments.
19 If you go back to the list of power uprates that
20 have been granted that I showed earlier, if you go to
21 earlier power uprates you can just tell by the volumes of
22 the SEs that Staff has written, some of the older power
23 uprates that were granted in the late '70s and early '80s,
24 you know, the SEs were like 20 pages or so, and then if you
25 go down to more current, in the mid-'80s to the late '80s,

1 the Staff's safety evaluations approving these power
2 uprates, these are substantial improvements in terms of the
3 thoroughness and the comprehensive coverage of different
4 areas.
5 The team has identified these inconsistencies in
6 the areas that were covered in the Staff's SEs for power
7 uprates and they have recommended that going forward the
8 Staff should ensure that the following areas had been
9 covered, and those include human factors, grid stability,
10 fuel pool cooling, balance of plant equipment, design and
11 capabilities, and the MOVs relative to Generic Letter 89-10
12 capabilities.
13 CHAIRMAN POWERS: I am surprised there is nothing
14 on this slide specifically referring to -- on core
15 stability, neutronic stability.
16 Is that part of the review process?
17 MR. CARUSO: I will be talking about that, but
18 neutronic stability for BWRs is an area that has to be
19 reviewed as part of the power uprate and it will be
20 considered. It is a deterministic acceptance criteria that
21 we consider.
22 DR. APOSTOLAKIS: So at some point I will find out
23 what the inconsistency in human factors was?
24 MR. KIM: No, what I mean by inconsistencies there
25 is that if you look at some of the older power uprate safety

1 evaluations, there's nothing on human factors. There's
2 nothing that was covered in the area of human factors, but
3 if you look at the more recent power uprates, Staff has done
4 extensive work on human factors.
5 DR. APOSTOLAKIS: And you gentlemen will cover
6 some of it today or this is just a statement?
7 MR. KIM: It is just a statement for the purpose
8 of today's briefing.
9 DR. APOSTOLAKIS: Well, I haven't seen -- there
10 must be a report with the lessons learned?
11 MR. KIM: Yes.
12 DR. APOSTOLAKIS: May I have a copy?
13 MR. BOEHNERT: Sure.
14 DR. APOSTOLAKIS: Thank you.
15 MR. KIM: Another item the Maine Yankee Lessons
16 Learned Task Force has recommended was for the Staff to
17 consider developing an SRP section for power uprates and
18 Staff has done exactly that.
19 We have studied for quite some time whether we
20 really need an SRP section on power uprates or not and we
21 have done a cost/benefit analysis and the conclusion the
22 Staff has come to is that for Monticello and Farley power
23 uprate reviews, Staff has incorporated all the Maine Yankee
24 lessons learned items and the Staff has been treating
25 Monticello and Hatch, Farley's SEs as templates, if you

1 will, for future power uprate reviews.

2 We believe those Staff SEs are robust and provide

3 very thorough guidelines for the technical staff as well as

4 the project managers to process future power uprates.

5 DR. WALLIS: These are deterministic criteria you

6 are using then?

7 MR. KIM: Yes, sir.

8 DR. WALLIS: Do you anticipate any power uprate

9 requests coming in using other criteria?

10 MR. KIM: I don't think so.

11 DR. WALLIS: There is no option to use risk or --

12 MR. KIM: They have to meet all the deterministic

13 criteria.

14 DR. APOSTOLAKIS: I think the next presentation is

15 titled, "Risk Informed Review."

16 MR. KIM: Right.

17 MR. RUBIN: But it is not in place of the

18 deterministic defense of the uprate.

19 MR. KIM: That concludes my prepared presentation

20 on the overview of the power uprate program and now we will

21 go to Mark Rubin on the risk informed aspect of power

22 uprate.

23 MR. RUBIN: Good afternoon. I'm Mark Rubin from

24 the Probabilistic Safety Assessment Branch in NRR. I just

25 would like to note that a number of the observations and the

1 e-mails from the ACRS members and the ACRS Fellows Report
2 has raised a number of interesting questions regarding
3 synergistic effects.
4 We've given the issues some initial thought, some
5 initial reflections, and we want to share those with you and
6 certainly solicit your feedback, your thoughts, your
7 observations.
8 I certainly don't want to leave you with the
9 impression that what you are hearing are final conclusions
10 in this area.
11 I'll just give a few general perspective issues on
12 the extended power uprates, and some of these will be
13 touched on by other presenters here this afternoon.
14 First of all, the extended power uprate
15 applications aren't requesting any relaxation of
16 deterministic requirements. All the deterministic
17 requirements are still met. Mr. Caruso will be discussing
18 that after I conclude.
19 However, when the Hatch and Monticello uprates
20 were looked at, there was the potential for some risk
21 impact, when you go up beyond the original stretch power to
22 the extended uprates, and reductions in margin, potential
23 increase in risk, and that was why at the Hatch and
24 Monticello reviews that the Staff wanted to see some risk
25 assessment information, and it was part of our review and

1 part of our conclusions that were documented in the safety
2 evaluation.
3 And we asked a number of questions during the
4 course of that review.
5 DR. WALLIS: This is a little puzzling to me. I
6 know that I was part of this, but we're sort of establishing
7 that the differential risk to power is zero. And this can't
8 go on forever. There must be some point where it turns up.
9 MR. RUBIN: I don't believe we're saying it's
10 zero.
11 DR. WALLIS: That seemed to be the conclusion,
12 essentially; that there's no effect on risk of these power
13 uprates at Monticello or Hatch.
14 MR. RUBIN: Well, there were some actual
15 calculations done and we'll be reviewing them in a moment.
16 Yes, they were very small.
17 To the extent that the impacts were modeled, they
18 were very small.
19 DR. BONACA: Just as you go through and discuss
20 those, you know, you probably read a paper I sent you that
21 quoted that.
22 MR. RUBIN: Yes, the HSK.
23 DR. BONACA: In that I refer to that study made
24 for the Swiss plant.
25 MR. RUBIN: Yes.

1 DR. BONACA: And essentially they indirectly
2 critiqued the performance measure being used. And they
3 refer to a 30 percent increase in risk as measured by the
4 risk methods of activity of the release.
5 And essentially they refer to two essential
6 elements: One is that you have more fission product; and,
7 second, you have an acceleration of phenomena by which
8 you're challenging the containment.
9 And so maybe you want to refer to and maybe
10 comment on that study.
11 DR. KRESS: Are you implying that CDF and LERF are
12 not sufficient risk measures?
13 DR. BONACA: That's what the paper implies,
14 although it does not state that. But I think that --
15 DR. KRESS: That's an interesting concept.
16 MR. RUBIN: I will very briefly touch on some
17 thoughts form the HSK paper in just a moment, but again,
18 we're not here to revisit the CDF/LERF decision criteria in
19 totality right now, but I will give some reflection.
20 CHAIRMAN POWERS: Well, do the risk analyses that
21 you do look at the neutronic phenomena?
22 MR. RUBIN: Look at what?
23 CHAIRMAN POWERS: Neutronic phenomena.
24 MR. RUBIN: Only to the extent that decay heat
25 levels are changed, timing will be changed, but not

1 fluences, not --

2 CHAIRMAN POWERS: You're going to look at the

3 frequency of instabilities?

4 MR. RUBIN: No, not in the model.

5 CHAIRMAN POWERS: Recovery capabilities coming out

6 of ATWS?

7 MR. RUBIN: The ATWS sequences, I believe, were

8 looked at for timing. I can check with the reviewer who was

9 here, Sam Lee, but not detailed neutronic calculations.

10 As I said, the Hatch and Monticello reviews did

11 include some risk considerations. For future plant extended

12 operation submittals, we think it's quite likely that they

13 will include risk information by the licensees.

14 But if the licensee would choose not to make --

15 not to include the risk information, either as supplementary

16 material or not to make them risk-informed at all, our

17 decisions on whether to pursue a risk insight assessment

18 should be governed by SECY 99-246, which the Staff authority

19 issues which the Committee is well familiar with, and which

20 has been recently endorsed by the Commission.

21 We haven't had a challenge to do this on uprate

22 yet, since the latest plant to come in during our notes does

23 include risk assessment information as part of its

24 submittal. But if we were to get one, just hypothetically,

25 some random thoughts on what we might look at to try to

1 consider the 99-246 issues:

2 The size of the uprate; base link CDF; LERF of the
3 plant; insights from the deterministic evaluations such as
4 how much margins may be eroded or reduced; set point changes
5 that might impact plant transients; trips; operational
6 insights. If we start to see some directly attributable
7 from the extended uprate plants, that might give us some
8 insights.

9 And also to touch on the HSK issue, I thought the
10 information from that study was very interesting, showing a
11 disproportionate increase in release activity, weighted risk
12 versus the power uprate, and that does give an interesting
13 insight that might lead us to pursue risk assessment
14 information, even on plants that had -- would be thought to
15 have a relatively small, moderately small CDF/LERF impact.

16 DR. KRESS: This going to require a full Level II
17 type of analysis if you do that?

18 MR. RUBIN: Well, for the LERF assessments, we
19 will have to have --

20 DR. KRESS: No, no, for this risk of expected
21 activities.

22 MR. RUBIN: I'm not saying that we will do that
23 sort of assessment. I guess that right now, we haven't
24 given it any thought.

25 What I'm trying to convey, not very well, is that

1 the insight of the increased risk from the nuclide activity
2 would give some additional impetus to us pursing a risk
3 focus if the licensee didn't want to include it in the
4 review, even though we knew from the Monticello and Hatch
5 review that the CDF and LERF impacts were fairly small.
6 So in cases where -- they still would be presumed
7 to be fairly small, but this would give some additional
8 weight.
9 DR. APOSTOLAKIS: The way I understand this study,
10 the LERF was the same, but L was larger. That's exactly
11 what they found.
12 MR. RUBIN: That's right.
13 DR. APOSTOLAKIS: The current measure focuses on
14 the F, right? Second, is it conceivable that with the
15 current tools, your CDF baseline CDF and LERF, will not
16 change at all, even when you have DBA margin reduction?
17 MR. RUBIN: I believe it certainly could be
18 possible, yes.
19 DR. APOSTOLAKIS: Because we don't quantify the
20 margins in the PRA.
21 MR. RUBIN: That's right.
22 DR. APOSTOLAKIS: And also I'm under the
23 impression that we are risk-informing the regulations, just
24 as a side remark, but two of the major activities of the
25 Agency of the last two or three years, license renewal and

1 extended power uprates, are not risk-informed at all; is
2 that the correct perception of what is going on?
3 MR. RUBIN: For life extension, I believe that's a
4 correct statement. For the extended power uprates, they did
5 not come in as risk-informed, but there was a look at the
6 risk.
7 DR. WALLIS: This is independent of what the
8 Agency does. If the Agency decides to risk-inform 50.46, it
9 may well be that some local limiting aspects will change,
10 and this could lead to requests for power uprates based on a
11 new risk-informed --
12 DR. BONACA: One of the concerns I have, actually,
13 is that if you have risk-informed 50.46, then you give
14 additional margin to the licensee to use for things such as
15 power uprate. You're just simply reducing the apportionment
16 of that margin which you have right now for deterministic
17 requirements.
18 So ultimately you come up with a risk-informed
19 deterministic criteria that will be less strict than what we
20 have today, and that will allow for even more power uprates.
21 And when you look at 1.174, on the other hand,
22 1.174 doesn't make a distinction between regulatory margin
23 in the rule, and the extra margin that you have in the
24 plant.
25 MR. RUBIN: Well, it attempts to use best

1 estimate.

2 DR. BONACA: Exactly.

3 MR. RUBIN: Good methods.

4 DR. BONACA: So, therefore, it gives you a better
5 measure if you use the right metrics, to make an assessment
6 of whether or not you have an increased risk. And it tells
7 you most likely in some evaluations that there is a risk
8 increase.

9 DR. APOSTOLAKIS: But the application that you
10 have now does not raise the issue of risk, right?

11 MR. RUBIN: Which application? Duane Arnold?

12 DR. APOSTOLAKIS: Yes.

13 MR. RUBIN: Duane Arnold came in not risk-informed
14 by -- not defined as a risk-informed licensing submittal,
15 but does include a risk assessment of the uprate impact on
16 CDF and LERF.

17 DR. APOSTOLAKIS: Whatever they could quantify
18 anyway?

19 MR. RUBIN: Whatever they could quantify, and it
20 we'll be specifically touching on those in a couple of
21 viewgraphs.

22 DR. KRESS: George, whenever you calculate LERF
23 currently, what one calculates, in my view, is really a
24 conditional containment failure probability, early
25 containment failure probability.

1 Now, you wouldn't expect the power uprate to have
2 much effect on that. It adds a little load to the
3 containment within the containment margin, anyway, that the
4 loads are not going to fail the containment very early.
5 What I have been contending is that that LERF was
6 backed out of -- to be a surrogate for prompt fatalities.
7 DR. APOSTOLAKIS: Right.
8 DR. KRESS: And that has built into it, as part of
9 the surrogate, the quantity of the fission products that are
10 released.
11 DR. APOSTOLAKIS: That's right.
12 DR. KRESS: So if you uprate the power, and
13 increase the inventory, then basically what I'm saying is
14 that the LERF acceptance criteria ought to be reduced at
15 least -- it's not linear, but if it were linear, it would be
16 reduced proportionately to the amount of -- the acceptance
17 value would be reduced proportionately to the amount of
18 inventory.
19 And I don't see us ever doing that.
20 DR. APOSTOLAKIS: That's right; you're right. It
21 was the L that has changed.
22 DR. KRESS: The L has changed. And that's what
23 you were saying, that the L was changed and the F hasn't,
24 and all we calculate is an F.
25 DR. APOSTOLAKIS: That's right, and when we did

1 the calculations, Rick, he showed that there is no
2 plant-to-plant variability. He used certain factors for the
3 existing power, the power that -- I wonder whether the
4 earlier part would be affected, too.
5 DR. KRESS: The loads are increased a little, but
6 not much.
7 DR. APOSTOLAKIS: So it's really the L.
8 DR. BONACA: There is one additional question I
9 have of the evaluation you performed, you know, the PRA
10 evaluation you performed for Monticello and Hatch, and what
11 you're planning to do.
12 Did you give any consideration to the effects of
13 aging on margins?
14 MR. RUBIN: No. We'll talk a little bit about
15 that in two or three viewgraphs.
16 DR. WALLIS: George, just for the public reading
17 this, I mean, the L has changed. What you mean is that
18 there is more -- that the actual release quantity would be
19 bigger, so the net risk to the public, which is quantity
20 times frequency, would be bigger, although the frequency is
21 still the same.
22 DR. APOSTOLAKIS: Exactly, and that's exactly what
23 the Swiss paper is saying.
24 MR. RUBIN: I would just note that Dr. Kress's
25 point on potential difference in LERF criteria is a very

1 good one, but I would also like to observe that the
2 delta-LERF acceptance criteria is quite a bit smaller than,
3 if you remember, the gray zones, quite a bit below the ten
4 to the minus fifth total LERF that we are in our comfort
5 zone on.
6 DR. APOSTOLAKIS: Six, for LERF, six.
7 MR. RUBIN: Delta-LERF, yes. Delta-five was sort
8 of the baseline where I think the zones changed. But, yes,
9 that's certainly a very good point.
10 Let's see, I'll talk a little bit about the
11 approach that was taken for the risk-informed assessment of
12 Monticello and Hatch, and what we would probably perceive
13 would still be done for the additional extended uprates,
14 such as Duane Arnold and the rest to come on the BWRs.
15 The areas that were looked at and specifically
16 addressed as part of the risk evaluation by the Staff and
17 the licensee for the Monticello and Hatch review were the
18 core components of the PRA, the initiating event
19 frequencies, equipment, component failure rates,
20 availabilities, operator error probabilities, and the
21 thermal hydraulic equipment success criteria coming from the
22 thermal hydraulic evaluations.
23 Not shown here, but implicit in this list is also
24 containment failure modes or failure mechanisms that might
25 change as a result of the uprate, and if such changes did,

1 indeed, occur, the conditional containment failure
2 probabilities that were just mentioned by the Committee
3 would come into play and possibly impact the delta-LERF
4 calculations.
5 Well, when we were doing Hatch/Monticello, looking
6 at these four core areas, if we want to call them that,
7 Areas 3 and 4 were quite amenable to modeling and assessment
8 in the licensee's risk model. Operator error probabilities,
9 what was looked at there, was predominantly -- in fact,
10 included the timing changes, the sequences that included
11 operator action, were specifically looked at.
12 If the times were changed due to higher decay
13 heats, those were factored in an reassessments were made for
14 the sequences that were impacted, and those were quantified,
15 the differences were quantified.
16 It is the same on success criteria. The higher
17 decay heats might require more flow rates, what was at first
18 a one out of three success criteria for a pump or an HVAC
19 system now became two out of three.
20 Well, the physics, the heat transfer, allowed
21 explicit modeling of those changes. They were assessed,
22 they were incorporated into the risk model, and they were
23 requantified.
24 DR. APOSTOLAKIS: Did they look at uncertainties
25 in those calculations?

1 MR. RUBIN: I'm not sure if it was a point
2 estimate, or they did a fully propagated uncertainty
3 analysis. Mr. Lee?
4 MR. LEE: For Hatch power plant, uncertainty was
5 factored in.
6 DR. APOSTOLAKIS: Part of the uncertainty.
7 MR. LEE: Yes.
8 DR. APOSTOLAKIS: Can you give me an idea of what
9 changes in timing you're talking about here?
10 MR. RUBIN: I think it was just a few minutes.
11 Sam, do you remember?
12 MR. LEE: Yes, one of the significant changes in
13 the operator timing response was basically depressurizing
14 when your initiation for the injection system didn't work.
15 And typically the changes were very small. One case went
16 from 26 minutes to 23 minutes in the required time period.
17 So, the probability that the failure rate that was changed
18 as commensurate with the change in response time was very
19 small, which resulted in a very small change in risk.
20 DR. APOSTOLAKIS: So the accurate way of stating
21 this is really that we still don't have a very good method
22 that tells us what the human error rate is, but we expect
23 the difference to be small?
24 MR. LEE: That's correct.
25 DR. APOSTOLAKIS: That would be the accurate way?

1 MR. LEE: That's correct.

2 DR. APOSTOLAKIS: From 26 minutes to 23, yes.

3 MR. RUBIN: Well, we felt we got our hands around
4 Areas 3 and 4. Obviously it's more difficult to assess the
5 potential impact on things such as initiating event
6 frequencies, component failure rates, due to the phenomena
7 that change as a function of uprate.

8 You don't have models for those impacts. They
9 were assessed qualitatively by the licensee, and it was
10 argued that they were quite minimal. And the Staff did not
11 take issue with that conclusion.

12 I'll be speaking a little more about perhaps some
13 reasons why or maybe not why in another viewgraph or two.

14 What is the potential for synergistic impacts
15 beyond what we could explicitly model, such as the operator
16 timing and thermal hydraulic success criteria?

17 Well, the conclusions on Monticello and Hatch were
18 based largely on that there was solid deterministic bases
19 for the uprate, that the changes that the components --
20 fuel, rest of the SSCs would see would be appropriate to
21 operate in the changed conditions.

