

1 MR. HOPKINS: Right, and I wasn't trying
2 to insinuate that.

3 CHAIRMAN WALLIS: And so you don't want a
4 letter from us. I think it would be inappropriate for
5 us to write a letter now until perhaps you have
6 reached some firm conclusions on these points. Is
7 that a correct assessment?

8 MR. HOPKINS: I agree with that
9 assessment, yes.

10 CHAIRMAN WALLIS: And so you are going to
11 appear before the full committee?

12 MR. HOPKINS: Yes.

13 CHAIRMAN WALLIS: Is that what we plan to
14 do? And do you somehow have to shorten this
15 presentation to something that the rest of the
16 committee needs to know?

17 DR. BOEHNERT: We can discuss what we want
18 to do as far as having them come before the committee
19 next month. There are some issues that --

20 CHAIRMAN WALLIS: You do need to focus on
21 some other issues that we need to worry about. That
22 is the important thing. Otherwise, it is really a
23 question of whether you are on track with your review,
24 and that is more of a management issue for you folks
25 than it is for us. We may have an opinion, but it is

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1 not really our job to plan your activities.

2 MR. HOPKINS: Yes.

3 CHAIRMAN WALLIS: We may catch you in the
4 hallway and say something about that and say whatever.

5 MR. HOPKINS: I understand that it is a
6 management decision, and new priorities are looked at
7 continuously. All I can say is that the Duane Arnold
8 power uprate is a high priority.

9 CHAIRMAN WALLIS: I think we need to be
10 somehow assured that the bases are properly covered
11 and that things are done by October and something is
12 not overlooked, and that is the sort of thing that we
13 worry about.

14 MR. HOPKINS: I appreciate that.

15 CHAIRMAN WALLIS: Is there anything else
16 from the other members of the committee at this point?
17 Can we move ahead then. Is this Jack Rosenthal?

18 MR. HOPKINS: Yes.

19 CHAIRMAN WALLIS: Thank you very much.

20 MR. ROSENTHAL: My name is Jack Rosenthal,
21 and I am the newly appointed branch chief of the
22 safety margins and systems analysis branch. Farouk L.
23 Quila (phonetic) is my division director.

24 DR. KRESS: Is that a new branch? I have
25 never heard of that branch?

1 MR. ROSENTHAL: No, it is Farouk's branch.
2 Farouk was promoted to be the division director.

3 DR. KRESS: I knew that and we need to
4 congratulate him I guess. Did you change the branch
5 name or --

6 MR. ROSENTHAL: No, no, the branch has
7 always been the same, but it was Farouk's branch.
8 This is a reorganization from a year ago March, and
9 about every two years we reorganize. So Farouk became
10 the acting division director, and I became the acting
11 branch chief for a while.

12 DR. KRESS: And how it is no longer
13 acting.

14 MR. ROSENTHAL: Right. And I am not
15 pretending either. And although I am speaking from a
16 branch perspective, I did coordinate what I have to
17 say with the risk assessment people, and also with the
18 division of engineering.

19 And we do fuels, thermal-hydraulics, and
20 severe accidents, and consequence analysis. And I
21 don't mean this to be -- I won't dwell on the point,
22 and I don't want to be overly scholastic, but we see
23 lots of system interactions that we can think of, and
24 I have yet to come up with what I consider synergy.

25 And let me explain what I meant. I went

1 to my fuels expert, and he says, gee, if you run the
2 fuel a little bit harder, or a little bit hotter
3 temperature, don't you release more fission and gas,
4 and he said, yes, we have known that for 35 years, and
5 it is a sensitive function of the temperature.

6 And if you go to higher burnup, core
7 average burnup, because you still want the same
8 overall fuel cycle, don't you end up with a bigger
9 fission -- and he said, yes, we know that also.

10 And I said, well, is there a situation
11 where 3 percent and 3 percent ends up as 9 percent
12 rather than 6 percent, and the answer was no. So that
13 we sort of know these effects.

14 And so I have yet to come up with what I
15 consider a synergy. And distinct from that, we know
16 of lots of interactions. I mean, we clearly know that
17 the fluents goes up and the effect on the vessel,
18 which is small for a boiler --

19 DR. KRESS: Was this Ralph Myer that you
20 were talking to?

21 MR. ROSENTHAL: Yes, sir, who is part of
22 the branch. Some of the phenomenological interactions
23 are things like the effect on the core instabilities
24 that would be the result of -- well, as it turns out,
25 if you have an ATWS, you trip the recirc pumps.

1 And once you trip the recert pumps,
2 automatically you fall into the unstable breaches as
3 it turns out, but what that would mean in terms of
4 fuel performance is an outstanding question.

5 DR. CRONENBERG: Let me give you a synergy
6 there, Jack. Flow assisted corrosion. Corrosion by
7 itself will take a certain amount of time.

8 MR. ROSENTHAL: Right.

9 DR. CRONENBERG: And flow by itself would
10 rip away material from a piping wall.

11 MR. ROSENTHAL: Right.

12 MR. CARUSO: But corrosive products with
13 added flow could be a compounding effect. So you
14 asked Ralph for a quick answer, and maybe you should
15 have asked some materials people, and you might have
16 gotten a different answer.

17 MR. ROSENTHAL: Fair enough.

18 DR. KRESS: And I think that Ralph is
19 basically correct on those things that you said.

20 MR. ROSENTHAL: Okay. It is also somewhat
21 of a management challenge for us, which we will
22 address, to face up to some of these issues, because
23 they are truly interdisciplinary, and I will give you
24 an example.

25 Yesterday, I was talking with a true

1 expert in thermal-hydraulics, and I said, you know, if
2 you push harder on the generator and you have not
3 changed the generator, you will get more power and
4 fewer BWRs, and he said what is a BWR.

5 So I raised my right hand and I said a BWR
6 is -- and he said, oh, I remember. Okay. And the
7 point is that what we need to do in this search for
8 interaction synergies is to go across disciplines, and
9 I will get back to that specific example in a moment.

10 And what I am trying to do is describe in
11 fact researcher's plans, and that we are not currently
12 doing a project, although I do owe my boss a formal
13 memorandum of plan with tasks, and I owe that this
14 month.

15 We intend to be quantitative in our
16 assessment, and we have the ability to run codes like
17 TRAC and we have coupled three, or it is now a module
18 of TRAC, and so we can do 3-D based on kinetics.

19 And we intend to use that capability for
20 things like ATWS, and it is because we believe that
21 when we do the analysis that we learn a lot by doing
22 some quantitative work.

23 CHAIRMAN WALLIS: So when will you do
24 this?

25 MR. ROSENTHAL: In Fiscal 2002 and 2003.

1 CHAIRMAN WALLIS: But they want an answer
2 by November of this year.

3 MR. ROSENTHAL: This is a generic, and not
4 a --

5 CHAIRMAN WALLIS: So it is a long term
6 anticipatory research?

7 MR. ROSENTHAL: Yes, sir. We will start
8 with boiling water reactors. I think if there are
9 some questions on PWRs and again involving ATWS, where
10 there is the potential for more positive MPCs that we
11 would like to look at.

12 But to the extent that we are dealing with
13 real boiling water reactors, we are asking for
14 extended power uprates, and that is where we should
15 look first. But we will do some PWR work later on.

16 We are going to not focus on the Chapter
17 15 analysis. The licensee, the vendor, and NRR are
18 pressing those issues; but rather to at least have our
19 focus being on success criteria in --

20 DR. KRESS: I think that is really a good
21 choice for you guys, because I think you can rely
22 mostly on this staff's review of the licensees for the
23 design basis stuff, and this is added value here.

24 MR. ROSENTHAL: Thank you. And we also
25 would like to look at some of the generic issues and

1 severe accident issues that would be part of -- or may
2 not be part of and addressed otherwise. As I said,
3 this is a two year effort.

4 Farouk did speak before this committee
5 several months ago, and we have been through a budget
6 cycle, and it is now as we see it a currently budgeted
7 activity. We do intend to do the work, and distribute
8 it at least amongst three branches.

9 So how will I -- well, this is a search
10 for issues, and there may not be any. I do not have
11 a smoking gun, and if I did, it would be my obligation
12 to notify NRR.

13 So if we could look at this list, and we
14 will look at blackout and loss of heat removal, and I
15 think we will look at loss of coolant, because it is
16 of interest to us, even though we recognize that in
17 most PRAs that loss of coolant actions are not
18 scenarios.

19 We want to also -- and I will say review,
20 less significant accident sequences, and ask ourselves
21 the question could these sequences -- because the
22 success criteria may change -- become more important.

23 And the example that I could use, and it
24 is only as an example in my thought process, is large
25 break LOCA and boiling water reactor is clearly not a

1 risk dominance sequence.

2 If we were to somehow conclude that with
3 the flatter power distributions, core spray now is
4 very important, and the core spray distribution is
5 very important, and if there is a problem with it,
6 then --

7 DR. KRESS: How would you look at that?
8 Would you just go in with your code and arbitrarily
9 say or do some power metric studies on the
10 distribution and see what it does to success?

11 MR. ROSENTHAL: It is a capability that we
12 have developed with TRAC, and put in a flat power
13 distribution which we think is representative of what
14 is going on. We won't know anything more about core
15 spray distribution.

16 DR. KRESS: No, but you could arbitrarily
17 vary that.

18 MR. ROSENTHAL: Yes, sir.

19 DR. KRESS: And the bypass amount that you
20 get is okay.

21 MR. ROSENTHAL: And see if it affects the
22 results. And it is conceivable, although I don't
23 expect, that there is some problems with the success
24 criteria.

25 If it were, then it would make something

1 that is not risk dominant, and make it very important.
2 That is the type of search we would like to do.

3 DR. KRESS: I think where your problems
4 are going to be are in the carryover term, and I don't
5 know how you deal with that. When you increase and
6 flatten out the profile, I don't know what that does
7 to carryover. But that is the only place I see where
8 that could make a lot of difference.

9 MR. ROSENTHAL: Yes. But we think we
10 ought to be looking at those, and not just -- well, at
11 least do some looking, and we will do definitely some
12 quantitative analysis, and we will do some reviewing
13 of the less sequence and think our way through it.

14 I think we want to also review some of the
15 prior generic issues. We put in this power/flow
16 stability issue in that category, but there were other
17 things that the agency faced and resolved in the past,
18 like the hydro-dynamic loads on the Torus, which would
19 be different now.

20 And we would intend to go back and look,
21 and in fact what I intend to do is go down the list of
22 generic issues that we have resolved and think our way
23 through which things might be different at the higher
24 power.

25 CHAIRMAN WALLIS: Do you know you have the

1 -- coupled with the neutronics code, does it predict
2 flow stabilities? Do we know that yet?

3 DR. KRESS: I don't think it does.

4 MR. ROSENTHAL: I don't know.

5 DR. KRESS: I don't think it does.

6 MR. ROSENTHAL: As I said, what I have
7 brand new is this 3-D spaced on kinetics capability
8 that we now have.

9 DR. SCHROCK: What is the name of that?

10 MR. ROSENTHAL: Well, it is a module, and
11 we have made it into a module of TRAC and its parts,
12 and that is from Purdue.

13 CHAIRMAN WALLIS: So one success that you
14 could establish would be that you could model power
15 flow stabilities with these codes, that would be a
16 success if it hasn't been done before. I don't know.

17 DR. KRESS: Well, they have models.

18 CHAIRMAN WALLIS: And if you have a model
19 and the codes can't do it, that's not so good. It
20 would be better if the code did it by itself.

21 MR. ROSENTHAL: Well, then you have to
22 know whether you trust what you have got. But in that
23 case, it is an area that we would like to explore and
24 we think it is appropriate to explore this area.

25 I have a related area, and that is that

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1 again it is ATWS, where the concern is to have a
2 rewetting of the clad, and will the temperature of the
3 clads go up. And for that, we are actually looking at
4 -- we have a fuel code called PROCTRAN (phonetic), and
5 we are working with of all things the Fins on a
6 subchannel code called GENFLO, and that will allow us
7 to look at that phenomena.

8 And we can couple that with the TRAC work,
9 but we want to look at other potential generic issues.

10 DR. LEITCH: I assume -- and not to pick
11 on the words, but when you say Torus, I suppose that
12 applies to other kinds of suppression pools as well?

13 MR. ROSENTHAL: Yes, to the extent that it
14 was an issue.

15 DR. LEITCH: And so pool snow and all
16 those hydrodynamic effects are also in Mark Iis?

17 MR. ROSENTHAL: Yes.

18 DR. LEITCH: Okay.

19 MR. ROSENTHAL: And we would also like to
20 go back and revisit some of what I will term severe
21 accident issues. You have the Mark I liner melt
22 issue, and you are now potentially putting down more
23 material with more decayed heat in it, and will it
24 move out further across the floor and affect the
25 liner.

1 That is something that we ought to look at
2 as an example of a severe accident issue that we put
3 to bed and that we could take a look at.

4 DR. KRESS: That was put to bed by the
5 peaponus (phonetic) methodology.

6 MR. ROSENTHAL: Yes. I doubt if you could
7 factor into that the increase through the power level.
8 It is well -- well, the uncertainties are well beyond
9 what you get out of that. I don't know how you would
10 do that, but that is your problem.

11 CHAIRMAN WALLIS: They can try.

12 MR. ROSENTHAL: I know what you are
13 referring to, but I think we have an obligation to try
14 to look at the sphere of consideration.

15 DR. KRESS: Well, you quantify how much
16 melt is going to come down.

17 MR. ROSENTHAL: Right.

18 DR. KRESS: So you might change that by a
19 ratio of 20 percent.

20 MR. ROSENTHAL: But once it is on the
21 floor, it has got more decayed heat.

22 DR. KRESS: Yes.

23 MR. ROSENTHAL: And the severe accident,
24 the containment venting size for certain power, and we
25 can go back and look if it sized with greater power as

1 being representative issues that we thought that we
2 would rethink.

3 Now, to whatever degree that has already
4 been rethought, we don't have to instill again. But
5 that was the scope of the kind of places that we
6 thought that we would look to identify issues within
7 the success criteria, and within the previously
8 resolved generic issues, and within some of the severe
9 accident issues.

10 And let me go outside my branch a little
11 bit, and some of these things I found interesting.
12 Let me get back to the generator again. If I am
13 pushing more power through VARS, and in fact I have a
14 somewhat less stable system electrically.

15 And if I am tripping 120 percent power
16 offline rather than a hundred percent offline, that
17 potentially also affects the grid. So I discussed
18 that with the PRA people, and they said, yes, those
19 things are true, but we don't know how to quantify
20 them, or at least now we don't know how to quantify
21 it.

22 It would be something that we ought to
23 look into, and that the risk may be dominated, a
24 blackout, by harsh weather events, or external events,
25 like seismic events in the past, and so these things

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1 may not be important.

2 But that is a good illustration of where
3 the -- of the feedback between the electrical
4 discipline and the thermal hydraulic systems.

5 CHAIRMAN WALLIS: VARS are reactive -- you
6 have kept us in suspense by saying that some thermo-
7 hydraulists don't know what VARS are.

8 MR. ROSENTHAL: We also would like to look
9 at the possibility that just electrical equipment is
10 going to be running hotter throughout the plant. So
11 the division of engineering is interested in that.

12 And the division of engineering is
13 interested in loads and vibrations, and fatigue, and
14 thinning, and corrosion, although just as you heard
15 just a little while ago, we don't have a good link
16 between those issues and the ability to quantify them,
17 which maybe be a capability that we would like to
18 develop.

