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UNITED STATES NUCLEAR REGULATORY COMMISSION'S

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

March 8, 2007

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on March 8, 2007, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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

1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

5 + + + + +

6 THURSDAY,

7 MARCH 8, 2007

8 + + + + +

9 The meeting was convened in Room T-2B3 of

10 Two White Flint North, 11545 Rockville Pike,

11 Rockville, Maryland, at 8:30 a.m., Dr. William J.

12 Shack, Chairman, presiding.

13 MEMBERS PRESENT:

14 WILLIAM J. SHACK Chairman

15 GRAHAM B. WALLIS Vice-Chairman

16 SANJOY BANERJEE Member

17 SAID ABDEL-KHALIK Member

18 DANA A. POWERS Member

19 THOMAS S. KRESS Member

20 OTTO L. MAYNARD Member

21 MICHAEL CORRADINI Member

22 GEORGE APOSTOLAKIS Member

23

24

25

1 NRC STAFF PRESENT:
2 GARY HAMMER
3 RALPH CARUSO
4 TED SULLIVAN
5 AL CSONTOS
6 MICHELLE EVANS
7 TAI HUANG
8 JOSE MARCH-LEUBA
9 SAMUEL MIRANDA
10 JARED WERMIEL
11 ERVIN GEIGER
12 TONY SHAW
13 PAULETTE TORRES
14 ROB TREGONING
15 WILLIAM KROTIUK
16 TOM HAFERA
17 JOHN MONNINGER
18 MARY DROUIN
19 EILEEN McKENNA
20 FAROUK ELTAWILA
21
22
23
24
25

1 ALSO PRESENT:

2 DAVE RUDLAND (via video teleconference)

3 CRAIG HARRINGTON

4 WARREN BAMFORD

5 ALEX MARION

6 DENNIS WEAKLAND

7 WILLIAM SIMS

8 PETE RICCARDELLA

9 MIKE SCOTT

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I-N-D-E-X

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

2 8:30 a.m.

3 CHAIRMAN SHACK: On the record. The
4 meeting will now come to order. This is the first day
5 of the 540th meeting of the Advisory Committee on
6 Reactor Safeguards. During today's meeting, the
7 Committee will consider the following: technical
8 basis associated with proposed NRC staff action for
9 dealing with dissimilar metal weld issue; proposed
10 revisions to Standard Review Plan Sections 15.0,
11 Accident Analysis Introduction and 15.9 BWR Core
12 Stability; final results of the chemical effects head
13 loss tests related to the resolution of the PWR sump
14 performance issues; technology neutral licensing
15 framework and related matters; and preparation of ACRS
16 reports.

17 This meeting is being conducted in
18 accordance with the provisions of the Federal Advisory
19 Committee Act. Mr. Sam Draiswamy is the Designated
20 Federal Official for the initial portion of the
21 meeting. We have received no written comments or
22 requests for time to make oral statements from members
23 of the public regarding today's sessions. A
24 transcript of portions of the meeting is being kept
25 and it is requested that speakers use one of the

1 microphones, identify themselves and speak with
2 sufficient clarity and volume so they can be readily
3 heard.
4 I will begin with some items of current
5 interest. During lunchtime today, the members are
6 scheduled to interview two candidates for membership
7 on the ACRS. You should have a schedule and some
8 background information on the candidates.
9 Eric Thornsbury who has been with the NRC
10 for 10 years of which two years have been with the
11 ACRS staff is leaving the NRC to join Aaron
12 Engineering and Research in West Chester, Pennsylvania
13 on March 16, 2007. For the past two years, he has
14 provided outstanding technical support to the
15 Committee in reviewing numerous matters including
16 risk-informing 10 CFR 50.46, digital alliance research
17 plan, SPAR models development program, human
18 reliability analysis, safeguard and security matters,
19 ESBWR, PRA, several regulatory guides and SRP
20 sections. His technical competence, dedication, hard
21 work and professionalism are very much appreciated and
22 I certainly enjoyed working with Eric and I've enjoyed
23 working with him before he joined the ACRS and we want
24 to thank him for his exceptional contributions to the
25 Committee and good luck in his new job.

1 (Applause.)

2 CHAIRMAN SHACK: Jermila Perry joined the
3 Operations Support branch staff on February 12th. She
4 will be working on budget formulation, financial
5 analysis, records management and IT-related items. So
6 members may be able to get back on their computers
7 soon. Jermila has a Bachelors degree in English from
8 the University of Maryland College Park. She joined
9 the NRC in the Office of the Chief Financial Officer
10 in August 2003 and was a program analyst with primary
11 responsibilities for several offices including
12 ACRS/ACNW.

13 Prior to coming to the NRC, Jermila worked
14 for over four years at the National Academy of
15 Sciences as the senior procurement assistant and as a
16 contract assistant. Jermila has also worked FEMA,
17 Department of Commerce, Patent and Trademark Office
18 and the Department of Treasury. Welcome aboard to
19 Jermila.

20 (Applause.)

21 CHAIRMAN SHACK: A portion of today's
22 meeting will be closed to discuss safeguards and
23 security matters. This matter is being conducted in
24 accordance with the provisions of the Federal Advisory
25 Committee Act. That's tomorrow. Sorry.

1 Our first item today is the NRC staff
2 action or the technical basis associated with NRC
3 staff actions for addressing the dissimilar metal weld
4 issue arising from the Wolf Creek pressurizer flaw
5 inspection results. We heard a little bit about this
6 before in October 2006.
7 There was an inspection at the Wolf Creek
8 plant. The UT inspection produced some UT indications
9 that the licensee and industry experts had decided
10 were circumferential stress corrosion cracking flaws,
11 although no samples were taken to actually confirm
12 that. But again, the staff and the industry are
13 moving ahead on the assumption that those flaws were
14 fairly sizable circumferential flaws.
15 Again, it's not unexpected that we have
16 cracking in this Alloy 182 weld metal. The industry
17 has already had a program under way to do inspection
18 and mitigation on these welds. It involves putting on
19 an overlay of much more resistant metal that will
20 provide full structural reinforcement, so that even if
21 there was a full 360 degree crack through the original
22 weld metal the pressurizer nozzle would retain its
23 original structural strength.
24 There is some discussion with the cracks
25 that have been found at Wolf Creek and the fact that

1 we've only inspected something like 11 to 15 percent
2 of the pressurizer nozzle welds so that the
3 characterization of the state of the rest of the
4 nozzles is somewhat uncertain whether there needs to
5 be an acceleration in this schedule and the staff and
6 the industry are working together to really assess the
7 technical basis for deciding whether an accelerated
8 schedule is necessary or not and the staff will be
9 opening their presentation today and Ted Sullivan will
10 be leading us in discussion for the staff.
11 I should mention that we did have a
12 Subcommittee meeting Tuesday in which we had much more
13 discussion of the technical details than we'll be able
14 to go through today.
15 MR. SULLIVAN: Thank you very much, Dr.
16 Shack. My name is Ted Sullivan and I'm joined by Al
17 Csontos. We're dividing up the presentation material
18 this morning for the NRC staff.
19 On February 2nd, we had about an hour and
20 a quarter, an hour and a half, something like that to
21 brief the full Committee. We shared that time with
22 the industry and what we talked about just to
23 elaborate a little bit more on the introduction was
24 the inspection findings where five flaws were
25 identified in three pressurizer nozzle welds. NRC

1 performed fracture mechanics analyses and they were
2 not bounding analyses or best estimate as we said at
3 the time, but they were scoping analyses to try to
4 understand what could happen and we concluded that a
5 distinct possibility would be that there would be
6 little or not time between leakage and rupture
7 particularly for the relief nozzle cases that we
8 analyzed.
9 Our conclusion as we tried to capture them
10 on February 2nd was that we did not consider the Wolf
11 Creek indications to be anomalous. They couldn't be
12 treated that way despite the fact that there are
13 limitations in our understanding of that information.
14 VICE-CHAIRMAN WALLIS: Can you say what
15 you mean by "anomalous"? Do you mean that it's likely
16 there will be similar events somewhere else if they're
17 not anomalous? Or what do you mean?
18 MR. SULLIVAN: We think it is possible
19 that it could occur somewhere else. I think what we
20 were trying to reflect was that we hadn't seen
21 indications like this at other plants in terms of
22 size, multiple circumferential indications. They were
23 all of similar depth which is a little bit puzzling
24 and so there was a fair amount of discussion about
25 whether these indications were some sort of artifact

1 that we didn't understand or whether we should treat
2 them as PWSCC and we concluded we needed to treat them
3 as PWSCC.
4 VICE-CHAIRMAN WALLIS: Thank you.
5 MR. SULLIVAN: We also concluded that
6 based on the information available, inspections and
7 mitigations need to be accelerated for some plants and
8 later in the presentation I'll be a little bit more
9 clear about what those particular plants are as
10 distinguished from the rest of the group of plants.
11 Then we also concluded that in the
12 interest of safety, enhanced leakage monitoring should
13 be put in place to shut down the plant and visually
14 inspect welds.
15 VICE-CHAIRMAN WALLIS: When you visually
16 inspect, you simply look for water. Is that what you
17 look for?
18 MR. SULLIVAN: What they would have to do
19 is remove the insulation from these nozzles if the
20 action levels are tripped that would put them into a
21 shutdown and they would -- I'm sort of getting at this
22 at a high level.
23 VICE-CHAIRMAN WALLIS: What can they
24 really see.
25 MR. SULLIVAN: They would have to be able

1 to really see. They'd be looking for boric acid.

2 VICE-CHAIRMAN WALLIS: They're looking for

3 a leak.

4 MR. SULLIVAN: Right. Okay. And we

5 believe these actions only need to be put in place

6 until the nozzles are inspected one time or mitigated

7 and for the most part --

8 VICE-CHAIRMAN WALLIS: If there's a short

9 time between leak and break as you said on your first

10 slide, who's going to go and look for it?

11 MR. SULLIVAN: That's why I tried to couch

12 it in terms of in the interest of safety. It's not an

13 absolute guarantee or else I think we wouldn't be

14 uncomfortable with the schedule they're on. We didn't

15 find the same lack of time between leak and rupture

16 for the surge line and for the safety line which had

17 smaller nozzles we saw that most of the cases we

18 analyzed did show time between leakage and rupture.

19 So it's kind of a balance. It wasn't all one-sided in

20 terms of saying this is a useless exercise. We

21 thought it would be a fruitful thing to do.

22 On page 4 what I wanted to just indicated

23 was that we discussed the fraction mechanisms analyses

24 and results on February 2nd and again in some detail,

25 two days ago. But at the February 2nd meeting with

1 the full Committee, we didn't get into leakage. There
2 were some questions that were raised and we didn't
3 think we were in the best position at the time to
4 answer them. So we have about three slides on leakage
5 today just to introduce the subject and that's what
6 Al's going to talk about. Then after Al is done, I'll
7 get back into picking up more of the regulatory
8 picture of what we've been doing in regulatory space
9 and where we see that we're going. So with that, I'll
10 turn it over to Al.
11 MR. CSONTOS: My name is Al Csontos and I
12 will be discussing the results of the weld evaluation
13 study that we evaluated back in late October or
14 actually mid November of '06. On the VTC over here,
15 we have Dave Rudland who was a principal investigator
16 and the principal author to the report that I believe
17 you all received on our analysis. He is at Engineer
18 Mechanics Corporation of Columbus and he is the RES
19 contractor responsible for this evaluation.
20 So I'll just go through quickly the
21 analysis. Let me say that we broke this down. We had
22 six cases individually that we evaluated, three
23 different weld residual stress cases, a weld residual
24 stress that we picked from one of our other older
25 programs and then a weld residual stress plus a repair

1 residual stress and a no residual stress case and then
2 we also looked at normal operating conditions and
3 faulted operating conditions which included normal
4 operating plus the safe shutdown earthquake loads.
5 We broke this down into the three nozzle
6 types, surge, relief and safety nozzles. For the
7 first case, the surge nozzle, we had three cracks or
8 three flaws in them. We evaluated the worst case, the
9 worst of the three flaws. We didn't evaluate any
10 connection or any crack linkage between the three.
11 The relief and safety, there was just one flaw. So we
12 looked at that individually.
13 For the case of the surge line, leakage
14 was predicted to occur between 1.0 to 2.2 years after
15 the discovery in October '06 and in all cases for
16 that, all residual stress cases and all operating
17 conditions, we had six months between leakage or at
18 least six months between leakage and rupture.
19 For the relief nozzle, the leakage was
20 predicted to occur 1.9 to 2.6 years after the
21 discovery in October '06 and in that case, 20 out of
22 24 cases showed no time, no margin, between leakage
23 and rupture. The four cases or all the cases had no
24 residual stresses which is sort of -- That is the non-
25 conservative, bounding assumption.

1 In that case, many of those flaws, in
2 fact, all of them, the surface cracks were unstable
3 before they ever went through-wall and so that is
4 something that we evaluated two cases. We evaluated
5 a critical through-wall flaw and we also evaluated a
6 critical surface flaw and in those cases we have a
7 surface flaw going unstable before they even went
8 through-wall. So that time we would have no time
9 between leakage and rupture.
10 MEMBER BANERJEE: Is this also for the
11 case with no residual stress?
12 MS. CSONTOS: Yes. No, I just said that.
13 That's no, no-residual stress before cases, no.
14 MR. SULLIVAN: But when you look at 20 out
15 of 24 the remaining four are the no-residual stress
16 cases.
17 MS. CSONTOS: That's correct. There are
18 four in the no-residual stress case for what we call
19 a constant C/R ratio that shows no time between
20 leakage and rupture. But the more realistic K-driven
21 analysis for the only four that showed a little bit of
22 time between leakage and rupture was the K-driven, no-
23 residual stress case and in the slides from the
24 Subcommittee we had those all listed out, each 24
25 cases.