22 We thought that the first order synergistic
23 effects that I spoke of, timing and success criteria, were
24 handled and were modeled and we thought those would very
25 probably be the driving changes.

1 There is the potential though for unexpected
2 impacts in the other areas that you need to build a PRA
3 model on the initiating event frequencies and the failure
4 rates of components.
5 In the absence of experimental or operational
6 data, it is very, very difficult to try to reflect or
7 predict what those might be.
8 We at this point think it's likely that these are
9 going to be pretty small secondary impacts. I won't say it
10 is a basis, but our reflections on why this is possibly or
11 likely the case is that there is a very strong deterministic
12 basis in analysis for the SSCs to operate in the uprated
13 conditions and Mr. Caruso will be speaking on that.
14 If there were significant changes in initiating
15 event frequencies, system failures, plant trips, those would
16 tend to be self-revealing for large changes, of the ones
17 that have fairly high frequencies to occur. Significant
18 changes in unavailability for normally operating equipment
19 would also tend to be self-revealing, as the recirc pump
20 flow-induced vibration problem that was identified in the
21 ACRS Fellows Report.
22 Now in some areas it becomes a little less
23 certain. Standby equipment might not tend to be
24 self-revealing. It doesn't have a high challenge rate. You
25 won't have a lot of information if it is more likely to have

1 an increased probability of failure.

2 However, the standby systems are either somewhat

3 or largely more isolated from the conditions that an uprated

4 plant would see, not completely of course, but somewhat --

5 isolated from the reactor coolant system, discharge check

6 valves, standby emergency feedwater systems, component

7 cooling systems, things of that nature may be somewhat

8 isolated, won't see the predominant thermal hydraulic fluid

9 condition changes from the uprate, so even though you

10 wouldn't see them with as high a confidence, it would appear

11 that they probably wouldn't be as challenged.

12 DR. KRESS: If you had a power uprate, let's say

13 20 percent, a fairly large one, you accommodate that by

14 still operating on the same fuel cycle, changeout cycle, I

15 think, so that basically you are increasing the average

16 burnup to the core by about 20 percent?

17 MR. CARUSO: I am not sure that necessarily the

18 burnup increases. In BWRs what is really changing is

19 feedwater flow and steam flow.

20 DR. KRESS: I am pretty sure you increase the

21 burnup about the same percentage.

22 MR. CARUSO: Core flow increases a slight amount

23 but not really a linear amount.

24 DR. KRESS: Well -- if my assumption is correct,

25 that you would increase the burnup, I don't see that listed

1 in the synergistic effects anywhere up there.

2 For example, burnup would affect the way that the

3 core melts. It might affect the timing of that and it is

4 almost sure to affect the fission product releases, release

5 rates that you get, as opposed -- the total source term, it

6 is going to affect it, as opposed to just the inventory.

7 Somehow I didn't see that reflected, those sort of

8 things. You do the inventory, I know that, but I don't see

9 these other synergistic effects like how it would affect the

10 fission product release rate, and how it might affect the

11 core meltdown rate and the potential for generating more

12 hydrogen -- those are just kind of synergistic effects that

13 I was looking for. I don't see that reflected anywhere.

14 MR. SIEBER: It is not clear to me that the burnup

15 would necessarily increase by 20 percent.

16 DR. KRESS: It will increase though.

17 MR. SIEBER: Yes, probably what would happen is

18 that at each refueling you unload more assemblies.

19 DR. BONACA: Yes, you unload more assemblies, but

20 it is not clear that there is a correlation directly

21 one-to-one, but it's something that should be addressed

22 because if there is an increasing burnup, those are issues

23 that have to be addressed.

24 MR. CARUSO: I will get into this a little bit

25 later on.

1 DR. APOSTOLAKIS: A thought occurred to me related
2 to operator actions that was discussed earlier. The timing
3 really is an issue here, the available time and as I
4 remember, the operator actions are really important during
5 shutdown operations.
6 You will have a much higher level of decay heat
7 here, so that time will be shortened as well, just as for
8 available time for action?
9 DR. KRESS: I don't know if much higher is a
10 descriptive term but you will have higher, yes.
11 DR. APOSTOLAKIS: Higher. Did you look at this at
12 all when you approved the earlier requests? Did you look at
13 shutdown operations?
14 DR. KRESS: We certainly didn't because we had no
15 information to review.
16 DR. APOSTOLAKIS: And the prevailing thinking
17 appears to be that, yes, we not only know the risk level but
18 the existing risk management programs are good enough.
19 Would that assumption hold under the new power
20 levels?
21 MR. LEE: Dr. Apostolakis, this is Sam Lee.
22 We did not specifically look at the impact on
23 shutdown risk per se, but in response to the question that
24 ACRS had raised at that time, in which we responded by a
25 letter.

1 What we basically said was that the time factor
2 during the shutdown situation is so much longer in general
3 that the increase in decay heat will not impact the operator
4 response time by that much and therefore no calculation was
5 looked at for time.
6 DR. APOSTOLAKIS: It is more than just the
7 operator action though. I mean if you look at the PRAs that
8 have been done, limited scope for shutdown operations, they
9 had to consider time windows, you know, and all these are
10 tied to the decay heat.
11 DR. BONACA: That is, by the way, what they are
12 referring to in the study -- not operation. They are
13 referring to acceleration of events -- the release, getting
14 all the challenges to containment due to the higher decay
15 heat.
16 DR. APOSTOLAKIS: What I am driving at is since we
17 have this impact, higher decay heat, shouldn't shutdown
18 operations attract more attention here than just power or
19 are we still satisfied with the assumption that the existing
20 risk management programs, the ones that are based on OREM
21 and SENTINEL and so on, would be good enough no matter what
22 and we just focus our attention on power operations?
23 MR. RUBIN: It is certainly a good question and I
24 can't give you a good answer. With the power assessments or
25 what was looked at, it might be an issue to look at

1 deterministically on transitions.

2 We did not do transition risk studies as part of

3 these reviews. It's much more limited than that.

4 DR. BARRETT: If I could add a word about that --

5 sorry.

6 DR. BONACA: I think one of the issues was exactly

7 that. For the higher power level you can manage for example

8 the primary system boundaries as far as the relief capacity

9 and as far as other things, but you still have the same

10 containment.

11 The containment hasn't changed in any way or form,

12 and once we get to severe accident conditions you are

13 dealing with a smaller relative containment, especially in

14 the original design and you have accelerated timing of

15 certain actions in the failure of the containment.

16 DR. APOSTOLAKIS: Should we be looking into it or

17 not? Because I agree that the times for most actions are

18 longer, but the plant is more vulnerable too, so I wonder

19 whether the focus should be exclusively on power operations

20 or we should do something more than what we have been doing

21 regarding shutdown operations.

22 DR. WALLIS: Let me broaden the question.

23 You are looking for something we should think

24 about. It seems to me the story is so nice up to now there

25 is no problem --

1 DR. APOSTOLAKIS: Do people agree that --

2 DR. WALLIS: What are the problems we should

3 anticipate? Maybe this is one of them.

4 DR. APOSTOLAKIS: That is what I am asking.

5 DR. WALLIS: What about the other ones? In

6 looking at this, maybe Dr. Eltawila is going to tell us,

7 what kind of considerations are you going to have to worry

8 about in the future that might limit these uprates? What do

9 you need to know?

10 DR. BONACA: I would bring up again the issue of

11 aging. I mean this is not -- again aging is being managed,

12 sure, in the plant, but the margin of components is being

13 reduced as we speak because the plant is being run, so those

14 kind of margins which are used for operator margin to run

15 the plant, they are somewhat reduced.

16 Now the PRA, when you look at risk, takes into

17 account those margins and is there going to be consideration

18 of that?

19 MR. CARUSO: The problem is we use the word

20 "margin" and we are using it in a quite broad sense here,

21 okay, and there are margins to temperature limits, there are

22 margins to pressure limits, there are operator margins in

23 terms of timing and they are affected in different ways.

24 These BWR power uprates that we are doing right

25 now, I don't know if you realize but every one I believe

1 that is going to come in is what is called a "zero pressure
2 upgrade" -- that means that the pressure in the reactor
3 vessel isn't going to change.
4 The safety relief valves are going to stay the
5 same. The set-points are going to stay the same. The
6 vessel isn't going to see any difference in terms of
7 pressure --
8 DR. BONACA: May I give you a couple of examples
9 that concern me?
10 MR. CARUSO: I'm sorry?
11 DR. BONACA: I will give you a couple of concerns,
12 issues.
13 Let's talk about containment.
14 MR. CARUSO: Right.
15 DR. BONACA: Okay. The only commitment the
16 Licensees have is to the design pressure of containment --
17 say in a BWR, 50 psi --
18 MR. CARUSO: Right.
19 DR. BONACA: Anything above that, however, has
20 been credited in their IP. They take credit for 130 psi but
21 we also know that there is corrosion taking place on liners.
22 You have safety research programs looking at the issues of
23 corrosion and how much they are going to increase the
24 capability of that containment.
25 As we speak, in the deterministic world I am very

1 comfortable, 50 psi is still there, but somebody has to
2 account for the fact that you don't have any more than
3 margin in containment that you credited for your PRA.
4 Now I don't hear that the PRA evaluation has
5 considered at all this potential reduction of margin due to
6 the simple corrosion that takes place and of which you are
7 fully aware, because you have a research program looking at
8 some of those issues.
9 This is just an example. Another example may be
10 if you look at fatigue of components -- components are being
11 fatigued as you speak. Limits are not being exceeded but
12 again those are deterministic limits you are looking at.
13 In a risk information context those reductions
14 that are taking place now are important.
15 MR. CARUSO: I do know in terms of reactor vessel
16 internals that fatigue due to vibration is considered as
17 part of these uprates and as part of aging of the plant.
18 DR. BONACA: Are they looking at the criteria?
19 The deterministic criteria cannot be exceeded, and I agree
20 with you it's being done. I am only saying that looking at
21 risk perspectives there should be some recognition of the
22 fact that components are getting more fatigued just because
23 they are being operated, although the regulatory margin is
24 not being affected. That is deterministic.
25 CHAIRMAN POWERS: Will we be discussing thermal

1 fatigue at all?

2 MR. CARUSO: I'm sorry, thermal fatigue?

3 MR. KIM: No, we hadn't planned on that today.

4 MR. CARUSO: I don't believe that we are going to

5 be talking about thermal fatigue, no.

6 CHAIRMAN POWERS: I assume that the Licensees look

7 at that kind of thing.

8 MR. KIM: Yes, and they are addressed in each of

9 the Licensee amendments.

10 CHAIRMAN POWERS: I think that is a pretty

11 straightforward examination.

12 MR. LEITCH: Have you considered flow assisted

13 corrosion and piping systems?

14 MR. KIM: Yes, that is one of the subjects that we

15 will cover later this afternoon.

16 MR. RUBIN: Not to imply that we are saying that

17 everything is totally wonderful and you don't even need to

18 think about this -- we are not trying to send that message.

19 The first quick look suggests that it probably is

20 secondary, these other synergistic effects are secondary to

21 the ones we explicitly modeled, at least with the

22 information we have right now, but to address them more

23 completely to get a good handle on their impact, some things

24 would have to be done that it is difficult with the

25 available state of knowledge to do.

1 What are the challenges to us coming to grips with
2 the full breadth of what the committee is talking about or
3 at least attempt to come to grips with it?
4 The problem is, as we all know, that the risk
5 models don't include provisions for assessing SSC
6 reliability impacts based on the operating condition
7 including aging phenomena. The models aren't available to
8 put into the PRAs. If they were available, they could be
9 either time-dependent or just step changes for different
10 times in the plant's life, but we don't have that
11 information.
12 Also, we don't have information how the initiating
13 event frequencies might change as a result of the uprate and
14 the big changes there of course could have a significant
15 impact on plant risk profile.
16 As I just mentioned, there are no models for
17 passive system degradation on pipe break frequencies of the
18 kind to directly put into the risk models at this point,
19 though there is considerable work going on --
20 DR. WALLIS: It's on the next transparency.
21 MR. RUBIN: I would just point out --
22 DR. WALLIS: The one with "5" on the bottom.
23 MR. RUBIN: I would just like to mention that
24 there have been some examples of induced failures to do
25 uprates, and at this point the causality I think would need

1 to be looked at in a little more detail to help get more
2 models.
3 DR. APOSTOLAKIS: Wouldn't these affect Option 2,
4 the special treatment requirements, impose some extra
5 requirements? You see, this reminds me of Option 2 a lot.
6 We don't have models to assess the impact of this or assess
7 the impact of that, so in Option 2 we go through importance
8 measures and categorize SSCs and try to relax certain
9 requirements.
10 Maybe with this you can follow that route and
11 impose something extra on some of the SSCs that might
12 deserve it, not wholesale, but there is a way around the
13 issue of not having models that will tell you what happens
14 to the failure rates.
15 MR. RUBIN: Certainly.
16 DR. UHRIG: Could you give us some examples of the
17 updated uprate-induced impacts you are going to --
18 MR. RUBIN: I was alluding to the ones the ACRS
19 and the Fellows were kind enough to mention in the e-mails
20 and in the report. Those were interesting.
21 CHAIRMAN POWERS: He is talking about the stuff
22 that Gus put together for us.
23 MR. RUBIN: In preparation of this meeting. I am
24 sorry if I wasn't clear.
25 I will give you some initial thoughts of the

1 significance of the unmodeled effects and certainly they can
2 be more significant than this, but we think there are some
3 moderating effects, programmatic areas, that will tend to
4 moderate the impact and likely we think at this point to
5 keep these issues secondary rather than primary.
6 The maintenance role is of course going to provide
7 us a lot of feedback and its corrective action program for
8 active SSCs. Degradation of the active components will
9 probably be identified through the maintenance rule and
10 corrected. We will start to see them. Corrective action
11 will be taken, and it would be one data source of course
12 also to incorporate in any risk models if the information
13 was shown to be directly related to uprate condition.
14 The maintenance rule also, of course, does include
15 structures, passive component inspections. Some may well be
16 identified by the maintenance rule if degradation was
17 occurring due to uprate conditions, or even, I imagine,
18 aging.
19 But there would be some less confidence being
20 identified, just because the passive structures are
21 challenged in the same way that active components are
22 challenged.
23 The inspections or observations are more visual,
24 you look at how it appears, anything occurring, bolts
25 broken, hangers broken, things of that nature.

1 Standby components could be very important,
2 obviously, if they had a significant decrease in
3 availability/reliability. They may, as I said before, not
4 be as readily identified, due to the lower challenge rates,
5 but again, they're less subject to the conditions of the
6 uprated plant.
7 Piping, other passive system degradations, can
8 also be very important. There are risk-informed ISI
9 programs; there's probabilistic fracture mechanics, a lot
10 that goes into assessing break frequencies. If there was
11 degradation, it certainly could have an impact on the risk
12 profile.
13 I would only point out that there is a great deal
14 of sensitivity. When failures are observed, they are
15 focused on with great intensity. The root cause mechanisms
16 are identified and corrective actions are put in place.
17 Does this mean we have to see pipe breaks or
18 cracks before we could identify the mechanism related to
19 uprate? I think that to a great extent, yes. We'd have to
20 start seeing some sort of degradation to be able to account
21 for it.
22 But certainly once it is observed, it would get a
23 great deal of scrutiny, as the recent pipe break --
24 DR. SEALE: Mark, it is possible to sense enhanced
25 vibration in systems. Is there going to be any measures

1 taken to perhaps try to monitor whether or not vibration is
2 occurring during the initial phases of the operation of
3 these plants at increased power rating, increased flow
4 rates, and so on?
5 MR. RUBIN: That belongs to my colleague to my
6 left.
7 MR. CARUSO: I don't know of any.
8 MR. KIM: Yes, the licensee, as part of the power
9 ascension test program, the licensee has procedures and
10 processes in place to monitor any additional vibration.
11 DR. SEALE: Those are the things you do in the
12 100-hour certification run at the beginning of the plant
13 life?
14 MR. KIM: Yes, yes.
15 DR. SEALE: That's reassuring.
16 DR. LEITCH: I sort of have the same question for
17 flow-assisted corrosion. I would think that there would be
18 -- I would think that the corrosion --
19 CHAIRMAN POWERS: Flow-assisted corrosion is a
20 topic that they're going to specifically address.
21 DR. LEITCH: What is that?
22 CHAIRMAN POWERS: They are going to specifically
23 address that.
24 DR. LEITCH: I'll hold my question.
25 MR. RUBIN: As mentioned again before, the changes

1 in transient frequencies could have a significant impact on
2 risk, if the variations were fairly significant. For the
3 last 15 years or more, plant transients, trips, operational
4 data, has gotten a great deal of scrutiny. It's looked at
5 carefully; it's reported publicly.
6 And we think trends in this area would be
7 identified and would be responded to, we hope, traced to
8 root cause, related to uprate, if, indeed, they were from
9 that result.
10 So it's likely that impacts in this area would be
11 identified, corrected, and if not corrected, the trends at
12 least reflected in the plant risk models.
13 Next viewgraph: Of course, the emphasis is on
14 utilization of the as-built, as-operated PRAs to support
15 risk-informed decisionmaking.
16 As in our other risk-informed activities, we would
17 expect the utilities to reflect as much of the operational
18 plant performance data as possible in their updated PRA and
19 in answering questions that arise during power uprate
20 reviews.
21 If they see increased trip frequencies, reduced
22 availability of safety systems, perhaps failure rates
23 generically in the industry, pipe breaks, we would hope to
24 see this reflected in their PRAs. However, in honesty,
25 there will be a lag in the update cycle.

1 You won't see it right away, and I think it likely
2 that if there is any impact in these areas, they will be
3 identified and most likely corrected before there is a
4 pervasive industry change that might have to be reflected in
5 the risk model. But plant-specific SSC reliability impacts
6 should be picked up as part of the maintenance rule, and
7 should be reflected in the PRA.
8 Now, plants that are not involved in risk-informed
9 activities, that don't have active PRA update programs,
10 obviously will not be focusing closely in this area. But
11 they will be looking at the maintenance rule and the
12 corrective action program.
13 And repetitive failures that occur due to
14 inadequacies in the maintenance program or other programs,
15 get a lot of regulatory attention and oversight. But again,
16 if they're not doing PRA updates, they wouldn't be in the
17 position to as actively reflect what the potential impact on
18 that particular plant is, but they should be getting a fair
19 amount of data from the maintenance rule.
20 I'll conclude with some preliminary conclusions:
21 Overall, we think that the scope of the risk evaluations for
22 the extended uprates provides an adequate level of insight
23 to allow those uprates, at least in the case of Hatch and
24 Monticello to go forward, and a similar assessment in the
25 others.