19 With the primary system, we will look at
20 things like the vessel, and we will attempt to think
21 our way through on piping loads. On containment
22 systems is where I meant to have the cable, and where
23 we already have experience.

24 I remember Pilgrim ended up baking a lot
25 of cable up in the upper head and having to replace

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1 cable. Now, on one hand, just as you heard earlier
2 from NRR, there were programs in place to monitor, and
3 when people find that stuff no longer works, or it
4 gets changed down, that doesn't mean that there is a
5 safety issue.

6 But nevertheless we think there are going
7 to be issues of thermal fluences and running hotter in
8 containment. I meant to have a bullet under
9 containment on the cables specifically.

10 And then of course we are interested in
11 the higher pool temperatures and the effect on NPSH of
12 equipment. There may be control systems issues that
13 we didn't recognize, in terms of things like steam, to
14 condensers, and if that fails, you are pulling more
15 steam out and how does that affect the thermal-
16 hydraulics.

17 And the PRA people will look at the human
18 response times. So that is for the human error rate.
19 So that is the scope of the considerations that RES
20 would like to do.

21 CHAIRMAN WALLIS: It sounds big to me. It
22 sounds like a large scope. What is the funding that
23 is anticipated?

24 MR. ROSENTHAL: The scope of the FY '03
25 budget is not out yet.

1 CHAIRMAN WALLIS: Is this going to be done
2 in-house or are you going to hire some consultants?

3 MR. ROSENTHAL: I have an FTE in the
4 branch and some contract dollars that would be a
5 little more outside than inside, but yes, we will do
6 some of the work inside in-house, through the other
7 divisions.

8 CHAIRMAN WALLIS: Do you have the
9 capability to model these systems with your codes and
10 computers and it is not a big struggle to get all the
11 information that you need to do that?

12 MR. ROSENTHAL: There is always a loop
13 around, and there is always the struggle to come up
14 with DAECs.

15 CHAIRMAN WALLIS: Is G.E. going to give
16 you DAECs, or is something going to give you DAECs?

17 MR. ROSENTHAL: We are planning on using
18 an existing one, and for some of these other issues
19 that involve that involve either the PRA group or the
20 division of engineering, it is obvious that there are
21 concerns, and I don't know how we are going to go
22 about quantifying them.

23 CHAIRMAN WALLIS: I think you have a
24 management concern. You have got so many issues that
25 you might involve, let's say, a dozen people.

1 MR. ROSENTHAL: Yes.

2 CHAIRMAN WALLIS: And you are going to ask
3 for a few hours of a dozen people to make an
4 assessment which is not superficial, and which is then
5 going to be coordinated by some people who can put it
6 all together and figure out if it means anything.

7 DR. KRESS: Jack can do it.

8 CHAIRMAN WALLIS: So you are going to be
9 the guy doing the work and not managing it?

10 MR. ROSENTHAL: Within the branch which I
11 control, we do intend to do it. I have somewhat
12 dedicated resources to work, on at least the thermal-
13 hydraulic issues.

14 CHAIRMAN WALLIS: And when they come in
15 front of this committee are they going to give crisp
16 answers and not waffle?

17 MR. ROSENTHAL: The intent is to give yo
18 numerical answers.

19 CHAIRMAN WALLIS: Good.

20 MR. ROSENTHAL: The last part, you had a
21 discussion in terms of the source terms and
22 consequence analysis, and we do have the capability to
23 generate source terms, and we do have the capability
24 to run consequence analysis using math and that was
25 not in my mental larva of what we would do at this

1 time.

2 CHAIRMAN WALLIS: I think we should keep
3 this piece of paper.

4 MR. ROSENTHAL: And you are going to hold
5 me to it?

6 CHAIRMAN WALLIS: Absolutely. I will put
7 it up on my wall. When are you going to come and tell
8 us, in 2002 or 2003, and we will have a reorganization
9 by then, and you won't be in charge.

10 MR. ROSENTHAL: I would prefer that the
11 next time that we would come before the committee
12 would be sometime in late Fiscal 2002, when we had
13 results of something to show you.

14 CHAIRMAN WALLIS: Yes, this is a very
15 ambitious program.

16 MR. ROSENTHAL: As distinct from a -- you
17 know, I can share the -- well, as I said at the
18 beginning, I have to write a program plan, and that I
19 would be perfectly willing to do.

20 CHAIRMAN WALLIS: Well, we see a lot of
21 plans, and results are what really matter.

22 DR. KRESS: I would like to see your
23 plans, too.

24 CHAIRMAN WALLIS: Oh, I know that we would
25 like to see plans, but --

1 DR. CRONENBERG: But this is really one
2 FTE, right?

3 MR. ROSENTHAL: No, no, no. My branch is
4 one FTE, and --

5 DR. CRONENBERG: And so all the other
6 branches have some money for this? What is the total
7 program?

8 MR. ROSENTHAL: As Farouk said, it would
9 be 850K and --

10 CHAIRMAN WALLIS: That's big.

11 DR. CRONENBERG: That is significant.

12 CHAIRMAN WALLIS: So it is going to be a
13 big fat new Reg report that addresses all these
14 issues?

15 DR. KRESS: Well, that can be decided
16 later.

17 CHAIRMAN WALLIS: Well, there is the
18 opportunity to do something like that, and put
19 together some really authoritative report which
20 addresses all these issues, and finds out the ones
21 that are important and gives us some good answers.

22 MR. ROSENTHAL: I just hope that I have
23 not been overly enthusiastic enough. The thermal-
24 hydraulic analysis we can clearly attempt to do, and
25 we will do it and get the results, and we will write

1 the report on that.

2 CHAIRMAN WALLIS: Is that first?

3 MR. ROSENTHAL: On some of the other
4 issues like if there is a small incremental change in
5 the grid reliability can you actually ever quantify
6 what that is, and can you put that back in your PRA,
7 I can't make promises on that. That is really state-
8 of-the-art.

9 And putting in pipe degradation back in
10 the PRA is state-of-the-art stuff. So that is much
11 harder for me to make promises on that.

12 DR. LEITCH: Professor Wallis, I think we
13 can deal with additive things intuitively, but I would
14 hope that if there are some subtle synergistic effects
15 that come to light that we would be made aware of
16 those prior to late 2002.

17 And if there are such things that surface,
18 that we be notified, because we have been doing a lot
19 of thinking about these things ourselves, and we have
20 a concern, but I am not sure that we have identified
21 any specific synergistic issues.

22 But should there be some, I for one would
23 like to be aware of it as soon as you have a sense as
24 he does.

25 MR. ROSENTHAL: At the beginning, I said

1 that I have no smoking gun. If we found a technical
2 issue, we would feel obligated to --

3 CHAIRMAN WALLIS: Well, I don't know if it
4 is a smoking gun. Smoking guns are usually after the
5 event. It is more like a smoldering fire or
6 something. It is something that could grow into
7 something important.

8 So thank you very much, and you have
9 helped us to get to go to lunch before 12:00 noon. So
10 we will reconvene at one o'clock.

11 (Whereupon, the meeting was recessed at
12 11:58 a.m.)

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

(1:01 p.m.)

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2
3 CHAIRMAN WALLIS: We are now going to hear
4 a presentation by ACRS Fellow Gus Cronenberg, who has
5 studied the matter of power uprates for a period of
6 time and is going to give us some insights on his
7 conclusions.

8 DR. CRONENBERG: Okay. I have two
9 presentations, Graham. I went through this last week
10 at a full ACRS meeting, and so what I plan to do is go
11 through the margin reduction estimates fairly quickly,
12 and then go to the review of some LERs operating
13 experience for power uprates for a number of
14 incidents, such as the Wolf Creek incident, and Maine
15 Yankee, and some of the pipe ruptures that we saw.

16 And some safety implications of those
17 operational events. So I will run through this fairly
18 quickly, but this was a chart that ACRS gave me at the
19 beginning of the year to try to figure out what are we
20 talking about, and their concern about margin
21 reductions for the significant power uprates that were
22 coming in this year.

23 My overview is basically a little bit of
24 margin reductions in the regulatory process, and I
25 will go through that real fast; Estimates for power

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1 uprates, and estimates for renewal, and findings.

2 I think everybody here knows what we are
3 talking about when we talked about margins, and it is
4 always used in a general sense.

5 For example, when a design criteria in
6 10CFR50, it says reactor core and associated coolant,
7 control, and protection systems shall be designed with
8 sufficient margin to assure acceptable design limits.

9 And we have other various criteria
10 throughout Appendix A of 10CFR50. Again, in
11 containment also, including access openings,
12 penetrations, et cetera, shall be designed without
13 exceeding leakage rates and with sufficient margin.

14 So that basically the rule of law says
15 that there shall be some margin that shall not be
16 exceeded in nuclear power plant designs.

17 These margin requirements are more
18 explicitly spelled out in regulatory guidance and the
19 standard review plan, and basically the standard
20 review plan for the construction permit essentially
21 defines what the margin shall be.

22 Basically, there are pressure limits,
23 pressure temperature limits, stress limits, ductility
24 limits on cladding, and allowable materials that can
25 be used, and then those go down into the ASME, for

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1 example, and --

2 CHAIRMAN WALLIS: Gus, limits are not the
3 same as margin though are they? I always thought they
4 were two distinct things.

5 DR. CRONENBERG: Well, basically there is
6 allowable margin if you don't exceed these limits. It
7 is basically what the regulatory inspection says, and
8 that if you don't exceed a design parameter, then they
9 say you --

10 CHAIRMAN WALLIS: Well, yes, that is one
11 view of margin, that it is built into the limit, and
12 the other view of margin is that even if you stay
13 below the limit, then you have some extra margin, and
14 that is the margin that is often discussed; is the
15 margin between where you are and where this limit is,
16 which itself has a margin.

17 DR. CRONENBERG: Well, maybe the best
18 thing is by example then, and basically a licensee
19 will come in with an application and say I have a
20 pressure in this -- that my pressure in this piece of
21 piping is a thousand psi, and the design limit for
22 that by the ASME pressure vessel code is 1,250 psi.
23 Therefore, I have adequate margin.

24 And that is basically all that he will
25 say, and the same thing with ductility limits on

1 cladding. I predicted for this amount of burnup and
2 I will not exceed 14 percent cladding oxidation, and
3 the cladding limits are 17 percent on station limit,
4 and I have sufficient margin.

5 DR. KRESS: But I anticipate that they are
6 going to come in and say that the design pressures --
7 I don't remember what number you said, but --

8 DR. CRONENBERG: Well, 1,250.

9 DR. KRESS: And I anticipate that they are
10 going to come in and say that our calculations show
11 that our pressure is 1,249. Therefore, we have
12 adequate margin.

13 DR. CRONENBERG: Well, they will never get
14 quite that close, but they will always say in the
15 application that we have adequate margin.

16 DR. KRESS: But that is an example of what
17 I think is going to happen, and what should be the
18 response to that is that they probably do have
19 adequate margin because it is built into the design
20 limit like you said.

21 DR. CRONENBERG: Well, that is for you
22 people and the staff to negotiate what that should be
23 if it came that close. And I will show you an example
24 where the margin was exceeded in the design.

25 DR. KRESS: And my own feeling is that

1 whether that is adequate margin or not depends on the
2 uncertainty of the calculation. There is a large
3 uncertainty in that calculation.

4 Maybe they don't have adequate margin, and
5 I think the staff tended to agree with that view and
6 said that's why they want to see more, and the closer
7 you get to that margin, they want to see more
8 uncertainty analysis.

9 Or the flip side of that coin is the
10 design pressure for a piece of pipe that is 1,250 psi,
11 and yet that piping broke at a thousand psi because it
12 had the flow assisted corrosion or something.

13 So, you know, those things do happen, and
14 we just passed Aconie, and said there was plenty of
15 margin left in the control rod housing, and six months
16 later they found cracks. So even when we think we
17 know everything, sometimes we don't.

18 Okay. Impact of power uprates on plant
19 operating conditions and margins. Basically, for a
20 power uprate, you have a coolant enthalpy changes, and
21 flow rates, and coolant temperatures, and fuel
22 temperatures, and then you have usually some major
23 changes to operating conditions on the secondary side.

24 Here are some examples, and as I said, I
25 am going to run through this quickly because ACRS has

1 already seen this. What we are talking about here is
2 a fleet of aging plants, 25 or 30 years old, that are
3 coming in for major power uprates.

4 So this is why the ACRS asked me to look
5 at this question of what we are talking about as far
6 as pushing these plants further out for license
7 renewal, and power uprates, the same fleet of plants
8 that have been around for quite a while.

9 And what are we talking about in terms of
10 margins. I used as a case study, and I only looked at
11 one, and I am not talking about Duane Arnold today.

12 I looked at a case study, the Hatch,
13 because the Hatch had two power uprates. Hatch is
14 under current review for license application, and
15 Hatch was also a lead plant, Monticello and Hatch, for
16 the G.E. extended power uprate program.

17 It is an older plant, an early '70s
18 vintage plant, BWR-direct cycle Mark-I containment,
19 two power uprates in '95 and '97. And it is also
20 under current review for license application.

21 So I looked at what the impact of those
22 two separate actions on the plant, and basically we
23 have a direct cycle plant, and so what I did was march
24 around the primary system, and the secondary system,
25 and see what I could see as far as design parameters,

1 and changes in design parameters, and therefore
2 changes in margins.

3 For recirculation, piping, the feed water
4 piping, the primary steam piping, and that sort of
5 thing, and what was the impact of the power uprates
6 and the license renewal on those kinds of systems.

7 Okay. Here is -- and I don't know if you
8 can see that clearly, but these are the powers for
9 unit one and unit two. They are sister units, and
10 essentially the same power, and what was changed. For
11 example, the steam flow rates were increased from an
12 original 10 to 10.6, to 11.5; and steam dome pressure,
13 the original was 1015 and then it jumped to 1050, and
14 then a constant pressure type of uprate to 1050 again
15 on the second power uprate.

16 The temperatures changed from the first to
17 the second, and of course the feedwater flow rates and
18 temperatures increased progressively as you went up in
19 power.

20 There were two types of margins, and I
21 wrote down operational conditions, and then also what
22 are the changes in margins for design basis LOCA
23 conditions; and that I also looked at fatigue
24 estimates for the license renewal from the time
25 limited aging analysis.

1 My margin was based on what I would call
2 a definition of -- well, it doesn't say there shall be
3 adequate margin, and that is what the rule says, 10
4 CFR 50.

5 Basically, I said that you can't exceed
6 the design limit from the ASME pressure vessel code.
7 So the operating parameter scaled to the design
8 pressure, or design temperature, or whatever.

9 Okay. The main steam line pressure, we
10 saw that increase from 1015 to 1050, and the design
11 limit for that piece of piping is 1250 psi. So we had
12 a margin of 18 percent when we built the plant, and
13 reduced to 16 percent.

14 So there is a 2 percent degradation in
15 margin, and one would say that is not much of a
16 decrease in margin. The same with steamline pressure.
17 The design pressure or design limit for that piece of
18 piping is 1575, and we go from 546 to 551.

19 So we go from 5 percent to 4 percent
20 margin, and of course, from what Dr. Kress said, there
21 is also excess margin above the ASME allowable design
22 parameters.

23 Feed water piping, and 1650 is the design
24 limit, and we go from 1130 down to a lower pressure,
25 and then the feedwater piping temperature we increase.

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1 So we go from 30 percent margin to 28 percent margin.