1 MEMBER BANERJEE: And all the other cases
2 had a --
3 MS. CSONTOS: Had no time. Right. For
4 the safety nozzle, leakage was predicted to occur 2.6
5 to 8.0 years. That also depends on what conditions
6 you're looking at. Out of those cases 8 out of 24
7 showed no time between leaking and rupture.
8 MEMBER BONACA: For the surge line, how
9 far apart were the flaws from each other?
10 MS. CSONTOS: We really don't have much
11 information, I don't think, on that.
12 MR. SULLIVAN: I can get that information.
13 MS. CSONTOS: Yes.
14 MR. SULLIVAN: I'm not sure we brought it
15 today.
16 MS. CSONTOS: In the industry's White
17 Paper they have --
18 MEMBER BONACA: Would that be a
19 consideration, I mean, if you have multiple?
20 MS. CSONTOS: It is something that we are
21 considering in the next finite element modeling that
22 the industry is proposing to do that one of the issues
23 that we have is crack leakage and the effects of
24 multiple cracks because as anyone knows it looks at PW
25 SCC or just stress corrosion cracking. A lot of times

1 it's multiple initiation, multiple cracks, that do
2 link up and they look like they're one large crack,
3 but in reality, they may be multiple small cracks that
4 link up.
5 MEMBER BONACA: If you could find the
6 information, I would appreciate it.
7 MR. SULLIVAN: Right. One thing we're not
8 going to be able to show you is whether they're in the
9 same plane. We don't know that.
10 MS. CSONTOS: Yes, the co-planarity of the
11 flaws, the UT was not able to distinguish that. So we
12 don't know if the cracks are like this or if they are
13 in the same plane where they could link up.
14 So here is the leak rate. I don't know
15 who asked this question at the last ACRS meeting, but
16 there was a question on leak rates and what kind of
17 leaks would be coming out of some of these flaws or
18 these through-wall cracks and that's the purpose of
19 this study. We did this as a corollary at the end of
20 the study and we used the validated NRC Code called
21 SQUiRT and you can read what the title is there for
22 these leak rate calculations.
23 The assumptions we used here are that we
24 used an idealized equivalent through-wall crack size.
25 The "idealized" means that the flaw goes all the way

1 through-wall and it's circumferential all the way for
2 that size. But then the "equivalent" is that -- This
3 shows the idealized through-wall crack, a surface
4 crack that goes through-wall at this point. You can
5 choose -- What we did is we chose two types. One was
6 the idealized where all these red lines were where
7 this entire length here was considered the crack size.
8 We thought that was a little over conservative or too
9 conservative and so we went to what we called the
10 "equivalent" through-wall crack size which is saying
11 that the area under this crack size, we take that area
12 and make the through-wall crack size which is this
13 size here (Indicating). So it reduces the size, but
14 it's more realistic in terms of these kinds of
15 calculations.
16 CHAIRMAN SHACK: If you need a new
17 integration routine though.
18 MS. CSONTOS: Yes. Let me just say this
19 is not drawn to scale.
20 MEMBER ABDEL-KHALIK: Wouldn't this burr
21 sort of break up as soon as the ligaments --
22 MS. CSONTOS: The ligaments.
23 MEMBER ABDEL-KHALIK: That's right.
24 MS. CSONTOS: Yes, it would and so we did
25 the calculation for both. What we're going to show

1 you here is the equivalent through-wall crack size
2 which will show --
3 MR. RUDLAND: The purpose of the
4 equivalent size was to try to at the time (Voice
5 breaking up.)
6 MS. CSONTOS: Dave, you're breaking up.
7 MR. RUDLAND: Yes, I hear a lot of echo.
8 MEMBER ABDEL-KHALIK: Could you repeat
9 what you just said.
10 MS. CSONTOS: Can you repeat what you
11 said?
12 MR. RUDLAND: We chose the equivalent size
13 because we were trying to estimate the time from first
14 leakage, from initial leakage, until the non-idealized
15 through-wall crack had an idealized size since we
16 recognized that there would be some time between the
17 first leakage and the time where it reached an
18 idealized size.
19 MS. CSONTOS: There's a time period
20 between where it goes through-wall where there's a
21 little pinhole leak to when it goes complete through-
22 wall and what we said is that by estimating this
23 initial first idealized through-wall crack that was
24 really over estimating and we wanted to see -- We were
25 being non-conservative because we were estimating more

1 leakage and we were concerned about detectability. So
2 we wanted to see how small and be more conservative on
3 that end.
4 That's where we have to say -- Let me go
5 back one second. This model, the SQUiRT model, when
6 we looked at this, this was built for the LOCA program
7 in the past and so we were -- Conservative in that
8 case was over predicting leakage. In this case, we're
9 trying to make sure that we are more realistic because
10 we're trying to determine detectability limits and
11 determine whether or not we can get to those
12 detectability limits and what those detectability
13 limits should be. So in that case, that's where we're
14 going with this, the time between the pinhole through
15 through-wall and we're trying to be more conservative.
16 So we chose a smaller size.
17 MR. RUDLAND: And the K solutions and the
18 open displacement solutions don't exist for these non-
19 idealized through-wall cracks at this point. So we
20 had to make an approximation.
21 VICE-CHAIRMAN WALLIS: What does it look
22 like in the other dimension? Is it just a slot with
23 a uniform thickness?
24 MS. CSONTOS: It looks like a -- Yes, it's
25 almost --

1 VICE-CHAIRMAN WALLIS: It's a slot and
2 then it distorts under pressure to make a hole.
3 MS. CSONTOS: Yes, and that's what we
4 called the crack opening displacement. If you have
5 that and it opens up, obviously the greater COD will
6 be called crack opening displacement which the more
7 leakage you can get out.
8 MEMBER CORRADINI: You create a fisheye.
9 MS. CSONTOS: No, these are tiny. These
10 are microns in depth.
11 CHAIRMAN SHACK: They open.
12 MS. CSONTOS: Yes, they open when they get
13 larger.
14 CHAIRMAN SHACK: But not the fish mouth
15 that you're thinking about.
16 MS. CSONTOS: Right.
17 CHAIRMAN SHACK: By the time we're at the
18 fish mouth, we're in trouble.
19 MS. CSONTOS: We're in trouble especially
20 for circumferential cracks.
21 CHAIRMAN SHACK: This through-wall crack
22 size works quite well in steam generator tubes. So I
23 don't know that we have a whole lot more data on
24 pipes, but when we do the leakage calculation for
25 steam generator tubes we use a similar type model and

1 it actually predicts the leakage at the pop-through
2 when you fail that initial through-wall ligament and
3 you get the first pop-through and leakage, it works
4 pretty well.
5 MS. CSONTOS: I'll just go through quickly
6 the assumptions here. I wanted to go through the
7 equivalent through-wall crack size. The crack opening
8 displacement, what I just talked about, is dependent
9 upon what we call the PWSCC crack morphology
10 parameters. The crack for PWSCC is very tortuous and
11 so to account for that we have a parameter there that
12 limits the amount of water that comes through because
13 of the water having to go through all these channels.
14 We used the GE EPRI estimation steam to
15 evaluate or to calculate the COD and also there is
16 another factor here where weld residual stresses can
17 actually shift the crack face and the crack fronts and
18 if that's the case, the crack opening displacement can
19 be reduced even more.
20 For the surge line we used a sub-cooled
21 liquid. For the spray and the relief lines, we used
22 100 percent steam and we didn't predict or we didn't
23 evaluate the restraint of pressure induced bending.
24 When you have a rigid pipe, that can also effectively
25 close or keep the crack opening displacement tighter.

1 We didn't account for that and those are some non-
2 conservatisms in our analysis.
3 So what we did here is we calculated the
4 leak rate by crack size and COD and that's on slide 8.
5 The results of our analysis show that for the surge
6 line depending upon the weld residual stress case that
7 you're looking at, 0.2 being the no residual stress
8 case meaning the smallest crack and the 3.1 being the
9 larger crack for the weld residual stress plus the
10 repair weld residual stress, that gives you a 3.1
11 gallon per minute leak rate.
12 VICE-CHAIRMAN WALLIS: 3.1 gallons per
13 minute at 2,000 psi is a pretty powerful jet.
14 MS. CSONTOS: And it's steam. No, that's
15 water. Sorry.
16 VICE-CHAIRMAN WALLIS: Sub-cooled water,
17 it's pretty powerful.
18 MEMBER BANERJEE: But it's turning to
19 steam, won't it?
20 VICE-CHAIRMAN WALLIS: Yes. But it will
21 draw holes through the insulation presumably. What
22 kind of insulation do you have?
23 MS. CSONTOS: I think it's different for
24 each. I don't know the kinetics.
25 MEMBER POWERS: It's probably the

1 insulation restraining the leak rate pretty much.

2 VICE-CHAIRMAN WALLIS: You're not going to

3 get a tie like that. You're going to get something

4 that punches out and you're going to get some kind of

5 --

6 MS. CSONTOS: Yes, that's equivalent to,

7 I think, about an eight crack size that you'll get a

8 3.1 gpm leak.

9 MEMBER ABDEL-KHALIK: Even on the low end,

10 the 0.2 gpm is above the tech spec action point for

11 various plants. Isn't that at 0.1 gallons per minute?

12 MR. SULLIVAN: No, the spec tech actually

13 says 0.1 gpm.

14 MEMBER ABDEL-KHALIK: 1.0 gpm.

15 MR. SULLIVAN: But licensee in general

16 have administrative procedures in effect that would

17 cause them to react at level probably less than 0.2

18 gpm, not necessarily shut down, but react and start to

19 try to find the leakage.

20 MEMBER ABDEL-KHALIK: But if the minimum

21 leakage is calculated to be 0.2 gpm that means those

22 actions are really irrelevant because --

23 MR. SULLIVAN: I think there's a couple of

24 things. One is that as Al was mentioning there were

25 some non-conservatisms in his analysis, the analysis

1 that we need to go back and get a better handle on.
2 So we don't really know exactly what the value is
3 going to be. We need to get a better handle on that.
4 But what we did in regulatory space and
5 I'm getting a little bit ahead of myself, but what we
6 did was we reached an agreement with the licensees
7 that have not yet inspected or mitigated that if the
8 day-to-day leak rate changes like 0.1 gpm or 0.25 gpm
9 above a baseline value, so we're getting either slowly
10 evolving changes or more rapidly evolving changes,
11 that they'll start to basically enter some action
12 levels that would require them to shut down if that
13 level of leakage is sustained for three days. But
14 those are the kinds of numbers.
15 MEMBER BANERJEE: What is the accuracy of
16 -- This is done by mass balance I take it.
17 MR. SULLIVAN: Right.
18 MEMBER BANERJEE: How accurately can you
19 get that?
20 MR. SULLIVAN: Maybe somebody from
21 industry could correct me if I misstate but I think
22 it's generally believed that it's accurate within
23 about 0.05 gpm per day.
24 MEMBER CORRADINI: That's an integrated
25 number over so much time window.

1 MR. SULLIVAN: Right.

2 MEMBER BANERJEE: What is the time window?

3 MEMBER CORRADINI: What is the typical

4 time window?

5 MR. SULLIVAN: They do these calculations

6 at least once a day, not per tech specs but per the

7 agreement that we reached with licensees.

8 MEMBER BANERJEE: You're getting a

9 difference between large numbers. Right?

10 MR. HARRINGTON: Craig Harrington with

11 EPRI. The best people to answer that question aren't

12 here, but the 0.05 number is at least -- That may be

13 a little bit low for accuracy, but it's just the kind

14 of range, 0.05, 0.1, someplace in there is I think

15 what is generally considered a number that can be

16 fairly precisely identified as a change through the

17 mass balance systems and things like that.

18 MEMBER CORRADINI: Just so I'm clear, I

19 guess I was thinking the same thing that Sanjoy was

20 asking. So it's 0.1 plus or minus ten percent, plus

21 or minus 20 percent, plus or minus 50 percent. When

22 you say 0.1 I'm trying to -- Or is it 0.1 plus or

23 minus zero to 0.2. Do you see my question?

24 MEMBER MAYNARD: I don't remember the

25 exact accurately. It is fairly -- It's not just a

1 mass balance on how much goes in versus how much comes
2 out of the big mass of the RCS. It incorporates sumps
3 and other measurements. It's not just a mass balance.
4 MEMBER CORRADINI: So it's detectability
5 of other things.
6 MEMBER MAYNARD: Yes and of course, you
7 have other things that can help identify locations and
8 stuff. But if you have a leak you're also going to be
9 raising radiation levels. You're going to be changing
10 pressures and there are other things that factor into
11 that, not just a mass balance of the whole RCS.
12 MR. BAMFORD: I'm Warren Bamford from
13 Westinghouse. Let me try to help a little bit. The
14 utilities are looking at leakage from several
15 different points of view. One is from an actual
16 leakage at a given time which is what you guys are
17 talking about. The other thing they're doing is
18 they're doing a trending over a period of time and so
19 they're going to take like a five day or a seven day
20 moving average and when the leakage, the unidentified
21 leakage, departs from that moving average they use
22 that too and that's far more useful than looking at
23 the leakage at any given time. So I'm not sure you
24 can attach a specific accuracy, plus or minus, but I
25 think they're doing a really nice job of trending, far

1 better than they have in the past.

2 MEMBER CORRADINI: Okay. Thank you.

3 VICE-CHAIRMAN WALLIS: This gets back to

4 my question then of how long does it take to detect

5 this if it's going to take you five days and you have

6 three gallons per minute. You have 20,000 gallons of

7 water somewhere in the containment.

8 MR. SULLIVAN: If it were ever at the

9 level of 1.0 gpm, they'd already shut the plant down.

10 VICE-CHAIRMAN WALLIS: But how long does

11 it take them to know that? How long does it take them

12 to detect 1.0 gpm? If they're doing an average over

13 time or something, it must take some time.

14 MR. SULLIVAN: It couldn't take longer

15 than a day under the current regime.

16 MEMBER MAYNARD: One gpm, you're going to

17 know very quickly.

18 MR. SULLIVAN: Yes.

19 MEMBER BANERJEE: Yes, it's more the 0.1

20 gpm. You had numbers of 0.1 and 0.25 as action

21 levels. I was wondering how accurately you could

22 determine that.

23 MEMBER MAYNARD: I don't remember exactly.

24 I think with 0.1 you're going to see within -- You'll

25 starting seeing it within 6 to 12 hours again

depending on the location because there may be other indications besides just your leak balance there. But at 6 to 12 hours, you're going to start seeing it and be able to confirm it usually in 12, something like that.

MEMBER BANERJEE: How large was Davis-Besse?

(Off the record comments.)

MR. SULLIVAN: I'm sorry. I wasn't involved in Davis-Besse.

CHAIRMAN SHACK: I think the on-going leak rates as I remember were on the order of 0.2 gpm.

MEMBER CORRADINI: That's what I thought. That's the number that I remember.

MEMBER BANERJEE: So they should have been detected. Right?

CHAIRMAN SHACK: You can detect it. You have to then decide what you're going to do about it.

MR. SULLIVAN: I think that the fleet of reactors has gotten much more sensitive to leakage since Davis-Besse. The climate has changed quite a bit.

All right. I would like to move onto some of the maybe more forward-looking things since the analyses were done. PWRs can be put in various types

1 of categories and with respect to pressurizer nozzle
2 welds we would break it down into these four
3 categories. There are 69 PWRs in the United States.
4 Nineteen of them don't have Alloy 82/182 welds at
5 their pressurizer nozzles. They either weren't there
6 originally which is the case for most of these 19.
7 Four of them happen to be replacement pressurizers
8 that didn't use this alloy.
9 There are also plants that have already
10 inspected or mitigated. The MRP-139 program came out
11 in late 2005 and between them and now there's another
12 group of plants, I don't know exactly what the number
13 is, that have already done inspections or mitigations
14 of the welds that we're talking about in today's
15 presentation.
16 Then there's another group of plants that
17 plan to inspect or mitigate in 2007, both the spring
18 outages, there's at least one plant if not more in an
19 outage just as we speak, and then there's the fall
20 outages. And then there's also nine plants whose
21 outages, next outages in fact, are in 2008 and that's
22 when they had planned to do inspections or
23 mitigations.
24 As you might recall in the second or third
25 slide, I indicated that one of our conclusions was

1 that we wanted plants to get this job done sooner
2 rather than waiting until 2008. It's the plants with
3 2008 outages that we were concerned having the problem
4 or having the situation possibly go that long. So we
5 reached agreements with licensees to both implement
6 and enhance leakage monitoring as well as complete the
7 inspections or mitigations this year which for those
8 nine plants would require mid-cycle shutdowns. But
9 that's pending some advanced analyses that are just
10 getting underway by industry and which are discussed
11 in correspondence that I know was given to the
12 Subcommittee. I'm not sure if the full Committee
13 members have copies of that. Did the full Committee
14 get copies of all that correspondence related to --
15 PARTICIPANT: Everybody got everything.
16 MR. SULLIVAN: Great. Now what we're
17 trying to do in those advanced analyses or what
18 industry is trying to do and the agreement that we've
19 reached with industry is kind of captured on page 11
20 and what we're saying there is if industry's advanced
21 analyses provide reasonable assurance to the NRC staff
22 that PWSCC will remain stable and will not lead to
23 rupture without significant time from the onset of
24 detectable leakage, plants with 2008 outages will not
25 have to shut down in 2007.