1 The Committee has raised some thought-provoking
2 questions in the areas of shutdown, some of the aging
3 phenomena, and we'll certainly think about that.
4 I'm being told I'm using too much time, so I'll go
5 on.
6 Really, the final concluding point I'd like to
7 make is that as thought-provoking as a number of these
8 phenomena issues are, our ability to put them into the risk
9 models right now doesn't appear to be available to us. And
10 absent operational data showing reasonably significant
11 changes in event frequencies and failure rates for important
12 equipment, it's not clear to us at this point that would it
13 would be fruitful or productive to attempt to perform a
14 broadly-based risk assessment to show the full possibility
15 of impacts to these synergisms, because we really don't have
16 --
17 DR. WALLIS: I think what you're saying is that
18 you don't know what's going to happen, so you're going to
19 try it and see. That's the impression I have.
20 MR. RUBIN: Well, we've tried it, and we've see
21 two years of two uprated plants, but certainly --
22 DR. SHACK: I guess I don't really share all the
23 concern for some of the aging phenomena, the reduction in
24 margin. I mean, in many cases, either you have enough
25 margin or you don't, and changing the margin doesn't change

1 the failure rate very much.

2 Many of these failure rates are such slow,

3 cumulative things, that just intuitively, I would think that

4 they would not change. The thing that you really have to

5 worry about is tripping some sort of instability.

6 If you don't have flow vibration at one flow rate,

7 then all of a sudden you increase the flow rate and you have

8 flow vibration, I mean, you don't design against flow

9 vibration. The way you design it is to avoid it.

10 You know, it's not as though as I can take a

11 little bit more flow-induced vibration. I'm either going to

12 have it or I'm not.

13 But in many ways, it's the deterministic

14 calculations, whatever limitations they have, that will tell

15 you whether you're tripping those instabilities. I mean,

16 they will be checking for flow-induced.

17 Now, maybe they'll get the calculation wrong, but,

18 you know, they will be checking for that. Flow-assisted

19 corrosion is a somewhat similar sort of thing, that, you

20 know, you can trip over an instability, and as Dana said, if

21 it's thermal fatigue in the sense of a kind of slow up and

22 down, that's easy to design against, that's a very

23 cumulative thing.

24 The tricky thing is, again, if you induce some

25 sort of instability phenomenon, you know, that you then have

1 thermal striping at one flow rate, and all of a sudden, I
2 now have thermal striping, well --
3 But those are the sorts of things that I just
4 can't envision you picking up in your PRA. I mean, if
5 you're going to find them anywhere, you're going to find
6 them in your deterministic calculations; if your models
7 aren't good enough, you're just going to simply find out
8 that your models aren't good enough.
9 DR. BONACA: I would normally would agree with
10 you, if there weren't two perspectives. One is this issue
11 of performance of components that you can monitor and
12 correct, and there are plenty of those to do.
13 When you talk about some passive components,
14 however, for which there is no planning for replacement,
15 okay, you can monitor performance. The only question that
16 remains is, is the capability of that component as a barrier
17 in case you have a severe accident, for example, the same at
18 the 20 years, or 40 years or 60 years? I doubt it.
19 I mean, I gave you an example for containment. I
20 think containment will perform, will perform effectively at
21 50 VSI; they have programs tested there. But there is no
22 question about the fact that you have corrosion taking place
23 in the liners and probably they will not be able to deliver
24 what the PRA says it delivers.
25 So, if I really were able to perform a PRA that

1 would account for some of these aging effects, I would be
2 looking mostly at the release area, in fact, and the effect
3 that there is on the population fatalities due to the fact
4 that you have a less capable plant and you have a higher
5 power level at which you're running the plant.
6 You have a higher amount of fission product, and
7 you have accelerated timing of releases, and for those
8 issues, I don't get sufficient confidence just from by the
9 existing problems. Simply you have a plant which is older.
10 DR. SHACK: Well, again, I can't speak for every
11 analysis, but if you take steam generator tubes, for
12 example, I mean, when a steam generator tube is new, you
13 have a margin of perhaps five against burst.
14 That margin is decreasing. But the NRC has set an
15 absolute limit; you will have a factor of three, you know.
16 And so that's the only thing that they credit for, so if
17 it's gone from five to four, and you're only taking credit
18 for three, you know, the aging doesn't bother you.
19 And then it's the same with piping. Now, in the
20 containment, I simply don't know the -- I don't know what
21 was really done in the analysis for the PRA. I'm sure it
22 was well above the design. I suspect that it's still a
23 conservative estimate of the true design margin. But in
24 many cases --
25 DR. BONACA: It was a mean value with --

1 DR. SHACK: We're still making conservative --
2 we're making more realistic, but still conservative
3 assumptions of the real margins. Margin is such a loose
4 word that it's very difficult to get your hands around it.
5 DR. APOSTOLAKIS: So what you're saying, Bill, is
6 that essentially the issue is one of a deterministic review?
7 DR. SHACK: At the moment, I would think that
8 deterministic gives you the best handle on it.
9 DR. APOSTOLAKIS: Nobody questions that.
10 DR. SHACK: Whether it's perfectly adequate or not
11 is another question. But what I worry about is tripping
12 over these instabilities.
13 Am I going to suddenly somewhere induce
14 flow-induced vibration? You know, in my 20 years of
15 experience, I've never seen flow-induced vibrations here
16 before, you know, I now up the flow rate a little bit, and
17 all of a sudden, I have flow-induced.
18 And once you step over those instability regions,
19 you know, failures can -- they're not general accumulations,
20 you know; you've stepped off the ledge.
21 DR. BONACA: But those, you identify.
22 DR. SHACK: Well, you identify them after they
23 happen.
24 [Laughter.]
25 DR. BONACA: I understand that.

1 CHAIRMAN POWERS: I think we ought to probably
2 move along. I want to hold us to the schedule pretty
3 closely here today.
4 MR. RUBIN: Can I have 30 seconds to conclude?
5 CHAIRMAN POWERS: Sure, please.
6 MR. RUBIN: Oh, thank you. I wouldn't want to
7 leave you with the impression that we are totally oblivious
8 to some of the concepts mentioned here. There is work going
9 on in the Office of Research.
10 There is a program to assess age-related
11 degradation of structures, of passive components, as was
12 alluded to, of course, by the Committee in discussion
13 earlier, and NRR is following this work.
14 A recent Phase I study looking at passive
15 components concluded that it was mostly in the potential
16 seismic response area where there may not be programs
17 already ongoing that would provide some confidence of
18 capturing the effects.
19 And the Phase I results identified masonry walls,
20 flat-bottom tanks, anchorages, reinforced concrete
21 structures, and buried piping as potential areas for
22 risk-significant impacts that would be followed up for more
23 detailed modeling in Phases II and III that might provide
24 the framework for inclusion in actual risk models in the
25 future.

1 The other area that we're giving a little
2 consideration to is in future uprates, whether we should
3 focus a little bit more on operational data, perhaps
4 ourselves, as well as pursuing it with the licensee, to make
5 sure that failure data, transient data, is assessed with a
6 look mindful of it being as a result of power uprates and
7 being able to capture these and dig out the root cause due
8 to uprate. That will give us a little fuller database to
9 move forward on that.
10 With that, I conclude my presentation.
11 MR. KIM: Mr. Chairman, I'm noting that we're
12 about 20 to 25 minutes behind schedule.
13 CHAIRMAN POWERS: Right.
14 MR. KIM: I don't know whether you wish to alter
15 the agenda in any way, or do you want us to just go ahead
16 and proceed?
17 CHAIRMAN POWERS: I think go ahead and make the
18 points that you intended to make, and recognize that the
19 Committee is pretty good at reading.
20 MR. KIM: Yes, sir. Our next presenter is Mr.
21 Ralph Caruso.
22 MR. CARUSO: Good afternoon. My name is Ralph
23 Caruso. I'm with the Reactor Systems Branch in NRR.
24 I'm going to talk to you today about some of the
25 aspects of the design basis analytical reviews that the

1 Staff does as part of the power uprates. I'd like to start
2 by emphasizing again that we are mindful of the potential
3 for reductions in plant margin and increases in risk as part
4 of these proposed power uprates.
5 I'm going to focus mostly this afternoon on BWR
6 power uprates, because that's really where the larger power
7 uprates are, and that's where I think the concern is.
8 Realize that we've been looking at this for, as
9 T.J. said, for about eight to 10 years, and GE has put
10 together two topical reports that describe this process in
11 quite a bit of detail.
12 They are guidelines for both licensees who want to
13 do power uprates, and they provide the Staff with additional
14 guidance on how to do the reviews.
15 The Staff uses them in the same way we would use a
16 revision to the SRP, as T.J. mentioned. We also use the
17 existing SRP to provide us with the regular deterministic
18 guidelines and criteria for doing a plant review.
19 And we use the SERs that we've approved in the
20 past for earlier power uprates.
21 Monticello and Hatch, as Mark described, were two
22 significant power uprates that were reviewed an approved in
23 accordance with this guidance.
24 And I want to make this clear; I'm going to say
25 this several times: Extended power uprate applications are

1 required to meet all deterministic requirements for
2 licensing. There is nothing about a power uprate that
3 causes any of the deterministic acceptance criteria to
4 change.
5 In the area of fuel performance, in the area of
6 ECCS performance, in the area of mechanical performance, the
7 criteria are the same. And people who want to do power
8 uprates have to do the power uprates within those
9 deterministic acceptance criteria, within that box.
10 We defined that box; they have to live with it,
11 okay?
12 DR. SHACK: Do people using the power uprates
13 always use the best estimate kind of analyses? Are they
14 forced to go to that?
15 MR. CARUSO: I'll get into that in a minute. Let
16 me get to that.
17 One other item I wanted to mention at the bottom
18 of my first slide is that we have been talking to the
19 licensees and to the vendors about these power uprates on a
20 very frequent basis.
21 Duane Arnold is the first plant that's come in.
22 And I believe we've had at least a half a dozen meetings
23 with them over the past year.
24 We've had meetings with Commonwealth, now Exelon.
25 We've had meetings with Brunswick, and at all of these

1 meetings, the Staff asks question after question after
2 question about these uprates, about how does it affect this
3 particular aspect of plant operations? How does it affect
4 that aspect of plant operation?
5 And in our discussions with the licensees and with
6 the vendors, it's clear that they're asking the same
7 questions of themselves. They don't want to be blind-sided
8 by a flow-induced vibration.
9 They don't want to fall into a hole there and have
10 something break off. So, I want you to realize that we're
11 all concerned about this, and we're all looking at it, and
12 we're all thinking very hard, not just the Staff, not just
13 the ACRS, but licensees and the vendors.
14 We want these power uprates to work. We don't
15 want to just do them to raise power.
16 First of all, the licensing calculations that are
17 done as part of what we call design basis space, are done in
18 accordance with methodologies that have been previously
19 approved by the Staff on a generic basis.
20 These are the methodologies that define the box
21 that the licensee, the vendors operate in. For GE, for
22 these plants, the current methodology for LOCA is the Safer
23 Jester Model. It's a very complex methodology that uses a
24 lot of different computer codes.
25 The staff has reviewed those computer codes and

1 the way they are applied by the licensees and by the vendors
2 is that there are initial conditions and boundary conditions
3 for their applications, and the vendors and the licensee
4 have to make sure that the analyses are done in accordance
5 with those initial and boundary conditions.
6 We defined the conditions under which they work.
7 They can't run off the end of a correlation, for example.
8 We define those conditions.
9 The Staff has the ability right now to perform
10 independent audit calculations of these particular
11 scenarios, when we deem it appropriate. As part of any
12 licensing review, we do occasionally do audit calculations.
13 In the area of stability, for example, Dr. Powers,
14 you mentioned that. We have a number of people that have
15 been doing some stability calculations.
16 We look at stability scenarios to verify that the
17 operating flow maps are proper.
18 We have the authority to verify that the
19 methodologies are actually being applied properly by going
20 to G.E.-Wilmington or the Licensee's offices and actually
21 looking at the calculations and I can assure you right now
22 that for these particular power uprate reviews we plan to do
23 exactly that.
24 There are a number of calculations that we are
25 interested in seeing to make sure that the Licensees and the

1 vendors are doing the calculations in accordance with the
2 limits that we prescribe when we approve the methodologies,
3 so we are going to do those.
4 The next sentence there -- as I said, we have all
5 been thinking about this. We have been thinking about these
6 synergies, synergistic effects. Right now as it sits, we
7 have not been able to think of any phenomena or any issues
8 that arise uniquely out of power uprates that would cause us
9 to think that the methodologies that have been reviewed and
10 approved are no longer valid. These are the deterministic
11 methodologies.
12 CHAIRMAN POWERS: I knew you were going to get to
13 this. It seems appropriate to ask the question now.
14 One of your confederates has appeared before us in
15 connection with high burnup fuel and said that she sees
16 evidence that burnup rate makes a difference.
17 MR. CARUSO: That is correct.
18 CHAIRMAN POWERS: And so doesn't that cause you
19 some pause about the methodologies?
20 MR. CARUSO: No. Now let me explain. We do --
21 well, I will skip two pages.
22 I will go to high burnup fuel.
23 High burnup fuel -- first of all, the definition
24 of high burnup fuel.
25 For us right now high burnup fuel is fuel that is

1 burned above 62 gigawatt days per metric ton.

2 CHAIRMAN POWERS: Above?

3 MR. CARUSO: Above. Okay?

4 CHAIRMAN POWERS: Let's talk about --

5 MR. CARUSO: Right now, no one --

6 CHAIRMAN POWERS: -- 55 to 62.

7 MR. CARUSO: Right now no one is allowed to burn

8 fuel above 62.

9 CHAIRMAN POWERS: That's right, so there is no

10 high burnup fuel.

11 MR. CARUSO: So there is no high burnup fuel. We

12 are not talking about that. I want to make that clear.

13 [Laughter.]

14 CHAIRMAN POWERS: Let's talk about intermediate

15 burnup fuel then.

16 [Laughter.]

17 MR. CARUSO: Fuel that is almost high burnup -- we

18 know that there are a number of issues involved with almost

19 high burnup fuel. One of the big issues that we are facing

20 right now is what is called fuel duty, which is how fast do

21 they burn it up.

22 We agree that there are some problems there, but

23 what we see when you look at power uprates, power uprates

24 will get you to the burnup limits faster but there is

25 nothing about the power uprates that creates a fuel duty

1 that is any different from the fuel duties that we are
2 currently seeing in operating plants.
3 The plants that we are seeing the problems in are
4 not the ones that are going to power uprates. What I am
5 saying is the issue of higher duties is here. We know it
6 is. We are dealing with it. There is nothing about power
7 uprates that is going to change that phenomena or make it in
8 any way different, worse -- we don't think it is going to
9 get any worse. We know it is a problem, but the way it is
10 going to be dealt with is through fuel designs, new
11 materials, maybe changes in chemistry, something like that,
12 but we don't see any relationship of duty to power uprates.
13 DR. KRESS: What is the general level of burnup
14 that plants operate under, at current -- average burnup?
15 MR. CARUSO: In the BWRs I believe -- I want to
16 say 50,000 to 55,000.
17 DR. KRESS: I thought it was about 50,000. Now
18 this is another one of those margins questions, Mario.
19 I am sure that they will want to use that margin
20 from fifty up to sixty-two in this process of power uprates,
21 so I mean there is another margin erosion.
22 MR. CARUSO: Realize that fuel is licensed with
23 certain acceptance criteria and what we do is we say you
24 have to meet these acceptance criteria and as long as they
25 meet those acceptance criteria, that's fine.

1 DR. KRESS: Right, but that's the margin they are
2 using up.
3 MR. CARUSO: Right. If they want to go higher
4 than sixty-two --
5 DR. KRESS: Then they've got another problem.
6 MR. CARUSO: They have got to generate the data to
7 show that the fuel can go to that limit under whatever power
8 level, whatever duty they plan to burn at.
9 DR. KRESS: I am just worried about going up to
10 sixty-two.
11 CHAIRMAN POWERS: I know of nobody that's come to
12 this Staff and said they want to go over sixty-two yet. In
13 fact, I think in general the boilers are a little lower,
14 because each core load is approved and there is no blanket
15 approval. They approve each core load and I think the
16 boilers are running a little lower than sixty-two across the
17 board right now.
18 I mean defining high burnup fuel is above
19 sixty-two. Fine. Any way you want to define it, but in fact
20 to me anything over forty-five is high burnup because that
21 is where we start to see rim effects and some significant
22 amount of oxidation --
23 DR. KRESS: That aren't accounted for in PRAs.
24 CHAIRMAN POWERS: PRA is probably the wrong tool
25 to look at this. It's a blunderbuss and this is a

1 neutronics issue.

2 I think I understand what you are saying. It is a

3 little confusing to me because it seems to me that if I am

4 moving to higher power I am using my fuel faster. More of

5 it has higher duty than it did before.

6 It doesn't change the problem that you already

7 know.

8 MR. CARUSO: That's correct.

9 CHAIRMAN POWERS: Now that seems perfectly

10 plausible to me.

11 MR. CARUSO: What I am saying is that there is no

12 new phenomena or issue that comes out of power uprates.

13 CHAIRMAN POWERS: Or uprateness itself doesn't

14 cause the problem. It is a fuel problem on duty --

15 MR. CARUSO: Right.

16 CHAIRMAN POWERS: -- and you are tackling that

17 somewhere else, and they may have more of this problem in

18 uprated power but that is not where you are going to attack

19 it.

20 MR. CARUSO: It's not really a power uprate

21 problem. It's a fuel duty problem.

22 CHAIRMAN POWERS: I think I understand this.

23 MR. CARUSO: Okay. Let me go back to the second

24 slide on best estimate methods. Right now there's only one

25 best estimate method that has been approved and it is not

1 for BWRs. It is WCOBRA-TRAC for Westinghouse.

2 In the course of talking to the vendors about

3 these power uprates we have gotten the feeling that the

4 existing DBA methods that are being used are probably at

5 their limits and that we should expect to see the best

6 estimates for the BWRs start to come in sooner rather than

7 later.

8 We think that is a good idea. We believe that

9 when we get them they are going to be submitted with CSAU

10 methodologies and quantification of the uncertainties which

11 will help in the evaluation of uncertainties in PRA.

12 CHAIRMAN POWERS: Which code?

13 MR. CARUSO: TRACG.

14 CHAIRMAN POWERS: TRACG.

15 MR. CARUSO: Right. So we are all in favor of

16 best estimate methods. We think it gives better, more

17 accurate results and we encourage it but we don't have it

18 yet.

19 DR. SEALE: Are you going to insist that one of

20 your benchmarks on this revised, better racing stripe code

21 be to successfully predict the performance of the plant as

22 it exists prior to the uprate?

23 MR. CARUSO: Whatever methodology is approved for

24 any plant has to include the conditions at which the plant

25 will operate.

1 DR. SEALE: No, before you do the uprate.

2 MR. CARUSO: No.

3 MR. WERMIEL: I am not sure I understood the

4 question. You are asking actually like a delta review is

5 what it sounds like -- to take the code, go back and analyze

6 the plant --

7 DR. SEALE: All I am saying is that the best lab

8 you've got for what the core is what you have got.

9 MR. WERMIEL: And you have operating experience --

10 DR. SEALE: And then what happens when we add the

11 power to it?

12 MR. WERMIEL: I don't think we have thought of

13 doing that. By the way, my name is Jared Wermiel. I am

14 Chief of the Reactor Systems Branch.

15 I don't think we've thought of that. It's an

16 idea, I guess.