2 So nothing major so far here as far as
3 operational conditions. However, if we start looking
4 at LOCA conditions, things change a little. The
5 reductions in predicted margins become greater, and
6 when I get into my next set of slides, we will look
7 at, for example, the Maine Yankee experience, which
8 was not a very pleasant experience.

9 But that was as you know related to a
10 power uprate for Maine Yankee. They could not quite
11 satisfy their LOCA conditions, and I will get into
12 that story in a little while.

13 DR. SCHROCK: And when you are talking
14 about percentages, they are based on what?

15 DR. CRONENBERG: Just the design limit
16 over the value, and how the value changed as a
17 function of power. We went from whatever it was --
18 well, from 392 to 4000.

19 DR. SCHROCK: And do you need sort of an
20 absolute number denominator?

21 DR. CRONENBERG: Yes, it is. It is the
22 562. It is the design limit.

23 CHAIRMAN WALLIS: And we could make it
24 degrees --

25 DR. SCHROCK: Yes, that is what I was

1 getting at. You can get a different answer if you use
2 --

3 DR. CRONENBERG: Oh, I see. I just used -
4 - it is specified in terms of degrees fahrenheit, the
5 design limits, and so that is what I used it as.

6 DR. SCHROCK: You probably shouldn't
7 express it as a percentage.

8 DR. CRONENBERG: Well, this is just a
9 signature. I am trying to give a feeling for what
10 things are changing, and --

11 DR. SCHROCK: I know what you are trying
12 to do, but the significance of the number should not
13 be dependent on an arbitrary choice in the system of
14 units that you want to use.

15 DR. CRONENBERG: Well, margin is in and of
16 itself kind of an arbitrary term used in the
17 regulatory process, and we will never find a
18 definition of you can't exceed a parameter by .2
19 percent or something.

20 You do have things in terms of allowable
21 dose limits, and that sort of thing.

22 The only things that we have are design
23 parameters in the boiler and pressure vessel code, or
24 curies, or dose, or something like that.

25 Okay. Here is some predictions for the

1 Hatch plant on the design of LOCA calculations. For
2 example -- I wanted to go to the primary system first
3 -- here is one for the vessel shroud and support weld,
4 the vessel shroud and head bolts, and the access cover
5 plate.

6 All right. The vessel access cover plate,
7 et cetera. Now, all these numbers I got from the
8 licensee's own submittal, okay? The safety analysis
9 report, the SAR, and the SER. I didn't go beyond
10 that. I just used the licensee's own numbers.

11 And, for example, the predicted stress at
12 the original power at the support welds was 8.9
13 kilopounds per square inch, and it jumped to a 9.05.
14 So not much change in margin there. The same for a
15 head bolt.

16 Now, this access hole cover plate is an
17 interesting comparison, because it looks like with an
18 8 percent power uprate; that between the first uprate
19 and the second uprate that there was an 8 percent
20 power increase.

21 The predicted stress jumped from 64 to 90,
22 but that is a little unclear because -- and one of the
23 conclusions that I am going to make in my
24 presentation today is that I don't think either the
25 safety analysis report, nor the NRC's safety

1 evaluation report, the SER and the SAR, give you
2 enough detail and enough information to do a good job
3 on margin assessment.

4 I don't know if it is the number one bolt
5 in the first calculation, and the number six bolt in
6 the second calculation. I don't know if you had
7 superimposed loads. I don't really know if one was a
8 seismic induced and one was not a seismic induced.

9 You don't get in the SAR a picture of the
10 EISO bars for the stress predictions for all the
11 components. All you get is a little summary table
12 saying that these were my predicted stresses for these
13 5 or 6 components.

14 And then the SER basically says that we
15 had no problems or we requested information on this
16 particular number.

17 So if ACRS is asking for a detailed
18 assessment of the impact of a power uprate on margins,
19 I can't pull it out from the data that I worked out
20 from the historical FSARs.

21 And there is no defined criteria; that
22 this piece of information shall be given for this
23 component every time you do an uprate, so that you can
24 compare apples and apples, and so you can get an
25 historical picture of what is happening to this

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1 reactor over time, and for the various licensing
2 actions

3 Also, you change models and you change
4 calculational procedures, and there is not enough
5 detail in what we get I believe from the applicant, or
6 what I can find out in the evaluation report by the
7 agency.

8 So I don't know how we are going to get a
9 good handle on margins if that is what this committee
10 is concerned about, and that will be one of my
11 conclusions. The information base to me is sketchy.

12 DR. FORD: Just to go back through that,
13 did you ever resolve the question of whether the --

14 DR. CRONENBERG: No, I looked back and I
15 couldn't tell which bolt it was for, and I couldn't
16 tell the exact details of the boundary conditions on
17 the stress calculation. There was not enough detail.

18 What I can tell you is, and what I told
19 you before, that access plate was replaced because of
20 what was found at Peach Bottom. They found stress
21 corrosion cracking in the welding of that plate, and
22 then the NRC required that they do inspections at each
23 outage.

24 And the licensee, because the inspection
25 program was going to cost them so much, they decided

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1 to just replace that access cover plate. I don't
2 think it resulted from these kinds of numbers.

3 But from my reading, I couldn't get a good
4 indication of what are the boundary conditions in the
5 stress calculations. They are not discussed in the
6 submittal, and they are not really discussed in the
7 evaluation report.

8 But all I saw was tables and these are the
9 numbers, and it is probably hard to go back to
10 something in '95 and ask for that contractor report.
11 Sometimes it is not even the licensee.

12 The licensee will go to G.E., and G.E.
13 will go to Structural Analysis Associates, and I will
14 show you some of what you have to backtrack to pull
15 the information out when we get to the time limited
16 aging analysis.

17 It was not easy to pull information to get
18 these numbers. And then we had the same thing on the
19 margins on the LOCA conditions for the containment,
20 and for the drywell pressures, we go from a 14 percent
21 margin down to a 10 percent margin.

22 In some cases the peak drywell gas
23 temperature exceeds the design limits, but you look at
24 the calculations, and it is for a short period of
25 time. So the NRC says that's fine.

1 It is only for a short period of time, and
2 it is basically a few seconds in this calculation
3 during the flow-down, and the exemption is still
4 granted, and you can't go up in power.

5 And then the same suppression pool
6 temperature, of course, and the temperature goes up
7 because you have higher power, and the margin goes
8 down.

9 But there is nothing major here so far,
10 except for what we saw for that access cover plate.
11 Since I am interested in the license renewal, I think
12 you can get a better handle on margins. There is more
13 requirements that go into a license renewal
14 application going from 40 to 60 years operation
15 conditions.

16 We have a standard review plan that is
17 based on several years of agency efforts between the
18 staff and ACRS going back and forth on what will be
19 required for an adequate submittal on license renewal.

20 And there is a lot of calculations there,
21 and you can calculate margin, and it is more clearly
22 documented. It is easier to pull out something on
23 margin reductions if it is more clearly documented.

24 Basically, I looked at the time limited
25 aging analysis, and we talked about this this morning,

1 and the cumulative usage factor for the questions of
2 fatigue that Peter was bringing up.

3 And we heard a response from the NRC staff
4 that for these uprate applications that the staff is
5 requiring some cumulative usage factor estimates.

6 And then I said that was the first time
7 that I had seen from the applications that I looked at
8 in the past, and I never saw any cumulative usage
9 factor estimates for pipes or any real components.

10 And this was new to me, and I think it is
11 a good way to at least get a handle or a feeling for
12 degradation and the effects of increased flow, and
13 increased vibration, aging, and that sort of thing.

14 And accumulative usage factor is just a
15 fatigue estimate, and basically it is based on
16 historical data, and then projecting that out in time.

17 And we can see what the estimates are for
18 the heat removal suction piping at 40 years, and
19 basically you can't exceed one, and if you calculate
20 one, then you have to do something for that component.

21 It is essentially from the agency's point
22 of view it has filled up its bucket as far as fatigue
23 in Ralph's analogy of a bucket. So we have some
24 buckets for irradiation induced embrittlement, and we
25 have buckets for fatigue, and so forth.

1 We have some buckets that we fill up for
2 pressure temperature limits, and for license renewal,
3 I don't know how many buckets we look at for the power
4 uprate. It is not as clearly defined for me.

5 And then you can estimate it for 60 years,
6 and so your residual margin here went from 43 to 23,
7 and feedwater piping has a margin of 39 percent down
8 to 17 percent.

9 It looks like if this is an accurate
10 prediction of what is happening over time, then you
11 did increase your fatigue on that piping, and you
12 reduce margin.

13 It is something anyway, but to get these
14 estimates, these cumulative usage factors will not or
15 are not part of the licensee submittal. They are not
16 a part of appendix material.

17 This was referenced in Appendix C of the
18 license submittal. I asked for these numbers from the
19 staff, and we couldn't find them. I had to go back
20 and go through Brent Busher, and he had to go back to
21 the licensee.

22 And the licensee had to go back to the
23 subcontractor, to G.E., to get these numbers. That's
24 why I am saying that sometimes it is hard to pull this
25 information out.

1 If this committee wants to know something
2 and this agency wants to know something about margins,
3 it is going to have to define what is required and
4 what kind of information we are going to keep. Right
5 now we don't have a clear definition of that.

6 The pressure temperature limits were in
7 the Appendix E of the license renewal application for
8 the Hatch plant, and we did have those numbers in-
9 house.

10 And basically that if you have a certain
11 pressure of a piece of piping, you have to have a
12 certain temperature to keep that pipe ductile enough.

13 And because of irradiation embrittlement
14 the ductility is going down with irradiating dose and
15 time, and so the temperature has to get and higher,
16 and higher, and higher. So these are estimates in
17 Appendix E of the license renewal for 36 effective
18 full power years, 40, 44, 48, 50.

19 We go from a margin of say about 30 to
20 half that at 60 years. So to me there is a clearer
21 indication of margins and how they are affected for
22 the license renewal, because we thought about it, and
23 we thought it through over a number of years, and we
24 know something about aging, and fatigue, and flow
25 assisted corrosion.

1 And we asked the licensee this is what you
2 have to submit to us to show that this plant will be
3 good for another 60 years, and have we clearly thought
4 that through for significant power uprates for an aged
5 fleet of plants, and that is the kind of question that
6 I think is really before this committee. What does
7 this agency need to be looking for.

8 Okay. These are just data sources.
9 Again, I wanted to really indicate to you that you
10 have to look at a lot of different data sources. It
11 is not easy to pull all of this together, because
12 every licensing action is an individual action.

13 We look for a power uprate in an
14 individual way. We look for extended fuel burnup as
15 an individualized licensing action. We look for a
16 license renewal in that individual licensing action.

17 No one puts this all together in terms of
18 margins for the plant as a whole. The point of this
19 slide is that this is all the information that I got
20 out and it was proprietary information as an appendix
21 to the LOCA calculations for the Hatch SAR, and these
22 were the stress calculations.

23 It is a summary table and very little is
24 told you about the boundary conditions, the models,
25 and so forth that I used in there. So it is hard to

1 predict from one power uprate to another, because they
2 will give you different components or different bolts,
3 or whatever.

4 So the task that you asked me to do was
5 almost an impossible task to give you a clear answer,
6 because we don't have clear dictates on what is
7 required on calculational results.

8 It is just tell me what the maximum stress
9 is for a couple of components, and that is basically
10 what you get in a summary report. The analogy to me
11 is when we went to the IPEEE process. We didn't ask
12 for the dependency tables in the PRA.

13 All we asked for is a summary report, and
14 then we tried to glean information out, and it was
15 hard to pull, and then we started asking questions.
16 Well, what does this mean. Well, we only have summary
17 reports and we don't have dependency tables.

18 DR. FORD: So do the stresses change?

19 DR. CRONENBERG: The loads are different
20 because the blowdown loads are different because of
21 the power increase. The coolant enthalpy is increased
22 and the blowdown loads are increased.

23 DR. BOEHNERT: Gus, you should probably
24 pull that slide. That is proprietary material and we
25 are in an open session.

1 DR. CRONENBERG: Okay. Sorry. And a lot
2 of this information is also proprietary. All right.
3 Summary and observations to date. Safety margins are
4 used in a very broad sense and in the regulatory
5 process.

6 And there is a lot of difficulty in
7 getting consistent data to assess the margin impact.
8 Different models change, and things that are looked at
9 change from one update to another.

10 There was some success nevertheless from
11 Hatch, and that's why I titled my talk "Signatures of
12 Margin Estimates and Margin Reductions." We get some
13 sign posts here and there of what is going on but we
14 don't have a good integrated assessment of what the
15 margin impact is for that whole plant.

16 You can't tell if it is a synergy and you
17 get it for a piece of pipe or a bolt, or something,
18 but it is not the plant as a whole. Generally though
19 as you might expect from the start before we even
20 looked at this, that there is some reduction in
21 margins because you increase power and you increase
22 LOCA based stresses.

23 And you increased pressures and
24 temperatures on piping and that sort of thing. So
25 there is some indication of a degradation in margin

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1 from design limits.

2 And also I believe the SARs, and what we
3 are requiring in the SARs and the SERs do not appear
4 to be of sufficiency, detail, and consistency to make
5 a good assessment of a margin impact on this
6 particular licensing action.

7 I think that the data is too sketchy to
8 give you a good feeling for margin. Basically you
9 will see in the SER and what -- and basically all the
10 agency is required to do is to assess the current
11 regulations are satisfied. That is what we regulate.

12 The kinds of concerns that this committee
13 has, you go, well, will we be caught in the Maine
14 Yankee situation, and you look at it in a little
15 broader sense.

16 What is the real safety impact, and so the
17 questions asked by this committee are probably a
18 little different than the questions asked by the
19 staff.

20 And to answer the questions that the
21 committee has asked me to look at is -- well, you
22 can't get a clear answer as to that. I do have some
23 suggestions on power uprates, and these are
24 observations, personal observations and suggestions
25 that tell me what should be asked for.

1 Basically, the NRC uprate review process
2 centers on the assessment of current regulatory
3 requirements are satisfied. There is no requirements
4 for risk impact, margin reductions, or impact of
5 multiple licensing actions and synergies.

6 It is just that the current regulatory
7 requirements are satisfied, and that is rightly so
8 what the staff should be looking for. Nevertheless,
9 I endorse prior recommendations from the Maine Yankee
10 lessons learned report.

11 You know about the Maine Yankee history
12 here, and one of the principal conclusions of the
13 lessons learned was that we need a standard review
14 plan. We need some sort of guide post, and the G.E.
15 uprate and extended power uprate is one step in that
16 direction.

17 And basically for the PWRs, the last thing
18 we had on the power uprates was for guidance, and we
19 never had a guidance from CE, and we never had
20 guidance from BWR, and we only have a W-Cap report
21 from 1984 for the Westinghouse.

22 And that is the last time that we had
23 guidance come in from vendors on what it takes to do
24 a power uprate for a PWR. PWRs still follow the W-Cap
25 guidance from 1984 that Westinghouse provided, which

1 is a very minimal -- it is like a 10 page report. It
2 just lists the kinds of things that you might look at.

3 Also, Scitech did a review for research,
4 or it was for NRR or research, but it was a contractor
5 report, and to do a review of the uprate applications
6 to that time, and the Scitech conclusion also
7 concluded that this agency would be better served if
8 it had a standard review plan.

9 It looked at large variances for one
10 upgrade application to another, and the review
11 procedures, and there was no clear definition of
12 acceptance criteria, and why you looked at this
13 control rod drive.