1 VICE-CHAIRMAN WALLIS: Could you clarify
2 what you're going to inspect? Are you going to
3 inspect the locations similar to Wolf Creek or a much
4 broader band of locations where there might be cracks?
5 MR. SULLIVAN: In this particular case,
6 we're just focusing on the pressurizer nozzle welds.
7 I think I could answer the question a little more
8 fully but I think the industry presentation may
9 capture that. I'll just give a little bit a preview.
10 The MRP-139 document which industry is following as a
11 mandatory industry program under their programs, not
12 the regulatory program, has a different schedule for
13 different locations. The schedule in their program
14 for the pressurizer nozzle locations was to get all
15 this work done in 2007.
16 The next group of plants or the next group
17 of locations, I think, is hot leg locations that are
18 less than 14 inches and they have to be done in 2008.
19 Greater than 14 inches has to be done or 14, I'm not
20 sure exactly where the cutoff is at 14 inches, but
21 greater than 14 inches has to be done by 2009 and then
22 cold legs have to be done by 2010. So we're really
23 focusing here on the pressurizer locations.
24 Industry has a process that they refer to
25 as the deviation process that if they justify it

1 within their definitions of the deviation process,
2 they're allowed to extend those actions and that's why
3 there are some plants in 2009 time frame.
4 VICE-CHAIRMAN WALLIS: But we don't have
5 a predictive tool for saying where and when there will
6 be cracks.
7 MR. SULLIVAN: No.
8 VICE-CHAIRMAN WALLIS: We don't really
9 know the likelihood of them being somewhere else.
10 MR. SULLIVAN: What they're trying to do
11 is balance between the temperature which affects the
12 susceptibility to cracking and trying to get all this
13 work done in a manageable time frame given the
14 resources that are available to get all this kind of
15 overlay work done. I think that's more a question for
16 industry, but that's how they set up their program and
17 we thought it seemed to be a reasonable approach.
18 VICE-CHAIRMAN WALLIS: The hot leg, okay.
19 But temperature makes a big difference, doesn't it?
20 MR. SULLIVAN: Yes.
21 MEMBER MAYNARD: Yes, I would suspect that
22 with the industry's presentation, especially EPRI, I
23 see they have a presentation here. I'm not sure
24 there's a predictive tool, but I know there was a
25 process to go through to prioritize and identify the

1 potential locations and prioritize those. So I know
2 there was a process used.
3 CHAIRMAN SHACK: Yes. Just in a rough
4 sense, you look at the hottest locations where you're
5 most likely to get the cracking. You look at the
6 smallest diameters where you're most likely to violate
7 leak before break and you can almost start your
8 priority process.
9 MEMBER BANERJEE: But presumably some
10 estimates of residual stress have to be made as well.
11 I mean this obviously must come into the equation
12 somewhere.
13 CHAIRMAN SHACK: But almost all welds have
14 bad stress states from this point of view.
15 MEMBER BANERJEE: Right. So you take --
16 You put some upper bound on that.
17 CHAIRMAN SHACK: Yes.
18 MEMBER BANERJEE: And the chemistry
19 doesn't play any role in this or the history? I would
20 think that all of these would have a role, residual
21 stress, temperature, chemistry, history. I mean it's
22 not a straightforward thing to do.
23 CHAIRMAN SHACK: The chemistries are
24 fairly well -- We're on the primary side. So the
25 chemistries, they're just aggressive for these

1 materials.

2 MEMBER BANERJEE: Some history affect

3 that.

4 VICE-CHAIRMAN WALLIS: Does temperature

5 cycling make a difference?

6 CHAIRMAN SHACK: Time. Yes.

7 MEMBER MAYNARD: A number of transients,

8 a number of different operational factors.

9 MEMBER CORRADINI: Repairs of the welds.

10 CHAIRMAN SHACK: Yes. Probably the

11 biggest thing is the repairs and just how bad the

12 stress state is at the weld. MRP-106 has some

13 calculations for these particular welds that show that

14 if you don't do any repairs in the welds, the stress

15 state isn't all that aggressive. However, a weld

16 without a repair is probably a beast you will never

17 find.

18 MR. SULLIVAN: Another factor is that

19 despite the limitations with predicting the

20 inspections that are ongoing aren't going to be lock

21 step like I just talked through. If a plant has an

22 opportunity because it's pulled the core barrel to

23 inspect the cold legs and the hot legs, they're not

24 waiting until 2010 to do that work.

25 Wolf Creek, for example, has -- We found

1 these laws as mitigated the pressurizer location with
2 weld overlays and inspected the hot leg locations and
3 the cold leg locations at least at the reactor vessel
4 nozzles and they didn't find any indications. So some
5 inspections are going to ongoing between now and when
6 they have to for all these locations between now and
7 when they have to complete this program. So there is
8 some data coming in.
9 MEMBER BANERJEE: And these inspections
10 are fairly accurate?
11 MR. SULLIVAN: They're --
12 MS. CSONTOS: That's a loaded question.
13 MR. SULLIVAN: They're much better
14 inspections than were done prior to the beginning part
15 of this decade. They're based on performance
16 demonstration techniques as opposed to what we used to
17 call amplitude-based. We believe that they're as good
18 as can be made.
19 MEMBER BANERJEE: And that's the
20 difference between these?
21 MR. SULLIVAN: The difference is that
22 these under this inspection regime there are criteria
23 in terms of detection and sizing that have to be
24 satisfied with the inspectors to be qualified and the
25 procedures are put through pretty -- The procedures

1 themselves are put through rigorously demonstrations
2 to make sure the procedures can satisfy that criteria
3 and then the inspectors also have to be qualified to
4 pass certain criteria in terms of detection as well as
5 sizing.
6 MEMBER BANERJEE: It's like training a
7 radiologist or something.
8 MEMBER CORRADINI: Not paid as much.
9 MEMBER BANERJEE: I understand.
10 MEMBER BONACA: For VC Summer, they found
11 that if they augmented UT with any current they were
12 more successful because they could identify the
13 (Cough.) and then go with UT. Are they doing
14 something similar here?
15 MR. SULLIVAN: No, I don't think in
16 general they are, but in the VC Summer time frame
17 which was 2000, they weren't using PDI-qualified
18 examinations just in prior inspections. So they
19 didn't see the flaws that apparently were there.
20 To bring this back to regulatory space,
21 it's probably a lot less interesting, we obtained the
22 grievance from licensees to the kinds of actions that
23 I outlined in some of the previous view graphs. We
24 are in the process of confirming those agreements with
25 a kind of standard NRC practice of issuing

1 confirmatory action letters.

2 And I alluded a couple of view graphs ago

3 to this more advanced analyses that industry is doing,

4 their finite element fraction mechanics analyses.

5 They were described in a letter to us dated February

6 14th. We provided a response to them just Monday and

7 we had, I think, a reasonably productive meeting with

8 industry yesterday to talk about their project plan

9 and to go over a number of critical points that

10 basically define the framework, not the details, but

11 the framework for these analyses and we're going to

12 continue to interact with industry on this program to

13 follow it through to its conclusion this summer.

14 We're doing a fair amount of additional

15 analyses ourselves as Al alluded to. We're modifying

16 our code, for example, so that it basically parallels

17 the kind of software modifications that industry is

18 doing. That will enable us to do a certain amount of

19 checking of industry results and it will also allow

20 our code to be used for benchmarking purposes against

21 industry's code.

22 VICE-CHAIRMAN WALLIS: How big are these

23 pipes?

24 MR. SULLIVAN: I believe the safety and

25 relief nozzles are, at least at Wolf Creek, they were

1 8 inch OD.

2 VICE-CHAIRMAN WALLIS: And the surge line

3 is bigger than that, isn't it?

4 MR. SULLIVAN: Yes.

5 VICE-CHAIRMAN WALLIS: What is it?

6 MR. SULLIVAN: The surge line is, I think,

7 it's 14 inches.

8 VICE-CHAIRMAN WALLIS: Fourteen.

9 MR. SULLIVAN: Warren, can you clarify?

10 MR. BAMFORD: Not only 14 but there are

11 some as small as 12 and some as high as 16, I think.

12 MR. SULLIVAN: And the spray lines can be

13 as small as three as large as four generally.

14 MR. BAMFORD: Right.

15 VICE-CHAIRMAN WALLIS: And the probability

16 of the 14 inch pipe breaking predicted by the experts

17 is how much, 10^{-4} or 10^{-5} or something a year?

18 MR. SULLIVAN: I think it's something like

19 10^{-4}. Okay. I have a couple of conclusion slides

20 that are in your package. But since this was a fairly

21 short presentation, I would just be reiterating what

22 I talked about a couple minutes ago.

23 MEMBER MAYNARD: Aren't we going to learn

24 from the inspections that are going on in the spring?

25 In addition to the industry analysis, aren't we get

1 some additional information for what's found in the
2 springtime here?
3 MR. SULLIVAN: We'll get a little bit of
4 information. We talked about this on Tuesday which I
5 think is why Dr. Shack is smiling and what we --
6 CHAIRMAN SHACK: My first question.
7 MR. SULLIVAN: What we discussed was that
8 --
9 MEMBER MAYNARD: And a great question.
10 CHAIRMAN SHACK: Great question. You
11 won't like the answer though.
12 MR. SULLIVAN: There are two reasons why
13 licensees are mitigating these welds with weld
14 overlays. One of them is because it provides a full
15 structural replacement with the materials that are
16 believed to be much less susceptible to PWSCC. But
17 the second reason and it works hand-in-hand is that
18 for the most part these nozzles are, I don't know what
19 the percentage is, probably 85 percent of the time are
20 not really inspectible anyway. The licensees cannot
21 obtain the coverage which is defined in the ASME Code.
22 So these new weld overlays provide a platform and a
23 new boundary that is inspectible.
24 There are a handful. I think what we were
25 thinking was something like three or so plants are

1 able to do these inspections that are planning to do
2 them between now and the end of 2007.
3 MEMBER MAYNARD: The rest are just
4 overlay.
5 MR. SULLIVAN: Most of them are going to
6 weld overlay anyway, but there are even some plants
7 that are not planning to overlay, they just going to
8 inspect which they recognize puts them in a little bit
9 of risk because they could get into the outage, do the
10 inspections they plan and find that they now have to
11 line up a crew to do the weld overlays.
12 MEMBER CORRADINI: So I had one question
13 that kind of goes to what you were saying. You said
14 that they're going to plan to overlay and that
15 improves, unless I misheard, inspectibility. Did you
16 say that?
17 MR. SULLIVAN: What it does is it provides
18 a platform so that they can get an inspectible volume.
19 They actually can't -- It doesn't provide a platform
20 to go and --
21 MEMBER CORRADINI: Platform meaning enough
22 metal? I don't know what you mean by a "platform."
23 MR. SULLIVAN: I'm sorry. I'm using a
24 confusing term. The reason I use "platform" is
25 because it provides a flat surface for -- to ride

1 along.

2 MEMBER CORRADINI: All right. Got it.

3 MR. SULLIVAN: That's why I was using that

4 term. It doesn't mean that the new configuration is

5 such that they can now insonify both the weld overlay

6 and all of the original weld.

7 MEMBER CORRADINI: Just the overlay.

8 MR. SULLIVAN: And in most -- Unless

9 there's a cast stainless steel they can insonify and

10 look at the top 25 percent as well. That was a figure

11 that was arrived at by industry as a desirable thing

12 to do to see whether flaws are potentially propagating

13 up through the original weld and maybe approaching the

14 new weld.

15 MEMBER CORRADINI: Thank you.

16 MEMBER BANERJEE: So they are not all

17 lining up a team to be ready to take action if they

18 find something.

19 MR. SULLIVAN: Most of them are, but there

20 is like what was said on Tuesday a handful and we

21 pressed "handful" we said something like three. I

22 actually have a document here that I could look

23 through or I could --

24 MEMBER BANERJEE: The exact number is not

25 important.

1 MR. SULLIVAN: Yes, it's less than a
2 handful.
3 MEMBER BANERJEE: Okay. And in that case
4 if they found something they would just have to have
5 a prolonged outage.
6 MR. SULLIVAN: They would hopefully have
7 a prolonged outage and they would land up having to
8 line up an inspection or a welding crew and inspectors
9 because the weld overlays have to be inspected and
10 it's going to be very challenging if that happens
11 because these teams, they're just going to be
12 traveling from one plant to the other. I think their
13 schedules are all completely booked up. So it would
14 be really bad news for a plant if that happens.
15 MEMBER BANERJEE: Okay.
16 CHAIRMAN SHACK: Thank you, Ted. I
17 believe we're going to have an industry presentation.
18 Alex, are you going to give that?
19 (Off the record comments.)
20 MR. MARION: Good morning. My name is
21 Alex Marion. I'm the Executive Director of Nuclear
22 Operations and Engineering at the Nuclear Energy
23 Institute and I have with me Mr. Dennis Weakland who
24 is with Post Energy and he's chairman of the EPRI
25 Materials Reliability Program Issue Integration Group.