17 DR. SEALE: I don't know how you are going to say

18 you have a decent model unless you can predict --

19 MR. WERMIEL: Because the model, as with any best

20 estimate code, correct me if I'm wrong, Ralph, the model

21 will have to be assessed and benchmarked for its

22 application.

23 MR. CARUSO: Yes.

24 MR. WERMIEL: Whether or not that assessment and

25 benchmarking should be done at the old power level or at the

1 new power level, I don't know that it matters that much, so
2 long as whatever application the code is being subjected to
3 has been appropriately assessed and we can agree with that
4 assessment.
5 MR. CARUSO: Dr. Seale, one of the steps in the
6 CSAU methodology is assessment of the entire code in
7 integrated fashion against an integrated, either a test
8 facility or a plant, okay? -- and as we understand it, G.E.
9 is planning on submitting TRACG and using CSAU, so we fully
10 expect that they will include plant data as part of the
11 assessment of TRACG.
12 DR. WALLIS: Now is CSAU the only specification
13 that these codes have to meet or do you anticipate something
14 else?
15 Have you looked at CSAU and said if we really did
16 all these things right, would that be all we would need?
17 MR. CARUSO: Well, the CSAU method is a way to do
18 code, scaling, assessment and uncertainty to show that you
19 meet the criteria of 50.46, paragraph (1), which is to be
20 able to quantify the uncertainty in the calculations.
21 It is a general purpose methodology that I have
22 been looking at for about 12 years. I think it's -- to use
23 a phrase that one of our consultants use -- it is a
24 world-class methodology, okay? -- and as far as I know,
25 everyone who I have talked to in the world about this

1 agrees.

2 It is quite complex. It is quite comprehensive

3 and it provides you with a way of determining whether the

4 code will predict what you want it to predict if you follow

5 it properly.

6 DR. WALLIS: That is sort of a statement of faith.

7 If you actually did it, would it answer all the questions

8 you anticipate in terms of these power uprates and the

9 answers you are going to get from these best estimate codes?

10 MR. CARUSO: I think it is going to answer the

11 questions about the calculations of how the plant is going

12 to behave during the DBA accidents.

13 It is not going to answer I don't believe Mario

14 Bonaca's question about how much margin is there to

15 containment failure after 60 years when the containment has

16 had a chance to corrode. It is not designed for that and I

17 am not sure how that question is going to get answered,

18 because I don't know what the containment ultimate

19 capability is going to be after 60 years of corrosion.

20 I don't know. I mean there may be somebody that

21 does.

22 DR. WALLIS: It's a little bit "iffy" it seems.

23 You have great faith in CSAU. It is a very good method, but

24 it hasn't really been applied with all the bells and

25 whistles and everything yet, so we don't yet know perhaps

1 enough about whether it will be adequate for all these
2 questions.
3 MR. CARUSO: Right. I don't disagree with you.
4 DR. SHACK: Thermal hydraulics guys -- you are
5 waiting for somebody to do CSAU. As soon as you get
6 somebody it isn't good enough.
7 [Laughter.]
8 DR. SEALE: It's been contaminated by those high
9 burnup fuels.
10 CHAIRMAN POWERS: I want to try to hold to the
11 schedule as well as we can, so let's --
12 MR. CARUSO: That's all I've got to say.
13 CHAIRMAN POWERS: -- progress ahead.
14 I think we can move then to the flow-induced
15 corrosion.
16 MR. KIM: Yes. Next up is Gene Carpenter from the
17 Staff.
18 CHAIRMAN POWERS: Gene is to be congratulated for
19 not overburdening the committee with an excessive number of
20 viewgraphs.
21 [Laughter.]
22 CHAIRMAN POWERS: Oh, he's brought more.
23 MR. CARPENTER: Good afternoon. I am Gene
24 Carpenter and I am with the Materials and Chemical
25 Engineering Branch and I am here to talk to you briefly

1 about erosion-corrosion issues on power uprate.

2 Just as a little side-note, the first time that I

3 addressed the committee was about 10 years ago, and that was

4 when we were doing the Fermi power uprate, the very first

5 one, so it just never goes away, does it?

6 One of the questions that was asked to us in the

7 memo was about the effects of erosion-corrosion and had we

8 considered it, and as I say in my memo here, yes, we have

9 addressed it. We looked at it and we do believe that it

10 will not cause any adverse conditions to the reactor coolant

11 piping system.

12 The reasons for that are twofold.

13 First, the Licensees are required to re-examine

14 their inspection programs based on the plant-specific uprate

15 concerns, and to evaluate those effects, to tell us about

16 it. We look at that. Also, the Licensees are required to

17 verify that the power uprate will have no significant

18 effects on any erosion-corrosion, either on existing flows

19 or on potentials flows.

20 DR. SHACK: You guys don't have Checkworks to do

21 it, so what do they do when they do this? They go off and

22 they do it and they say our inspection intervals are fine

23 and you have to believe them?

24 MR. CARPENTER: Well, they go off. They perform

25 their inspection, their evaluations of it. They provide us

1 with the results of those, not the specific details but the
2 results saying that, yes, we have evaluated -- there will be
3 no significant increase. Oh, by the way, these are the
4 inspection programs that we have in place to ensure that
5 there will be no significant degradation.
6 DR. UHRIG: This is done after the power uprate is
7 approved? They have to tell us that there will be an
8 inspection program in place that will determine that there
9 will be no adverse effects that will not be seen?
10 MR. KIM: It's an ongoing program at each of the
11 facilities.
12 DR. UHRIG: That's just a hand-waving argument?
13 How do you determine that?
14 MR. CARPENTER: Well, as was said earlier, until
15 we actually see that there is erosion-corrosion occurring
16 that causes degradation --
17 DR. UHRIG: That only appears after you have got
18 the power uprate.
19 MR. CARPENTER: Erosion-corrosion is an effect
20 that occurs any time --
21 DR. UHRIG: All the time.
22 MR. CARPENTER: -- that you have flow going
23 through. If it continues excessively or if it continues
24 once you have it and it increases to an excessive amount,
25 you have to have a program in effect that will determine

1 that it is increasing.

2 So far they have been able to prove to us that

3 they will have an inspection program someplace to catch

4 that.

5 Any other questions?

6 CHAIRMAN POWERS: I guess the question still boils

7 down to what Bill was asking you.

8 They go through and do an analysis. They probably

9 use Checklist. Okay. They give you the results. Now what

10 do you do? I mean you got -- you guys say yeah, I did this

11 and I don't have to change my inspection frequencies at all?

12 I mean are you a particularly religious person and

13 you --

14 [Laughter.]

15 MR. CARPENTER: Well, that and politics I really

16 don't intend to discuss in public.

17 CHAIRMAN POWERS: I mean this sounds like a very

18 faith-based operation here.

19 MR. CARPENTER: Faith in engineering, yes.

20 CHAIRMAN POWERS: I guess I am asking you about

21 the engineering part and not the faith part.

22 MR. CARPENTER: If their determination comes in We

23 have taken a look at it. We have said, yes, we do agree with

24 you that you do not have a significant concern, and then

25 they come back and over the course of years -- for instance,

1 as I said at the beginning of my comments, I first came to
2 you guys when we were talking about Fermi 10 years ago. As
3 far as I know, Fermi has not found any erosion-corrosion
4 issues of significance, even though they have been operating
5 at an increased power level in the past 10 years.
6 If a plant comes in and they have found
7 erosion-corrosion occurring, then we are going to go back
8 and re-evaluate what we have been saying about their ability
9 to determine the effects of erosion-corrosion due to power
10 uprates.
11 CHAIRMAN POWERS: Let me see if I understand what
12 you have told me. They come in and they say I have looked
13 at this thing, it's okay. My inspection internals are
14 these -- whatever they are.
15 You guys look at it and you say based on our
16 engineering experience with this, that looks about right?
17 DR. SHACK: To be fair, you have got a fair amount
18 of historical experience because all these guys have had
19 erosion-corrosion programs for 10 years now or something,
20 you know, formal erosion-corrosion programs, and I guess the
21 boilers at least have managed to avoid blowing any pipes
22 out, haven't they?
23 MR. CARPENTER: To the best of my knowledge, yes.
24 CHAIRMAN POWERS: The PWRs have more of a problem.
25 DR. SHACK: So to that extent it does build some

1 confidence that the inspection programs are meaningful, but
2 they do see erosion-corrosion, right?
3 It is not as thought they are always coming back
4 and reporting well, didn't see anything. I mean they do see
5 erosion-corrosion. They just manage it.
6 MR. CARPENTER: They do manage it, yes, and as a
7 point of reference, and this is something that we will be
8 discussing with you at a later ACRS meeting, the BWRs have
9 been providing to the Staff a comprehensive report of all of
10 the inspections that they do each outage season, so we are
11 monitoring what is going on there.
12 MR. LEITCH: Your first bullet you talk
13 specifically about reactor coolant system piping. Have you
14 considered piping in balance of plant at all?
15 MR. CARPENTER: Well, for BWRs you have got the
16 steam system. It's all primary. So, yes, we look it up for
17 the whole thing but we don't look at the secondary --
18 radioactive side.
19 DR. SHACK: BWRs.
20 MR. CARPENTER: Correct.
21 MR. LEITCH: I mean specifically have you looked
22 at piping around the turbine, turbine extraction piping?
23 Feedwater -- drain piping, so forth --
24 MR. CARPENTER: I'll have to get back to you as to
25 that level of detail.

1 DR. SHACK: How about feedwater?

2 MR. CARPENTER: Yes. Yes, we have looked at

3 feedwater.

4 DR. SHACK: Certainly in a boiler where everything

5 is stainless steel not much of a flow. It's just a

6 corrosion problem.

7 CHAIRMAN POWERS: Thank you. Farouk can go to his

8 Viewgraph 3 and tell us the bottom line quickly.

9 MR. ELTAWILA: Thank you, Mr. Chairman. You can

10 see that I am lonely here for two reasons: One of them is

11 that my -- Tom King and Mike Mayfield, who have much more

12 promising careers than I --

13 [Laughter.]

14 MR. ELTAWILA: And I just want to make it clear

15 that NRR told us that -- I'm going to give you some

16 initiatives from the Office of Research. And I would like

17 to state that NRR does not see a need for that initiative,

18 and they are not part of it.

19 So that's an RES initiative, and with that, I want

20 also to make a couple of comments before I start my

21 presentation.

22 Most of the discussion here today focused on power

23 uprate, but I thought that the ACRS concern, and based on

24 information that I read from you, Mr. Bonaca, and Gus, that

25 the issue is the synergistic effect.

1 And that, I will try to focus on, and might touch
2 every now and then on power uprate, but that's not the main
3 focus of my presentation.
4 The other thing, again, it is clear that we
5 really, in the Office of Research, are not saying that NRR
6 should stop doing power uprate or license renewal pending
7 the Office of Research finishing its work. I think they are
8 doing a good job.
9 They spend a lot of time on the issue, more than
10 me, so for me to sit here and try to poke holes in their
11 work, I think it will be unprofessional, but they spend more
12 time.
13 But so I'm going to try to pose my presentation in
14 a set of questions, rather than I know the answer. They
15 might have asked the same questions themselves, and they
16 have the answer, so hopefully that will not be construed
17 that I'm really second-guessing them or anything like that.
18 With that, again, the issue that is raised is the
19 -- a lot of design changes have been taking place over the
20 years. We're talking about high burnup fuel, longer fuel
21 cycles, higher peaking factors, increased power levels, use
22 of mixed core, new fuel design, and life extension.
23 All of these have taken place over the past
24 several years. And although we have the deterministic way
25 of looking at each one of these issues, and we have done

1 research or license amendments to deal with each one of
2 these issues, looking at them in a global synergistic
3 fashion has not taken place.
4 And the Office of Research is going to have an
5 initiative to look at that particular one.
6 Let me pose a couple of questions. I think you
7 raised a lot of questions about this issue, but let me pose
8 the question: One of the important things about it is the
9 quality of the PRA.
10 I know it's not my area, but I'm going to touch on
11 it a little bit. I think you asked the question, Professor
12 Apostolakis, about the timing, the change in timing and
13 things like that.
14 That's a very good question, but if you look at
15 the answer alone, you might be misled. I think we have to
16 look at how the baseline PRA was done. Have we changed the
17 models between that baseline PRA and the current PRA to
18 assess the upgrade or not?
19 If you change that model, you can always get a
20 zero delta risk. So if you want to see if it has an effect
21 on the risk or not, you have to look at the details of the
22 model.
23 We're not saying that better models should not be
24 used, but we're saying you have to look at the change in
25 models, not only at the answer alone. And those are the

1 things that I think the PRA quality is one of the important
2 things, and we look at the underlying assumption of what
3 went into these analyses.
4 The second question, I think, is related to how do
5 we have enough data, are the model that we are using right
6 now are applicable to a plant that's maybe 30 and going to
7 be 40 years old and have life extension for another 20 to 60
8 years old?
9 I don't think we have these data right now, and I
10 think Mark indicated that they will be looking for
11 operational data. But we have to look at the models and see
12 if these models are suitable to assess these new reactors,
13 including all these activities.
14 I just want to touch a little bit on the analysis
15 that was done by HSK. As you know, they have looked at a
16 14.7 percent increase for the Liebstadt reactor, and they
17 found there is an increase of about 30 percent in the
18 fission product release, namely due to the increase in
19 inventory.
20 But I think some of the insight coming out of that
21 study is very important. For example -- and I'm repeating a
22 lot of the stuff that you mentioned:
23 The acceleration of the event itself, which will
24 lead into a shorter time for operator action; reduced safety
25 margins for important mitigating systems, these factors,

1 collectively, resulted in a change in the success criteria
2 and an acceleration of the time of core melt by about 20
3 percent.
4 That's what important, so there has been some
5 changes. What we would like to be able to have is a PRA
6 like that done by licensees and we tried to change some of
7 the parameters ourselves, and reviewing a PRA by itself
8 might not be sufficient.
9 Let me go to the issue of containment integrity
10 because it was raised a couple of times. As you know, we
11 resolved the direct containment heating issue for
12 pressurized water reactors only.
13 We still have not finished our assessment of
14 direct containment heating for boiling water reactors. So
15 when you have plants like Clinton, for example, that is
16 proposing 20 percent power increase, we will be interested
17 to see the 20 percent increase in the decay, what effect it
18 will have on direct containment heating.
19 Again, the issue of containment aging and the
20 other stuff that's talked about, we need to be looking at.
21 I'm trying to give several examples in the way we
22 like to look at it from the Office of Research's
23 perspective. Again, we still are considering that issue. I
24 think Ashok Thadani and Margaret, who is sitting in the
25 back, have strong interest that we pursue that issue.

1 So we are looking -- going to look at it from the
2 deterministic and risk-informed point of view.
3 In each area, there are certain information. For
4 example, in the thermal hydraulic and reactor physics area
5 and fuel area, I think one of the ways they try to
6 accomplish this high power increase is by the use of
7 different fuel design that at least in the Office of
8 Research -- I'm qualifying that -- we have not looked at it
9 before. They use complex water hole in the fuel.
10 That produce a very complex reactor physics that
11 we have not dealt with them in the past. We need to look at
12 the effect of that.
13 The issue of operator action and the ATWS: The
14 envelope of power versus flow rate is going to change with
15 the burnup and with the power increase, and we need to look
16 at the new operating range and the time available to the
17 operator to be able to assess if they have enough time to
18 deal with that scenario or not.
19 Also, we want to look at the range of the
20 applicability of the critical thermal hydraulic model in GE
21 models or in NRC models. They are, again, increase of 20
22 percent power might lead to be D&P might become an important
23 issue for boiling water reactors, which we never considered
24 before.
25 So, the margin to critical heat flux is reduced

1 and we want to look at the applicability of the existing
2 model and the database to support this model for this new
3 application.
4 In the area of engineering, I think the Staff will
5 be interested -- again, NRR might have looked at it, but the
6 Staff will be interested in looking at the problem
7 associated with the internal of the vessel with the safety
8 relief valve, with check valves, all of these are issues
9 that would be worth looking at again in an integral fashion
10 of the aging of the equipment and the power rate increase
11 and the other changes that -- the license.
12 Again, in the area of containment, when you have
13 20 percent power increase, the pool temperature will
14 increase significantly, accordingly, so when you have a
15 fission product and you take credit for the decontamination
16 of the separation pool, with that, the contamination effect
17 is the same at high temperature versus low temperature? We
18 need to look at that and see that the credit that's taken
19 for the contamination still is valid and accordingly you can
20 have a better understanding of the risk?
21 In the area of PRA, again, it's one of the more
22 important things to look at the effect of human factors, and
23 the station blackout coping capability. We need to look at
24 all these and some of these transients, and see if the
25 frequency of these initiating events are changed as a

1 result, again, of all the design changes that have taken
2 place over the years.
3 CHAIRMAN POWERS: The one I would worry about is
4 not so much station blackout as it ATWS.
5 MR. ELTAWILA: ATWS, there is no doubt that ATWS
6 is one of the most important issue for boiling water
7 reactors. I agree with you 100 percent.
8 CHAIRMAN POWERS: It seems to me that you run into
9 the approved way of getting out of an oscillation and it has
10 problems if the fuel is running hot. You have to drop a
11 little -- to get the -- to mix and things like that. It
12 just seems like that. I don't know that it does, but it --
13 MR. ELTAWILA: I think that's an important issue,
14 and the -- indicated that it's one of the important issue,
15 and the frequency was increased, too.
16 They are going to have a much narrower range to
17 operate within, and that will increase the complexity of the
18 operator action. They will have a much shorter time to deal
19 with the event, and so we need to look at that very closely.
20 As I indicated earlier, you know that we are
21 operating with a budget right now that we approved two years
22 ago, so there is not any surplus in that budget, so we will
23 have to option either we go and request additional fund from
24 the Commission, or Ashok will have to reprogram the
25 activities in the Office to give that a higher priority and

1 to start working on it.

2 The last viewgraph is a disclaimer that this is a

3 Research initiative, and NRR does not see a need for that

4 work at that time.

5 CHAIRMAN POWERS: You could probably take the

6 money out of something like environmentally-assisted

7 cracking or something like that.

8 [Laughter.]

9 MR. ELTAWILA: I will be happy to answer any

10 question.

11 DR. WALLIS: I think what you're saying is that

12 these are big power uprates, and the view seems to be that

13 we know enough to handle decisionmaking associated with

14 them.

15 What you're saying is that somebody ought to be

16 looking at and anticipating possible problems with these

17 things.

18 MR. ELTAWILA: That's all what we're saying;

19 that's correct.

20 CHAIRMAN POWERS: It seems to me that there ought

21 to be somebody that should be able to turn around and give

22 you a direct answer to the question you asked, which is,

23 okay, discount the balance of plant, and at what point can't

24 you expand the power on these plants, looking strictly at

25 primarily the nuclear part of the plant.

1 DR. WALLIS: What stops you first?

2 CHAIRMAN POWERS: What's the first thing that
3 stops you? What's the next thing that stops you?

4 DR. APOSTOLAKIS: Since you are talking about
5 long-term stuff here, perhaps you should consider the
6 possibility of starting something in the near future on
7 quantifying the safety margins.