14 In one case, you didn't look at control
15 rod drive calculations, and on another you looked at
16 fuel behavior effects, and on another you did not.
17 Scitech's conclusion was basically that there was no
18 clear guide posts for a review of uprate applications.

19 And they also endorsed a standard review
20 plan, and the same with my 1999 recommendation, I also
21 thought that this agency would be better served if it
22 had a standard review plan in place for power uprates.

23 DR. LEITCH: In spite of all those
24 recommendations, we seem to be moving forward without
25 such a standard review plan.

1 DR. CRONENBERG: Partly because most of
2 them, I guess, are for G.E. so far, and G.E. is ahead
3 of the other plants.

4 DR. LEITCH: Yes, but the recommendations
5 stemmed largely from Maine Yankee, which -- and as you
6 said, it is more applicable to BWRs.

7 DR. CRONENBERG: Again, an uprate standard
8 review plan might include a standardized listing of
9 all system structuring and components subject to an
10 uprate review. It kind of mirrors the kinds of things
11 that we have in a license renewal application.

12 Assessment of impact on system structures
13 and component margins for both operational and DBA
14 conditions. A clear definition of methods to be used
15 and acceptance criteria that the staff will review
16 that application.

17 That is the kinds of things that we have
18 in the license renewal application. We don't have a
19 clear definition of, for example, acceptance criteria
20 for the staff to review.

21 We have input from G.E. on what they will
22 submit, but do we have a clear definition that this
23 committee is comfortable with as far as acceptance
24 criteria for the review of that application.

25 I also talked about something that I

1 called the legacy tables, and it is some sort of time
2 line or history of what is happening with that plant
3 as you go on in time, and as you uprate power.

4 Right now we don't have that a licensed
5 application for an uprate will include what was on the
6 prior power, and what was on the original FSAR, and
7 what changes were made as far as fuel burnup, and how
8 that might have impacted the same components, and
9 structures, and systems that are impacted by the power
10 uprate.

11 And a standardized table for DBA predicted
12 loads. We do have these kind of standardized formats
13 that one has to follow in our license renewal process.
14 We don't have it for the proper uprate process.

15 So that is basically what I wanted to say
16 about margins, and then I have a second talk that I
17 was asked to do on looking at uprates, and past uprate
18 applications, and events that occurred for plants that
19 had received uprate approvals.

20 And so are there any questions at this
21 point on margins? Now, this work I did back in '99,
22 and again I was asked to review uprate applications
23 and see if there was a potential synergistic safety
24 issue.

25 And the way I approached that is that I

1 looked at operational events for uprated plants. I
2 will review some of those applications and NRC review
3 procedures, and altered plant conditions, events noted
4 for uprated plants, potential synergistic safety
5 issues, and observations and recommendations.

6 And some of this I guess I can skip here.
7 These are the uprate applications up until the early
8 or mid-1990s. I think there was something like 21
9 uprates, and most of them are 4 or 5 percent power.

10 Those are the kinds of applications we
11 used to see in the mid-1980s and early '90s.

12 DR. FORD: You have Oyster Creek there and
13 there are three really quite big ones. Any reason why
14 those are big ones and how they got through at that
15 time?

16 DR. CRONENBERG: Well, Maine Yankee was
17 one, and Indian Point.

18 DR. FORD: Indian Point was PWRs and that
19 was 10 or 11 percent?

20 DR. CRONENBERG: Some of them, and I am
21 not sure, because it has been a while, Peter. But
22 some of them were asked to go to a certain power
23 level, even though the design base or the FSAR
24 calculations were all based upon higher power levels.

25 And I would have to go back and look and

1 see which of those plants were, but some of them --
2 all the FSAR calculations were done at a certain power
3 level, and their original operating license was for a
4 lower power level than their design basis
5 calculations, and they are allowed to step up to
6 those.

7 DR. BOEHNERT: Certainly Oyster Creek was
8 one of those, and I bet you that the other two were as
9 well. Indian Point was the other one, and Maine
10 Yankee.

11 DR. CRONENBERG: I don't need to go
12 through that plant. Okay. What I am going to
13 concentrate on are the power uprate events. Now,
14 maybe I shouldn't use this term, but these events that
15 happened for power uprated plants, whether they were
16 due to the uprate or something else.

17 It is not always an easy story to pick
18 out. The first one you know about, the Maine Yankee
19 one, and that went for two power uprates. There was
20 a deliberate faulty LOCA analysis submitted by the
21 licensee that involved the critical heat flux and
22 alteration of the decay heat models.

23 It was a whistle blower type of notice
24 that came before the agency. The whistle blower went
25 to the State Agency, and the State Agency came to the

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1 NRC after the uprates had been approved. There was
2 two of them.

3 Both incorporated faulty analysis, which
4 was not caught by the NRC and only after we received
5 insider information from the whistle blower.

6 Wolf Creek and North Anna, both of those
7 had uprates, and there were control rod insertion
8 problems noted in high power hot, and high burn up
9 assemblage. And we will go through that.

10 There was the Callaway and Susquehanna,
11 which were pipe ruptures, and a long history of all
12 kinds of pipe ruptures in nuclear power plants, and I
13 will go through some of that.

14 Brunswick was a faulty use of DBA
15 criteria, and then we have Limerick instability
16 problems. Okay. In Maine Yankee, we had allegations
17 of a deliberate faulty LOCA analysis submitted by the
18 licensee.

19 The DBA declared limit of 2,200 was
20 exceeded for uprate conditions, and the LOCA analysis
21 was performed for altered decay heating critical flow
22 models.

23 The NRC did not question the licensee's
24 analysis, and there was no really audit calculations
25 using our own audit codes of the licensee submittal.

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1 However, after the allegation was submitted to the
2 agency, we did an internal study and we verified that
3 indeed there was a faulty analysis submitted by the
4 licensee.

5 Maine Yankee was shut down and never
6 operated again. The lesson learned from Maine Yankee
7 was a need for independent staff analysis or audit
8 calculations, some of which Ralph talked about this
9 morning, and that the NRC at this time is aggressively
10 doing some audit calculations for these type of power
11 uprates, and which was not done during the time frame
12 of the Maine Yankee.

13 DR. LEITCH: Just one point of fact. When
14 you say it was shut down and never operated again, it
15 was reduced to the pre-uprate power level and did
16 operate at that power level for quite some time.

17 DR. CRONENBERG: Okay.

18 DR. LEITCH: And for quite some time I
19 mean a year perhaps.

20 DR. CRONENBERG: A year, and then they had
21 to upgrade their ECC and they decided not to do it for
22 one reason or another and the plant was shut down.

23 DR. UHRIG: I thought it was steam
24 generators.

25 DR. LEITCH: There were a number of

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1 issues.

2 DR. CRONENBERG: And I think that the
3 injection system was not adequate for the LOCA.

4 DR. LEITCH: Yes.

5 DR. CRONENBERG: Wolf Creek and North
6 Anna. Wolf Creek had a --

7 MR. ROSENTHAL: Can I just interrupt for
8 just a moment, please. Jack Rosenthal. I was on the
9 Maine Yankee independent safety assessment, and I led
10 the team at Yankee Atomic while most of the team was
11 up at Maine Yankee.

12 And we reviewed all different sorts of
13 analyses, the higher scope of Chapter 15 analyses, and
14 were generally satisfied with a broad range of
15 analyses.

16 And I believe, or from what I understand,
17 that the reason that Yankee did not ultimately
18 continue operation were questions concerning its steam
19 generators, and it had done a hundred percent plugging
20 of the sleeving of the steam generators.

21 And they were faced with a financial
22 question about replacing the steam generators, and
23 cable separation issues that dated back a long period
24 of time, and they were faced with a large cost of
25 replacing the steam generators.

1 It was in a State in which there had been
2 referendums in the past on whether the plant would be
3 allowed to run a lot. So there was a great deal of
4 financial uncertainty associated with the plant, and
5 so they made a business decision to shut down the
6 plant.

7 And in fact if it was only the LOCA
8 analysis, that would have been readily overcome by
9 either them doing the analysis or going to still a
10 third party.

11 And their large break LOCA analysis was
12 always a combustion evaluation model. It was a small
13 break LOCA issue. So I think in the characterization
14 of Yankee, it would be fair to say that they
15 ultimately made the decision to shut down the plant
16 for commercial reasons.

17 DR. CRONENBERG: My point was that the
18 small break LOCA calculations were submitted, and we
19 accepted them, and then after we had the allegation,
20 we audited those calculations and found that, yes,
21 indeed the models were altered.

22 And we didn't catch that in the review,
23 and that was my main point. The Wolf Creek and North
24 Anna, we had an uprate in 1996, and this is PWR plant,
25 with Advantage 5H type of fuel assemblies, and

1 basically they had a control rod insertion problems
2 for the high power, high burn-
3 up assembly, and basically the thimbles swelled due to
4 irradiation growth mode, and then the control rod
5 couldn't be placed down into those thimbles again.

6 I would like to read you what was -- well,
7 because it happened in high power, high burn-up
8 assemblies, it could have been reviewed as part of the
9 power uprate application and I just wanted to read
10 here what was in the SER on the control rods.

11 The only thing that was looked at was the
12 control rod drive mechanisms as far as the
13 documentation of the review. The licensee evaluated
14 the adequacy of the control rod drive mechanisms by
15 comparing the design basis input parameters with the
16 operational conditions for the proposed uprate.

17 The licensee stated that he uprate
18 conditions would have an insignificant impact on the
19 original design basis analysis for the control rod
20 drive mechanism.

21 The staff has reviewed the licensee's
22 evaluation and concurs with the licensee's conclusion
23 that the current design of the control rod drive of
24 the control rod drive mechanism would not be impacted
25 by the uprate.

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1 That is the only thing on control rods
2 themselves, and at least from the review procedures
3 the thimbles the irradiation growth. There is nothing
4 telling me in here, and it just says the staff
5 reviewed the licensee applications.

6 I had no idea of what the acceptance
7 criteria of that is. It just said we reviewed it and
8 find it acceptable. I think with a little more
9 tightened review procedures, where we define what the
10 acceptance criteria are, just like we do on a
11 construction application.

12 And that we would be better served, and
13 that the staff will have a better guidance as to what
14 is acceptable and what isn't acceptable. So we had an
15 incident at Wolf Creek, and all you can say that it
16 did happen, and with the high power assemblies it
17 might have been a review question, but we looked
18 mostly at the control rod drive mechanism.

19 We didn't say anything about irradiation
20 and induced swelling of zurcoroid guide thimbles. And
21 maybe if we had a standard review plan we would say
22 that this is what you have to look at, and these are
23 the kinds of calculations that you have to make with
24 fluence.

25 And you have to monitor and this is the

1 acceptance criteria, and you shall not have such
2 swelling, and so forth, and so on. On North Anna, we
3 had -- and this is again a PWR, and we couldn't insert
4 new rods into assemblies that were being stored in the
5 spent fuel pool.

6 They tried to bring in some new control
7 rods, and insert them into the assemblies that they
8 had in the spent fuel pool, and those guide thimbles
9 were also warped, and we couldn't temporarily store
10 the new control rods into those assemblies.

11 Neither uprate SER addressed changes in
12 fuel rod or control rod performance for high burner,
13 high power conditions. The lesson learned here again
14 is that maybe we need something -- a tighter review
15 process for power uprates.

16 Okay. Pipe ruptures. We talked about
17 corrosion and erosion problems, flow assisted
18 corrosion. We had many pipe ruptures. We have 53.
19 There is an IPEEE report, a detailed IPEEE report on
20 pipe ruptures, and we have 53 pipe rupture events for
21 pipings greater than 2 inches in diameter.

22 Most of those were attributed to an
23 erosion/corrosion mechanism as Peter noted this
24 morning, and erosion is a flow, a flow synergism, and
25 corrosion is an aging phenomena, and here we have a

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1 synergism or a linkage with enhanced degradation of
2 flow assisted corrosion process.

3 Empirical evidence for flow/aging effects,
4 lessons learned, is a need for a staff review of
5 potential synergisms, and this is --

6 DR. FORD: The 53, is that 53 between how
7 many plants?

8 DR. CRONENBERG: I have a table coming up
9 on that. Basically, I just took that from an EPRI
10 report. It is not anything that I did.

11 Nucleonics Week. I just wanted to talk
12 about the Susquehanna shutdown, and this just came up
13 this morning, and there were some statements that it
14 was more than just maybe a flow associated vibration
15 effect.

16 But I just wanted to quote the headlines
17 from Nucleonics Week with respect to Susquehanna. "A
18 recent Susquehanna-2 forced outage could be the result
19 of weld fatigue from increased vibrations from a power
20 uprate in 1995, and NRC is looking at potential
21 generic implications for other uprated BWRs."

22 "BWR uprates have increased the speed of
23 recirculation pumps and caused increased vibrations in
24 the recirculation systems, said the NRC resident
25 inspector at Susquehanna."

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1 The reason that I put this slide up is
2 that this is the only time that I see anyone really
3 stating what they believe is a direct linkage between
4 an uprate and a pipe rupture.

5 MR. KLAPPROTH: This is Jim Klapproth with
6 G.E. I would like to comment on that. We saw that
7 article come out and we do not agree with that
8 position. Really, there was an increase of flow, and
9 Susquehanna moved to an increased core flow
10 concurrently with the power uprate, but it was not
11 specifically a power uprate issue. It was increased
12 core flow.

13 DR. CRONENBERG: Okay. But the --

14 DR. FORD: Well, 53 is an astounding
15 number.

16 DR. CRONENBERG: And 53 isn't just from
17 flows. I put this up because this was a statement by
18 an NRC official that an event, an LER to uprate.

19 MR. KLAPPROTH: I understand, but I would
20 just like to go on record as saying that G.E. does not
21 agree with that position.

22 DR. CRONENBERG: I understand, but you do
23 agree that it was a flow enhanced flow, but the flow
24 was not dictated by the power uprate?

25 MR. KLAPPROTH: It was not due to power

1 uprate, yes.

2 DR. CRONENBERG: And here is a piping
3 rupture mechanisms through 1995, and basically EPRI
4 did this for the Swedes. The Swedes wanted some
5 information on pipe ruptures, and what are the
6 mechanisms.

7 And so they did it for a range of piping
8 sizes. It was according to small piping, larger than
9 2 inch piping and that sort of thing. Erosion and --

10 DR. LEITCH: This surely isn't primary
11 system.

12 DR. CRONENBERG: No, this is all piping in
13 the plants.

14 DR. LEITCH: This is piping in nuclear
15 plants that ruptured?

16 DR. CRONENBERG: Yes. And the EPRI report
17 is a real detailed report on pipe ruptures in nuclear
18 power plants, but you can see the highest here for
19 vibrational fatigue and erosion/corrosion, both of
20 which one might expect vibrational fatigue for
21 increased flows, and erosion/corrosion for higher
22 powers and higher flow rate that might accompany a
23 power uprate.

24 To me, this indicates that most from our
25 experience to date, that most of our ruptures for

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1 large piping, and this is 2 inch and above piping, are
2 for kinds of phenomena that we would see in an uprate;
3 vibrations due to flow, and flow assisted corrosion.

4 DR. KRESS: If I have got a hundred plants
5 out there, and I look at vibration frequency, and
6 there is one a year?

7 DR. CRONENBERG: Yes, one a year.

8 CHAIRMAN WALLIS: I am trying to relate to
9 your previous thought. You said it was erosion
10 problems, and presuming it was carbon steel pipes,
11 right?