1 I also have a team of some of our experts sitting in
2 the back who will hopefully keep both of us out of
3 trouble and anyway, we'll be prepared to handle any
4 questions you may have. But let me just thank you for
5 the opportunity to discuss industry actions that deal
6 with the generic implications of Wolf Creek inspection
7 findings.
8 This slide represents the four areas I
9 intend to cover. We want to provide a little bit of
10 background on the Industry Inspection Guideline MRP-
11 139. We want to discuss briefly our initial response
12 to the inspection findings from Wolf Creek, provide a
13 brief overview of the finite element analysis that we
14 are working with the NRC on and discuss ongoing
15 meetings we've had with the staff.
16 Let me just say that the inspection
17 program detailed in MRP-139 is a significant element
18 of a more comprehensive, extensive industry initiative
19 that was undertaken in 2003 to position the industry
20 to be more proactive in terms of managing materials
21 degradation. And this is a commitment that's been
22 made with the industry chief nuclear officers via NEI
23 and it's a serious commitment. As we went through
24 evaluating the potential generic implications of Wolf
25 Creek, we were through February at a point where we

1 were having conference calls with the chief nuclear
2 officers two times a week at a minimum. This was the
3 chief nuclear officers representing all of the
4 pressurized water reactors and also when we became
5 more focused in terms of the 2008 plants, those
6 interactions included the chief nuclear officers
7 representing those utilities.
8 But MRP provides a structured process for
9 inspecting pressurized water reactor primary system
10 welds and it's built upon a safety assessment that's
11 been provided to the NRC that has the deterministic
12 and probabilistic approach. We assessed the margins
13 related to the onset of leakage and critical crack
14 sizes and we've considered previous industry
15 regulatory guidance and operating experience on a
16 worldwide basis.
17 And let me just clearly say that the
18 findings of Wolf Creek do not fit, if you will, our
19 experience base to date. The staff referred to that
20 as anomalous. It's just unique and it's very
21 different from anything else we had seen previously.
22 There is a review and approval process
23 associated with deviations. When we initially
24 established the schedule for these inspections we
25 recognized that that's a very high standard, a very

1 difficult schedule to implement and I'll talk about
2 that in a little more detail with another slide later
3 on. But there's an internal review process that
4 addresses deviations. But from the standpoint of this
5 inspection guidance it had been thoroughly reviewed
6 not only through the advisory structure, the materials
7 reliability program, but it was also reviewed by the
8 chief nuclear officers because of the extensive
9 resource commitment that was associated with
10 implementing this guidance.
11 Just briefly, the guidance contains an
12 inspection regime to manage degradation as we go
13 forward. The intent was to establish a baseline of
14 the condition of the butt welds consistent with ASME
15 Appendix 8 demonstrated techniques and we initially
16 focused the initial phase of the effort on the high
17 temperature welds, specifically in the area of the
18 pressurizer and as I said earlier, we've established
19 extremely aggressive implementation schedules.
20 Let me just say the first phase for the
21 pressurizer locations was identified as having to be
22 completed by December 31, 2007. We could have very
23 well picked April 2008, June 2008 or January 2009. We
24 felt we had a legitimate technical basis to support
25 those, but we chose 2007 and we recognized that not

1 everyone could accommodate that and that's why we
2 established the deviation process which is a very
3 disciplined process to justify deviating from that
4 implementation schedule and that process is analogous
5 to what's allowed in NRC's Regulation 10 CFR 50.55(a)
6 related to alternatives to meet the code requirements.
7 This slide represents the complete
8 schedule of activities for implementing MRP-139. As
9 you can see, this program extends through 2010.
10 Initial phase, as I mentioned before, focuses on
11 pressurizer locations and just to indicate if you look
12 at these dates and consider 18-month and 24-month
13 outage schedules and recognize that MRP-139 was issued
14 in August 2005. This is March 2007. So we recognized
15 that not everybody could meet December 31, 2007. As
16 I said before, that's why we established the deviation
17 process.
18 There was a little discussion in the staff
19 presentation about the factors that contribute to
20 primary water stress corrosion cracking and there are
21 three factors. One is susceptible material and we all
22 know we have that. The second is stresses during the
23 manufacturing of the piping and the application of the
24 welds and also to stresses induced by the operating
25 conditions of a nuclear power plant and also the

1 environment and the environment of course includes
2 temperature and to some extent water chemistry.
3 In terms of the Wolf Creek pressurizer
4 locations, the next couple slides just -- I provide a
5 little synopsis of what happened at Wolf Creek. The
6 examination that that utility was pursing --
7 VICE-CHAIRMAN WALLIS: Presumably this
8 schedule is flexible. I mean you have four years of
9 schedule here. But if you find something in the first
10 year, this is going to presumably modify what you do
11 in the second, isn't it?
12 MR. MARION: Absolutely. We're prepared
13 to revise this schedule based upon inspection
14 findings.
15 I just wanted to point out that the Wolf
16 Creek examinations were consistent with what was
17 recommended in MRP-139. I believe the staff indicated
18 that the industry had provided a number of documents
19 recently that captured our evaluation of the Wolf
20 Creek inspection results. We also completed a survey
21 and provided that to the NRC, I think, in February
22 that captured the status of inspection activities to
23 date and we have had a number of public meetings with
24 the staff. As I mentioned before, we've had a number
25 of extensive interactions with the chief nuclear

1 officers to try to address or try to develop a
2 consistent approach to dealing with this issue going
3 forward.
4 CHAIRMAN SHACK: Alex, just on that
5 question, is there a consistent approach whether
6 people are going to be doing inspections before they
7 do the overlays or if you're planning to do the
8 overlay, you just do the overlay and do the inspection
9 afterward to demonstrate that you have your
10 insonification.
11 MR. MARION: I think Ted Sullivan gave you
12 a really good explanation of what's involved. There
13 are only three plants that we know of today that are
14 planning to do inspections prior to any kind of
15 mitigation activity. They'll pursue mitigation if the
16 inspection indicates that there's a -- inspection
17 results and some indication.
18 All of the other plants for the reasons
19 that Ted described are going directly into mitigation
20 with a structure weld overlay primarily because they
21 can't meet the NRC requirements to do an adequate PDI-
22 qualified or ASME Section 11.
23 CHAIRMAN SHACK: I thought Ted was saying
24 there were three that were going to do inspections
25 without necessarily committing to mitigation. I was

1 sort of wondering whether people who were doing
2 mitigation were just doing inspections so we would
3 have a better idea, for example, of the incidence of
4 cracking in alloy welds. It would be useful
5 information.
6 MR. WEAKLAND: For most plants, you have
7 an uninspectible geometry.
8 CHAIRMAN SHACK: Okay. It's just that.
9 MR. WEAKLAND: So these plants happen to
10 have an inspectible geometry and it gives them more
11 flexibility of when they may want to do mitigation or
12 if they need to do mitigation. For plants with an
13 uninspectible geometry, you really don't have much
14 choice.
15 VICE-CHAIRMAN WALLIS: Are you going to
16 make it inspectible when you put the overlay on?
17 MR. WEAKLAND: Yes.
18 VICE-CHAIRMAN WALLIS: So you might then
19 discover some things that you couldn't see before.
20 MEMBER CORRADINI: No, because they can't
21 see as far down, I guess.
22 MR. WEAKLAND: You only see the 25 percent
23 of the existing.
24 CHAIRMAN SHACK: He can inspect the
25 overlay. He can't inspect the original weld.

1 VICE-CHAIRMAN WALLIS: But you can't see
2 all the way in?
3 MR. WEAKLAND: No.
4 VICE-CHAIRMAN WALLIS: So you'll never
5 know until -- Not never, but you won't know for an
6 awful long time what the state is of the original
7 weld.
8 MR. WEAKLAND: That's true.
9 MEMBER ABDEL-KHALIK: So it's quite
10 fortuitous that these things were first observed at
11 Wolf Creek simply because they had a sort of an
12 inspectible joint.
13 MR. WEAKLAND: You could take that
14 approach. But I don't know if I could call
15 fortuitous. These were indications. They are
16 ultrasonic indications. We've dispositioned. It has
17 given us reason for concern and why we want to
18 maintain our aggressive schedule.
19 MEMBER ABDEL-KHALIK: But after 69 PWR
20 fleet, there are only four plants according to what
21 you're saying that have an inspectible geometry.
22 MR. WEAKLAND: No, there are more than
23 that that I'm aware of. There are three that I know
24 we're planning to inspect. Craig. Craig's very
25 familiar with this information.

1 MR. HARRINGTON: Again, Craig Harrington
2 with EPRI. We did work through the survey in November
3 and December trying to understand everyone's plans,
4 how inspectible they felt they were, whether they
5 intended to do inspections before mitigation. There
6 are -- It's three or four plants that have some number
7 of welds this year that they are going to inspect in
8 the spring and fall outages. That may be one or two
9 welds. It may be all the welds, the six welds. It
10 varies. Some of them they've already inspected.
11 CHAIRMAN SHACK: As I read the White
12 Paper, I get two numbers. One says you get 31 nozzles
13 that are inspected. The other says that 42 are
14 inspected and I'm not sure why there's a difference.
15 It may be the 31 really meet the fully coverage and
16 the 42 mean you've looked at them and you have some
17 fraction of coverage on the 42 minus 31. But it's
18 about somewhere between 10 and 15 percent of the welds
19 that we've looked at.
20 MR. HARRINGTON: I think that's an
21 accurate representation. At the end, it is a
22 relatively small percentage of the total population
23 and it's scattered around plants.
24 MEMBER CORRADINI: That can be looked at.
25 MR. HARRINGTON: That can effectively meet

1 PDI exam requirements.

2 MEMBER CORRADINI: So let me ask the

3 question differently. Of those that can be looked at,

4 they all will be looked at.

5 MR. HARRINGTON: I don't know that you can

6 make that statement.

7 MEMBER CORRADINI: Okay. I think that's

8 Bill was going. I was just trying to understand.

9 MEMBER BONACA: And yet I think it would

10 be important to understand if this is anomalous

11 characterization of these cracks is really anomalous

12 and yet if we don't inspect, we'll never know.

13 MR. WEAKLAND: There are some plants that

14 have performed what would be considered non-PDI

15 qualified examinations meaning that they did not get

16 the extent of coverage to be acceptable under the code

17 PDI requirements. I know for instance one of my

18 plants is like that.

19 MR. MARION: One of the challenges here is

20 that the inspection requirements changed. I think it

21 was in 2004 NRC incorporated ASME Section 11 Appendix

22 8 which represented the most sophisticated inspection

23 technique we refer to as performance demonstration

24 initiative inspection protocols. And so that has a

25 specific requirement relative to coverage and a lot of

1 utilities can't meet that coverage requirement. So
2 they can't do an inspection and take credit for it
3 under NRC's regulatory expectations. That's part of
4 the difficulty here.
5 VICE-CHAIRMAN WALLIS: I'm just trying to
6 assess what's the probability that among these 30 or
7 whatever they are non-inspected that there might be
8 something like a Wolf Creek. It's not a negligible
9 number, is it?
10 MR. MARION: We don't believe that's the
11 case.
12 VICE-CHAIRMAN WALLIS: Why is it that
13 they're all so sure that they're not like Wolf Creek?
14 MR. MARION: Well, we provided analysis to
15 the NRC justifying this inspection regime indicating
16 that we had sufficient time to execute or implement
17 the inspections by the schedules that have been
18 identified without compromising safety or compromising
19 plant risk.
20 VICE-CHAIRMAN WALLIS: If you've inspected
21 17 percent the Chairman said or something and you
22 found one, then what's the probability you're going to
23 find one in the remaining 83 percent?
24 MR. MARION: I believe, Craig, that's
25 something we're looking at as part of this evaluation

1 of the generic implications, isn't it? Aren't we
2 looking --
3 VICE-CHAIRMAN WALLIS: It seems to me to
4 be fairly significant probability unless there's some
5 other evidence.
6 MR. HARRINGTON: We have done some
7 probabilistic analysis of how that might propagate
8 into the rest of the plants. If we were to inspect
9 every weld, what might we expect to find? Of course,
10 it's a somewhat limited data set, but I looked at the
11 numbers. It's 47 nozzles that we expect to have
12 inspected prior to mitigation when we're finished with
13 pressurizers. Thirty-one of those have been inspected
14 to meet PDI requirements thus far. So it's not an
15 insignificant population that's been looked at, but
16 still trying to predict the whole --
17 CHAIRMAN SHACK: Bigger than Mr. Gallo
18 takes anyway.
19 MR. HARRINGTON: That's true.
20 MEMBER ABDEL-KHALIK: You've made a point
21 of making the statement that the findings at Wolf
22 Creek do not fit the experience base. Now where did
23 you get that and what is it that you're trying to say
24 by making that statement?
25 MR. MARION: Our evaluations to date and

1 our understanding of primary water stress corrosion
2 cracking does not fit, if you will, the indications
3 that were found at Wolf Creek.
4 MEMBER ABDEL-KHALIK: So you're not saying
5 that these indications are not real or impossible to
6 find --
7 MR. MARION: Those are indications and we
8 unfortunately do not have a sample of the metal to do
9 a metallurgical analysis to definitely establish what
10 kind of indications they were and what the size,
11 depth, etc. was.
12 MR. SIMS: This is William Sims, Energy
13 Operation. The expected indication is that it will be
14 axial because of the higher hoop stresses. But going
15 back to the question about inspections, all of these
16 welds will be inspected after the overlay. We will
17 inspect the weld overlay itself and at least 25
18 percent of the OD surface of the base material and the
19 existing weld. So if there are some further issues
20 out there, we should see them and that's PDI-
21 qualified. You can actually see below the 25 percent,
22 but it's not a qualified process after that point.
23 MEMBER ABDEL-KHALIK: Thank you.
24 MR. MARION: Okay. In terms of the
25 advanced finite element analysis work that we're

1 doing, our objective is to determine margin between
2 leakage and rupture and the approach is to provide
3 reasonable assurance that we have sufficient time
4 between the onset of leakage and rupture. We had --
5 VICE-CHAIRMAN WALLIS: How does that
6 support the staff's conclusion at Wolf Creek that
7 quite a few of these were going to rupture very soon
8 after leakage?
9 MR. MARION: I'm sorry. I'm missing.
10 VICE-CHAIRMAN WALLIS: I think that the
11 staff's slides showed that in the Wolf Creek case they
12 were predicting rupture very soon after leakage or
13 simultaneously with leakage.
14 MR. MARION: Yes.
15 VICE-CHAIRMAN WALLIS: You're saying here
16 that you're going to provide assurance that's
17 sufficient time exists between leakage and rupture.
18 MR. MARION: Yes.
19 VICE-CHAIRMAN WALLIS: It doesn't seem to
20 be quite consistent with what the staff was saying.
21 MR. MARION: Well, the staff analysis was
22 somewhat conservative and they had to make some
23 assumption given that we weren't able to fully
24 characterize the indications that were found at Wolf
25 Creek. And we feel that with this finite element

1 analysis we can do an improved job of addressing some
2 of the assumptions that are necessary. We're going to
3 hopefully get NRC endorsement of our approach and
4 methodology and we're reasonably confident that we can
5 come up with some demonstration of additional margin
6 between the onset of leakage and pipe rupture.
7 In terms of the analysis, the crack shape
8 remains semi-elliptical as it grows through the weld
9 thickness. This is the area of conservatism that we
10 have. So as we go through refining the analysis, we
11 think that we can allow the stress intense factored at
12 each point along the crack and its development in
13 terms of the shape of the flaw or the shape of the
14 crack. We intend to evaluate the specific indications
15 that were identified at Wolf Creek and let me just
16 point out that one of the challenges we have is trying
17 to get an understanding of what the depth of that
18 indication was because the inspection technique was
19 qualified for detection and sizing but not for depth.
20 So there was an assumption of the depth of the flaw.
21 And I believe -- I'm trying to remember if
22 Ted said it this morning, but it was stated at the
23 Subcommittee meeting on Tuesday that the indications
24 that we've seen in the locations are relatively
25 consistent in depth sizing which is another unique

1 trait compared to our experience base relative to
2 PWSCC. So there are a lot of questions about what
3 actually exists at Wolf Creek and that's one of the
4 challenges that we need to work on with the staff in
5 terms of how do we integrate that into this finite
6 element analysis. We intend to perform sensitivity
7 studies and we have a peer review effort under with
8 the team to provide us input on dealing with some of
9 the quantified assumptions that need to be made in
10 conducting this analysis.
11 MEMBER KRESS: Alex, just what is the
12 relationship between the stress intensity factor, the
13 K, and the local shape of the curve of the crack?
14 MR. MARION: I'm an electrical engineer.
15 So I'm going to have to defer.
16 MEMBER KRESS: Are they related to the
17 curvature?
18 MR. MARION: I'm going to have to defer to
19 one of our experts in the back. Please.
20 MR. RICCARDELLA: I'm Pete Riccardella.
21 I'm not actually doing the analysis, but I'm a member
22 of the peer review panel. The analyses that have been
23 performed to date both by the NRC staff and the
24 industry assume a fairly standard approach which is a
25 semi-elliptical crack shape and that's just because

1 that's mathematically convenient to analyze.