8 Now, you're going to tell me you have that
9 already?

10 MR. ELTAWILA: No, no, I have to write it down.

11 [Laughter.]

12 DR. APOSTOLAKIS: And then everything else that
13 you discussed here --

14 CHAIRMAN POWERS: Farouk, do you realize what I'm
15 going to have to put up with for the rest of the day? It's
16 going to go around and it will say that Farouk wrote my
17 words down.

18 [Laughter.]

19 DR. KRESS: First you have to tell us what you
20 mean by safety margins, George.

21 DR. APOSTOLAKIS: It's up to Farouk.

22 DR. KRESS: He's going to tell us.

23 DR. BONACA: There is an observation that I would
24 like to make. You know, we talked about the deterministic
25 processes to monitor, et cetera, et cetera, et cetera.

1 I think that, to me, it's a problem akin to the
2 fuel performance. Fuel performance has been increasing
3 incredibly over the past 40 years.
4 And based on performance of fuel, licensed to
5 62,000 megawatt day per metric ton, because that's what
6 every PWR did there, and one would judge that, in fact,
7 there is no concern whatsoever about fuel.
8 The issue is, however, that fuel, old fuel is not
9 good as new fuel, or let me say that old cladding is not as
10 effective as new cladding when you have significant enthalpy
11 to position in it, and that's why there is a full effort to
12 modify and change it, so on and so forth.
13 And I believe that, to me, it makes sense that I
14 will have the same concern with other pressure boundaries or
15 fission returning boundaries there for aging components.
16 So I appreciate your presentation and your
17 perspectives on some research. Any other comments from
18 members?
19 MR. ELTAWILA: I think it goes back to --
20 DR. BARRETT: I would just like to make a couple
21 of points. I hope that the presentations today give you
22 some assurance that NRR is covering the important issues in
23 power uprates and will continue to do with regard to the
24 ability to meet the current licensing criteria.
25 Regarding risk, we are now operating under the

1 guidance of 99-246, which tells us how to do business in
2 this arena, and within that -- within those constraints, we
3 are looking at what we think are the most important
4 potential impacts, as Mark Rubin pointed out, and we will
5 continue to do so with the possibility that at some point we
6 would identify what we would call some sort of an issue that
7 could be raised under 99-246.
8 We recognize that there are some other issues that
9 could be raised, that have been raised today, that are of
10 potential increase interest, such as the long-term effect on
11 containment and questions related to how large is the L in
12 LERF, and whether CDF and LERF are the right criteria.
13 But I think that we would, given the current
14 guidance, we would continue to focus on CDF and LERF.
15 Regarding the program proposed by the Office of
16 Research, I think I want to make sure you understand that we
17 clearly recognize and support the Office of Research's
18 mandate to initiate inquiries in areas where they see
19 potential issues.
20 I think what Farouk was saying is that there is no
21 specific user need from the Office -- from NRR, requesting
22 this work. And we will follow and monitor the work as it
23 emerges.
24 Hopefully it will be conducted in a way that
25 perhaps looks at issues in a way that can identify problems

1 first and perhaps identify those which are most promising to
2 pursue further.
3 But as the research work emerges, we would
4 certainly take into account in our reviews. But for the
5 time being, what we would propose to do is to continue on
6 our current course, and that we would certainly be
7 interested in anything the Committee has to say about it in
8 terms of course corrections that we ought to make in the
9 near term.
10 DR. KRESS: I don't mind you focusing on CDF and
11 LERF. It's just that in my opinion, LERF ought to be a
12 variable. It's a function of the power level, acceptable
13 level of LERF, not the -- LERF is a variable, but the
14 acceptance value or LERF ought to be a variable that's a
15 function of power level.
16 CHAIRMAN POWERS: That may be a distinction
17 without a difference. If you said, gee, the power level
18 varies, I mean, the power level goes up by 20 percent, and
19 if I increase or decrease my acceptance value for LERF by 20
20 percent, there is no difference from the number I've got
21 right now.
22 DR. KRESS: They're not linear; we know that.
23 CHAIRMAN POWERS: I measure the LERF with a
24 decade-based ruler. I mean, it would have to take a tenfold
25 increase in power before I'd ever see it in a LERF measure,

1 right?

2 DR. KRESS: Yes, but they're focusing on

3 delta-LERFs also, and I think there will be a significant

4 difference in the delta-LERF you might see.

5 CHAIRMAN POWERS: Are there any other comments

6 that people would like to make on this?

7 [No response.]

8 CHAIRMAN POWERS: Then I'd like to take recess for

9 15 minutes. We're going to come back and discuss some

10 things about the Differing Professional Opinion.

11 [Recess.]

12 CHAIRMAN POWERS: Let's come back into session.

13 We're now going to return to the subject of the Differing

14 Professional Opinion on the alternative repair criterion for

15 steam generator tube integrity.

16 DR. SHACK: Mr. Chairman, I will have to recuse

17 myself from this issue because I have a conflict of interest

18 because I'm doing research work for the NRC on this issue.

19 CHAIRMAN POWERS: Very good. You will be allowed

20 to sit there and be mum. Pretend like he's not there.

21 DR. KRESS: You don't have to leave the room.

22 CHAIRMAN POWERS: The Committee chartered a

23 Subcommittee to gather facts and develop draft positions on

24 this issue. All the members should have a copy of that

25 Subcommittee's report.

1 In the course of preparing that report, it became
2 apparent to us that there was one area under contention that
3 we had not been completely briefed on and didn't have a
4 coherent story on that we could develop ourselves if we
5 needed additional information.
6 And that was the issue of if the tube support
7 plates were to move in the course of a depressurization
8 event, what happened to the tubes? How did damage progress
9 on those and the like?
10 What I have asked is that the Staff come give us a
11 supplemental briefing on that. I have not asked them to
12 begin at the beginning and go through the entire story on
13 the alternative repair criteria or anything like that.
14 I've asked them to give a fairly focused 15 or 20
15 minutes on that particular question.
16 I will, of course, afford them the opportunity to
17 make comments on other areas that they want to make comments
18 on, just as I have -- we're making available time for Dr.
19 Hopenfeld, if he has any comments that he wants to make on
20 any particular issue connected with this.
21 Then we will, once those presentations are over,
22 will go to discussion of the Subcommittee report itself. So
23 with that, I will turn this over to Jack.
24 MR. STROSNIDER: This is Jack Strosnider from NRR,
25 and Ken Karwoski will make a presentation with regard to the

1 role of support plates in the context of Generic Letter
2 95-05. I think you have the handout material, so I'll just
3 turn it over to Ken.
4 MR. KARWOSKI: My name is Ken Karwoski. I'm in
5 the Materials and Chemical Engineering Branch of NRR.
6 I'll be discussing the effects of support plate
7 movement on the cracks present that are left in service as a
8 part of the Generic Letter 95-05 methodology.
9 DR. UHRIG: Could you allude here to the type of
10 holes going through these support plates? Are these just
11 the cylindrical holes, or are these the multi-lobe?
12 MR. KARWOSKI: These are drilled holes.
13 DR. UHRIG: Drilled holes only?
14 MR. KARWOSKI: So not multi-lobed or trifoil or
15 qudarafoil like you're referring to. And I'll just give a
16 little background, just so everybody is familiar.
17 Generic Letter 95-05 allows certain degradation at
18 the support plate elevation to remain in service. It allows
19 predominantly axially-oriented outside diameter stress
20 corrosion cracking to remain in service.
21 This degradation occurs in the crevice between the
22 tube and the tube support plate. The support plate is
23 approximately three quarters of an inch thick and it's made
24 of carbon steel. The crevice is typically packed with
25 corrosion products such as magnetite.

1 The two fundamental goals of this repair criterion
2 is to ensure the structural and leakage integrity of the
3 steam generator tubes.
4 And correlations were developed relating an
5 inspection parameter to the voltage to both the burst
6 capability of the tube and also to the amount of leakage
7 that you would experience from these indications.
8 The correlations include data from two sources:
9 It comes from whole tube data, from tubes removed from
10 inservice steam generators, and also tube specimens produced
11 in the laboratory in autoclaves.
12 The destructive examinations typically performed
13 on these samples include leak testing, where the tube is
14 pressurized to steamline break conditions, and then amount
15 of leakage is measured.
16 This is used in both a probability of leakage
17 correlation and also a conditional leak rate correlation.
18 Burst testing is also performed on these tubes
19 where the tubes are pressurized until gross rupture occurs,
20 and these are used in the burst pressure correlation for the
21 structural integrity analysis.
22 And there is also metallurgical examinations
23 performed which ensures that the degradation mode is
24 consistent with those data from other plants and between the
25 laboratory specimens.

1 It's important to understand how this testing is
2 performed. Once the specimens are removed from the
3 inservice steam generator or from the laboratory autoclave,
4 when they do the burst and leak testing, what they do is,
5 they place the -- they do not place any collar or any
6 support plate around this degradation, so essentially when
7 they do this testing, the testing is done as if the
8 degradation was in the free span.
9 So all degradation was exposed. So during the
10 depressurization event, if the tube support plate moves,
11 basically the modeling that we've done with respect to
12 leakage and burst would be appropriate because all the data
13 is based on free span degradation.
14 So even if the tube support plate moves three
15 inches up or three inches down, the testing that's done in
16 support of the correlation assumes that the degradation was
17 in the free span.
18 CHAIRMAN POWERS: It seems to me that I can follow
19 that argument if this plate is some sort of an ideal plate
20 that moves up and down.
21 But you're going to tell me that, no, this plate
22 is not such an ideal plate. It has a bunch of corrosion
23 products packed in around this tube.
24 And when it tries to move up, it puts some sort of
25 torque on the tube and possibly even a twisting motion,

1 because it's being pulled off against different supports.
2 I mean, it seems like that's a lot more -- it's
3 not just that the plate gets out of the way; it does
4 something else to the tube.
5 MR. KARWOSKI: The plate may bend and flex some,
6 whether or not those corrosion products would come loose.
7 They may, in which case it would expose the degradation, and
8 if it were to expose the degradation, then it would leak.
9 But once again, if the plate is still covering the
10 degradation, then the testing we've done has been
11 conservative in that the degradation was all assumed to be
12 in the free span portion of the tube.
13 CHAIRMAN POWERS: What if the plate, in its
14 motions, bends or flexes the tube? Then what does it do?
15 MR. KARWOSKI: There has been some testing
16 performed. Part of the analysis for the alternate repair
17 criteria had to do with the effect of safe shutdown
18 earthquakes and also the effects of LOCA in steamline break
19 on whether or not -- you know, what effect that would have
20 with respect to deforming the tube or causing the tube to
21 burst early.
22 I don't recall a lot of the results from that
23 test, but in general, unless the plate was very stiff like
24 at the periphery around the wedge groups, that wasn't a
25 concern.

1 There would have to be a lot of deformation to
2 effect, for example, the burst capability of the tube.
3 MR. STROSNIDER: This is Jack Strosnider. I'd
4 like to add something to the discussion here if I could,
5 also.
6 One thing I think, if I understand the situation
7 you're postulating with those support plates picking up some
8 load and then transferring that load to the tubes, is that
9 that load is going to be distributed across all the tubes
10 that are locked in the support plate, for one thing.
11 So you have to understand that that load is pretty
12 widely distributed, and also it's a primarily a
13 circumferentially-oriented load that's -- or
14 axially-oriented, rather, which is going to have more impact
15 on circumferentially-oriented degradation.
16 This is predominantly, as we indicated, axial,
17 although I have to acknowledge that's largely because from
18 the pressure testing, it always fails in the axial
19 direction.
20 But I think those loads would be distributed, and
21 I don't think they'd be the major driving force in terms of
22 integrity of this degradation.
23 DR. WALLIS: Well, the thing that concerns me is
24 this stuff that fills the gap. You said that the crevice is
25 packed with corrosion products, with magnetite.

1 MR. KARWOSKI: Yes.

2 DR. WALLIS: If I try to pull a rusty tube out of
3 a hole, it makes a lot of difference, how the rust packs
4 when I try to pull it. I mean, it jams up or it puts loads
5 on there; doesn't it?

6 MR. KARWOSKI: Right.

7 DR. WALLIS: Those are rather hard to evaluate.

8 MR. KARWOSKI: That's right. If you're trying to
9 take credit for the support plate not moving, and --

10 DR. WALLIS: If I use DW40 or something, it's
11 supposed to make a big difference. I don't know how you
12 evaluate those forces when you've got stuff in the hole
13 which is jamming up.

14 MR. KARWOSKI: But we didn't try to evaluate -- we
15 did not try to evaluate those forces as part of this
16 submittal. That's why we assumed the degradation was, in
17 fact, in the free span.

18 DR. WALLIS: And you think that's really
19 conservative?

20 MR. KARWOSKI: Yes.

21 DR. WALLIS: There aren't additional forces
22 because there's something jamming up when the support plate
23 is moving relative to the tube?

24 MR. KARWOSKI: There may be additional forces. As
25 Jack pointed out, those forces are probably distributed

1 amongst a lot of -- well, basically all the tubes where the
2 tubes are locked into the tube support plate.
3 And, once again, those forces are probably
4 predominantly axial, which would affect a circumferential
5 flow more than an axial flow.
6 MR. STROSNIDER: This is Jack Strosnider again.
7 One other thing, I guess it doesn't seem we can have it both
8 ways. If you can't pull the tube out of the support plate
9 if it's really so bound in there, then the tube is going to
10 provide some restraint against burst and limit the leakage
11 to some extent.
12 On the other hand, if it pulls out, that's what
13 we've modeled, and that would give the largest leakage and
14 the highest likelihood of failure, of burst.
15 DR. WALLIS: I guess what I'm asking about is if
16 it's failing while it's being pulled out, it seems to be a
17 different mechanism than both of the things you're
18 describing.
19 It's being restrained by the plate to some degree,
20 so that a tube which is somehow stuck more than the other
21 tubes are, would have more forces on it while it's moving,
22 and, therefore, it might fail because of that.
23 MR. BALLINGER: There are two questions here that
24 we're answering. One is, if the tube support plate simply
25 moves and exposes cracked tubes, that's the scenario that

1 you're dealing with.

2 Since you're doing the burst test when there's no

3 exposed plate anyway, the leakage should be independent of

4 that.

5 But the other question is, what happens if the

6 tube and the tubes and support plates are locked together

7 and the tube support plate starts to move, or even maybe

8 more important, what happens if the support plate is

9 cracked?

10 In a lot of these generators, the older

11 generators, these support plates, because of denting,

12 they're all deformed and cracked.

13 Now what happens? It's a separate question. It's

14 not a question of leakage; it's a question of if the support

15 plate moves, does it mechanically damage tubes that existing

16 cracks, and does that -- can that lead to additional

17 failures of tubes which would not otherwise occur?

18 DR. WALLIS: You're getting closer to my question.

19 MR. KARWOSKI: First of all, with respect -- that

20 condition would exist, whether or not you had implemented

21 this alternate repair criteria or not.

22 If the tube support plate is locked in place and

23 starts to move, it would be -- it won't matter whether or

24 not you implemented this repair criterion.

25 DR. KRESS: Unless it's easier to tear and open up

1 the cracks that you've left in there, because they've grown
2 more and they're more vulnerable.
3 MR. KARWOSKI: Right. You potentially have left
4 more cracks in service.
5 DR. KRESS: They may be more vulnerable to this
6 mechanism.
7 MR. BALLINGER: So you're correct in the sense
8 that it's a generic issue as well, independent of GL 95-05.
9 MR. KARWOSKI: That's correct. If you believe
10 that the support plates -- you know, in the case of the
11 Generic Letter 95-05, though, you would have to postulate
12 that it moves just enough to expose that degradation to
13 result in a burst and/or a leakage concern.
14 MR. STROSNIDER: This is Jack Strosnider. I'd
15 like to add still a couple of other observations.
16 I'm not sure if this completely gets to your
17 question, but we need to recognize that the tubes that are
18 in the database that were tested that were removed from the
19 steam generators, were pulled out of these support plates,
20 okay? None of them came apart when they were pulling them
21 out of the support plates.
22 If you're talking about the support plate moving,
23 in this case, they were moving the tube, and the tube broke
24 loose before it failed.
25 In addition, we had some discussions during our

1 first meeting a couple of months ago or whenever it was,
2 with regard to -- I think there was one tube that was an
3 example where it was tested in situ, and then it was tested
4 after it was pulled, and it did influence the leakage.
5 There was a higher leakage because of the tube pull forces
6 had caused -- it had affected the degradation at the
7 intersection, and it created some higher leakage, which, you
8 know, when you go in to put the correlation together, all
9 those pulled tubes are probably giving some higher level of
10 leakage then they would if the support plate didn't move.
11 Or if you did have to pull them free from the
12 support plate, it's reflected in the correlation. I'd just
13 point out that there are data in that database where the
14 tubes were pulled from the support plates.
15 But I do have to also say one other thing with
16 regard to this whole -- from a broader perspective: There
17 are issues that come up because the tubes are locked in the
18 support plates with regard to thermal expansion.
19 And there are issues that have come up, for
20 example, in some of the design of the sleeving repairs, and
21 when there was discussion about whether they should be
22 stress-relieved or not after some of these things are
23 welded. And some of the stress-relieving processes didn't
24 do some very high stresses in these tubes that were locked
25 in place between the support plate and the tube sheet. So

1 they had to be very carefully designed; that is, the amount
2 of tube that was heated up during the stress relief and that
3 sort of thing.
4 So there are issues, certainly with regard to
5 thermal stresses that can be developed.
6 DR. SHACK: Let me just say one thing and put my
7 contractor's hat on again. You also want to remember that
8 initially these tubes end up in a 2:1 stress state; that is,
9 it's always going to fail by burst from internal pressure
10 alone.
11 So the internal pressure forces are giving you
12 twice the load on this tube, so that having the support
13 plate there is a tremendous advantage in preventing the
14 failure by the hoop stresses.
15 And you have to essentially double the axial load
16 on it before you've even equalized the possibility of
17 failure from the internal pressure and any additional axial
18 loads.
19 So if you want to postulate that those tubes
20 double the load on it, you still haven't really increased
21 your probability of failure.
22 CHAIRMAN POWERS: I'm not sure that I've been
23 entirely clear about the concern. If I take an arbitrary
24 motion of the plate, what impact does it have on the cracks,
25 both obscured and away from the plate?

1 Does it cause them to grow? Does it cause them to
2 open up early?
3 Okay, now, I think we understand that when you
4 evaluate these flaws in your testing program, that there is
5 no collar around them; that they break under conditions that
6 they probably would not break if the plate were there.
7 But if you have arbitrary motions, because the
8 plate doesn't just go up and down, it has other kinds of
9 components to its motion.
10 Does it cause the cracks to do anything?
11 MR. KARWOSKI: If the plate flexes and imparts
12 different types of forces on the tube you have the potential
13 to deform the tube. If you deform the tube enough it could
14 open up a crack, but those forces would have to be pretty
15 great.
16 As I was indicating, as part of this criteria they
17 did analyze for example like a safe shutdown earthquake
18 where some of those loads and concerns were taken into
19 account and in those, in that analysis, and once again I am
20 not that familiar, that in general was not a concern for
21 this degradation mechanism.
22 DR. KRESS: Can we be assured that the kind of
23 motion you get, an internal part of the steam generator for
24 a safe shutdown earthquake, is equivalent in some respect to
25 the blowdown portions that would be imposed those plates?