12 DR. CRONENBERG: Yes.

13 CHAIRMAN WALLIS: And yet you said there
14 were 53 events of erosion/corrosion of carbon steel
15 plants.

16 DR. CRONENBERG: Well, 53 events for pipe
17 ruptures greater than two inches. That could e all
18 types of ASME type designations of all kinds of
19 piping. Basically, it is steel piping, but 53 large
20 pipe breaks. Now, on this slide --

21 DR. LEITCH: And worldwide presumably,
22 because you have a foreign plant listed there.

23 CHAIRMAN WALLIS: That's right.

24 DR. CRONENBERG: Yes.

25 DR. KRESS: And if I add up all of those

1 listed over there, I don't get 53.

2 DR. CRONENBERG: This is just the
3 breakdown of where you see these breaks, okay?

4 DR. KRESS: But those are just U.S.
5 plants.

6 DR. CRONENBERG: I have to go back. I
7 don't know if they are just U.S. plants, Tom. I have
8 to go back into the EPRI database. They did it for --
9 I can get you a copy of that. They did it for the
10 Swedes. It might have included other plants.

11 DR. KRESS: But if you add it up and
12 multiple it by a hundred plants, it doesn't add to
13 very many.

14 DR. CRONENBERG: No.

15 CHAIRMAN WALLIS: Three a year.

16 DR. KRESS: I forgot about multiplying it
17 by the number of years.

18 DR. FORD: Previously, you said that
19 Callaway and Susquehanna, and I assume you are
20 referring to erosion/corrosion problems in the carbon
21 steel pipeline, and you said Guillotine pipe failures?

22 DR. CRONENBERG: Yes. Well, no. Did I
23 say Guillotine?

24 DR. UHRIG: Yes, you did.

25 DR. CRONENBERG: Sorry. Susquehanna was

1 not a Guillotine. Susquehanna was on a line to the
2 recirculation system. Callaway was a large pipe --
3 somehow will have to help me. Do you know what the
4 Callaway was again? I will have to go back and give
5 you an answer on Callaway.

6 DR. FORD: Maybe you could relate to how
7 many gallons per minute you are losing in heat.

8 DR. UHRIG: It is Callaway and Susquehanna
9 guillotine pipe rupture.

10 DR. CRONENBERG: Yes, Guillotine should be
11 out of there. And in the DBA analysis of the wet weld
12 design limit is 220 and NRC did not challenge the
13 licensee's evaluation at 220. However, the real
14 number should have been 200.

15 So it was just an oversight that got
16 through, and the licensee then came back and said,
17 sorry, it should have been 200 and not 220. It is
18 just an example of something that we didn't catch.

19 Where if we had a more detailed or
20 checklist, and again I am trying to say that we would
21 be better served if we had a tighter process, a
22 standard review plan, and maybe these kinds of numbers
23 would be in there, and we would not have been caught
24 in this type of situation.

25 And where we didn't catch it and the

1 licensee had to come back and say that we didn't catch
2 it, and you didn't catch it, and we did catch it.

3 And then Limerick, and we have these --
4 well, when we restart, we have these instabilities
5 that we see for BWRs, where the predicted Delta-K over
6 K is different from the measure, and it gives the
7 operator a little bit of heartburn when he sees that.

8 And then we have to back off on power, and
9 then find out what was wrong with our calculations,
10 and then start up again.

11 DR. UHRIG: I didn't understand that. They
12 are not determining a design limit are they?

13 DR. CRONENBERG: Which one do you have
14 questions on?

15 DR. UHRIG: On Brunswick. You had
16 licensee based on wet weld design limit of 220, and
17 NRC did not challenge the 220. I thought the NRC
18 would set the limit.

19 DR. CRONENBERG: In the FSAR, the design
20 limit for the wet weld for that plant was 200 degrees
21 F. The analysis was based at if the design limit was
22 220, and it was submitted by the licensee.

23 We believe that our design limit for a wet
24 weld is 220, and NRC went and said, yes, we reviewed
25 the application, and you are below 220. It is fine.

1 A couple of months later, the licensee came back and
2 said, oh, sorry, I told you the wrong number for the
3 design limit. The design limit was 200.

4 What I gleaned from looking at some of
5 these LERS, license events for uprated plants besides
6 the generic implication of a need for a tightened
7 review process, and a standard review plan, is that
8 maybe there are synergisms.

9 For example, rod fretting, and flow
10 induced rod vibration, leading to contact wear with
11 adjacent structures, and increased core flow at
12 uprated powers, and zry-irradiation growth. We know
13 that there is irradiation growth, which may lead to
14 some fretting problems.

15 Axial power offset. We know about the
16 axial power offset problem, and boron added to
17 compensate for excess reactivity for high burn up and
18 high enrichment, crud buildup for long fuel duty
19 times. And boron is gettered.

20 There seems to be evidence of boron
21 gettering by the crud, and we have an axial power
22 offset. The effect is compounded, and it seems to be
23 the evidence that it is compounded at high-power core
24 locations.

25 DR. UHRIG: Where is that evidenced? I

1 have not heard that before.

2 DR. CRONENBERG: The boron?

3 DR. UHRIG: No, the effect that it is
4 compounded by high-power.

5 DR. CRONENBERG: Mostly, they find it at
6 the high-power central locations and don't find it at
7 the lower power assemblies. It is something that we
8 look at for high burn up assemblies.

9 Other synergisms, and Jack talked about
10 these, and looking at cable degradation, insulation
11 breakdown due to irradiation effects, and that is
12 exacerbated by elevated temperatures.

13 We do have cable aging type of things in
14 our license renewal requirements. However, if we are
15 talking about higher temperatures for power uprates,
16 and for plants that are 30 years old, maybe we should
17 be looking at those sort of things on power uprates,
18 too.

19 And so forth and so on. And of fluid
20 mechanical components, and degradation of elastomers
21 at higher temperatures, and those are the kinds of
22 things that maybe if we had a more detailed assessment
23 of the impact of power uprates on a checklist, or a
24 standard review plan, we might need to look at it.

25 So I had some recommendations which are

1 not too dissimilar from looking at margins, and
2 looking at licensee event reports, and current
3 application review processes, and reevaluation of
4 design basis conditions, and uprated conditions, and
5 there is essentially no requirements to look at
6 synergistic effects.

7 We review based upon current regulatory
8 requirements. Events show indirect evidence of
9 potential synergisms, and the agency, I believe, would
10 be better served if we had a standard review plan for
11 power uprates for BWRs.

12 And G.E. goes a long way to that goal, and
13 the NRC needs to do something on acceptance criteria,
14 I believe, for the PWRs. It has been a long time
15 since a licensee or a vendor did anything on power
16 uprates, and basically we are still dealing with the
17 1984 W-CAP report. And that is basically all I want
18 to say.

19 DR. LEITCH: Gus, your third bullet down
20 there says that that standard review plan for power
21 uprates is in progress. These slides are a couple of
22 years old. Is that still true?

23 DR. CRONENBERG: The standard review plan
24 is still an on-the-burner sort of issue that -- well,
25 at this point, the agency is not doing a standard

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1 review plan, and maybe the staff can answer that.

2 CHAIRMAN WALLIS: Did you have a comment
3 on that, Ralph?

4 MR. SWAYBE: This is Mohammed Swaybe
5 again. No, we are currently pursuing a standard
6 review.

7 DR. KRESS: I am intrigued by your bottom
8 bullet, and intrigued by the fact that you added QHO
9 in parentheses there. Do you have any ulterior motive
10 for that?

11 DR. CRONENBERG: I just put that in for
12 you, Tom.

13 DR. KRESS: Thank you. I appreciate that.

14 DR. CRONENBERG: We don't have any
15 requirements for license renewals particularly, but
16 anyway something about that. PRAs can give you --
17 well, you know, you believe in PRAs, and it gives you
18 some sense of a holistic integrated assessment of what
19 things are.

20 We talked about a raw risk aversion LERF,
21 and not a risk aversion LERF for a component, but a
22 risk aversion LERF for a system, and all these issues
23 are before the ACRS. And some thinking needs to go
24 into how we get a better assessment of how systems
25 behave as a whole, rather than components, or how the

1 plant behaves as a whole.

2 DR. KRESS: You know, the reason that I
3 wanted that QHO over there is you are actually talking
4 about power uprates, and you ought to refer back to
5 the QHO itself rather than LERF, because what we are
6 doing is changing the source term.

7 And LERF is dependent on the source term,
8 and of course I think there is enough site dependence
9 of things that we really ought to revert back and see
10 what we are really doing instead of using LERF.

11 DR. CRONENBERG: Well, maybe we should
12 like at something like a QHO, and the source term is
13 changing, but core damage frequency doesn't tell you
14 always the whole story as you know. It doesn't tell
15 you anything about consequences.

16 DR. KRESS: And I don't think that LERF
17 tells you enough of the whole story.

18 DR. LEITCH: I have heard a couple of
19 times today that the G.E. topical reports are to
20 perhaps stand in place of the standard review plan.
21 Yet, there are a number of the issues that you talk
22 about here as being potential effects that are really
23 behind G.E.'s scope of supply; electrical cables, and
24 cement control systems, and so forth.

25 So I guess I just don't understand that.

1 Also, I don't understand why the real recommendation
2 coming out of Maine Yankee is that there be a standard
3 review plan for power outrates, and why aren't we
4 doing that.

5 You know, we are looking at a whole bowel
6 wave of power uprates here, and what are we going to
7 do to them? Is it on an individual basis, and looking
8 at them as though each one is a new case?

9 Isn't there some benefit that could be
10 achieved by having a standard review plan, rather than
11 considering each one as a separate issue?

12 MR. SWAYBE: This is Mohammed Swaybe
13 again. I can't speak too much on a standard review
14 plan, but I know that was considered and right now we
15 are not pursuing a standard review plan.

16 However, as far as future power submittal
17 applications, and what we are doing, and the ones that
18 are ongoing right now, for the major extended power
19 uprate applications, we are considering the Quad
20 Cities, Duane Arnold, Dresden, as first of a kind.

21 We are going through those and we will be
22 having a public workshop after the completion of
23 those. We are also going to be looking for ways to
24 get information out to industry, in terms of how they
25 should be submitting these applications, and format,

1 and getting the information that we need out to
2 industry so that they know what to submit.

3 It is not a standard review plan, but it
4 will provide some guidance.

5 CHAIRMAN WALLIS: What form will it take
6 then?

7 MR. SWAYBE: I am not sure at this point.
8 We are considering several options. It may be a RIS,
9 and it may be through workshops, and it may be through
10 webpage. We are not really sure at this point.

11 DR. LEITCH: It just seems to me that we
12 all learned some pretty painful lessons at Maine
13 Yankee, and we are kind of flying in the face of that
14 experience.

15 MR. SWAYBE: I think one of the
16 recommendations may have been a standard review plan,
17 but there have also been some other lessons learned.

18 And I remember in working in the reactor
19 systems branch that there was guidance given down to
20 the reviewers, in terms of the kinds of things to look
21 for that came out of Maine Yankee.

22 I mean, there was more than just a
23 standard review plan recommendation for that. There
24 were some letters that came down from management that
25 said that this is what we learned from Maine Yankee,

1 and be sure that you are looking for this kind of
2 information when you do your reviews.

3 DR. LEITCH: Yes, that is good for those
4 specific things, but what I am saying is that the way
5 that we improve is by institutionalizing some of this
6 experience, and capturing it, and getting smarter as
7 we go along; a little bit like we have done in the --
8 well, at least I think we have done and are maybe
9 continuing to do in the license renewal process.

10 But here it seems like we are starting
11 each one kind of with a blank sheet of paper.

12 MR. SWAYBE: Well, I think on the first
13 few that you are probably right. We do think of them
14 as first of a kind, the first few. You know, 15 or 20
15 percent. But I think after that, that you will see
16 that we will provide some guidance and hopefully
17 things will be a little more standard.

18 CHAIRMAN WALLIS: This will be a sort of
19 lessons learned from Duane Arnold, Dresden, and Quad
20 Cities.

21 MR. SWAYBE: Okay.

22 CHAIRMAN WALLIS: Anything else? If not,
23 it is probably better if we take our break now before
24 we hear from G.E. so we don't interrupt your
25 presentation.

1 Well, I guess we will do your introduction
2 first and then we can take our break. Let's do that.

3 DR. FORD: Mr. Chairman, I have to say
4 that I have a conflict of interest here, being an ex-
5 G.E. member, and as I understand the rules of the
6 game, I am allowed to comment, but not judge.

7 DR. KRESS: Only on factual matters and
8 not expressing opinions.

9 CHAIRMAN WALLIS: You can ask questions
10 and we can judge the answers. It would be very useful
11 if you would ask the right questions. So let's
12 proceed with the open part of G.E.'s presentation.

13 MR. KLAPPROTH: Okay. My name is Jim
14 Klapproth, and I am the manager of engineering and
15 technology in San Jose, and I would like to thank the
16 committee for an opportunity to come and give an
17 update from our perspective on power uprate.

18 We have not been in front of this
19 committee since 1998, and I think that as we have seen
20 here there is a lot that has transpired in the last 2
21 to 3 years, especially with the extended power uprate
22 sitings.

23 And it is very timely for us to have an
24 opportunity to have this discussion. I have two ot
25 her individuals here with me that I would like to

1 introduce.

2 Israel Nir is on the far left, and he is
3 the power uprate process project manager at G.E., and
4 he will be speaking primarily about the constant
5 pressure power uprate approach, which I believe the
6 committee has had an opportunity to at least look at.

7 And also to my immediate left is Gene
8 Eckert. Gene is the engineering fellow for transients
9 and reactor systems control, and he will be speaking
10 primarily to a lot of the issues that have come up
11 today relative to the special topics and synergistic
12 effects.

13 As an aside, I would like to note that
14 this is Gene's 65th birthday today, and I couldn't
15 think of a better present than to have him here today.

16 So, anyway, I will run through a quick
17 introduction here. We will have some opening remarks
18 and then I will turn it over to Gene to kind of go
19 through an introduction and give you a little history.

20 We have heard a lot today about the G.E.
21 topical reports. I want to step through the five
22 percent stretch power uprate, and then move to the
23 mid-1990s and to the extended power uprate in the 5 to
24 20 percent uprate.

25 The third step in our progress has been

1 the thermal-power uprate program, or thermal-power
2 optimization, which takes advantage of the improved
3 water flow on certain need characteristics so we can
4 realize a 1-to-1-1/2 percent power uprate.

5 And then finally the constant pressure
6 power uprate, which we will focus on. Then we would
7 like to go into closed session and really get into
8 more details and specifics about what the impacts of
9 power uprate are.

10 And before I turn it over to Gene, just a
11 couple of opening remarks, and basically these five
12 bullets are the key messages of our presentation.
13 First of all, there has been an extensive amount of
14 experience with extended power uprates.

15 And there are five plants, and it says
16 four here, but there are four utilities, and actually
17 five plants that are currently operating under
18 extended power uprate conditions; three domestic and
19 two overseas.

20 And in addition, we have completed the
21 analysis and it is currently under staff review, of
22 power uprate programs for an additional five plants.