2 MEMBER KRESS: With the K constant all

3 along the whole thing.

4 MR. RICCARDELLA: No. Actually, that

5 analysis calculates 1 K at the deepest point of the

6 crack.

7 MEMBER KRESS: The deepest point.

8 MR. RICCARDELLA: And 1 K, a second K, at

9 the surface where the semi-ellipse intersects the

10 surface and then propagates the whole ellipse based on

11 the rates of those two points. Those two points turn

12 out to be very, very conservative because you have

13 high residual stresses on the surface. So that drives

14 the K at the surface very high and then, of course,

15 the deepest point, you have the through-wall crack

16 propagation. You have a deep crack. So you're taking

17 the two fastest crack growth rates and assuming that

18 this whole ellipse propagates at the rate that those

19 two points would tell you.

20 The way the industry, this new analysis,

21 more sophisticated, is a finite element analysis which

22 will look at the K at point for point along the crack

23 surface and propagate each point as it would want to

24 go based on the stress intensity factor correlation.

25 MEMBER KRESS: My question was what is the

relationship that gives you the K at each point on the curve. What is that relationship?

MR. RICCARDELLA: That's based on a finite element model where you can go into the model and do what's called a J integral at each point and determine the K at each point along the crack surface. That comes directly out of the finite element analysis.

CHAIRMAN SHACK: There's no simple relationship.

MEMBER KRESS: This is a stress intensity factor.

MR. RICCARDELLA: Yes.

MEMBER KRESS: Isn't that determine by the crack shape at that point?

MR. RICCARDELLA: Yes. But the finite element model models the crack shape and so the K --

MEMBER KRESS: Yes, but isn't --

CHAIRMAN SHACK: He's thinking it's a purely local property.

MEMBER KRESS: I'm looking at it as the local property, yes.

CHAIRMAN SHACK: It's the kind of integral overall crack shape or local geometry and the overall stress field and unless you can really do influence functions in your head, it's very difficult to --

1 MEMBER KRESS: So why am I going to
2 believe this new calculation?
3 CHAIRMAN SHACK: They're going to
4 benchmark it.
5 MEMBER KRESS: With a calculation that's
6 exactly like it.
7 MR. RICCARDELLA: No. Also with
8 experimental work where it's available and field data
9 where available.
10 MEMBER KRESS: Okay. You're going to have
11 that in time to --
12 MR. RICCARDELLA: The experimental work
13 already exists. We're going to compare it against
14 experimental.
15 MEMBER KRESS: You have experimental that
16 already exists.
17 CHAIRMAN SHACK: Some experimental work.
18 VICE-CHAIRMAN WALLIS: Does that go for
19 one crack? There's not multiple cracks.
20 MEMBER BONACA: Are you looking at
21 multiple cracks?
22 VICE-CHAIRMAN WALLIS: There's not a crack
23 that grows, eats up another crack and joins with
24 another crack.
25 MR. RICCARDELLA: One of the sensitivity

1 studies in the analysis program is to look at multiple
2 cracks in this model, yes.
3 MEMBER ABDEL-KHALIK: I assume that this
4 analysis requires some kind of an initial condition to
5 be well-defined and if you indicate that there is
6 uncertainty about the crack depth found at Wolf Creek,
7 how is the initial condition for this analysis
8 defined?
9 MR. RICCARDELLA: The initial cracks we
10 will use a variety of initial crack sizes that will
11 encompass with time reaching the Wolf Creek
12 configuration and then we'll see how they continue to
13 grow.
14 MEMBER ABDEL-KHALIK: So when the staff
15 presented results indicating times between link and
16 break, what sort of initial conditions did you assume
17 in those analyses?
18 MR. SULLIVAN: We just used the initial
19 conditions based on the measurements that were given
20 to us by the Wolf Creek inspection personnel.
21 MEMBER ABDEL-KHALIK: But they're saying
22 this is one of their biggest uncertainty in as much as
23 all the measurements indicate that all the cracks have
24 the same depth.
25 MR. SULLIVAN: Right. But that was the

1 best information we had to go on at the time.

2 MEMBER MAYNARD: On the uncertainty part

3 of this, the cracks, I don't believe there's any

4 uncertainty as to the cracks may be bigger. I talked

5 to the people who did it and they're totally confident

6 that what they were saying was absolute bounding. It

7 could be considerably smaller than that, but not any

8 bigger than what they had characterized as their fault

9 from an uncertainty standpoint.

10 CHAIRMAN SHACK: But again because we're

11 dealing with a sample from a population, you're going

12 to have to make sensitivity studies that looked at

13 range of these crack sizes and it wasn't clear from

14 the Subcommittee meeting just how one was going to

15 come to the acceptance criteria. I think -- I believe

16 that the real hope is that when they introduce what

17 seem to be reasonable elements, departures from non-

18 axi-symmetry, that for a very wide range of starting

19 conditions they're going to be able to demonstrate

20 leak before break and I think that's the real hope

21 from the analysis that as soon as you begin to include

22 any kind of reasonable departure from axi-symmetry

23 you'll demonstrate a leak before break margin despite

24 all the other uncertainties that you still have. But

25 again, I think you really won't know that until you

1 begin to see some of the results of the analysis.

2 MR. RICCARDELLA: I think a significant

3 aspect of this when we were talking about the semi-

4 elliptical shape, where we talk about time between

5 leakage and rupture, what really determines rupture is

6 how much of the cross-sectional area is lost. So if

7 you're assuming that's always semi-elliptical, you're

8 making a fairly conservative assumption in terms of

9 the amount of cross-sectional area that's lost if, in

10 fact, the crack is shallow over most of its front and

11 just deep over a short portion of it.

12 MEMBER ABDEL-KHALIK: You know, my concern

13 is that you're sort of hanging your hat on this

14 analysis and we don't even know the initial condition

15 for which the analysis should be done. So I'm not

16 sure how much doing this analysis will reduce the

17 uncertainty as to what to expect during the two or

18 three or four year period of this inspection program.

19 MEMBER KRESS: What -- Given a rupture

20 type at this location, it looks like the conditional

21 core damage should be what? About 10^{-3} per year?

22 CHAIRMAN SHACK: Yes.

23 MEMBER KRESS: That translates into a

24 probability, say you have a year's time between now

25 and shutdown, the 10^{-3} --

1 CHAIRMAN SHACK: Per plant.

2 MEMBER KRESS: Per plant. Now if you
3 assume a conditional containment failure of 0.1,
4 that's a 10^{-4} probability. Isn't that an acceptable
5 LERF? It meets the QHOs because the QHO of 1 X 10^{-5}
6 was meant for about 100 plants over 40 years. Now
7 here we have less than 50 plants over a year's time/.
8 Isn't that an acceptable probability for this same
9 case assuming a rupture probability of one?

10 MEMBER BONACA: In the industry that
11 wouldn't be.

12 MR. RICCARDELLA: And clearly the rupture
13 probability in the next year isn't one.

14 MEMBER KRESS: Yes. Of course, it's not.

15 MR. RICCARDELLA: The 41 plants that we
16 looked at in the statistics --

17 MEMBER KRESS: I'm trying to arrive at a
18 reason for delaying shutdown inspection if I don't
19 believe the calculations. The only other criteria I
20 can use, I think, is risk. My question is is that an
21 acceptable risk now. Now I know you don't want to
22 have core damage.

23 MEMBER BONACA: You don't want to have a
24 rupture.

25 MEMBER KRESS: I don't even want to have

1 a rupture.

2 MEMBER BONACA: We're looking at new

3 reactors here.

4 MEMBER KRESS: But you're not going to

5 have a rupture. You know it and I know it, but --

6 VICE-CHAIRMAN WALLIS: Well, I don't know

7 it. There's a probability associated with it.

8 MEMBER KRESS: Sure.

9 CHAIRMAN SHACK: A CDF of 10^{-3} normally

10 falls into our unacceptable region.

11 MEMBER KRESS: Yes, but that's 10^{-3} --

12 CHAIRMAN SHACK: Now you have to decide

13 how much --

14 CHAIRMAN SHACK: But that's 10^{-3} for a

15 plant that's going to operate for 40 years.

16 MEMBER BONACA: That's condition.

17 MEMBER KRESS: We've talked about short --

18 CHAIRMAN SHACK: He's thinking a rupture

19 probability of one.

20 MR. RICCARDELLA: Yes.

21 MEMBER KRESS: We talked about short-term

22 risk as it doesn't have to be the same long-term risk.

23 MR. MARION: We did a probabilistic

24 analysis to support the time frames for this

25 inspection program and I think Mr. Riccardella's

1 organization did that.

2 MEMBER KRESS: You did one of those.

3 MR. MARION: And I think our values were

4 on the order of 10^{-8}, weren't they, in terms of core

5 damage?

6 MR. RICCARDELLA: Yes, but the NRC

7 questioned some of the assumptions in the analysis.

8 But clearly, the probability of a rupture in the next

9 18 months or so is not one. It's significantly less

10 than that. And, Bill, to answer another question --

11 MEMBER KRESS: But we don't know what the

12 probability is.

13 MEMBER POWERS: I guess I don't

14 understand. I just heard somebody tell me that 20 out

15 of 24 cases and things like that that there was no

16 time between leak and rupture, I mean, for a variety

17 of calculations. So why would I conclude that -- I

18 mean, why do I know that there's not going to be a

19 rupture?

20 MEMBER KRESS: I don't think we know the

21 probability.

22 MEMBER POWERS: You said you knew it and

23 that Jack knew it.

24 MEMBER KRESS: Intuitively.

25 MEMBER POWERS: Well, intuitively.

1 MEMBER KRESS: But I don't really know it.
2 MEMBER POWERS: So now I'm asking you how
3 do you know that it's less one.
4 CHAIRMAN SHACK: Less than or equal to
5 one.
6 VICE-CHAIRMAN WALLIS: Tom, you're losing
7 credibility. Next time you say you know something I'm
8 going to take it with a grain of salt.
9 MEMBER MAYNARD: Let me make a comment on
10 that please.
11 MEMBER KRESS: I didn't base any of my
12 conclusions on that. I said given a rupture in a
13 standard risk. So I didn't use that information even
14 though --
15 MEMBER MAYNARD: I believe that overall
16 safety is better served by sticking to the schedule
17 that is there for several reasons. First of all,
18 moving the spring of '08 into somehow 2000 (sic),
19 we're not talking about a significant amount of time.
20 But by doing that, you're creating quite a
21 perturbation to the whole industry and to the people
22 who actually do the work, do the inspections, do the
23 weld overlays and I'm not sure you get the same
24 quality of work as when you do it with the --
25 MEMBER POWERS: I heard the same thing

1 prior to Davis-Besse. It was almost identical --

2 MEMBER MAYNARD: I'm sorry. I think there

3 are some real considerable differences. At Davis-

4 Besse, there was a indication of leakage and there

5 were many other factors that fall into that. I

6 believe that for these plants again, you're not

7 gaining that much time and I believe that rushing it

8 creates additional problems.

9 In addition, I believe that all these

10 plants, if something were to happen, it falls within

11 the accident analysis that's out there. We're not

12 creating a new accident that's not covered by the

13 current design basis accident, I don't believe.

14 MEMBER BONACA: Those accident have behind

15 them an implication of frequency even in the current -

16 - approach and that's an element that we don't

17 understand. What's the probability that we don't

18 know? That's the issue. So the consequences may be

19 within the bound and I think it's more than anything

20 else the benefit of the industry. Right now, we have

21 plans for a lot of new plants. If you have a break in

22 there, then those plants will fly out the window.

23 MR. MARION: Pete, did you want to add

24 something to this?

25 MR. RICCARDELLA: Just on this question of

1 the probability of an actual barrier. There was a
2 probabilistic analysis that was presented in the White
3 Paper that we presented and, you know, there were 49
4 data points in which nozzles of this type were
5 inspected. The reason for the difference between 41
6 and 32, Bill, is that the 41 includes some overseas
7 plants and includes some non-pressurizer nozzles like
8 drain lines and things like that in which haven't been
9 inspected and in which creaks were found.
10 Of those 41, over 20 were clean, had
11 nothing. Another 10 or 12 had just axial cracks. And
12 there were only a handful like six or seven that had
13 circumferential cracks.
14 CHAIRMAN SHACK: I didn't think the number
15 difference between seven and ten was all that large
16 and to demonstrate that it's predominantly axial --
17 MR. RICCARDELLA: I'm not saying, but
18 clearly, if you plot those, the Wolf Creek indications
19 are in the tails of that distribution.
20 VICE-CHAIRMAN WALLIS: It's six out of 41.
21 It's not insignificant.
22 MR. RICCARDELLA: But most of those six
23 were smaller and the Wolf Creek cracks, if you look at
24 them in terms of lost cross-sectional area, they were
25 clearly in the tails of that distribution. So there

is some evidence that even though you wouldn't say that it's an anomaly, it is in the tails of the distributions and then you look at what crack size would actually cause a failure and you can estimate some probabilities of a rupture occurring which are clearly on the order of 10^{-3}, I think, or less even if we take into account the most conservative assumptions. So you take the 10^{-3} and then the 10^{-3} core damage probability and you're in the 10^{-6} range I think.

MR. MARION: This slide just provides an overview of some of the parameters that are going to be evaluated in the calculation of this enhanced finite element analysis and we already touched on many of these.

In summary, I would like to say that or I will say rather that the materials initiative is successful to this particular point in time, recognizing that we are in an initial phase, if you will, of the inspections of primary systems welds and we are going to continue the inspection program through 2010 and make adjustments accordingly based upon the inspection results that are identified along the way.