1 MR. KARWOSKI: I couldn't comment on that.

2 CHAIRMAN POWERS: What you can be very confident

3 about is that the duration of the forces during the

4 depressurization are much longer --

5 DR. KRESS: Much longer.

6 CHAIRMAN POWERS: -- than what they consider on a

7 safe shutdown.

8 DR. KRESS: And that is my second question. Have

9 we calculated the magnitude of those blowdown forces on the

10 support plate? I presume we have but I didn't see that in

11 any of the data I tried to read.

12 MR. STROSNIDER: This is Jack Strosnider. I might

13 add, and apologize to keep interrupting, but I am not sure

14 we completely understood the question, so some of this we

15 are kind of providing as we go along here, but the other

16 thing that might be taken into consideration is I think we

17 mentioned during our briefing the alternate repair criteria

18 that were approved at Byron and Braidwood, which involved a

19 higher voltage level.

20 In developing that criteria they went in and

21 expanded tubes in order to hold the support plates in place

22 during the blowdown loads, and they did thermal hydraulic

23 analyses of the blowdown loads. There was some uncertainty

24 and there was a fairly large factor of safety as I recall

25 put on those blowdown loads, but I was just checking.

1 My recollection is that they had to expand
2 something on the order of 22 tubes. What I mean by expand
3 is they wanted each support plate intersection that expanded
4 the tube to lock it to the support plate and basically
5 turned it into a stay rod.
6 So by expanding 22 tubes plus the original stay
7 rods that were in the steam generator, the analyses
8 indicated that the plates would stay in place and continue
9 to cover the cracks, so what I was suggesting earlier is
10 that if you look at these loads and how they would be
11 distributed through the bundle of the generator, it takes a
12 relatively small number of tubes picking up the load to keep
13 the plates in place.
14 In fact, it would be distributed over a much
15 larger number, so I think that might have some relevance
16 also.
17 DR. KRESS: What bothers me about that, Jack, is
18 that they concluded they had to go in and expand a certain
19 number of tubes to hold it in place.
20 Is that because they are neglecting those other
21 forces?
22 MR. KARWOSKI: They don't consider the magnetite
23 in the crevice. They assume a free crevice.
24 MR. STROSNIDER: Yes, they assume that they had
25 clean crevices and that when they did the thermal hydraulic

1 analysis they did not credit any crevice buildup --

2 DR. KRESS: You are saying that would be

3 equivalent to these --

4 MR. STROSNIDER: What I am saying is that if you

5 believe these things are locked in place so tightly that you

6 could develop some high axial loads in them that in fact

7 that would be a lot of tubes in the bundle would be in that

8 situation and those loads would be distributed. I would

9 expect that the axial loaded added here would be relatively

10 small for each tube.

11 Given that 22 tubes plus the stay rods were able

12 to react to those loads according to the analysis.

13 CHAIRMAN POWERS: A couple of questions come to

14 mind. I have seen an internal memorandum that questions the

15 utility of a particular thermal hydraulics code for

16 calculating the loads on the plate. I don't if it is the

17 code that was used for the Braidwood application but it was

18 a particular, commonly used thermal hydraulics code and it

19 listed down some eight or nine reasons why the code probably

20 couldn't be used, the bottom line being that there is no

21 data to verify any of its predictions.

22 So again, do we have tools to calculate what the

23 loads are on this plate?

24 MR. HOLAHAN: This is Gary Holahan of the Staff.

25 I think most of the calculations done recently

1 were done with RELAP and I think we all know that RELAP,
2 although it is good for a lot of purposes, was never meant
3 to handle these sort of load situations.
4 I think what you have seen reflected, if it is
5 what I am thinking of, fairly recently, it is in fact the
6 same issues that were discussed when the Byron and Braidwood
7 issues were, and that is the code can calculate loads, and
8 then the question is how confident are you of the answers.
9 The issues that we are concerned about now are the
10 same as what we were concerned about then, and it is why we
11 wanted to have large margins available because we don't
12 think that there are accurate codes which are verified
13 against test data or even from first principles intended for
14 this purpose.
15 I think the bottom line is there are codes that
16 can calculate these things but they don't do them very well
17 and so we insist that there be lots of margin.
18 CHAIRMAN POWERS: The next question that comes to
19 mind is at least in previous presentations that you have
20 explained to us when they lock these plates in position, it
21 is not like they are locked and never going to move at all.
22 They actually move some.
23 The question is how much is "some."
24 MR. STROSNIDER: This is Jack Strosnider.
25 I mean there were displacements calculated between

1 the points at which the tubes were locked so there was some
2 displacement. I don't remember the exact amount.
3 MR. KARWOSKI: It was on the order of a tenth of
4 an inch.
5 CHAIRMAN POWERS: Quarter of an inch, something
6 like that.
7 MR. KARWOSKI: Definitely a tenth to .15 inch
8 displacement.
9 CHAIRMAN POWERS: Okay. Now what does that
10 displacement do to the tube?
11 MR. KARWOSKI: With respect to a burst from an
12 axial indication, a tenth of an inch degradation will not
13 burst, so if you moved a plate a tenth of an inch and
14 exposed a tenth of an inch long crack, that will not burst.
15 CHAIRMAN POWERS: And you are still working on
16 this idea that this plate is free to move, but it is not
17 because you already told me that when it moves it is going
18 to pull on that tube.
19 MR. KARWOSKI: Stretch it maybe.
20 DR. SHACK: By corrosion products it's not going
21 to move a tenth of an inch. It moved a tenth of an inch
22 because they assumed it was free everywhere except to where
23 it was pinned.
24 CHAIRMAN POWERS: Take the intermediate position
25 that, yes, it is pinned but the force is enough to

1 eventually cause it to move.

2 When it breaks loose, what does it do to the tube?

3 If the answer is nothing, that's fine.

4 MR. KARWOSKI: If you assume the force is totally

5 axial it would be like pulling the tube, like Jack said, and

6 all the pulled tube specimens basically would have that

7 force taken into account and so it would be included in the

8 methodology.

9 If it starts cocking a little bit, it would depend

10 on how much and that is where I would have to go back, well,

11 how do those loads compare to loads that were analyzed as a

12 result of some of the other accidents.

13 CHAIRMAN POWERS: Okay. I think it is the cocking

14 issue that one needs to worry about because what you are

15 saying is in pulling the tube you have done at least that

16 much to the tube.

17 MR. KARWOSKI: Right. Maybe a good deal more,

18 actually.

19 CHAIRMAN POWERS: Okay.

20 DR. WALLIS: Does it ever get locked so that you

21 can't pull it? It's so tight you can't pull it?

22 MR. KARWOSKI: There have been instances where

23 utilities have to abandon tube pulls because they could not

24 free it. In some cases though that may have been through

25 the tube sheet. I don't know if that situation ever

1 occurred --

2 DR. WALLIS: This corrosion product buildup is a

3 time thing. It starts off pretty free to move and then it

4 gets more and more locked as time goes on?

5 MR. KARWOSKI: I don't know if there is any data

6 but presumably --

7 DR. WALLIS: Well, buildup means time, right?

8 MR. SIEBER: It is very dependent upon the water

9 chemistry. You know, if you started off with phosphates and

10 switch to all volatile, the amount of crud that builds up in

11 the steam generator is much higher but it is softer. If you

12 started out with all volatile chemistry, the crud is far

13 less but it is very hard and embrittlement has a tendency to

14 hold the tube tighter.

15 DR. KRESS: I believe in the theory of relativity

16 but --

17 [Laughter.]

18 DR. KRESS: -- but I am not sure pulling one tube

19 out of the support plate is the equivalent of a support

20 plate being pushed up, just saying if it is strictly axial

21 by forces that would be sufficient to move it.

22 It's because when you do this you actually bend

23 plates like that and even though they are being moved

24 axially I don't think with one tube pulling out of a plate

25 is equivalent to a plate moving up through a lot of tubes.

1 CHAIRMAN POWERS: I guess the question is, is it
2 worse or --
3 DR. KRESS: I suspect it's worse.
4 CHAIRMAN POWERS: Okay.
5 DR. KRESS: Because the plate bends more under
6 the --
7 CHAIRMAN POWERS: I think that's what I meant.
8 What one worries about is you have got a plate that is in
9 fact doing something that good.
10 DR. KRESS: I am not even -- I am just looking at
11 static bending even.
12 CHAIRMAN POWERS: Yes, well, one of the normal
13 modes is like this. I mean it may have two normal modes
14 that they are going to get excited.
15 MR. SIEBER: I picture it like a rug hanging in
16 the wind.
17 DR. KRESS: That would be something else.
18 CHAIRMAN POWERS: Anything else you wanted to say?
19 MR. KARWOSKI: No. Basically the last slide is
20 just basically what the industry has included. It is that
21 there is so much corrosion product in those crevices that
22 they believe the plates are in fact locked in place.
23 We have had concerns. You mentioned some of them,
24 the thermal hydraulics, but there's also other concerns with
25 respect to how well do you know each intersection, you know,

1 how tight is each intersection.

2 CHAIRMAN POWERS: Good. Thank you.

3 I was remiss in opening this session not to

4 introduce Professor Ron Ballinger from MIT. He is a member

5 of the subcommittee that has been looking into this, and

6 they have been very helpful to us.

7 Are there any other comments that people want to

8 make?

9 DR. WALLIS: Well, I have a comment, that it would

10 help a great deal if there were some pictures.

11 CHAIRMAN POWERS: Pictures?

12 DR. WALLIS: So we could see what we are talking

13 about, of bending of tubes and pulling of tubes and where

14 the crud is.

15 CHAIRMAN POWERS: I think we can get you more

16 pictures than you can shake a stick at.

17 DR. WALLIS: During the presentation.

18 CHAIRMAN POWERS: Ah, well -- you needed to attend

19 the subcommittee meeting. Go ahead.

20 DR. HOPENFELD: This is the crux of the whole

21 problem.

22 CHAIRMAN POWERS: Sit down or get wired up, one or

23 the other.

24 [Pause.]

25 DR. HOPENFELD: This is the whole issue. This is

1 the whole issue of the DPO. What kind of damage do you get
2 during the transient beyond what you measure in the
3 laboratory? That is the whole thing.
4 What you heard before really doesn't address it.
5 Now we have seven hours of discussions which revolved around
6 various issues -- and I don't want to get into that now.
7 I do want to specifically address what you just
8 brought up -- what kind of damage you would get from the
9 motion of the support plate relative to the tube.
10 Now I provided you data which is proprietary. You
11 may want to look in there, but you can see that the
12 statement is very clear that when you pull those tubes you
13 break ligaments, and when you break ligaments you increase
14 the flow rate. The flow rate can be increased by as much as
15 two orders of magnitude, so now the question you have -- and
16 I also believe in the theory of relativity -- you also have
17 the relative situation when the plate moves or even just the
18 tube itself moves because of the tube sheet moving, because
19 of thermal expansion.
20 You still have up to 3500 pounds across that tube
21 sheet. What is that going to do to those tubes? So all
22 that is a fairly complex situation. Now industry realizes
23 that. I think they realize the thing more than NRR people
24 realize that, because from what you heard before the man
25 wasn't even talking about it.

1 What they said, if you take that data that they
2 have generated in the laboratory it behooves whoever uses
3 the data to extrapolate to what has happened during the
4 steam line break conditions. That is what that statement
5 says.
6 Now what they don't do, they don't provide the
7 industry any guidance as to how they should come and apply
8 it during the steam line break, and because we don't have
9 that guidance, you have Con Edison coming in here five years
10 ago using some kind of a computer code which really -- and
11 data which was not really designed to measure these kind of
12 pressure loads during the transient.
13 As a matter of fact it was underpredicting those,
14 because of the large dead space that was involved, and I
15 spent a lot of time talking about it, so I just -- there
16 isn't much time to repeat it, but if you go back to your
17 notes you will see that I did talk about that, because this
18 was the most instrumented bundle ever designed but it was
19 not designed to calculate the pressure gradients or the
20 pressure drops during the transient and the loads on the
21 plate.
22 The point is the industry does recognize it but
23 doesn't provide any guidance, so what happens? You get Con
24 Edison coming in here and making a story and NRR people buy
25 it and they approved it on that basis.

1 I think they have calculated it like motion of
2 one-eighth of an inch or something like that, .15, but they
3 have approved it.
4 A month ago you had another utility coming in
5 using a different modification of that code and unanimously
6 when people look at the thing more thoroughly that code had
7 nothing to do with the problem they were trying to solve,
8 yet the problem is there.
9 You have that potential damage during the event
10 that would increase the leakage, so now we heard last time
11 or the last presentation Mr. Holahan say that 95-05 is not
12 really limited to leakages more than forty or fifty GPM,
13 which is the limit that allows you to operate under part
14 hundred, but nobody has made the case that you are not going
15 to have more than 50, so if you approve the G.L. 95-05 or
16 you let it say and you still want to comply with part
17 hundred you have to show that you are not going to 650 GPM
18 and that is what you will have to show.
19 Now if you go to the risk and core melt frequency,
20 you will have to go to show that it is not going to exceed
21 600 GPM because if we exceed 600 GPM we don't know whether
22 the operator will be able to control the accident or not.
23 That is where you get to the 10 to the minus 4 frequency and
24 these are the issues.
25 Just talking about it is not going to solve the

1 problem. You just don't have the basic data to answer the
2 question you just brought up and I think you are hitting the
3 problem and I really appreciate it.
4 DR. KRESS: Joe, let me ask you this.
5 DR. HOPENFELD: Yes, sir.
6 DR. KRESS: When they pull these tubes to take
7 them to the laboratory to give them a leakage and burst
8 test --
9 DR. HOPENFELD: Right.
10 DR. KRESS: -- do you feel that this pulling of
11 the tubes out of the tube support plates does the equivalent
12 damage that you would get from the blowdown?
13 DR. HOPENFELD: Well, the first cut at it you will
14 have to say yes. I think in the blowdown you will have much
15 more, because in addition to this you have thermal expansion
16 of the tube sheet, so you are going to have pulling on the
17 tubes.
18 Now to answer you exactly, it is almost
19 impossible, because you are going to have this thing -- you
20 don't have a uniform distribution of forces there and how
21 that thing is going to shake out I don't know. It is a
22 large uncertainty, but you have got to recognize the problem
23 and that is all I am doing.
24 I think if those that want to -- it is not for me
25 to support it to a large degree. I think there's evidence

1 here to show that there is a potential problem. Those
2 people who want to support that 95-05, it behooves them to
3 prove it, to show you. The burden is on them, not on me,
4 and they haven't done that.
5 If you go and say, well, we are going to leave it
6 at 95-05 the EDO is going to keep on continuing to violate
7 part hundred.
8 DR. KRESS: What would it take --
9 DR. HOPENFELD: Plus the risk.
10 DR. KRESS: In your mind what would it take to
11 support the 95-05 contention? Would it have to be a
12 full-scale blowdown test with damaged tubes to see what
13 happened?
14 DR. HOPENFELD: We had at the beginning when this
15 started, we had a program which was supposed to answer those
16 questions. There was Generic Safety Issue 163. The
17 management here decided that they didn't want to understand
18 what the issues are. This is the first time we are hitting
19 that. They didn't want to know and so I cannot answer you
20 really. That should have been started ten years ago, and
21 when I say should have, that's gone. It is over the bridge.
22 But I really don't know how to answer the question
23 honestly. It is a difficult issue. But think about it.
24 There are so many disconnects here. Westinghouse or Con Ed
25 coming in here and saying, well, we want to operate with

1 three volts.

2 Why do they want to operate at three volts?

3 First of all, they have operated, under G.L. 95-05

4 they were allowed to operate at one volt and they find out

5 that those things are leaking, so they come back, well, we

6 want to increase that thing now to three volts, so we can

7 still keep more tubes in service, but you think of it as far

8 as all these uncertainties, it's very difficult to make a

9 case, whether it makes any difference between three volts or

10 one volt or half a volt how you are going to damage those

11 tubes.

12 The reason I have been criticizing Dr. Shack is

13 because in all his laboratory studies there, he completely

14 ignored that. He completely ignored that there are other

15 forces acting on those tubes and he proceeded with the

16 simplest case, which is looking at the internal pressure.

17 Well, that is a simple case and it is okay for

18 studies, basic studies, and I wish that you continue.

19 Hopefully they'll give you more money to do it, but you

20 should realize you are not addressing the problem, and that

21 is the problem.

22 I don't know the answer but that doesn't mean you

23 shouldn't work on it. Just keep on working, and it is the

24 same thing with the jet, the same thing.

25 There is no clear answer because you can't go to

1 one of those thermal hydraulic codes and say, well, I have
2 calculated this particle size and now I am going to build a
3 $10 million program and see what kind of erosion I have.
4 These codes are not capable of doing it and, you
5 know, South Texas came in here and they talked about that
6 RELAP code and the fact that this is acceptable to industry.
7 It's been used here. It has been used all over the place
8 and it's got all these fluxes and heat transfer, but they
9 haven't benchmarked it against the appropriate experiments.
10 I mean there are all kinds of K factors and
11 friction factors which affect what is going to be the
12 delta P across that plate, and they say, well, it doesn't
13 matter, but if it doesn't matter they still get some
14 displacement.
15 Well, I am getting away from it. I think that is
16 the problem, that's the issue. If you justify 95-05 you
17 will have to say that these things have disappeared, that
18 those forces are not there.
19 CHAIRMAN POWERS: Any other comments?
20 [No response.]
21 CHAIRMAN POWERS: Thank you. Do members have any
22 comments they want to make on the record?
23 [No response.]
24 CHAIRMAN POWERS: In that case we can dispense
25 with the transcription, and I propose we will take a

1 12-minute break.

2 [Pause.]

3 MR. STROSNIDER: Does the committee have a copy of

4 the Byron/Braidwood Safety Evaluation, or are you interested

5 in having one?

6 CHAIRMAN POWERS: I think the answer is no and

7 yes.

8 MR. STROSNIDER: Okay. We will get a copy of that

9 to Ondine. It talks about the factors of safety that were

10 applied on these blowdown loads, et cetera, so you can take

11 a look at that.

12 CHAIRMAN POWERS: That would be useful.

13 DR. KRESS: That would be helpful.

14 MR. STROSNIDER: Thank you.

15 CHAIRMAN POWERS: Okay. We will recess for twelve

16 minutes.

17 [Whereupon, at 4:12 p.m., the meeting was

18 recessed, to reconvene, at 8:30 a.m., Thursday, December 7,

19 2000.]

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CERTIFICATE

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

Name of Proceeding: 478th ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

Case Number:

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 transcribed by me from recorded tapes provided by the Nuclear Regulatory Commission, and that the transcript is a true and accurate record of the foregoing proceedings to the best of my belief and ability.