23 DR. KRESS: Who reviewed the overseas
24 plants?

25 MR. KLAPPROTH: KKL.

1 DR. KRESS: Was their review as extensive
2 as the ones that our staff does?

3 MR. KLAPPROTH: I believe so, yes.

4 DR. BOEHNERT: Were those 20 percent or
5 higher uprates? What was the uprate on those?

6 MR. KLAPPROTH: I think it was 117.

7 MR. ECKERT: KKL did a five percent
8 somewhere to our original uprates, and then they did
9 this additional 14-1/2 percent. So they are close to
10 120. And the KKM plant is up around 114, above the
11 original.

12 DR. SCHROCK: Is that the way that you
13 calculated it; that it is based on the percentage of
14 the original?

15 MR. ECKERT: That is the way of keeping it
16 in our books for sanity since they are going in
17 different steps here, yes. These are the numbers that
18 they give you and they are right around 119.
19 something. They are not above 120 from originally.

20 They were 104.2,. and then 114, or
21 something like that.

22 CHAIRMAN WALLIS: And was that the
23 Leibstadt one?

24 MR. ECKERT: Yes, that was the Leibstadt
25 one, the bigger one, yes. A bigger uprate.

1 MR. KLAPPROTH: In fact, I think we have
2 a chart later in the presentation.

3 MR. ECKERT: We have information from
4 their program.

5 MR. KLAPPROTH: The second major bullet,
6 we have had a lot of discussion today about margins,
7 and from our perspective, the safety margins are
8 maintained.

9 And both Ralph Caruso, who I think back in
10 December when he was in front of this committee, the
11 deterministic licensing criteria are maintained for
12 power uprate. There is no request for any relaxation
13 of the deterministic licensing criteria.

14 In other words, we believe that all the
15 safety margins are maintained. I think a lot of the
16 discussion we have been having previously is relative
17 to performance margin, and operating margin, and there
18 is a slight impact in some cases on operating margin,
19 and we understand that.

20 And relative to safety margins, we believe
21 that there is no impact on safety margins for power
22 uprates, especially under the constant pressure power
23 uprate approach, which is a no pressure increase.

24 And you will see as we go through the
25 presentation in the closed session the impact on plant

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1 systems, and on plant response to events, such as
2 design basis accidents, and transients, is fairly
3 benign relative to prior pressure increase power
4 uprates.

5 So again we believe that the safety
6 margins are not impacted for extended power uprates.
7 and power uprates.

8 DR. CRONENBERG: When you say that, what
9 about, for example, like the feed water line? Do you
10 view that as a non-safety impact, and design loads,
11 and even the operating conditions are higher flow
12 rates and higher temperatures on the feed water lines.

13 MR. KLAPPROTH: We have a specific
14 example, and we will discuss that in the closed
15 session, but basically our position will be that as
16 long as you stay under the 1250 limit, anything
17 underneath that is additional margin over and above
18 the safety margin.

19 DR. CRONENBERG: Okay. So you are
20 defining safety margin as anything above the design
21 limit?

22 MR. KLAPPROTH: Exactly. And I believe
23 that is consistent. I think if we go back 10 years,
24 I believe -- and, Tony, you can help me on this, but
25 in the improve tech spec role, I think NEI and others

1 took a very close look at what the definition of
2 safety limits and safety margins are.

3 And I think there was some guidance put
4 together by NEI which was accepted by the staff on
5 what the definition of safety margin is relative to
6 operating margin.

7 MR. ECKERT: And all the appropriate code
8 equations were checked again for the new operating
9 conditions, and any temperature change that took
10 place, and the flow changes that took place, and in
11 compliance with all the appropriate code equations for
12 the piping was done for each small uprate or big one.

13 DR. CRONENBERG: So when we see something
14 in an SAR that says the safety margin is not changed,
15 what we are really talking about is that you are below
16 the design limit?

17 MR. KLAPPROTH: Right.

18 CHAIRMAN WALLIS: Could you say more about
19 Bullet 3?

20 MR. KLAPPROTH: The constant pressure
21 power uprate bullet?

22 CHAIRMAN WALLIS: Yes, without getting
23 into something which is proprietary. It is not just
24 constant pressure. You get your power uprate by
25 flattening the power distribution of the core without

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1 changing to the maximum temperatures and all those
2 things which -- well, if you had just taken and raised
3 the power everywhere, you would be changing those
4 things.

5 But you have done some clever engineering
6 to keep other things constant other than just
7 pressure. Can you talk about those now or is that
8 something that is more proprietary?

9 MR. KLAPPROTH: I think we would prefer to
10 talk about that in the closed session.

11 MR. ECKERT: Well, on the pressure side,
12 we control pressure independent of power. I mean,
13 they interact, but we have a pressure controller that
14 keeps the pressure where we want it, and that this
15 plan for our uprate, we make sure that when we get to
16 the new higher power level that we have the same
17 reactor dome pressure that we had before.

18 CHAIRMAN WALLIS: Well, if we had that, it
19 would just draw out more water at the same pressure.

20 MR. ECKERT: Basically, yes. And we have
21 a control system that will hold it where we want it.

22 CHAIRMAN WALLIS: And you achieve that by
23 not -- without raising this sort of maximum fuel
24 temperatures and things like that. So there must be
25 some engineering done to distribute the load more

1 evenly across the core.

2 MR. KLAPPROTH: Well, we will talk about
3 that.

4 DR. KRESS: When you say constant
5 pressure, you are talking about the pressure in the
6 dome or --

7 MR. ECKERT: The reactor dome pressure,
8 yes.

9 DR. KRESS: Which means that you are
10 blowing more steam, and so the resistance between
11 there and the turbine has to be less?

12 MR. ECKERT: Well, it is built already.
13 The resistance is there, and so at the turbine, we
14 actually drop pressure a little bit at the higher flow
15 rates.

16 CHAIRMAN WALLIS: So you need an even
17 bigger flow rate to get the power uprate?

18 MR. ECKERT: We have to build the turbine,
19 and the MODs get a little tougher by holding this
20 pressure philosophy. But inside in the primary part
21 of our system, and the whole pressure boundary, it
22 becomes much simpler, and that is what we will talk
23 about.

24 DR. KRESS: Okay. We will wait until
25 then.

1 MR. KLAPPROTH: And in general, for
2 example, on the LOCA analysis, we will show that the
3 power uprate, really the effects of LOCA, the effect
4 of power uprate is very minimal on LOCA analysis.

5 CHAIRMAN WALLIS: And you still have the
6 vessel at the same pressure and so you make a hole in
7 it?

8 MR. ECKERT: It is the same sized pipes.

9 CHAIRMAN WALLIS: And that sort of
10 overview needs to come forward so that someone who is
11 looking in from the outside can understand how you
12 achieve it without it being too proprietary.

13 MR. KLAPPROTH: Okay. The fourth bullet,
14 the high volume EPU review request anticipated. There
15 was a question this morning on how many do we
16 anticipate over the next year or so.

17 Right now the staff has Dresden and Quad
18 Cities, and Duane Arnold reviews in progress. We
19 anticipate between now and the middle of next year
20 that there will be another five plants submitting for
21 power uprate, and extended power uprate applications,
22 using the constant pressure power uprate approach.

23 And beyond that our projections are over
24 the next several years that we would expect at least
25 another four plants per year coming to the staff.

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1 That's why we think it is appropriate to move to a
2 streamline approach, which is again linked to our
3 constant pressure power uprate.

4 And actually we will be meeting with the
5 staff tomorrow and getting the initial feedback on the
6 topical report that I believe the staff has seen on
7 our constant pressure power uprate, and hoping that we
8 would have a safety evaluation issue by the end of the
9 year.

10 DR. KRESS: Do you think we have reached
11 the limit of power uprates, or is there a potential
12 another round? How far can we go? I know that there
13 are different things that limit --

14 DR. SCHROCK: Isn't it limited by your
15 radial peaking? I mean, all you are doing is taking
16 advantage of the fact that the older plants are more
17 peaked, and now you are flattening it.

18 But there is a limit to what you can get
19 if you spread it uniformly --

20 MR. KLAPPROTH: Well, at this point, we
21 are really where we want to go at this point, which is
22 20 percent. We have not really looked beyond 20
23 percent in the NSSS environment to say what is the
24 next limit.

25 Ralph mentioned this morning a limit.

1 However, that is based on current licensing analysis,
2 and I think we have moved to more realistically track
3 the analysis, and we will find that we have some
4 additional margin that may allow us to go higher.

5 There may be some related issues that we
6 need to worry about when we go above 20 percent, but
7 we frankly have not done a study to say, well, we can
8 go to 129, or we can go to 142.

9 DR. KRESS: That is something that we
10 don't need to worry about right now. We are not faced
11 with that.

12 MR. KLAPPROTH: So, with that, I will turn
13 it over to Gene to walk through some of the background
14 information if there is no further questions.

15 CHAIRMAN WALLIS: I think it will be
16 interesting. Maybe it is not G.E.'s job to look at
17 one of these things and say with a pressure vessel,
18 and core geometry, what do you do to get more power
19 out of it, and presumably we circulate more water and
20 things like that.

21 And maybe you are not asking for it and so
22 you don't want to get into the details, but it is kind
23 of interesting for some HD student or someone to look
24 at one of these things and say, well, here are all the
25 things that we could do.

1 We could get a hundred percent more power
2 out or what, and I would be interested to see that.
3 Please go ahead.

4 MR. ECKERT: And we may be asked to answer
5 that question as good engineers by our managers. This
6 is a brief run through, and we have been with you
7 before, and especially connected with the extended
8 power uprate power program, and it is one of those
9 generic topical reports that were put together back in
10 June of '98.

11 We had some follow-up meetings with you in
12 July, answering some questions that you asked. It was
13 built off to 5 percent in an earlier program, and
14 keeping as Jim was saying the criteria for
15 acceptability of the plant was to be kept the same,
16 and that we were not changing the criteria that we had
17 to meet.

18 We expected this to be handled pretty
19 well, and it has been holding up pretty good, and we
20 can see that we are getting close to some things, and
21 that's probably it is not an automatic answer that we
22 go beyond 20 without some changes in the NSSS.

23 The balance of the plant did need
24 significant changes, and we recognize that, and the
25 utilities struggle with what is it worth, and is it

1 worth that investment at our plant, and many of them
2 are deciding, yes, it is.

3 I have this bullet about MELLLA. We are
4 throwing acronyms out here. This is a term that G.E.
5 has used over the years to describe the operating
6 domain that we use on our map.

7 We call it a power versus core flow map,
8 and we have defined the range of operability at which
9 we call normal operation, and it has expanded over the
10 years up to this title called, "Maximum Extended Load
11 Line Limit Analysis."

12 Load line meaning the rod line, flow line,
13 and that if we change core flow power, it moves up and
14 down with core flow, and that is a common way we
15 change power in the plants.

16 We don't change our rod patterns up at
17 high power generally. We change core flow to do that,
18 and we will see some pictures of it in the rest of the
19 presentation.

20 CHAIRMAN WALLIS: Are you going to show us
21 the stability and instability region?

22 MR. ECKERT: We will talk about which
23 region is most at risk for stability considerations
24 and what happens there. When we went to extended
25 uprate, we constrained ourselves in the utilities not

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1 to go above the previously licensed boundary, and that
2 was an important term relative to the stability
3 question, because we did not want to push ourselves at
4 that time, or now, beyond that line for these basic
5 extended upright plants.

6 And so there may be some plants that were
7 not licensed all the way to this line before, but the
8 fleet had examples of every product line that had gone
9 up to this boundary, and so some plants are moving up
10 to the previously licensed boundary, but none of them
11 -- and what we are calling the extended power uprate
12 program -- are going beyond this previously licensed
13 boundary on the power flow map.

14 And you can think about it as a power flow
15 ratio kind of boundary that we have agreed to remain
16 constrained within. There is a combination of things
17 that came out of this effort, which is partly generic,
18 and partly plant specific.

19 And that was differentiated and defined as
20 we went into our topical reports that tried to
21 establish the guideline that this is needed to be done
22 plant by plant because it has some unique features.

23 And that these are things that need to be
24 done even cycle by cycle, which is pretty costly
25 coupled to our GESTR effort for reloads, and there

1 were some things that we could handle generically and
2 say that all BWR4s are bounded by this one analysis,
3 or all BWR6s can be bounded by this one analysis. And
4 wherever possible that was included in our generic
5 material.

6 CHAIRMAN WALLIS: So this mellow boundary
7 is independent of the fuel or the flux distribution?

8 MR. ECKERT: It is applicable to all of
9 our fuel types, and plants operate up to that
10 boundary, and we will look at it in detail.

11 CHAIRMAN WALLIS: And the boundary is
12 somehow independent of fuel and so forth?

13 DR. KRESS: When you decrease flow, if you
14 had the same power, you would increase the void
15 fraction?

16 MR. ECKERT: Correct, which unbalances the
17 reactivity.

18 DR. KRESS: And so the reactivity comes
19 down.

20 MR. ECKERT: It pushes you back down.

21 DR. KRESS: And this MELLLA line is the
22 description of that effect?

23 MR. ECKERT: And it is almost -- you know,
24 for the first rule of thumb, it is a constant void
25 fraction line. It is not perfect, but it is basically

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1 that the reactor forces us to stay at the said void
2 fraction when we have the same rock pattern.

3 DR. KRESS: So it is a natural --

4 MR. ECKERT: It is a basic physical
5 characteristic.

6 DR. KRESS: -- physical characteristic of
7 all the reactors?

8 MR. ECKERT: Of our wonderful machine,
9 yes.

10 DR. KRESS: I think that is useful for
11 this committee to understand.

12 MR. ECKERT: We will have more detail
13 later, Tom.

14 DR. KRESS: So it would depend on your
15 fuel in some way wouldn't it?

16 DR. KRESS: Well, it really does depend
17 some on that, yes.

18 MR. ECKERT: We calculated for different
19 fuels, and it is amazing how close it follows, because
20 it has got the thermal-dynamics of the constant void
21 fraction built into this.

22 DR. KRESS: It is really the effect of
23 void fraction on the neutrons, and it is almost
24 independent of the kind of fuel it is. Not quite, but
25 almost.

1 MR. ECKERT: All of our fuels have strong
2 negative void reactivity characteristics, and so it
3 forces us back to very close to identical void
4 fraction, which is --

5 CHAIRMAN WALLIS: Which shuts itself down,
6 and moves it around.

7 MR. ECKERT: We submitted two different
8 topicalals basically. One we call ELTR1, and that had
9 followed our previous generic document LTR1, which was
10 the 5 percent uprate, and this is the bigger uprate,
11 but it was basically a guideline document.

12 Here is the scope of what needs to be
13 looked at and here are the key criteria that we are
14 going to commit ourselves to. We reviewed that with
15 the staff, and we reviewed it with you, and we reached
16 agreement on that.

17 And then ELTR2 is the place where we have
18 documented generic topical material that can be used
19 by different plans, and as generic, we think that this
20 issue can be settled this way, and a plant simply has
21 to confirm that we are within the generic package that
22 you have submitted before.

23 For the big uprates, obviously there were
24 a few less generic things that we could do than we did
25 for the smaller uprates, but we still had this

1 advantage to the total program.

2 We presented this and reviewed it with
3 you, and coupled very closely with the Monticello
4 extended uprate. So it was a BWR3 and then it went up
5 6.3 percent above what they had started operating
6 their unit at.

7 And then very closely coupled after that
8 were the Hatch 1 and 2 submittals that followed this
9 program. And we had questions from you, and tried to
10 and did resolve that, and have received acceptance of
11 that program. And that has led to all the activity by
12 the utilities.