MRP-139 provides an aggressive inspection

1 baseline program. By the end of this year, 70 percent
2 of the pressurizer dissimilar metal welds will have
3 been inspected or mitigated. We are working with the
4 NRC as we said previously on further analysis to show
5 reasonable assurance that you will have a leakage
6 prior rupture.
7 Our estimate is to complete the analysis
8 by late June and we had a technical meeting with the
9 staff yesterday to begin the initial exchange of
10 information and discussion on some of the technical
11 issues. We focused on the issues that were identified
12 in a letter that we received from the NRC. It was a
13 positive meeting. We're looking forward to working
14 with the staff to complete this analysis and we'll be
15 more than happy to brief this committee this summer
16 when the results are available if you so desire.
17 In conclusion, we fundamentally believe
18 acceleration of the implementation schedule that I've
19 discussed in our earlier slides is unnecessary. The
20 fact remains that given the operating experience and
21 the data that we have on an international basis we've
22 only had four very small leaks that have been
23 identified.
24 From a risk point of view or risk
25 perspective, we see no difference between inspecting

1 now and the spring 2008 for the initial exams. We
2 intend to monitor the spring 2007 inspection results
3 in the spring as well as in the fall. And as Ted
4 Sullivan indicated, the industry has implemented a
5 very conservative enhanced leakage monitoring program
6 as a compensatory measure to be in place until such
7 time that inspections and mitigation activities are
8 completed. This applies to the plants who have not,
9 if you will, completed their activities to date.
10 That completes the presentation I have.
11 We will be more than happy to any additional questions
12 from the Committee.
13 MEMBER POWERS: It seems to me that the
14 enhanced leakage monitoring is more of a key than the
15 risk analysis here.
16 MEMBER KRESS: If one believes leakage
17 before break.
18 MR. MARION: That's correct. Yes, as part
19 of that program as Ted indicated, there are action
20 levels that call for the utilities to basically
21 evaluate and try to identify the source of
22 unidentified primary system leakage within a certain
23 time frame and if that cannot be done, then the plant
24 is to shut down and do a bare metal visual inspection
25 and that's rather extremely conservative and it goes

1 well beyond the current requirements in the plant
2 technical specifications, but the utilities involved
3 in this effort have agreed that that's an important
4 compensatory measure that needs to be put in place.
5 MEMBER ABDEL-KHALIK: And how are these
6 changes codified?
7 MR. MARION: These changes to the leakage?
8 MEMBER ABDEL-KHALIK: Tech spec action
9 items.
10 MR. MARION: They're not codified per se.
11 The utilities have submitted letters to the NRC
12 committing to implement that program and as Ted
13 indicated in his presentation, the NRC probably over
14 the next week and a half, two weeks, is going to
15 provide a confirmatory action letter for each plant.
16 MEMBER POWERS: That's pretty codified
17 right there and that's serious.
18 (Several comments.)
19 MR. SULLIVAN: And they were also captured
20 in plant procedures. This is Ted Sullivan.
21 MR. MARION: Okay. Very good. Thank you
22 very much.
23 CHAIRMAN SHACK: Thank you. We are a
24 little bit ahead of schedule. Well, I'm not sure. We
25 have time for discussion, but I think we've probably

1 discussed as much as we have. There is some question
2 as to whether a letter is required. Do you want to
3 say anything about that, Ted or Michelle?
4 MS. EVANS: Yes. This is Michelle Evans.
5 I'm the Division Director of Division and Component
6 Integrity in NRR. I guess at this point we're not
7 looking for a formal letter at this point in the
8 process. We're interested in keeping you engaged over
9 the next several months as the industry goes on with
10 their analysis and we are engaged and we have the
11 Office of Nuclear Regulatory Research also engaged in
12 that process. So there is a possibility we would
13 request a letter later in the summer. But at this
14 point, we're not looking for a letter.
15 MEMBER ABDEL-KHALIK: When will this
16 advanced finite element analysis be completed?
17 (Several answer "June.")
18 MR. HARRINGTON: The current schedule
19 would have those results completed around the end of
20 June.
21 MEMBER BANERJEE: Is there any
22 experimental work going on at all?
23 MR. HARRINGTON: Experimental of what
24 sort?
25 MEMBER BANERJEE: I mean, if this is an

1 unexpected finding is there any sort of -- I'm just
2 trying to understand. Is it sufficient just to do
3 analysis or should we be doing some experiments?
4 MR. HARRINGTON: We are contemplating and
5 I think likely will fund some mock-up testing to try
6 to generate additional relevant data on welding
7 residual stresses in a virgin, unrepaired weld as well
8 as repaired welds. That program hopefully will get
9 under way shortly and would not generate results quite
10 -- I mean, it would be a little bit past that analysis
11 time frame, but late summer, we would start seeing
12 results from that.
13 MEMBER POWERS: I think, at the
14 Subcommittee, they indicated that there were
15 experimental data that could be used to validate the
16 modeling approach already in hand.
17 MR. HARRINGTON: There is some as was
18 commented earlier. It's limited. It's a varied data
19 set, but we are working to identify all the possible
20 avenues of that kind of validation for the analysis.
21 MEMBER BANERJEE: One of the things that
22 was said, I think, was the fact that circumferential
23 rather than longitudinal was unexpected. Is this sort
24 of what you would conclude from the available
25 experimental data that it was unexpected?

1 MR. HARRINGTON: That statement is based
2 on stress analysis. It's based on operating
3 experience. The stresses would tend to drive a crack
4 typically in the axial direction, but with weld
5 repairs, you do get much more complicated stress
6 patterns that could drive it at least locally in the
7 circumferential direction. But the operating
8 experience has largely been observation of axial flaws
9 in these kinds of materials.
10 However, when we developed 139, the
11 evaluation of just axial flaws and the presumption
12 that that is the most likely condition would have led
13 us to essentially little or not inspection program
14 other than what was already there. The decision was
15 made that notwithstanding those conclusions that it's
16 maybe unlikely or not expected that we would see large
17 circ flaws. That was the condition that we had to
18 evaluate and that was the condition that we had to
19 inspect for and, in fact, in MRP-139 a poor inspection
20 coverage for axial flaws is not a particular concern.
21 Poor inspection coverage for circumferential flaws is
22 a failure of the inspection and a non-compliance with
23 meeting the requirements and forces you to do more
24 work. So despite the fact that we didn't expect it,
25 the whole program is built around that kind of flaw.

1 MEMBER BANERJEE: I'm more trying to
2 understand. Is the understanding that this arose due
3 to some sort of a stress distribution that arises from
4 welding and, if so, is there some way of being able to
5 predict this and, if not, should there be an
6 experimental program in place to understand what the
7 stress distribution is?
8 MR. HARRINGTON: There has been analytical
9 evaluations of those stress conditions. I think in
10 BWR space they did some work on residual stresses from
11 welding, welding repairs. There has been work over
12 time, but in this whole problem as I think Ted and Al
13 alluded earlier, maybe the most unknowable factor is
14 the welding residual stresses. There is just way too
15 many variables in how those welds were produced and
16 there's an infinite number of combinations that you
17 could evaluate either analytically or experimentally.
18 So we're working to try to find ways that
19 we can bound that problem both analytically and
20 possibly experimentally as well. But we're also
21 dealing with the fact that left to the current
22 schedule in about 14 to 16 months pressurizers are
23 going to be done in this country and this will no
24 longer be an issue because they will have already been
25 either inspected per PDI requirements in those cases

1 where it's practical to do that or they will have been
2 mitigated.
3 MEMBER BANERJEE: How do you know first
4 that it won't happen after the inspection unless you
5 have some tool?
6 MR. HARRINGTON: There is a reinspection
7 interval. This is not a one-time program. The
8 inspection program does have a reinspection period
9 that if you do not mitigate you continue inspecting on
10 a fairly frequent basis.
11 MR. BAMFORD: (Off microphone.) Yes. Let
12 me add to that. The overlay has another benefit
13 besides adding additional metal. (On microphone.)
14 This is Warren Bamford from Westinghouse. The overlay
15 has another benefit that really hasn't been discussed
16 this morning in addition to adding additional metal
17 and that is it produces a clamping action on the pipe.
18 So it causes the inside surface of the pipe to go into
19 compression.
20 Even if there were a small flaw existing
21 in the pipe, it would be in a compressive stress area
22 and nothing would happen to it. So that's why it's
23 really called a mitigation in addition to a repair.
24 I think that's an additional action, an additional
25 advantage, of the overlay process that hasn't been

1 emphasized.

2 MR. HARRINGTON: On the current schedule

3 of inspections which would finish around April of '08,

4 we will have -- I can't remember the number offhand.

5 It's over 90 percent of the welds on the pressurizers

6 will have been not only inspected but mitigated either

7 in most cases through a weld overlay, in a few cases

8 through the mechanical stress improvement process

9 which also accomplishes the same change in stress

10 state on the ID surface that Warren just described.

11 MEMBER KRESS: I don't see how an overlay

12 produces compression to a circumferential. I see how

13 it would on an axial. That's a little more difficult

14 to put compression on circumferential.

15 (Off the record discussion.)

16 MR. RICCARDELLA: There are a couple of

17 effects and there's a lot of analyses. There's a

18 document called MRP-169 that we've submitted that

19 discusses the whole concept and a lot of analyses.

20 But the key is you have to make the overlay fairly

21 long. If you made it short, you're correct. You

22 would have some tensile stresses. But by making it

23 long, you get axial shrinkage and then you also get a

24 thermal effect that goes on, too.

25 MEMBER KRESS: I can see how that -- You

1 don't have much length on the nozzle side to the
2 pressurizer.
3 MR. RICCARDELLA: No, but we generally --
4 The length is set by what -- One of the requirements
5 for length is how long it has to be to achieve the
6 residual stress reversal.
7 MEMBER KRESS: But with respect to using
8 existing data to benchmark the new model, the most
9 sensitive influencing parameter seems to me like it's
10 the residual stress distribution. I'm at a loss as to
11 how you ever measure that, how you ever know what it
12 was and when it comes to finding a bounding value, I
13 think the bounding value will be fact dependent. I
14 mean you have to change it with time or something. It
15 depends where the crack is initially to get a bounding
16 value. I don't know how you're going to work that,
17 but maybe you know. Maybe you've given it some
18 thought.
19 MR. RICCARDELLA: There has been a lot of
20 analysis and testing of residual stresses under
21 various conditions including repairs and we can just
22 look at the distribution and --
23 MEMBER KRESS: I don't know how. I'm at
24 a loss to measure residual stress.
25 CHAIRMAN SHACK: Having measured residual

1 stresses and welds for a number of years.

2 MEMBER KRESS: What do you use? A strain

3 gauge?

4 CHAIRMAN SHACK: Yes. You don't have much

5 left of the weld by the time you're done.

6 MEMBER KRESS: Okay. You start cutting.

7 Okay. It's Heisenburg Principle.

8 CHAIRMAN SHACK: It's not a nondestructive

9 evaluation.

10 MEMBER KRESS: You have a Heisenberg

11 Principle. Your experiment destroys the --

12 CHAIRMAN SHACK: I've looked at admissive

13 welds. I've looked overlay welds. I've looked at

14 butt welds and --

15 MEMBER KRESS: What do you look at when

16 you cut it out?

17 CHAIRMAN SHACK: You're making strain

18 measurements.

19 MEMBER KRESS: Strain measurements.

20 CHAIRMAN SHACK: Right. And as Pete says,

21 they have been used to benchmark the analyses. The

22 real problem with Sanjoy's question is I think we can

23 actually predict residual stresses and welds

24 reasonably well if you know what the boundary

25 conditions are. The problem is that in many of these

1 cases you really don't know how many. The records on
2 the repairs are kind of sketchy. So there's a wide
3 distribution, but it's not infinite.
4 MEMBER KRESS: It depends on how hot it
5 got and how fast it cooled off.
6 CHAIRMAN SHACK: Yes.
7 MEMBER KRESS: And the constraints.
8 CHAIRMAN SHACK: The constraint are
9 actually an extremely critical situation. The more
10 highly constrained the weld is the bigger the stress
11 is that you can make in it.
12 MEMBER ABDEL-KHALIK: Now the first and
13 most significant conclusion in Mr. Marion's
14 presentation is that acceleration of the
15 implementation schedule is unnecessary. Is this
16 conclusion independent of the results of the advanced
17 finite element analysis?
18 MR. MARION: This is Alex Marion. That
19 conclusion is based upon our understanding of primary
20 water stress corrosion cracking in this location based
21 upon the experience and the knowledge that we have to
22 date. So it is independent of the analysis that we're
23 performing.
24 MEMBER ABDEL-KHALIK: So is there any
25 possible result that advanced finite element analysis

1 can produce within the wide range of possible results
2 that could cause you to change that conclusion?
3 MR. MARION: We're prepared to deal with
4 the results that come out of the analysis and if they
5 indicate that we need to make changes to that
6 conclusion and changes to the detailed aspects of the
7 inspection program we have in place, we will do so.
8 CHAIRMAN SHACK: I thought there was an
9 agreement with you and the staff that if the results
10 of the analysis were not considered acceptable that
11 you would, in fact, accelerate the schedule.
12 MR. MARION: Absolutely. That commitment
13 has been made by the utilities who have current plans
14 for 2008.
15 MEMBER ABDEL-KHALIK: Will we have an
16 opportunity to see the results of this advanced finite
17 element analysis and the conclusion as to whether or
18 not acceleration of the schedule is appropriate?
19 MR. SULLIVAN: I think we sort of have
20 tentative plans for schedule further Subcommittee
21 meetings if that's the level at which we do it.
22 CHAIRMAN SHACK: Yes. The answer is if we
23 want to we certainly will.
24 MEMBER CORRADINI: Can I ask a question
25 back to what Sanjoy was asking? Sanjoy was asking

1 about research experiments on residual stress. I'm
2 more interested in is the industry satisfied with the
3 inspection method. That is, it would seem to me that
4 you're going to have this continual aging problem with
5 various components and a lot of it is things related
6 to cracking and materials. Is that method of
7 inspection that you're using now that will then, if I
8 understand it correctly, be used with the overlays
9 going out further because you're going to have to
10 continually inspect this stuff? Are you satisfied
11 with it? What is the industry -- Or are you working
12 with the NRC in developing more enhanced inspection
13 methods so you can actually tell what's there?
14 Because my feeling is you're never going to know what
15 your bounding conditions are, but you could develop
16 more advanced methods to look at what you have as you
17 continually age these plants because most of these
18 will go into life extension. So what's the plan there
19 and if this is not the venue for that, I'd like to
20 include that on a discussion when we have this next
21 meeting relative to the advanced analyses because to
22 me, the inspection is the key and advanced methods to
23 inspect.
24 MR. MARION: I agree with you about
25 inspection being the key. The inspection methodology

1 is an evolving process, if you will. We have vendors
2 who are developing new probes, etc. The capability of
3 those probes to detect flaws is being reviewed and
4 evaluated in a program that we have with EPRI. So
5 that methodology is evolving. But as of this
6 particular point in time, I think the industry is
7 comfortable with the technology that we currently
8 have.
9 As a matter of fact, there's a new
10 inspection probe that's being used this year called
11 the "phased array" that's basically improving the
12 inspection technique and that's being integrated into
13 the overall process. And I can't say what it's going
14 to be like in 2010.
15 MEMBER CORRADINI: I understand.
16 MR. MARION: But there will be some
17 techniques that will be in play. But at this point in
18 time, we're satisfied with what we currently have.
19 MEMBER CORRADINI: I guess to follow on
20 what Said and Sanjoy said I would like to add
21 something like this. If we're going to have another
22 presentation about this, I would like to know more
23 about looking forward.
24 CHAIRMAN SHACK: Inspection technique.
25 MR. MARION: That would have to be a

1 completely separate discussion because I'm not sure we
2 could give it adequate coverage in half an hour or
3 something like that. But we would be more than happy
4 to support that.
5 MEMBER MAYNARD: Have there been any
6 discussions or plans if somebody else finds a
7 circumferential crack indication of anything different
8 that might be done as far as talking about taking a
9 sample if a plant finds that or has there been any
10 discussion on that?
11 MR. MARION: That's one of the options
12 that, of course, that's being considered. One of the
13 activities we have in place is to do a lessons learned
14 through each inspection cycle. Now we had an effort
15 to capture lessons learned from the fall 2006
16 inspections and that's being integrated into our
17 activities going into the spring. At the end of the
18 spring, we're going to capture lessons learned and try
19 to integrate that into the fall. A lot easier said
20 than done, but we recognize that we need to do that.
21 As my information indicates, I believe
22 there's only plant that's planning to do inspection
23 this spring and we've had discussions with the
24 personnel of that plant to make sure they understood
25 what the options were depending upon what they find.