Rose Gershon

Rose Gershon

Transcriber

Ann Riley & Associates, Ltd.

# CREDIT FOR TUBE SUPPORT PLATES IN GL 95-05 METHODOLOGY
# STEAM GENERATOR DIFFERING PROFESSIONAL OPINION ISSUES
# ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

**December 6, 2000**

**Kenneth J. Karwoski, Division of Engineering, NRR (301) 415-2752**

# GL 95-05: TECHNICAL OVERVIEW

GL 95-05 provides a methodology for an alternate tube repair criteria for predominantly axially oriented outside diameter stress corrosion cracking (ODSCC) at tube support plate elevations

Degradation occurs in crevice between tube and tube support plate - tube support plate is 0.75-inch thick

Crevice can be packed with corrosion products (e.g., magnetite)

2 fundamental goals of repair criteria: Ensure adequate structural and leakage integrity

Correlations were developed relating an inspection parameter (i.e., voltage) to the burst pressure and leakage from this type of degradation (i.e., ODSCC)

# STRUCTURAL AND LEAKAGE INTEGRITY CORRELATIONS

Correlations include data from 2 sources: Tubes removed from operating steam generators and specimens produced in model boiler facilities (i.e., laboratory facilities)

Destructive examinations typically performed:

- Leak Testing
  - Used in leakage correlations
- Burst Testing
  - Used in burst pressure correlation
- Metallurgical examination
  - Ensure degradation mode is consistent with those from other sources/plants

# PERFORMANCE OF BURST AND LEAK TESTING FOR GL 95-05

Burst and leak testing of model boiler and pulled tube specimens used in the burst pressure and conditional leak rate correlations was performed without the presence of the tube support plates (i.e., they were performed assuming the tube support plate moved infinitely away from the degradation)

All degradation at the support plate was exposed

**If the tube support plates move** during a depressurization event, the GL 95-05 methodology will provide an appropriate determination of the conditional probability of burst and the postulated accident conditions

Supporting data did not take into effect the presence of the tube support plates

**If the tube support plates do not move** (or do not move enough to expose all of the degradation) during a depressurization event, the GL 95-05 methodology will provide a conservative estimate of the conditional probability of burst and the postulated accident conditions

Presence of the tube support plate will limit leakage and will prevent tube from bursting

# INDUSTRY PROPOSAL ON DISPLACEMENT OF TUBE SUPPORT PLATES

A utility submitted a report assessing the potential for tube support plate displacement during a postulated steam line break

Their conclusion was that the plates are essentially locked in place due to corrosion product buildup in the tube-to-tube support plate crevice

NRC had a number of issues with the report as documented in a letter to the utility

- Large forces are required to move a tube past a packed and dented tube support plate intersection

*United States*
*Nuclear Regulatory Commission*

# ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

# NRC DRAFT SAFETY EVALUATION

# SOUTH TEXAS PROJECT REQUESTED EXEMPTIONS FROM SPECIAL TREATMENT REQUIREMENTS


***John A. Nakoski***
***Senior Project Manager***
***Division of Licensing Project Management***
***Office of Nuclear Reactor Regulation***


**December 7, 2000**

# AGENDA

1. TIMELINE
2. STAFF REVIEW PROCESS
3. CATEGORIZATION PROCESS
4. TREATMENT PROCESSES
5. CONTROLLING CHANGES
6. PRELIMINARY ASSESSMENT OF EXEMPTIONS

# TIMELINE

- *7/13/99* *Exemption Request Submitted*
- *8/31-9/1/99* *Meeting on Exemption Requests*
- *10/5-6/99* *Meeting on Exemption Requests*
- *1/18/00* *Request for Additional Information Issued*
- *4/10-11/00* *Meeting on Categorization*
- *6/20-21/00* *Meeting on Treatment*
- *7/19/00* *Draft Review Guidelines Issued to STP*
- *7/24-25/00* *Meeting on Commercial Practices*
- *8/31/00* *Revised STP Exemption Request Submitted*
- *11/15/00* *Draft Safety Evaluation Issued*
- 12/7/00 ACRS Briefing on Draft Safety Evaluation
- 2/15/01 Open Items from Draft SE Resolved
- 3/8/01 Commission Paper Due
- 3/15/01 Final Safety Evaluation Due
- 3/30/01 Commission Briefing
- 4/15/01 Issue Final SE and Exemptions

# STAFF REVIEW PROCESS

## Risk-Informed Decisionmaking - Key Principles

1. **Meets Current Regulations** (Unless Exemption or Rule Change)
2. **Consistent with Defense-in-Depth Philosophy**
3. **Maintains Sufficient Safety Margins**
4. **Increases in CDF/Risk Are Small** (consistent with the intent of the Commission's Safety Goal Policy Statement)
5. **Impact Monitored** (Using Performance Measurement Strategies)

## Review Guidelines Developed for Assessing STPNOC Exemption Requests (Provided to STPNOC on July 19, 2000)

# CATEGORIZATION PROCESS

- ☞ **Generally Acceptable to Define Risk Significance for Exemptions** (subject to open item resolution)
- ☞ **Tied to Confidence of Functionality Provided by Treatment Processes**

**Open Items on Categorization Process:**

- ★ **Equations for PRA Importance Measures on Common Cause Failure Contribution** (Open item 3.1)
- ★ **Criteria for Use of Fussell-Vesely Importance Measure to Categorize SSCs as HSS** (Open item 3.2)

# CATEGORIZATION PROCESS (con't)

## Open Items on Categorization Process: (con't)

- ★ Qualification Attributes for Expert Panel and Working Group Members in FSAR (Open item 3.3)
- ★ Risk Significance of SSCs that Mitigate Consequences of Accidents by Maintaining Containment Integrity (Open item 3.4)
- ★ Support for ASME Section XI ISI Exemption (Passive Functions) (Open item 3.5)
- ★ Use of "General Notes" (Open item 3.6)

# TREATMENT PROCESSES

## Treatment of HSS/MSS Structures, Systems, Components (SSCs), and Functions

☞ **Provides Confidence in Functionality** (subject to open item resolution)

- ★ **HSS/MSS Remain Within Scope of Existing NRC Special Treatment Regulations**
- ★ **Open Item 4.1 - Process Attributes for Determining Treatment Applied to HSS/MSS Functions Not Currently Covered by NRC Required Programs** (Safety- and Non-safety-Related)

# TREATMENT PROCESSES

## Treatment of LSS/NRS SSCs and Functions

- ☞ **Generally Provides Confidence in Functionality**
  **(subject to open item resolution)**

## LSS/NRS Open Items

- ☞ **Open Item 4.2: Process Attributes to Include in FSAR**

  ✓ **<u>Procurement</u>: (1) Item Received is Item Ordered; (2) Vendor Recommendations Considered; (3) Engineering Evaluations Provide Confidence That Replacement SSCs Meet Design-Basis Inputs; and (4) National Consensus Standards Used**

# TREATMENT PROCESSES

☞ **Open Item 4.2: Process Attributes to Include in FSAR** (con't)

- ✓ **<u>Installation</u>: (1) Provide Preoperational/Preservice Testing and Evaluation; and (2) National Consensus Standards Used**
- ✓ **<u>Maintenance</u>: (1) Vendor Recommendations Considered; (2) Implements Corrective Action Process; (3) Proper Maintenance and Acceptable Operation Demonstrated; and (4) National Consensus Standards Used**

# TREATMENT PROCESSES

☞ **Open Item 4.2: Process Attributes to Include in FSAR** (con't)

- ✓ **<u>Inspections, Tests, and Surveillances</u>: (1) Vendor Recommendations Considered; (2) Conducted, or Compared to Performance, at Design-Basis Conditions; and (3) National Consensus Standards Used**
- ✓ **<u>Management and Oversight</u>: (1) Training and Qualification per Vendor Recommendations and National Consensus Standards; and (2) Surveillance Equipment Controlled** (Including Attribute on Confidence of Functionality After Failure of Post-Calibration Checks)

# TREATMENT PROCESSES

## LSS/NRS Confirmatory Items

## Confirmatory item 4.1: Licensee Will Resolve Implementation Inconsistencies with Program Description

- ✓ 1E Component Not Fully Qualified Isolated from 1E Circuitry Without Discussing Functional Capability
- ✓ SSCs Exceeding Qualified Life Assumed Capable of Functioning and Not Replaced Unless Separate Reason
- ✓ Functional Requirements Envelope the Credible Design Basis Conditions Expected
- ✓ Designed to Function in the Installed Environment

# TREATMENT PROCESSES

## LSS/NRS Confirmatory Items (con't)

**Confirmatory Item 4.2: Confirm Commitment to Follow NRC-Endorsed NEI Guidance on Commitment Management**

- STPNOC Requested 10 CFR 50.59 Exemption to Extend to Other Special Treatment Provisions in FSAR
- NRC Cannot Support an Open Ended Exemption from 10 CFR 50.59
- As Committed, Follow NEI 99-04, "Guidelines for Managing NRC Commitments"

# CONTROLLING CHANGES

- ✓ Exemption Requests Based on Processes
- ✓ NRC Must Have Confidence that Changes to Processes do not Invalidate Bases for Exemptions
- ✓ STPNOC Must Have Flexibility to Change Implementing Procedures as Experience Gained
- ✓ Processes to be Documented in FSAR (10 CFR 50.59 Alone is not Adequate to Control Changes)
- ✓ No Changes to FSAR Description of Processes Allowed without NRC Approval (Open item 5.1)

# PRELIMINARY ASSESSMENT OF EXEMPTIONS

**Approve:** (Subject to Resolution of the Open/Confirmatory Items in the DSE)

- ✓10 CFR 21.3 - Definition of Basic Component
- ✓10 CFR 50.55a(f) - ASME Section XI Inservice Testing
- ✓10 CFR 50.59 - Changes, Tests, & Experiments - (Limited)
- ✓10 CFR 50.65(b) - Maintenance Rule Scope (Open item 13.1)
- ✓10 CFR Part 50, App. B - Quality Assurance Criteria
- ✓10 CFR Part 50, App. J - Type C Containment Leak Testing

**Not Necessary:** (Therefore, should deny)

- ☞ GDC 1 - Quality Standards and Records
- ☞ GDC 2 - Protection Against Natural Phenomena
- ☞ GDC 4 - Environmental and Dynamic Effects
- ☞ GDC 18 - Inspect/Test Electrical Power Systems

# PRELIMINARY ASSESSMENT OF EXEMPTIONS (con't)

## Deny: (Absent Additional Information From Licensee)

- ★ 10 CFR 50.34(b)(6)(ii) - App. B Information Included in FSAR
- ★ 10 CFR 50.54(a)(3) - Changes to QA Program (Open item 7.1)
- ★ 10 CFR 50.55a(g) - Section XI Repair/Replacement & Inspection (Open items 10.1 and 10.2)

## More Information Needed:

- ? 10 CFR 50.34(b)(11) - Related to SSE and OBE (Part 100, App. A)
- ? 10 CFR 50.49(b) - Electrical Equipment Important to Safety (Open item 8.1)
- ? 10 CFR 50.55a(h) - IEEE 279 Section 4.4 (Open item 11.1)
- ? 10 CFR Part 100, App. A, VI, (a)(1) & (2) - SSE and OBE (Open item 18.1)

United States Nuclear Regulatory Commission

# RES Views On Significant Power Uprate

**Farouk Eltawila**
**Division of Systems Analysis**
**and Regulatory Effectiveness**
**Office of Nuclear Regulatory Research**

# Plant Modifications & Power Uprate

- Plants' Modifications Are Being Made-- Higher Burnup, Longer Fuel Cycles, Higher Peaking Factors, Increased Core Power Levels, Use of Mixed Cores, New Fuel Designs, and Plant Life Extension
- Potential Concerns
  - Applicability of Models and Data to Understand Implications on Plant Design and Risk
  - The Mean Risk (Fission Products Release) Increases by ~ 30% Due to a 14.7% Power Uprate at Leibstadt Nuclear Power Plant (Mainly Due to Increased FP Inventory )
    - → Decay Heat Removal Success Criteria; Time Acceleration of Events (High Decay Heat)
    - → Shorter Time Available for Operator to Respond to Events
    - → Reduced Design Safety Margin for Important Mitigating Systems

# RES Proposed Initiative

- RES Is Considering an Initiative to Explore These Questions Using Deterministic and Risk-informed Approaches. Examples:
  - Range of Applicability of Important Models
  - Safety/Relief Valves, RPV Embrittlement, Flow Induced Vibration, Suppression Pool Temperature/Loads
  - Affect on Plant Procedures, Human Actions, Training
    - Effect on Plant Transient Behavior and PRA Success Criteria (e.g., Station Blackout Coping Capabilities)
- RES Did Not Allocate Resources for This Issue in Its Current Budget. Would Have to:
  - Request Additional Budget
  - Reprogram Existing Activities

# RES Related Activities

- Effort Would Be Carried Out Under RES Role to Conduct Research to Improve the Agency's Knowledge of Uncertainties and Margins to Permit Improved Regulatory Positions

# ACRS BRIEFING
# ON
# THE POWER UPRATE PROGRAM

December 6, 2000

T. J. Kim, Lead Project Manager, NRR

# AGENDA

- INTRODUCTION ..... R. BARRETT, NRR
- PROGRAM OVERVIEW & STANDARD REVIEW PLAN ..... T. J. KIM, NRR
- APPLICATION OF RISK-INFORMED DECISION MAKING ON POWER UPRATES ..... M. RUBIN, NRR
- USE OF MORE "REALISTIC" ANALYSES IN SUPPORT OF POWER UPRATES ..... R. CARUSO, NRR
- POTENTIAL SYNERGISTIC EFFECTS:
  - HIGH BURN-UP FUEL/UPRATE CONDITIONS ..... R. CARUSO, NRR
  - ACCELERATED EROSION/CORROSION DUE TO UPRATE/AGING ..... E. CARPENTER, NRR
- RES PERSPECTIVES ON EXTENDED POWER UPRATE ..... F. ELTAWILA, RES
- SUMMARY/CONCLUSION ..... R. BARRETT, NRR

# POWER UPRATE PROGRAM - OVERVIEW

- CAPACITY RECAPTURE FOR THE POL PLANTS
- 5% "STRETCH" POWER UPRATES
- "EXTENDED" POWER UPRATES OF 6-8%
- "EXTENDED" POWER UPRATES OF 15-20%
- MAINE YANKEE LESSONS LEARNED
- STANDARD REVIEW PLAN SECTION ON POWER UPRATES

## POWER UPRATE PROGRAM - CAPACITY RECAPTURE FOR THE POL PLANTS

- HADDAM NECK (24%) IN 1969
- OYSTER CREEK (14%) IN 1971
- PALISADES (15%) IN 1977
- GINNA (17%) IN 1984
- MAINE YANKEE (8%) IN 1978, FOLLOWED BY (2.5%) IN 1989
- INDIAN POINT 2 (11%) IN 1990

## POWER UPRATE PROGRAM - 5% "STRETCH" UPRATES

| | BWRs | PWRs |
|---|---|---|
| 1977 | | CALVERT CLIFFS 1&2 |
| 1979 | | ROBINSON<br>MILLSTONE 2 |
| 1980 | | FORT CALHOUN |
| 1981 | | ST. LUCIE 1 |
| 1985 | DUANE ARNOLD | ST. LUCIE 2 |
| 1986 | | SALEM 1 *(2%)*<br>NORTH ANNA 1 & 2 |
| 1988 | | CALLOWAY<br>TMI 1 *(1.3%)* |
| 1992 | GE 5% TOPICAL REPORT<br>FERMI ***(ACRS REVIEW)*** | |
| 1993 | | VOGTLE 1 & 2<br>WOLF CREEK |
| 1994 | SUSQUEHANNA 1& 2<br>PEACH BOTTOM 2 & 3 | |
| 1995 | LIMERICK 2<br>WNP2<br>NMP2<br>HATCH 1 & 2 | SURRY 1 & 2 |
| 1996 | LIMERICK 1 | TURKEY POINT 3 & 4<br>PALO VERDE 2 & 3 *(2%)* |
| 1997 | BRUNSWICK 1 & 2<br>FITZPATRICK<br>BROWNS FERRY 2 & 3 | FARLEY 1 & 2 |
| 1999 | LASALLE 1 & 2<br>PERRY | |
| 2000 | RIVER BEND | DIABLO CANYON 1 *(2%)* |

## POWER UPRATE PROGRAM - EXTENDED POWER UPRATES OF 6-8%

| BWRs | PWRs |
|---|---|
| ▸ GE TOPICAL REPORT (UP TO 20%)* - 1998<br>▸ MONTICELLO (6.3%)* - 1998<br>▸ HATCH (8%)* - 1998 | **NONE.** |

* GE TOPICAL REPORTS "ELTR-1" AND "ELTR-2" ADDRESSING POWER UPRATES OF UP TO 20%, AS WELL AS MONTICELLO & HATCH UPRATES WERE REVIEWED BY THE ACRS.

## POWER UPRATE PROGRAM - EXTENDED POWER UPRATES OF 15-20%

| | | |
|---|---|---|
| ▸ DUANE ARNOLD | (15%) | APPLICATION RECEIVED ON 11/17/2000* |
| ▸ DRESDEN 2 & 3<br>QUAD CITIES 1 & 2 | (17%) | APPLICATION EXPECTED IN JANUARY 2001 |
| ▸ BRUNSWICK 1 & 2 | (15%) | APPLICATION EXPECTED IN MID-2001 |
| ▸ CLINTON | (20%) | APPLICATION EXPECTED IN MID-2001 |

* THE LICENSEE HAS REQUESTED COMPLETION OF STAFF REVIEW BY MID-2001 TO ACCOMMODATE THE LICENSEE'S IMPLEMENTATION SCHEDULE.

# POWER UPRATE PROGRAM - MAINE YANKEE LESSONS LEARNED:

- ENSURE APPROPRIATE USE OF ANALYTICAL METHODOLOGIES AND COMPUTER CODES
- CONSISTENCY IN REVIEW AREAS COVERED:
  - HUMAN FACTORS
  - GRID STABILITY
  - FUEL POOL COOLING
  - BOP EQUIPMENT
  - MOVs
- CONSIDER DEVELOPING A SRP SECTION FOR POWER UPRATE REVIEWS
- STAFF SAFETY EVALUATIONS FOR THE FARLEY UPRATE IN LATE 1997 AND THE MONITCELLO UPRATE IN 1998 HAVE FULLY INCORPORATED THE MAINE YANKEE LESSONS LEARNED ISSUES, AND HENCE FORMED TEMPLATES FOR THE SUBSEQUENT UPRATE REVIEWS.
- THE STAFF HAS RECOMMENDED THAT THE COSTS OF DEVELOPING A SRP SECTION FOR POWER UPRATE REVIEWS OUTWEIGHS THE POTENTIAL BENEFITS AT THIS POINT IN THE PROGRAM.