13 CHAIRMAN WALLIS: And this concluded --
14 you are saying that ACRS concluded or you concluded?

15 MR. ECKERT: Well, mutually we concluded
16 it, and we are moving ahead.

17 DR. KRESS: We actually had a letter on
18 this.

19 MR. ECKERT: The staff has given us
20 approval.

21 CHAIRMAN WALLIS: Well, we certainly
22 approved it, and so I was wondering if we used these
23 exact words?

24 MR. ECKERT: I think these are my words.
25 And I am not too much of a salesman, but I have a

1 little. There is some terminology that we wanted to
2 make sure that you understood, and we have probably
3 since then, by using the term stretch power uprate a
4 little more than we did back then.

5 And that meant this early program that was
6 up to about 5 percent uprate, and it was basically
7 already built into most FSARs, and it was just that we
8 were not licensed there immediately, and we just went
9 up to it.

10 And it is based on percent of original
11 licensed in most of our discussions. Extended means
12 the step that could up to the 20 percent level above
13 the original license.

14 All plants are not choosing to go that far
15 based on what their economics are for their turbine
16 generators, or whatever their system might be. It
17 might be that they don't have room for another pump to
18 go in, or would need it, or whatever.

19 So economically each customer will look at
20 that, and pick a point to shoot for. And just
21 recently you are seeing the ones that are coming close
22 to saying, hey, we think we can get darn close to 120.

23 DR. LEITCH: Gene, just a terminology
24 question here. If I say the term extended power
25 uprate, that generally means that there is an increase

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1 in pressure; and if I say the term constant pressure
2 power uprate, I understand what that means.

3 MR. ECKERT: That's a good question. In
4 the past, our EPU program included the potential to go
5 up in power and pressure, depending on the balance of
6 design trade-off's that would go on.

7 And by going up in pressure, we could save
8 a little bit in our turbine MODs and things like that.
9 So the general program in 1998 had the option of
10 pressure increases, as well as power increases, and
11 you will see those topical's discussed it.

12 The CPPU, constant pressure power uprate,
13 fresh stuff coming at you now, is to constrain
14 ourselves to keep that dome pressure constant, even
15 though we may be going up as much 120 in power.

16 And that is the more recent path, and even
17 the ones that have done power uprates we will talk
18 about in a little bit. Many of them, if they have
19 gone up in pressure, they haven't gone very far, and
20 then they decided to do most of their uprates without
21 raising pressure because of saving lots and lots of
22 extra considerations for the primary boundary.

23 CHAIRMAN WALLIS: Do you have figures for
24 the cost per installed whatever, megawatt or whatever,
25 whatever the capital cost is for this uprate? I mean,

1 you are not buying a new reactor. You are just buying
2 some balance of power.

3 MR. ECKERT: You are asking the wrong guy.

4 CHAIRMAN WALLIS: Well, that is the motive
5 for this isn't it?

6 MR. ECKERT: Yes, it helps. It helps.
7 Some of it is avoiding just calculational costs, and
8 lots of paper, but there could well be some real hard
9 work changes, too, for the pressure change.

10 And that is these extra bullets here, the
11 different phases of uprate that have been coming at
12 you. There is one that we call thermal power
13 optimalization, and you may know it better just as an
14 Appendix K uprate.

15 In the sense where the better feedwater
16 measurement and equipment could get another 1 or 1-1/2
17 percent power by sneaking up closer to the analysis
18 that was done traditionally at 102 of the rated power.

19 And we have a parallel program for the
20 BWRs, and the staff has received a generic topical
21 that tried to scope out what was involved in doing
22 that type of uprate. That is not our main discussion
23 here today, but we wanted you to know that was also
24 coming along.

25 DR. BOEHNERT: Does that mean that someone

1 can go to 121.4 or 5?

2 MR. ECKERT: Well, that is a good
3 question, and we haven't really faced it. In theory,
4 the answer would be yes, but in practice, most of us
5 are being pretty cautious about saying that.

6 In reality, it says that if my license is
7 here, and my safety analysis is here, can I creep
8 closer to it because I have less power uncertainty,
9 and in theory the answer is yes.

10 I already have it basically. I do a 120,
11 and it says that I am going analysis at 123-1/2
12 already. So I would vote yes, but I have more
13 cautious people behind me.

14 And we are not forcing you to say, yes,
15 you can go beyond 120 that way. Some day somebody may
16 come and ask for that.

17 DR. BOEHNERT: So you have not made a
18 decision one way or the other, I guess?

19 MR. ECKERT: The topical that we have
20 submitted says that if a plant is already upgraded
21 five percent or whatever, they can abide this thing.
22 So in theory if somebody had really gone all the way
23 to 120, we would say it is theoretically possible.
24 We don't have a project pushing for that at this
25 point.

1 DR. BOEHNERT: Okay. Thank you.

2 MR. NIR: We recommend that the customer
3 will analyze and perform the analysis at 122, or 2
4 percent above 120.

5 MR. ECKERT: All of the new ones are being
6 done under the old rules with respect to power
7 uncertainty, and none of the new submittals to you or
8 the staff at this point are saying we are going to an
9 uprate, and we are only doing it with this tiny
10 uncertainty factor.

11 And in the constant pressure one, we will
12 talk about more during the presentation, and we have
13 already touched on that; that it just involves being
14 constrained, and constraining ourselves that dome
15 pressure does not go up with the power, which we can
16 control.

17 That is our common control system for all
18 our plants, and it is constrained by our tex specs.
19 We will talk a little bit about on-line
20 implementation, which is something that maybe wasn't
21 as actively on our table with you when we were here in
22 '98.

23 And that we have now come up with some of
24 the better ways to implement uprate as we go through
25 the licensing approval process, as well as the

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1 practical parts of doing plant MODs, and so forth.

2 CHAIRMAN WALLIS: You don't just suddenly
3 throw a switch and the power is 20 percent bigger?

4 MR. ECKERT: Right. These give you more
5 details about these different parts of the program,
6 and what was called the stretch, and the five percent
7 one, and it introduced this idea of LTR1, and LTR2.

8 And there was good communication between
9 us and the staff, and I thought a good exchange, and
10 a good challenge to each other. The standard was
11 similar and built on it, and here are some dates at
12 which these things were submitted, and when our
13 plants, the lead plants for this program made their
14 submittals.

15 I think Fermi-2 was the lead plant at the
16 five percent part of it, and Monticello and Hatch were
17 the lead plants on the larger ones, even though they
18 didn't go all the way to 20 percent.

19 On the so-called TPO or the small uprate,
20 this gives you a few details on the way that we were
21 doing this, and we are in the process of reviewing.
22 We have received some RAIs from the staff and are
23 responding to them and moving toward approval of this
24 half we hope.

25 I think there will be some plants that

1 follow this lead, or a couple that are submitting such
2 submittals to you independent of our topical approach,
3 and in some manner this will be merged together as the
4 staff reviews the process.

5 Basically, we are trying to take advantage
6 of everything that was already done at the 102 or more
7 above today's license, and to identify pretty clearly
8 what ought to be reviewed because it was done back at
9 a hundred percent.

10 Things like ATWS were agreed upon to be
11 done back at a hundred, for example, and so we talk
12 about what happens if we were up a percent or a
13 percent-and-a-half above that.

14 MR. KLAPPROTH: I think the only other
15 point that we should make here is that last bullet.
16 We do expect three submittals by the first quarter of
17 next year on a TPO approach.

18 CHAIRMAN WALLIS: And that involves some
19 different instrumentation then?

20 MR. KLAPPROTH: Better instrumentation and
21 measuring feed water flow, which is a primary element
22 in our power uncertainty calculation.

23 CHAIRMAN WALLIS: And is there certain
24 technology being used for that flow rate, flow
25 measuring?

1 MR. ECKERT: The technology has been
2 reviewed by the staff and has gone through the ringer.
3 Caldon is one of the suppliers, and I think ABB has a
4 system.

5 CHAIRMAN WALLIS: So anyone who can prove
6 itself is?

7 MR. ECKERT: Yes, and we are saying that
8 based on whatever they claim, you can creep ahead
9 following this guideline of scope of work.

10 DR. UHRIG: This is with the original
11 single pass system from Caldon, and the newest X
12 system?

13 MR. ECKERT: We have written our work that
14 says that we are not claiming what the improvement is.
15 We have said that if you can defend a claim of a
16 percent improvement, here is the safety work that
17 would be needed.

18 The CPPU you will hear us talk about quite
19 a bit today, and we hope that it facilitates the
20 future applications. It takes a lot of work out of
21 the process because we aren't pushing temperatures and
22 pressures harder in lots of the equipment.

23 It remains functioning at the same
24 pressure temperature conditions that it is operating
25 at today. It gives us another vehicle to work with,

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1 and our utilities to accomplish the uprates without
2 extra work involved that the pressure change would
3 have.

4 We have submitted this topical generic
5 approach to this earlier this year, and so we are in
6 the process of that review. Tomorrow is a meeting to
7 discuss this, and keep communicating about what needs
8 to be done to reach agreement on what should be
9 included in this approach. We will hear more later
10 and it involves some other recommended improvements
11 just in the process of going through the uprate
12 programs.

13 This little chart talks about the on-line
14 implementation IDF, which is trying to decouple the
15 moment we actually have approval on an SER from the
16 staff, and to say, yes, we agree, and you can go up in
17 power.

18 And from when outages are for a given
19 plant, and so the outages give the utility the time to
20 do any MODs that are needed, and they will do that in
21 a series of changes maybe for larger uprates.

22 But they would introduce some MODs and an
23 outage in anticipation of getting approval during the
24 cycle, and having submitted it to the staff for review
25 and resolving questions, and getting approval mid-

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1 cycle.

2 They are prepared to at least take
3 advantage of part of that approved new power level
4 during this first cycle that the approval is received.

5 The approval doesn't have to come
6 immediately at the time of a start up from an outage,
7 and that helped quite a few ways. There are some
8 things that you have to wait to get changed out here
9 perhaps.

10 But part of the uprate can be taken
11 advantage of right away, and it helps in the
12 scheduling of all this stuff with utilities and
13 ourselves, and with the staff.

14 It takes a little bit of heat off the
15 staff, and they don't have to be right there on the
16 day they want to pull rods and come out of an outage.
17 And so it made it more practical for all of us.

18 This chart -- we keep showing you these
19 with the list of plants, and the list keeps growing.
20 The column on the left are the plants that have
21 basically done uprates in the past and have included
22 some pressure increase in their plant.

23 And part of our discussion with you today
24 is especially aimed at helping you understand the
25 constant pressure path that we think that everybody

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1 else will be on.

2 Some of the plants on this column even
3 might have uprated or had increased pressure during
4 part of their uprate, but not all of it. Like this
5 plant in Switzerland, the Liebstadt plant, when they
6 did their first 5 percent uprate, they did the uprate
7 and pressure as well, and it was 20 pounds or
8 something. It was some amount.

9 But then when they went to the big uprate
10 that followed, they adopted our constant pressure
11 thing just for practical reasons of their own. So
12 they have gone the last 15 percent or 14 percent
13 without raising pressure.

14 But they did some analysis with the
15 pressure increase, and they looked back and said, hey,
16 I would rather try to do it without all those set
17 point changes, and all the other changes that are
18 needed, and they also have gone a long ways without it
19 for the second half of their uprate.

20 It is a pretty big list over here of
21 plants that have already or are planning to go up in
22 power using the constant pressure approach. And the
23 starred ones are the ones still in process, and
24 including the ones that we talked about before.

25 And Cofrentes is a plant in Spain that has

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1 done a small amount of uprate and are going to bigger
2 uprates in the process of that. We show the Brown's
3 Ferry units on here that weren't on the previous list,
4 but we have been working with them and aiming at a
5 target up here, and they are present in the crowd here
6 today.

7 And they are very interested in seeing the
8 same program, and there are others that we are talking
9 to. The last chart there is the real benefit for all
10 this that we are all seeing as an industry, and we are
11 trying to accomplish wisely and safely.

12 There are pretty big numbers starting to
13 add up here. Completed uprates in the neighborhood of
14 1,250 megawatts. There is some differentiation in the
15 charts here. The first block are the five percent
16 uprates, and then there is the little chunk on top of
17 here that are the EPU's, the bigger uprate programs
18 starting to be shown on the map.

19 CHAIRMAN WALLIS: I don't understand that.
20 Are you referring to total megawatts of?

21 MR. ECKERT: This is the added megawatts
22 to the fleet. It is not an individual plant, but this
23 is the sum of the plants that have uprated. And these
24 are the ones in process, and these are almost totally
25 the extended uprate plants that are part of our plan.

1 We are estimating from the year 2001 to
2 2003 that we will get these additional uprates and a
3 little bit coming in as part of what we are calling
4 thermal power optimization. Not as big, but still
5 vital power for these people.

6 DR. KRESS: Now, going from the second
7 column to the third column, does the third column
8 include the bottom of the second column that are in
9 progress?

10 MR. ECKERT: No. These are contracts in
11 hand, and --

12 DR. KRESS: They are expected to be
13 finished before you get to this other?

14 MR. ECKERT: Yes. And this would be even
15 our estimate out further.

16 DR. KRESS: So those are all new
17 megawatts?

18 MR. ECKERT: Yes, each column is
19 independent.

20 DR. CRONENBERG: And is Brown's Ferry in
21 the forecast?

22 MR. NIR: I believe it is in the third
23 column, 2001.

24 MR. ECKERT: Yes, at the time that this
25 chart was made.

1 CHAIRMAN WALLIS: And that is equivalent
2 to five new plants?

3 MR. ECKERT: Five, 930 megawatt plants.

4 CHAIRMAN WALLIS: And the problem is that
5 the 930 is so close to the 960 and the 1100, do you
6 think that you are talking about individual outrates?

7 MR. ECKERT: Yes, that is what is sounds
8 like, but it was just a way of expressing it. We
9 believe that we are consistent in supporting what the
10 staff requirements are in terms of supporting the
11 plants for additional power.

12 CHAIRMAN WALLIS: And this is your
13 contribution to the 10,000 --

14 MR. ECKERT: We just need some longer
15 extension cords to reach California though, and we
16 can't avoid the fact that this is giving high volume
17 work here through the process to the staff, and as
18 well for us, and for the utilities, too.

19 CHAIRMAN WALLIS: Are we through with the
20 open session?

21 MR. KLAPPROTH: That is the end of the
22 session, yes.

23 CHAIRMAN WALLIS: So let's take a break
24 and I think we can come back at five after, and that
25 will give us a 12 minute break.

1 (Whereupon, the Open Meeting was recessed
2 at 2:54 p.m. and the proceedings resumed in Closed
3 Session at 3:05 p.m.)
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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: ACRS Thermal-Hydraulic

Subcommittee

Docket Number: (Not Applicable)

Location: Rockville, Maryland

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



Paul Intravia
Official Reporter
Neal R. Gross & Co., Inc.

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Review of Power Uprate Applications and Potential Synergistic Safety Issues



**August W. Cronenberg
ACRS Fellow**

A handwritten signature in black ink, appearing to be "ACR".