1 Dr. Shack, if I may. In terms of the
2 letter from this Committee, I was kind of surprised at
3 the staff request and I recognize this Committee is
4 not here to serve the industry, but it would really
5 help if we could get some kind of an indication from
6 the Committee as to the reasonableness of the approach
7 that we're taking on this finite element analysis.
8 We're not asking for review and approval. We just
9 want some indication that this makes sense, if we can
10 get that in something.
11 VICE-CHAIRMAN WALLIS: I think we'd have
12 to see the finite element and more details of the
13 analysis itself and how it treats the temperature and
14 the chemistry and things like that. I don't know at
15 the moment how good this finite element analysis is.
16 MR. MARION: I'm not asking for that. I'm
17 asking for the approach that we're taking, does that
18 make sense, details notwithstanding.
19 CHAIRMAN SHACK: What they're getting rid
20 of is this artificial constraint that crack always
21 grows as an ellipse.
22 VICE-CHAIRMAN WALLIS: But do you know how
23 to predict crack growth with this environment?
24 MR. MARION: I believe we do.
25 CHAIRMAN SHACK: I think that we have data

1 to demonstrate that.

2 VICE-CHAIRMAN WALLIS: I think there's a

3 lot of scatter in that.

4 CHAIRMAN SHACK: Those are uncertainties

5 that have to be addressed.

6 MEMBER BONACA: Buy the path is the

7 correct path.

8 CHAIRMAN SHACK: I think it's a

9 substantial improvement to have a realistic crack

10 shape growth rather than the artificial. Whether it

11 turns out to be conservative or non-conservative is a

12 different question. But it's certainly an artificial

13 constraint that the crack growth is an ellipse.

14 VICE-CHAIRMAN WALLIS: This is affected by

15 history. We have a lot of in-flows and out-flows in

16 the surge line and temperature changes. Does this

17 influence this crack growth?

18 MEMBER BONACA: Yes.

19 VICE-CHAIRMAN WALLIS: Quite a few things

20 that can influence the crack growth.

21 MEMBER POWERS: And it's on the list.

22 CHAIRMAN SHACK: You get a large degree of

23 scatter. But again, I think whether they can

24 demonstrate this in the face of all the uncertainties

25 they have is an open question because I think it's a -

1 - I personally think it's an interesting approach.

2 VICE-CHAIRMAN WALLIS: It's interesting

3 but --

4 CHAIRMAN SHACK: We'll be considering.

5 MR. MARION: All right. Thank you.

6 MEMBER ABDEL-KHALIK: But without

7 presenting the details, I'm not sure the Committee can

8 give an informed opinion as to the validity of the

9 analysis.

10 MEMBER BONACA: It wouldn't be that.

11 MEMBER ABDEL-KHALIK: And absent the

12 results of the analysis, I'm not sure the Committee

13 can give an informed opinion as to whether or not the

14 current schedule is appropriate.

15 CHAIRMAN SHACK: Matter for discussion.

16 Yes. Any further comments at the moment? Okay.

17 We'll take a break until 10:30 a.m. Off the record.

18 (Whereupon, the foregoing matter went off

19 the record at 10:19 a.m. and went back on the record

20 at 10:32 a.m.)

21 CHAIRMAN SHACK: On the record. Our next

22 topic is proposed revisions to the Standard Review

23 Plan Sections covering Sections 15.0, Accident

24 Analysis and 15.9, BWR Core Stability and I guess

25 that's you, Sanjoy.

1 MEMBER BANERJEE: Right. We heard about
2 both of these standard review plans at the Thermal
3 Hydraulic Subcommittee Meeting last week and 15.9 is
4 going to go first because it's a little bit, I think,
5 shorter in terms of what the discussion will be in
6 this presentation and then we'll follow up with 15.0.
7 Now 15.9 really is addressing BWR
8 stability issues and it was previously covered under
9 SRP 4.4, Thermal Hydraulics Design. The objective is
10 to provide guidance to reviewers to ensure compliance
11 with GDC 10 and GDC 12 related to stability and
12 specifically, it will address acceptance criteria for
13 these what are called LTS Systems, suppress stability
14 and related generic issues. It's specifically also
15 will exclude ATWS which is covered under 15.8.
16 So with that, the Subcommittee really
17 didn't identify any major generic or other issues.
18 But we'll let Dr. Huang and March-Leuba tell us a
19 little bit about it.
20 DR. HUANG: This is Tai Huang from Reactor
21 Systems branch and I like Sanjoy mentioned in query
22 about a story of these standard review plans 15.9 BWR
23 stability and this is the new section of the NUREG-
24 0800, Standard Review Plan, for review of SECY
25 analysis report on nuclear power plants. Previously,

1 the stability was mentioned in the Standard Review
2 Plan 4.4 and only one term, so-called thermal
3 hydraulic stability evaluation in the area of review
4 and one paragraph in one of the review criteria. So
5 that's only two areas you know the stability in the
6 previous SRP 4.4.
7 And today, this SRP 15.9, a new section of
8 this standard review plan, we were going to have this
9 applicable to these operating plans, new plan and also
10 extended operation domain. And with today's BWR
11 stability, you have a potential of monitoring the
12 acceptable fuel design limits and also with the effect
13 of day-to-day operational BWRs. As you know today the
14 BWR operation, they're going to have more operating
15 domain and then also the fuel design is different. So
16 the detail we're following in that the slides on that
17 we're going to explain that later.
18 As far the regulatory requirements, GDC 10
19 for the reactor design and also the GDC 12 suppression
20 of the reactor oscillation bolts are mostly important
21 in that regulatory requirement to the base and why we
22 need this 15.9 as today for the BWR stability is there
23 is a long term solution that has the dedicated
24 protection system function today developed and
25 available. And stability can have significant impact

1 on the operation because you have an exclusion reason,
2 bigger or smaller, depending on your design conditions
3 and you have to have a specialized calculation
4 required to determine how big this exclusion reason as
5 you design. Specific guidance provided for issues
6 identified result in operating reactors. For example,
7 there are long-term solutions already results in what
8 data. We're going to explain that and generic
9 criteria that are applicable to new fuel and extended
10 operating domain and new reactors are provided in this
11 15.9.
12 And as you know in our long period of
13 experience and an effort between the NRC and industry,
14 this slide shows the history of BWR events back in
15 1970 in Vermont Yankee events and tests. And
16 following that in 1986, there's a Generic Letter 8602
17 and following that 1988 is LaSalle Events and they
18 keep going after LaSalle Event, there's the NRC
19 Bulletin 88-07 that highlight that the funding for the
20 power oscillation from LaSalle's two units.
21 And later on 1988, there's a Generic
22 Letter Part 21 come from GE to show that MCPR may be
23 violated if 10 percent APR is used as criteria for
24 manual scram.
25 And keeping going to the 1991 to 1993, the

1 effort between the NRC and industry to develop these
2 long-term solutions. So there's a generic topical
3 report from Owner's Group NEDO 31960 and also there is
4 a supplement and then 1992, there's a WNP-2 Event and
5 then the staff had a team to inspect the site and they
6 wondered what's going on there. So there is an
7 Information Notice 92-74. You can find out the detail
8 of what's going on there.
9 And then up to 1994, there is a Generic
10 letter 9402 and that's to require a long-term solution
11 for each BWR reactor. There's INPO SER 07-00 about in
12 the 1994 time frame and this tells us that from the
13 previous instability event and the lesson learned.
14 And then because the generic application
15 for long-term solution, so they said GE Part 21 DIVOM
16 issue came out there because the generic development
17 is a generically a DIVOM curve. But the reactor core
18 is quite different, different operations, so the
19 generic curve may not be applicable. So the Part 21
20 shows the plant-specific DIVOM should be provided for
21 plant-specific application.
22 And then 2003 there is Nine Nile Point-2
23 Event. And there is the long-term Option 3 parameters
24 insensitive. This is a lessons learned from Nine Mile
25 Point-2. And then there is Perry Event 2004. So this

1 is the time frame and then the history to show the
2 effort between the NRC and industry.
3 And following that, I will have Jose to
4 explain the need for these.
5 MR. MARCH-LEUBA: Good morning. I'm am
6 Jose March-Leuba. I'm a consultant to the staff on
7 issues of instability.
8 I wanted to start with this slide which we
9 spent last week probably ten minutes discussing and
10 the lesson I wanted to get to you is that BWR fleet
11 has stability. They are aware of stability. They
12 deal with it day-to-day and it really affects
13 operations on the day-to-day.
14 What I show here is a power-to-flow
15 operating map. Here we have a circulation line and
16 this is APRM flow scram. This type of figure is
17 contained on the COLR report in every plant and they
18 all have this region in red. That region in red which
19 is the most prominent thing on the map when you look
20 at it, it's because of instability. The region in
21 green is where one of these long-term solutions,
22 Solution 3, and can cause you scrams. So the
23 operators are really aware of the stability and this
24 is an improvement of over 15 or 20 years ago when they
25 didn't even know stability was a problem.

1 So this is actually to justify also why we
2 have a complete new SRP 15.9 as opposed to one
3 paragraph in 4.4. The review that COPR was mostly
4 density-wave instability which when you talk about the
5 stability of power, that's what we're worried about.
6 That's the one that has real potential of causing
7 SAFDL violations.
8 And there are three modes of instability
9 in density-wave. You have the core-wide, the regional
10 and the channel. In the core-wide, the whole core
11 moves up and down and it's the one that you would be
12 expecting to have when you have an oscillation in
13 flow, an oscillation in fraction and an oscillation in
14 power, all of them in phase.
15 On the regional mode, however, half of the
16 core goes up and the other half goes down. You have
17 what is called power channel oscillation. So you have
18 a slushing from side to side. The problem with
19 regional mode, that's the one that causes all these
20 long-term solution effects is that the scram system is
21 an average of a number of LPRMs which are distributed
22 through the core and you average the left side with
23 the right side. Whenever you have a large
24 oscillation, you really don't see LPRM oscillation.
25 The calculations show that before even you have a very

1 large oscillation in the local channels, you will not
2 reach the scram set point or by the time you reach the
3 scram set point, you certainly have violated CPR.
4 You can have a single channel oscillating
5 thermal hydraulic event by itself. But that is really
6 considered to be an accident and it has happened a
7 couple of times in foreign reactors and it can be
8 happening if you have a channel that is not properly
9 aligned and you have leakage at the entrance from the
10 channel.
11 The SRP also recognizes there are other
12 types of instabilities besides density-wave. The most
13 important one is the control system instabilities in
14 which case a controller goes out of tune and the way
15 to solve that one is to send a technician and to fix
16 it. And the SRP also recognizes that there are
17 design-dependent instability modes, for example, for
18 passive ESBWR. You would worry about the start-up and
19 achieving low pressure.
20 We also spent probably 15 minutes on this
21 slide last week. This again shows the power-to-flow
22 map circulation line and here is the 100 percent
23 power, 100 percent flow operating point which is
24 what's called the original license thermal power and
25 this is the normal 100 percent roll line.

1 Most reactors pre-EPU have been operating
2 not at this point but at this point because you are
3 allowed to have some flow maneuverability to account
4 for burn-up and -- mostly burn-up. So you can control
5 reactivity with increasing the flow and you still
6 maintain 100 percent power. So most reactors were
7 allowed to operate at this point.
8 When EPU came along, what they did is they
9 extended the role line all the way to here, so that
10 essentially the operating conditions power-to-floor
11 ratio remained an EPU at about the same conditions as
12 you were before pre-EPU. So it was just an extension.
13 Now what problem they're finding the EPU plants is
14 they don't have any flow window to compensate for the
15 burn-up day-to-day and most EPU plants have to change
16 control rods almost every other week which happens is
17 they're operating here and on the weekend, they have
18 to go down in power where they can move control rods
19 and go back in power again. So what they're trying to
20 move to and you will see this next month is something
21 called MELLA+ in which they regain the operating
22 flexibility on flow so that they can compensate with
23 burn-up without having to remove control rods.
24 Another advantage is the more you move to
25 the left the higher your spectrum is and you can gain

1 some plutonium production that gives you more time to
2 refuel. So it's good for everybody economically
3 speaking.
4 The red line shows the stability bounding
5 and this is a representative line of constant decay
6 ratio equal to one. If you were to the right of this
7 line, any operating point here, power-to-flow here,
8 you are stable. If you are on that side, you are
9 unstable and there are lines of constant decay ratio
10 to this side. For example, 0.8 would be like this.
11 The decay ratio 0.6 would be like that.
12 On the left side, then a limit cycle, once
13 you become unstable, a limit cycle develops and you
14 have lines of constant amplitude of the limit cycle as
15 you move into it. So the farther you move into the
16 unstable region, the larger your limit cycle is going
17 to be.
18
19 MEMBER CORRADINI: Can I ask a question
20 back to that?
21 MR. MARCH-LEUBA: Yes.
22 MEMBER CORRADINI: So if I go to the right
23 of the red line as you said 0.8 --
24 MR. MARCH-LEUBA: 0.6.
25 MEMBER CORRADINI: 0.6, whatever, it just

1 means the damping becomes more enhanced if I generate
2 an oscillation.
3 MR. MARCH-LEUBA: Correct. Well, if you
4 perturb it externally.
5 MEMBER CORRADINI: If I perturb it with
6 some sort of forcing function it will die away
7 quicker.
8 MR. MARCH-LEUBA: Correct.
9 MEMBER BANERJEE: But based on linear
10 analysis usually, right?
11 MR. MARCH-LEUBA: On the right side is
12 linear analysis. On the left side is not linear.
13 MEMBER BANERJEE: You know, there are many
14 situations where finite amplitude analyses show
15 instability whereas linear analysis doesn't.
16 MR. MARCH-LEUBA: That is correct. If you
17 have a perturbation that's large enough, you can have
18 -- And we're going to spend -- As I told you last
19 week, this should be a semester, not a 50-minute
20 presentation and indeed this line becomes a --
21 MEMBER CORRADINI: Are you teaching the
22 course?
23 MR. MARCH-LEUBA: I've done it before.
24 I've talked for two weeks once and I talk fast.
25 CHAIRMAN SHACK: Long story. I was afraid

1 of that.

2 MR. MARCH-LEUBA: I have a blackboard and

3 I know how to use it.

4 MEMBER APOSTOLAKIS: You are better than

5 we are.

6 MR. MARCH-LEUBA: In the interest of time,

7 let's get moving and if you have any questions, please

8 I love questions.

9 There are two types of instability events.

10 One, you can reach the unstable region by increasing

11 the power or reducing the flow. When you increase the

12 power, you do it two ways. You either pull control

13 rods or you have a sump cooling transient. Both of

14 these things are low in nature and therefore these

15 types of instability events result always in very

16 small amplitude of oscillation which are reversible.