# RISK-INFORMED REVIEW CONSIDERATIONS OF EXTENDED POWER UPRATE APPLICATIONS

by

Mark P. Rubin
Probabilistic Safety Assessment Branch
Division of Systems Safety & Analysis
Office of Nuclear Reactor Regulation

# General Perspective on Extended Power Uprates

- Extended power uprate applications are not requesting relaxation of any deterministic requirements.
- Licensee requests for power uprates are required to meet all deterministic requirements.
- Nevertheless, any request to operate at power significantly beyond "stretch power" represents the potential for reduction of plant margin and increase in risk.
- Therefore, for Monticello and Hatch submittals, staff believed it would be prudent to evaluate risk to see if the risk profile of the plant is changed in any significant way or if new vulnerabilities are introduced.
- Decisions on considering risk impact for future uprates:
  - Will be guided by policy in SECY 99-246
  - Will consider size of uprate, baseline CDF/LERF of plant and insights from deterministic evaluation such as DBA margins reduction, setpoint changes and fluid conditions, operational insights available from previous uprates, and risk of expected activity release.

# Risk-Informed Assessment for Monticello and Hatch

- RG 1.174 provided a sound framework to assess power uprate impacts.

- Areas that were addressed by licensees for Monticello and Hatch reviews

    1. Initiating event frequency
    2. Equipment/component failure rates
    3. Operator error probability
    4. Success criteria

- Areas 3 and 4 were amenable to modeling and assessment in the licensees' risk model. Changes in timing available for operator actions due to power uprates and changes to success criteria were considered and reflected in modified CDF/LERF estimates. Only minor impacts were observed.

- More difficult to assess potential impact on initiating event frequencies and failure rates.
    -- For Monticello and Hatch uprates, these areas were qualitatively assessed to have minimal impact.

- Staff did not identify any related concerns that revised risk insight.

# Potential for Synergistic Effects Beyond Operator Timing and Success Criteria

- Staff conclusion on Monticello and Hatch uprates:
  - Solid deterministic basis
  - First order (synergistic) risk impacts well understood and modeled explicitly (timing and success criteria)
- Potential exists for some "unexpected" impacts in areas in initiating frequency and SSC failure rates. Difficult to predict them in absence of operational data.
- These will likely be relatively small secondary impacts
  - Acceptable deterministic analysis for SSCs to operate in uprate conditions
  - Significant changes in initiating frequencies would be self-revealing
  - Significant changes in unavailability for normally operating equipment would be self-revealing. (Recirc pump vibration induced failure).
  - Standby equipment, which may not reveal availability reductions, will often not be subjected to full uprate conditions (partial isolation from RCS and secondary), therefore may not be as subject to degradation.

# Challenges for Incorporation of Broader Synergistic Impacts

- Risk models do not currently include provision for assessing SSC reliability impact for changes in operating condition, or impacts on IE frequencies.
- No models for passive system degradation, impacts on pipe break frequencies.
- Though uncertain of causality, examples of uprate-induced impacts have been reported.

# Initial Thoughts on Significance of Unmodeled Synergistic Effects

- Adherence to Maintenance Rule will provide reasonable feedback and corrective action. Performance problems for active SSCs will be identified.

- Passive system/component degradation may be identified in maintenance rule, but with somewhat less confidence than active components.

- Degradation of standby components may not be as readily identified due to lower challenge frequency, but may be less impacted due to reduced exposure to uprated parameters (temps, pressures, flows, vibration)

- Due to focus and sensitivity on pipe failures, degradation mechanisms related to power uprates will likely be fully explored and appropriate corrective actions identified and/or augmented inspection activities implemented.

- Due to sensitivity to plant level transients, mechanisms and degradation that lead to plant trips get significant attention and have root cause explored with corrective actions taken as necessary.

## Initial Thoughts on Significance of Unmodeled Synergistic Effects
(Continued)

- With emphasis on utilization of as-built as-operated PRAs, staff would expect utilities implementing risk-informed activities to reflect operational data that justifies changes in initiating frequencies and SSC availabilities, however the update cycle will result in delay of assessing the impact of these data changes.

- Plants not involved in risk-informed activities may not be assessing data and incorporating into updates; however, plants pursuing extended uprates will likely be active in risk-informed activities.

# Preliminary Conclusions

- Current scope of risk evaluations for extended power uprate provides adequate insights to support extended power uprate evaluations.
- Absent operational data showing reasonably significant degradations on SSC availabilities and reliability and initiating event frequencies, it may not be productive to attempt to perform risk assessments reflecting full "possibility" of synergistic effects.
- We are considering whether operational data should be assessed specifically for plants with extended power uprates.

# EXTENDED POWER UPRATE REVIEWS AND STAFF ANALYSIS

by

Ralph Caruso
Reactor Systems Branch
Division of Systems Safety & Analysis
Office of Nuclear Reactor Regulation

# EXTENDED POWER UPRATE ANALYSES AND STAFF REVIEWS

- The staff is mindful of the potential for reduction in plant margin and increase in risk associated with proposed extended power uprates.
- The staff has a process in place to review BWR extended power uprates
  - NEDC-32424P "Generic Guidelines for GE BWR Extended Power Uprate" (ELTR1)
  - NEDC-32523P "Generic Evaluations of GE BWR Extended Power Uprate" (ELTR2)
  - SRP
  - SERs for previously approved power uprates (up to 5%)
- Monticello and Hatch extended power uprates were reviewed and approved in accordance with this guidance.
- Extended power uprate applications are required to meet all deterministic requirements.
- The staff works closely with licensees to identify potentially significant issues/phenomena relevant to power uprates.

## AUDIT CALCULATIONS

- Methodologies are approved by the staff on a generic basis.
- The staff has the capability to perform independent audit calculations for each application when deemed appropriate.
- The staff verifies that methodologies are being used in accordance with conditions of approval.
- There is nothing about power uprate that causes the staff to believe that the currently approved methodologies are not valid for this application.
- The staff plans to audit selected power uprate calculations.

## BEST-ESTIMATE METHODS

- There are currently no approved "best-estimate" evaluation methods for BWRs.
- The use of "best-estimate" analyses may be necessary for future power uprates.
- The staff supports the use of "best-estimate" analyses for power uprates with prior staff review and approval of the methodology.

# HIGH-BURNUP FUEL

- Staff has briefed ACRS several times on high-burnup fuel issues:
  - April 23, 1998
  - June 4, 1998
  - March 10, 1999
- No significant developments since last briefing, no change in policy.
- Agency program plan for high-burnup fuel is in place.
- Staff continues to meet with industry.
- Approval has not been granted to exceed rod average burnup limit of 62 GWd/t.
- Future approval for extensions in burnup above the present limit will require data to demonstrate that the fuel design acceptance criteria will be met.
- No new phenomena associated with power uprate, if new phenomena are identified, industry will gather data and include in analyses.

# POTENTIAL EFFECTS OF EROSION/CORROSION ASSOCIATED WITH EXTENDED POWER UPRATE APPLICATIONS

by

C. E. Carpenter
Materials & Chemical Engineering Branch
Division of Engineering
Office of Nuclear Reactor Regulation

# POTENTIAL EFFECTS OF EROSION/CORROSION ASSOCIATED WITH EXTENDED POWER UPRATE APPLICATIONS

- Staff Has Concluded That BWR Power Uprate Will Not Cause an Adverse Increase in Flow-Induced Erosion/Corrosion Damage to Reactor Coolant System Piping.
- Licensees Are Required to Reexamined Their Inspection Programs in Light of Plant-Specific Uprate Concerns, and to Evaluate the Effect on Postulated Existing Flaws.
- Licensees Verify That BWR Power Uprate Would Have No Significant Effects on the Potential for Flow-induced Erosion/Corrosion in Those Systems Which Might Be Susceptible to the Phenomenon.

# South Texas Project Insights into Option 2 and the Proto-type Pilot Approach

## Meeting of the ACRS

## December 7, 2000

# Background

- Graded Quality Assurance SER received 11/97
- GQA SER did not provide expected and required flexibility during implementation. Obstacles included:
  - ASME - Seismic
  - Class 1E - Equipment Qualification
- 'Request for Exemption to Exclude Certain Components from the Scope of Special Treatment Requirements Required by Regulation' submitted 07/99
- Approach represents the prototypical Option 2 pilot per SECY 98-300 for risk-informing 10CFR Part 50

# Background (cont.)

- SECY-98-0300 states:
  - 'Under [Option 2], SSCs of low safety significance (from a risk-informed assessment) would move from 'special treatment' to normal industrial (sometimes called 'commercial') treatment, but would remain in the plant and be expected to perform their design function but without additional margin, assurance, or documentation'
- RAIs received 01/18/00 and responded to on 05/22/00
- Revised Exemption Request submitted 08/31/00
- Draft Safety Evaluation Report received 11/15/00

Future target dates

- 01/15/01 - STP to respond to the Draft SER
- 04/15/01 - Final SER to be granted

# SECY-98-0300 Option 2

- Per SECY 98-300, Option 2 would:
  - adjust the scope of SSCs to which special treatment requirements apply
  - adjust SSC scope without changing the regulations

  Low safety significant SSCs would:
  - remain in the plant
  - move from special treatment to normal commercial treatment
  - be expected to perform their design function but without additional margin, assurance, or documentation associated with high safety significant SSCs
- Adjustments to the regulation content (distinct from the scope) would be addressed under Option 3
- Safety-related SSCs would remain safety-related (not reclassified)

# STP Foundational Principles in Piloting an Option 2 Approach

- Emphasis is placed on proper categorization of SSCs
- Current commercial practices are sufficient for LSS/NRS safety-related SSCs
- Details of commercial practices are unimportant to safety given the low safety significance of LSS/NRS SSCs
- No additional controls required over LSS/NRS commercial practices
- HSS/MSS SSCs would continue to be governed by existing regulations and non-safety related HSS/MSS SSCs would be evaluated for enhanced treatment
- Focus on procurement benefits to be gained from ASME, EQ, Seismic, and 1E exemptions

# What Does the Exemption Request Ask For?

- Exemption seeks to exclude Low Safety Significant (LSS) and Non-Risk Significant (NRS) SSCs from the scope of special treatment requirements of the following regulations
  - 10CFR Part 21 (Defect notification)
  - 10CFR50.34 (Appendix B treatment)
  - 10CFR50.49 (EQ)
  - 10CFR50.54 (QA Program)
  - 10CFR50.55a (ASME)
  - 10CFR50.59 (Change Evaluation)
  - 10CFR50.65 (Maintenance Rule)
  - Appendix A; GDCs 1,2,4,18 (QA, Seismic, EQ, 1E)
  - Appendix B (QA Program)
  - Appendix J (RCB Leak Testing)
  - 10CFR Part 100 (Seismic)

# Feedback From the Draft SER

- Indication where Special Treatment Requirements can be relaxed pending resolution of open items:
  - 10CFR Part 21 - no issues
  - Appendix B -some restrictions apply
  - Appendix J - no issues
  - Maintenance Rule - some restrictions apply
  - 10CFR50.59 - partially granted
  - Inservice Testing - some additional restrictions placed on testing and inspections

# Feedback From the Draft SER (cont.)

- Indication where Special Treatment Requirements cannot be relaxed:
  - Inservice Inspection
  - Repair and Replacement of ASME with non-ASME
  - Changes to the QA Program
- Indication where it is indeterminate if Special Treatment Requirements can be relaxed (potential denials):
  - Equipment Qualification
  - Seismic
  - Class 1E

# More Insights Into Draft SER

- Additional Treatment may be Imposed on LSS/NRS SSCs

  DSER:

  - Current STP commercial treatment needs additional requirements
  - Additional requirements to provide confidence
    - Commit to National Consensus Standards
    - Testing at design basis conditions
    - Perform pre-service inspections/pre-operational testing
    - Engineering analyses for procurement

  Possible Impact:

  - Separate commercial programs for LSS/NRS safety related SSCs
  - Impose additional burden onto existing program
  - Certain testing and inspections are not warranted or feasible
  - May be unable to use commercial grade items in LSS/NRS applications

# More Insights into Draft SER (cont.)

- Categorization Process

  DSER:

  - STP categorization process does not fully address onsite and off-site dose consequences
  - Insights from containment systems that mitigate latent fatality risks should be added into the categorization process

  Possible Impact:

  - revision to the existing NRC-approved categorization process
  - potential reevaluation of SSCs

# More Insights into Draft SER (cont.)

- Restrictive Commitment Change Process

  DSER:

  - extensive detail requested for inclusion into FSAR
  - stringent change control processes which mirror controls imposed on Tech Specs

  Possible Impact:

  - prior NRC approval would be required for any changes in either categorization or treatment (including beneficial changes)
  - flexibility not given to permit changes to account for feedback
  - unable to adjust treatment (MOV, AOV, snubber testing scope) without additional NRC approval

# More Insights into Draft SER (cont.)

- Reliance on Deterministic Criteria

  DSER:

  – deterministic basis relied on for evaluating exemption request

  Possible Impact:

  – risk informed arguments are not given appropriate consideration (for example, ISI, Seismic):
    - LSS/NRS SSCs currently receiving special treatment only due to the deterministic definition of safety-related
    - industry data demonstrates that failure rates of safety-related and non-safety related SSCs are essentially the same
    - an assumed 10x increase in failure rates of all LSS/NRS SSCs results in only a 2% increase in CDF and LERF
    - if an LSS/NRS SSC fails, no significant impact on safety

# More Insights into Draft SER (cont.)

- Some Special Treatment Requirements are viewed as Design Requirements

  DSER:

  - Fracture toughness impact tests viewed as design requirement
  - Other ASME requirements (including allowable stress limits and hydrostatic testing) may also be viewed as design requirements

  Possible Impact:

  - These special treatment requirements may not be available for inclusion into an Option 2 approach
  - Unable to replace ASME components with non-ASME
  - Resolution may be deferred until revised Code case is approved or other Option 3 method is considered

# More Insights into Draft SER (cont.)

- HSS/MSS SSCs Require Additional Evaluations

  DSER:

  - HSS/MSS SSCs require a documented engineering evaluation to determine if a beyond design basis function exists and is properly treated

  Possible Impact:

  - Additional burden associated with preparing an engineering evaluation for every HSS/MSS SSC
  - SSCs will perform no unique function under beyond design basis conditions that are not already capable of being performed under design basis conditions

# Concluding Remarks

- Draft SER represents a significant effort
- SECY-98-0300 Option 2 is a challenging task
- Important to focus on the adequacy of categorization such that the current commercial controls can be used
- Benefits are expected in procurement of seismic, EQ, ASME, and 1E replacement components
- NRC staff and STP are working to achieve a mutually acceptable result

November 22, 2000

Mr. William T. Cottle
President and Chief Executive Officer
STP Nuclear Operating Company
South Texas Project Electric
Generating Station
P. O. Box 289
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT, UNIT 2 - REQUEST FOR ADDITIONAL INFORMATION RE: LICENSE AMENDMENT REQUEST ASSOCIATED WITH MODIFYING ALTERNATE REPAIR CRITERIA OF STEAM GENERATOR TUBES AT CERTAIN INTERSECTIONS OF TUBES AND TUBE SUPPORT PLATES (TAC NO. MA8271)

Dear Mr. Cottle:

The staff met with the representatives from the STP Nuclear Operating Company (STPNOC) on November 17, 2000, regarding the STPNOC's license amendment request to change the Technical Specifications for South Texas Project, Unit 2, to modify requirements associated with the alternate repair criteria of steam generator tubes at certain intersections of tubes and tube support plates. The amendment proposed revising the current alternate repair criteria of 1.0 volt to 3.0 volts.

The meeting focused on the technical issues raised in our previous request for additional information dated October 31, 2000. Based on our review of the additional information that was provided during the meeting together with your February 21, 2000, submittal, enclosed we are providing our initial assessment of the subject license amendment request. A full meeting summary will be issued in the very near future.

Please let me know if you have any questions regarding the enclosed staff assessments or if you desire a meeting with the staff to discuss these question.

Sincerely,

*/RA/*

Tae Kim, Senior Project Manager, Section 1
Project Directorate IV & Decommissioning
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-499

Enclosure: Staff Assessment

cc w/encl: See next page

## NRR STAFF ASSESSMENT

## SOUTH TEXAS PROJECT- UNIT 2

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The capability of RELAP-5 to address thermal/hydraulic problems for which it was designed and verified (benchmarked) is not in question provided the code is correctly applied. Correct application encompasses several considerations, some of which are identified below:

1. The application of RELAP-5 in this particular case requires verification by comparison of the version of RELAP-5 used for the analysis to applicable separate effects and scaled integral experimental data. Key phenomena that potentially affect the results must be identified and RELAP-5 must be assessed for these phenomena. Appropriate code options (such as two-phase flow model, critical flow model, choice of thermodynamic equilibrium versus non-equilibrium, drag model) and nodalization must be selected and justified. Applicable data are limited for this application. Component characterization data such as for the steam line flow restrictor, steam/water separators, and steam dryers should be used in the verification. Data from MB-2, containment systems experiments, Marviken critical flow data, GE level swell, LOBI-MOD2 steam line breaks, and perhaps other facilities are useful for needed benchmarking. Any changes between the test facility and the application must be carefully assessed with respect to scaling concerns and from the viewpoint that, since RELAP-5 is a one-dimensional code, application to multi-dimensional situations must be performed with extreme care.

2. Sensitivity studies must be performed to assess the effect of time steps, nodalization selection versus steam generator geometry, code option selection, and initial condition assumptions. They must be of sufficient depth to ensure freedom from numeric instabilities. The consistency of the nodalization for representative test models must be established with respect to the plant steam generator model. Variation of the steam line break size range must establish that bounds fo the pressure loadings have been obtained. Analyses based upon blocking the bottom of the downcomer in combination with a sensitivity study of the influence of the preheater region on the regions of concern would provide bounding insights. Nodalization studies and parametric studies must provide insight into suitable one-dimensional behavior in the vicinity of the tube support plates of interest. Modeling the lower plates is of particular concern including the plate immediately above the dividing partition between hot side tubes and cold leg tubes, the influence of axial flow passages between the hot and cold leg tubes, and potential "feedback" from the U-bend region above the plates. Reduction of flow resistance through components on one or both sides of a tube support plate of interest should provide a conservative result with respect to pressure difference across that plate.

3. The latest code version should be used to take advantage of error corrections and improved code flexibility unless use of an older version is justified.

4. Code selections, input data, modeling assumptions, and results must be fully presented and anomalies must be addressed to establish a complete understanding of the application of the code and the calculated results. Results must be provided in sufficient detail in the time region of interest so that an independent verification can be conducted. In addition to the pressure differential across each tube support plate, such parameters

as break critical flow rate, break flow quality, quality into and out of each node, temperatures, pressures, mass flow rates, and flow regimes must be provided for all locations.

5. There is considerable uncertainty regarding propagation of short-term transient effects which may translate into relative plate-to-tube movement. The ability of RELAP-5 to predict pressures consistent with such effects must be fully addressed or their absence must be conclusively established. Finer nodalization must be evaluated to demonstrate convergence. Where analysis weaknesses have been identified, or where conservatism have been assumed, the calculations must be established as bounding the responses of concern. *

6. Uncertainty studies must be performed to obtain insight into calculation accuracy. Such variables as flow coefficient and appropriate variables identified above must be included.