Outline

- **Power Uprate Overview
Applications, NRC Review Procedures,
Altered Plant Conditions**
- **Events Noted for Uprated Plants**
- **Potential Synergistic Safety Issues**
- **Observations & Recommendations**

Summary of Power Uprate Applications

Plant	Reactor Type	Year Startup	Original Power(MWt)	Year Power Uprate	Uprated Power(MWt)	% Power Increase
Oyster Creek	BWR	1969	1690	1971	1930	14.20
Calvert Cliffs-1	PWR	1977	2560	1977	2700	5.46
Main Yankee	PWR	1972	2440	1978	2630	7.79
Millstone-2	PWR	1975	2560	1979	2700	5.47
Fort Calhoun	PWR	1973	1420	1980	1500	5.63
St. Lucie-1	PWR	1976	2560	1981	2700	5.46
Cook-2	PWR	1978	3391	1983	3411	0.56
Duane Arnold	BWR	1975	1593	1985	1658	4.08
St. Lucie-2	PWR	1983	2560	1985	2700	5.47
Salem-1	PWR	1977	3338	1986	3411	2.19
North Anna	PWR	1978	2775	1986	2893	4.25
Callaway	PWR	1985	3411	1988	3565	4.51
Main Yankee*	PWR	1972	2440	1989	2700	10.65
Indian Point-2	PWR	1974	2758	1990	3071	11.35
Fermi-2	BWR	1987	3293	1992	3458	5.01
Wolf Creek	PWR	1985	3411	1993	3565	4.51
Vogel 1&2	PWR	1987	3411	1993	3565	4.51
Peach Bottom-2	BWR	1974	3293	1994	3458	5.01
Susquehanna 1&2	BWR	1983	3293	1994	3441	4.49
Surry 1&2	PWR	1972	2441	1995	2546	4.30
Nine Mile-2	BWR	1988	3323	1995	3467	4.33
Hatch 1&2	BWR	1975	2436	1995	2558	5.00
Limerick-2	BWR	1988	3293	1995	3458	5.01
Limerick-1	BWR	1985	3293	1996	3458	5.01

* Denotes second power uprate, percent power uprate based on original power level.

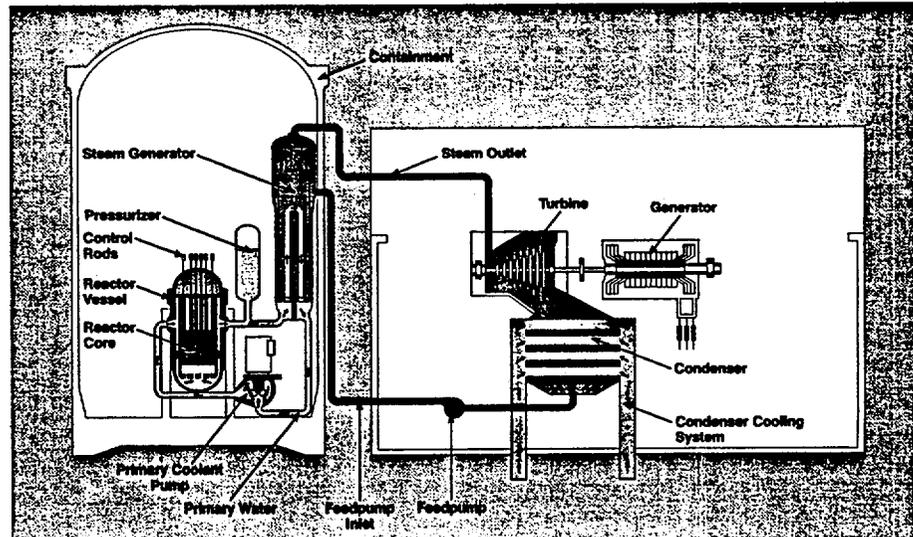
Slide 3

Licensee Uprate Responsibilities

- Uprate Application takes form of License Amendment Request
- Application Must Include Power Uprate Safety Analysis Report (SAR)
- SAR Generally Follows GE-BWR Generic Guidance (Series of Licensing Topical Reports through-1996) or W-PWR Generic Review Plan (WCAP-10263, 1983)
- SAR Centers on Re-evaluation of Design Basis Accidents, No Significant Hazards Assessment, Changes to Plant Conditions and Technical Specifications

Slide 4

Plant Characteristics Impacted by Power Uprates



Primary Coolant System (PCS)
Core Power
Core Inlet/Outlet Enthalpy
Vessel Outlet/Inlet Coolant Temperatures
Fuel Temperature
Primary Coolant Flow Rate

Secondary Coolant System (SCS)
Steam Generator Steam Flow Rate
Feedwater Flow Rate
Feedwater Temperature
Feedwater Pumping Requirements

Slide 5

NRC Uprate Responsibilities

- NRC staff reviews licensee's uprate SAR
- NRC reports findings in Safety Evaluation Report (SER)
- NRC review centers on an evaluation of the impact of power increase on plant operations and safety
- No agency uprate Standard Review Plan or standardized acceptance criteria
- No agency requirements for independent code analysis of plant uprate conditions

Slide 6

Power Uprate Events

- **Maine Yankee: Deliberate/Faulty LOCA Analysis by Licensee**
- **Wolf Creek/North Anna: Control Rod Insertion Problems**
- **Callaway/Susquehanna: Guillotine Pipe Ruptures**
- **Brunswick: Faulty use of DBA Criteria**
- **Limerick: Predicted Δ -K/K Less Than Measured**

Slide 7

Maine Yankee

- **Allegations of deliberate/ faulty LOCA submittal, DBA clad limit of 2200°F exceeded for uprate conditions.**
- **LOCA analysis performed with altered decay heat & critical flow models.**
- **NRC-SER did not question licensee analysis. No independent analysis performed by NRC staff.**
- **Subsequent investigations concurred with allegations.**

LESSON: Need for independent NRC staff analysis (code calculations) for uprate reviews.

Slide 8

Wolf Creek / North Anna

Wolf Creek: 4.5-% Uprate 1996

Control rod insertion problems for 5 high burnup rods (47 GWD).

North Anna: 4.3-% Uprate 1986

2 control rod assemblies fail to fully insert in high burnup (47-49 GWD) assemblies in spent fuel pool.

NRC-SER: Neither Uprate SER addressed potential changes in fuel or control rod performance for high-burnup/high-power conditions.

LESSON: Need for NRC staff review of potential synergistic high-burnup/high-power effects.

Slide 9

Pipe Ruptures

- Susquehanna, Callaway, Tsuruga, etc (53 rupture events pipe Diam. > 2")
- Erosion (flow)/Corrosion (age) mechanism is major cause of pipe ruptures
- Empirical evidence for synergistic flow/aging effects
- **LESSON:** Need for NRC staff review of potential synergistic flow/aging effects

Slide 10

NUCLEONICS WEEK

Vol. 40 No. 51 December 23, 1999

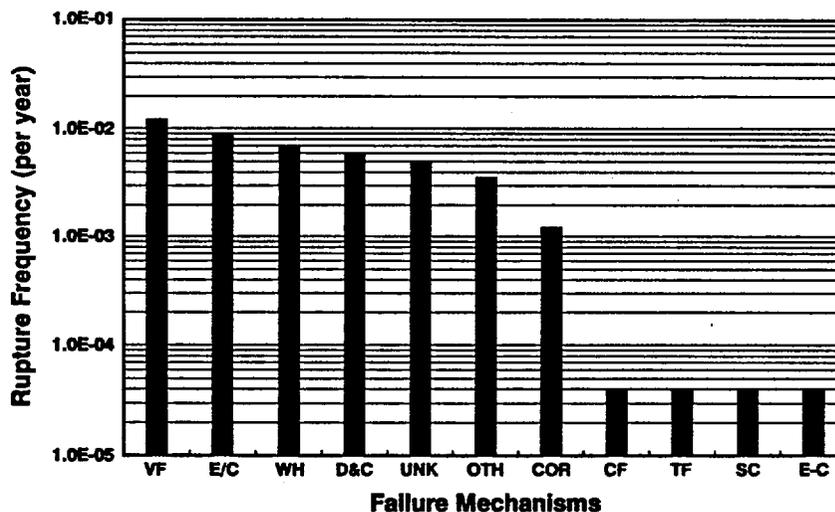
SUSQUEHANNA SHUTDOWN MAY SIGNAL NEW GENERIC PROBLEM FOR BWRs

“ A recent Susquehanna-2 forced outage could be the result of weld fatigue from increased vibrations from a power uprate in 1995, and NRC is looking at potential generic implications for other uprated BWRs...”

“ **BWR uprates have increased the speed of recirculation pumps and caused increased vibrations in the recirculation systems,** said Sam Hansell, NRC resident inspector at Susquehanna.”

Slide 11

Frequencies of Pipe Ruptures Mechanisms Through 1995



VF	Vibrational Fatigue	COR	Corrosion Attack
E/C	Erosion/Corrosion	CF	Corrosion Fatigue
WH	Water Hammer	TF	Thermal Fatigue
D&C	Design & Construction	SC	Stress Corrosion Cracking
UNR	Unreported Cause	E-C	Erosion -Cavitation
OTH	Others (human error, frozen pipes, etc.)		

Slide 12

Other Events

Brunswick 1 & 2 (BWR)

- Licensee DBA Analysis based on wet-well design limit of 220°F.
- NRC did not challenge 220°F analysis.
- Correct value of 200°F (Licensee).

Limerick-1 (BWR)

- Code predicted $\Delta K/K$ for restart less than measured for high-power/high-burnup core.
- Code inadequacies for high-power/high-burnups.

LESSON: Need for agency uprate SRP and assessment of adequacy of core physics codes for high-power/high-burnup/high enrichments.

Slide 13

Potential Synergistic Effects

High-power/High-Burnup Synergisms

Rod Fretting: Flow induced rod vibration leading to contact wear with adjacent structures. Increased core flow at uprated power and Zry-irradiation growth for high burnup may lead to fretting.

Axial Power Offset: Boron added to compensate for excess reactivity of high-enrichment/high-burnup rods. Crud buildup for long fuel duty times. Boron gettered by crud, leads to axial power offset. Effect is compounded at high-power core locations.

Slide 14

Potential Synergistic Effects

High-Power/Ageing Synergisms

Electrical Components: Insulation breakdown due to irradiation effects, exacerbated by elevated temperatures.

Fluid -Mechanical Components (pumps, piping, valves): Subject to flow assisted corrosion (FAC). Elastomer seal degradation at high temperatures.

Instrumentation & Control Systems: Ageing of I&C exacerbated at elevated temperatures and fluid velocities (vibration).

Slide 15

Observations & Recommendations

- **Current uprate application/ review process largely centers on re-evaluation of DBA conditions at uprated power. Nil consideration of potential synergistic effects.**
- **Events show indirect evidence for synergistic power-uprate/ageing and power-uprate/burnup effects.**
- **NRC Standard Review Plan (SRP) for power uprates should be issued (in progress). SRP should include acceptance criteria for synergistic effects.**
- **NRC uprate reviews should include staff T-H and core physics code calculations to verify licensee analysis.**
- **NRC uprate reviews should include comparison of safety measures (CDF, QHO, LERF) for prior & uprate power.**

Slide 16

ACRS BRIEFING
ON
THE POWER UPRATE PROGRAM

June 12, 2001

J. Hopkins, Senior Project Manager, NRR

AGENDA

- Introduction J. Hopkins, NRR
- Duane Arnold Audit R. Caruso, NRR
- Risk Informed Review Considerations D. Harrison, NRR
- RES Research Program J. Rosenthal, RES
- Concluding Remarks J. Hopkins, NRR

EXTENDED POWER UPRATES (15 - 20%)

<u>Plant</u>	<u>Uprate</u>	<u>Submittal Date</u>	<u>Review Completion</u>
Duane Arnold	15%	11/20/2000	10/15/2001 T
Dresden, Units 2&3	17%	12/29/2000	11/30/2001 T
Quad Cities, Units 1 &2	17.8%	12/29/2000	11/30/2001 T
Clinton	20%	06/18/2001 T	03/30/2002 T

RES Plans to Assess Synergistic Effects of Power Uprates

Presented to ACRS Subcommittee on Power Uprates

June 12, 2001



Jack Rosenthal

**Safety Margins and Systems Analysis Branch
Division of Systems Analysis and Regulatory Effectiveness
Office of Nuclear Regulatory Research**

RES Assessment

**Consider potential
synergies
systems interactions
phenomenological interactions**

Quantitative assessment

Consider Boiling Water Reactor “Extended” Power Uprates first

Focus on Probabilistic Risk Assessment Success Criteria

Focus on Severe Accident Issues

Fiscal Year 2002 -2003 Effort by multiple branches within RES

Identification of Issues

Quantitative Analyses at Extended Power for Risk Dominant Sequences

Anticipated Transient Without Scram

Station Blackout

Loss of Heat Removal

Loss of Coolant

Review of success criteria at extended power for range of sequences in PRA

Review of Generic Issues

Power/Flow Stability

Torus Hydro-Dynamic Loads

Identification of Issues (Continued)

Quantitative Analysis of Severe Accident/ Accident Management Issues

Mark I liner melt

Containment vent capacity

Electrical Systems

Grid Stability- more power, less VARS

Accelerated ageing due to temperature

Plant Systems

Potential increase of failure rates due to loads, vibration, fatigue, thinning, corrosion

Identification of Issues (Continued)

Primary System

Reactor pressure vessel- higher fluence induces embrittlement

Pipe loading

Containment Systems

Higher suppression pool temperatures correspond to reduced NPSH

Control Systems

Pressure and flow control, turbine and steam bypass

Human Actions

Response time

Duane Arnold Power Uprate Audit Results

**Ralph Caruso
Chief, BWR Systems and
Nuclear Performance Section
Reactor Systems Branch
US Nuclear Regulatory Commission**

June 12, 2001

Background

- **DAEC Power Uprate**
- **Staff Performing Review for Compliance with ELTR2 Topical Report**
- **Staff Review Includes Audit of Various Licensing Calculations in Support of Uprate Conditions**
- **Audit Performed on March 26-29 by Team of 4 Staff Members**

Audit Scope

- **SAFER/GESTR LOCA Methodology**
- **Long-Term Stability Option I-D**
- **GEXL14 Correlation**
- **Reactor Core Design**
- **Methodology and Uncertainties for Safety Limit MCPR**

Findings

- **SAFER/GESTR**
 - **Analyses for Rated Conditions Complied with SER Conditions and the Codes Were Appropriately Applied.**
 - **Analyses of Single-loop Conditions Used Uncertainties Derived from TRAC and Full Power Operation, Which May Not Be Directly Applicable to Off-rated Conditions.**
 - **However, Conservative Penalties Are Applied to Single-loop Operation, and Plants Rarely Operate in this Condition.**
- **Long-Term Stability Solution**
 - **Option I-D still Applicable to DAEC**
 - **Power Uprate and Change of Licensing Methodology Will Increase Operator Reliance on SOLOMON On-Line Stability Monitoring System**

- **Recommendation that DAEC and Fuel Vendor Work Together to Increase Operator Confidence in Ability of SOLOMON to Predict Instability**

- **GEXL14**
 - **Staff Review Identified Use of COBRAG-generated Data in GEXL14 Database**
 - **Staff and GE Discussing Appropriateness of COBRAG to Generate Data**

- **Reactor Core Design**
 - **Methods Continue to be Used Appropriately**

- **Safety Limit MCPR**
 - **Methods Continue to be Used Appropriately**

Conclusions

- **Approved Methods Continue to Be Used Appropriately at Up-rated Power Levels**
- **GEXL14 Correlation Database Evaluation Continues to be Discussed with GE**
- **Staff Will Continue to Perform Audits of Analysis Methods and Results for Upcoming BWR Extended Power Up-rates**
 - **Dresden 2,3, Quad Cities 1,2**
 - **Clinton**