17 If you pull the rod and the oscillations are started,

18 you insert the rod and the oscillations go away and

19 that has happened.

20 (Off the record comments.)

21 The type of instability that we really --

22 that the long-term solution is trying to prevent is

23 the flow reduction event in which you're operating up

24 here and suddenly you lose your recirculation pumps

25 and you end up down there, to the instability area and

1 then you will have a large amplitude limit cycle which
2 can indeed produce oscillations that can give you a
3 CPR violation.
4 Because of that, a couple of decades ago
5 right after the LaSalle Event which was a flow
6 reaction event, the industry and the staff started a
7 very large effort in producing what is called the
8 long-term solutions and a number of solutions were
9 developed back then which are categorized in two
10 types. One of them is prevention in which you limit
11 the operating domain so that you can not be unstable.
12 You will never operate at a low flow which is low
13 enough so instability will develop and that's called
14 Option E1A. And then you have the detect and suppress
15 solutions if oscillations are developed and the detect
16 and suppress solutions are Option II and Option III.
17 Last week, I have Option 1D as a prevent
18 one and after our comments, I make it as a mix.
19 Option 1 is a mixed one in which you protect one
20 instability mode by region, the original, and then you
21 do have a flow by a scram which is a detect and
22 suppress. All these options were developed by the BWR
23 Owners Group and they are publicly available. Many
24 will probably change hands and you have to change a
25 Solution 1A to a III, but it's publicly available.

1 Because we are moving into this expanded
2 operative domains like MELLA+, some of these options
3 may not -- Actually, we know Option III does not work
4 for MELLA+ and therefore the venders are getting into
5 proprietary, new options like DSS/CD for General
6 Electric which has already been approved and enhanced
7 Option III which is under review and this will be
8 proprietary.
9 The problem with the new operating domains
10 as you see if you operate now in the MELLA+ corner and
11 you lose your recirculation pumps you end up much
12 further into the instability domain and you cross it
13 during the pump run-back. So you have several effects
14 which affect the makeup on Option III inapplicable.
15 We did have a lot of fun last week and we
16 did talk for three to four hours about this. It was
17 very lively and they told us today to take the
18 Subcommittee word for ours, that they didn't have any
19 problems after those three hours. But I wanted to
20 reinforce to the Subcommittee that we listened to your
21 suggestions and we have made some changes the SRP.
22 One of the problems the Subcommittee had
23 was the definition of "reasonably prompt" as applied
24 to operator actions, how do you define that and we
25 have replaced that in the final SRP with as

1 accomplished within the two minutes that allow for
2 operator action in the demonstration calculations. So
3 if the operator can do the actions required of him
4 within two minutes which is the amount of time we
5 assume for the calculations, then this is okay.
6 VICE-CHAIRMAN WALLIS: What is the
7 consequence if he doesn't?
8 MR. MARCH-LEUBA: If he cannot do it, then
9 it's not an approvable long-term solution. Then you
10 cannot take credit for operation action. Then you
11 have to put an automatic action.
12 VICE-CHAIRMAN WALLIS: But suppose you
13 have a reactor and he doesn't do it. Suppose he waits
14 for three minutes. You have this run-back or whatever
15 you have.
16 MEMBER KRESS: You have oscillations.
17 VICE-CHAIRMAN WALLIS: Oscillations.
18 MR. MARCH-LEUBA: Potentially you have a
19 large oscillations and you --
20 VICE-CHAIRMAN WALLIS: Is there fuel
21 damage?
22 MR. MARCH-LEUBA: You will have a CPR
23 violation. But in the laboratory domain we assume
24 fuel damage but there really is not. There is a
25 significant margin. Beyond that because of the nature

1 of the oscillations, there's periodic dry-out and re-
2 wet, dry-out and re-wet every two seconds. So getting
3 to dry-out --
4 VICE-CHAIRMAN WALLIS: In terms of a PRA,
5 you would be predicting fuel damage and you would be
6 predicting core damage.
7 MR. MARCH-LEUBA: It will depend on the
8 particular analysis. It assumes CPR 1 equal fuel
9 damage and that's GDC 10 tells us. The industry has
10 tried to go beyond that.
11 VICE-CHAIRMAN WALLIS: We get to look at
12 this when we look at MELLA+, don't we? We're going to
13 do that in April or something.
14 MR. MARCH-LEUBA: April 16th, I believe.
15 We'll revise that again.
16 MEMBER MAYNARD: Now is this is a new
17 operator action or is this an existing operator action
18 that has to be depleted quicker?
19 MR. MARCH-LEUBA: Because this is an SRP
20 which happened to come, a revision of the SRP, it's a
21 new SRP, in the middle of new reactor emphasis on the
22 staff, on the agency. We have tried to make an effort
23 to make it applicable to future cases and as such, we
24 have placed some criteria what would apply to long-
25 term solutions for a future reactor. And that's where

1 this comes along. So whenever Areva or whoever
2 submits a new long-term solution if they take credit
3 for the operator in that solution it had better be
4 within two minutes.
5 MEMBER BANERJEE: Does this also do
6 something -- We haven't heard about MELLA+, but are
7 you trying to cover some eventuality there?
8 MR. MARCH-LEUBA: Yes, because we have
9 done the MELLA+ review.
10 MEMBER BANERJEE: Right.
11 MR. MARCH-LEUBA: We are documenting the
12 staff position that has been taken on this SRP so we
13 can do it in the future and the industry knows what
14 our position is. The SRP is good for two things.
15 We did have a lively discussion again on
16 the term "approved methodology." The SRP said thou
17 shall use approved methodologies when you do analysis
18 and it did -- if we don't do that in reality because
19 some times it is not an approved methodology that can
20 do the analysis that is required. So we went in
21 through those cases. We intended to handle them as an
22 exceptions and we clarified on the SRP with this
23 sentence, "In cases where an approved methodology is
24 not available, the staff may accept the use of other
25 methodologies based on the results of analysis." So

1 there is some flexibility for the staff to do an
2 analysis that needs to be done and there is no
3 methodology approved. And we certainly corrected
4 some typographical errors.
5 DR. HUANG: This is the summary of this
6 presentation. The staff concludes SRP 15.9 provide
7 adequate guidance and criteria on long-term solution
8 for operating reactors, new reactor and future design
9 changes and operating domain changes. So that's our
10 conclusion of this presentation.
11 MEMBER BANERJEE: Just one point we had
12 brought up which related to ESBWR. The matter of flow
13 regime instabilities which you said that they had
14 actually done some detailed studies with fine
15 nodalization which we had requested and shown that
16 this wasn't an issue. Right? And we haven't seen
17 that and I don't think we need to see it. We just
18 want to be assured though that those eventualities
19 would be covered under the SRP in the sense that the
20 reviewer would ensure that there was reasonable
21 assurance of that type of instability being excluded.
22 MR. MARCH-LEUBA: The SRP addressed the
23 generic and reminds the reviewer that --
24 MEMBER BANERJEE: All instabilities should
25 be.

1 MR. MARCH-LEUBA: Yes. Density wave has
2 been analyzed to death and we know the solution and
3 that's most of the SRP describes and it reminds the
4 user, the SRP reminds the user, whether it be the
5 industry or the reviewer, that all these things are
6 possible and you have to look at them.
7 MEMBER BANERJEE: And this may require
8 some fine nodalization studies to assure yourself.
9 MR. MARCH-LEUBA: Absolutely.
10 MEMBER BANERJEE: And I think we haven't
11 seen that from the vendors yet.
12 MR. MARCH-LEUBA: You have not seen that
13 because the SER for ESBWR is due at the end of this
14 month.
15 MEMBER BANERJEE: All right.
16 MR. MARCH-LEUBA: And I don't know when
17 the schedule is. I think you'll see it in the June
18 time frame, I believe.
19 MEMBER MAYNARD: Just from a regulatory
20 standpoint from what I understand this doesn't impose
21 any new requirements on licensees. This is a way of
22 evaluating and approving various solutions to maybe
23 some of the issues that they're dealing with. It's
24 not really imposing a new requirement on an operating
25 reactor.

1 MR. MARCH-LEUBA: The SRP does not impose
2 any requirements whatsoever.
3 MEMBER MAYNARD: And I understand.
4 MR. MARCH-LEUBA: In particular 15.9, what
5 it does is documents what the staff has already been
6 doing for the last 20 years.
7 MEMBER ABDEL-KHALIK: Just for the record,
8 I have looked at 15.8 inasmuch as it deals with the
9 BWR ATWS stability issue and for that particular
10 issue, 15.8 is adequate.
11 MR. MARCH-LEUBA: Yes.
12 MEMBER BANERJEE: There is a broader issue
13 as to whether we should review it separately which you
14 will speak to the whole 15.8.
15 MEMBER ABDEL-KHALIK: Later on, we will
16 come to that.
17 MEMBER BANERJEE: Thanks both of you for
18 a valuable presentation. So I think, Bill, should we
19 move on to 15.0 then?
20 CHAIRMAN SHACK: Yes.
21 MEMBER BANERJEE: Thanks a lot. I think
22 the next presentation will be on 15.0 and Mr. Miranda
23 will make it. Briefly, this is a revision of a 1996
24 document, again in 0800 and has objectives of
25 clarifying various event categories and acceptance

1 criteria. It classifies events into two categories,
2 AOOs and postulated accidents. Only two and it
3 stipulates that it shouldn't propagate from AOOs to
4 postulated accidents. ATWS is in a separate class
5 here.
6 MEMBER BONACA: But it creates the AOOs in
7 two categories.
8 MEMBER BANERJEE: No, it doesn't. It's
9 supposed to, as you will see, the sort of novel parts
10 of it which caused us a lot of controversy and
11 discussion was one that you don't have to consider
12 AOOs coincident with single failures. Secondly, in
13 coming to the sort of guidance it looks at the
14 principle, if it can be called a principle, but a
15 principle of constant risk and we'll let Mr. Miranda
16 talk about that.
17 So the Subcommittee really felt that the
18 first issue was really an important one and we want to
19 really see what the main Committee thinks about it.
20 Okay. I think that will be interesting.
21 MR. MIRANDA: Thank you. My name is Sam
22 Miranda. I'm a technical reviewer in NRR, Reactors
23 Systems branch, and this work is the result of the
24 work of other reviewers as well as myself in Reactors
25 Systems branch, namely George Thomas and Gene Hsii and

1 Lambrose Lois and Summer Sun.

2 Chapter 15.0 is the Introduction to the

3 Chapter 15 SRP sections which deal with the various

4 events of Chapter 15 and we're going to talk about the

5 AOOs, the Anticipated Operational Occurrences and this

6 first bullet here is the definition taken from the

7 GDCs from Appendix A of 10 CFR Part 50. We see that

8 AOOs are "conditions of normal operation which are

9 expected to occur one or more times during the plant

10 lifetime." And that is the definition we want to

11 apply in the SRPs. I'll talk a little bit more about

12 this later.

13 MEMBER APOSTOLAKIS: These -- You have to

14 have at least other things, don't you?

15 MEMBER BANERJEE: They have.

16 MR. MIRANDA: We have some examples.

17 MEMBER APOSTOLAKIS: This is just a

18 guidance how they define it. Yes?

19 MEMBER BANERJEE: Yes.

20 MR. MIRANDA: We want to include also in

21 the introduction Chapter 15.0, the Acceptance Criteria

22 for the AOOs. If we're going to define accidents in

23 various categories, we want to put in the acceptance

24 criteria that correspond to those categories.

25 And another item from the GDCs, in fact

1 several GDCs, an AOO is required not to cause fuel
2 damage. The way they state it is "an AOO shall not
3 cause acceptable fuel design limits to be exceeded"
4 and the way we interpret that requirement is that if
5 acceptable fuel design limits are exceeded as
6 indicated by D&B ratio, then that fuel is judged to
7 have failed.
8 So we want to apply the GDC definitions of
9 AOO and postulated --
10 VICE-CHAIRMAN WALLIS: As we discussed,
11 all this under the review plan is full of "shalls,"
12 "shall not exceed." It doesn't say anything about 95
13 percent probability. Are you going to address that
14 somewhere? All these are absolute prohibitions.
15 "Thou shalt not exceed" something. It doesn't say
16 anything about probability of exceeding it. Are you
17 going to address that today?
18 MR. MIRANDA: I can tell you that in the
19 subsequent chapters of SRP that they go into more
20 detail as to what --
21 VICE-CHAIRMAN WALLIS: What "shall not"
22 means.
23 MR. WERMIEL: Sam, let me give it a try.
24 Dr. Wallis, this is Jared Wermiel. I'm the Deputy
25 Director of the Division of Safety Systems in NRR.

1 When we use the word "shall" in the standard review
2 plan, we are taking criteria that would come directly
3 from a requirement and that implies to us either a GDC
4 or something in the regulations. When we use the word
5 "should" we are establishing the staff's criteria as
6 applied to that particular aspect, but it's not
7 directly drawn from a requirement of a regulation or
8 a general design criteria.
9 VICE-CHAIRMAN WALLIS: That's not my
10 question though. When you say "shall not exceed,"
11 that implies it shall never exceed and I understand
12 that the staff allows LOCA analyses to use to the so-
13 called 95/95 method.
14 MR. WERMIEL: There are specific criteria
15 in 10 CFR 50.46 that talk about use of realistic
16 analysis for design basis LOCAs.
17 VICE-CHAIRMAN WALLIS: With very high
18 probability.
19 MR. WERMIEL: And we defined "high
20 probability" as 95/95 confidence.
21 VICE-CHAIRMAN WALLIS: All right. But
22 this SRP says "shall not."
23 MEMBER BONACA: (Inaudible.)
24 VICE-CHAIRMAN WALLIS: All the "shall
25 nots" appear throughout this whole SRP.

1 MR. WERMIEL: I guess without some context
2 for the use of the word "shall." Sam is talking about
3 AOOs, anticipated operational occurrences.
4 VICE-CHAIRMAN WALLIS: "Shall" appears all
5 of this place.
6 MR. WERMIEL: I hope we're using "shall"
7 as I said in the context of a requirement drawn from
8 the regulations.
9 VICE-CHAIRMAN WALLIS: I don't think
10 that's the case on page seven but we'll get to that if
11 we get to that. That was one of the questions we
12 raised at the Subcommittee. I don't see it on the
13 slides. That's why --
14 MEMBER BONACA: Yes, because here the
15 criterion would be D&B. So the question is how you
16 apply the criterion D&B and looking at 95/95. Where
17 is it written? That's the question. Is it written in
18 following sections? This is the introduction.
19 MR. MIRANDA: Yes, this is just the
20 introduction and the following sections address all of
21 that and they indicate, for example, that "fuel has
22 considered to have failed if it doesn't meet the 95/95
23 D&B arm limit." In fact, 95/95 D&B arm limit has to
24 correspond to acceptable fuel evaluation model which
25 has been reviewed.

1 VICE-CHAIRMAN WALLIS: That does not imply
2 that you can predict with 100 percent certainty
3 whether or not these limits will be exceeded.
4 MEMBER BONACA: No.
5 MR. MIRANDA: This is a requirement.
6 VICE-CHAIRMAN WALLIS: It implies that you
7 can enforce it.
8 MEMBER BONACA: But it defines later on in
9 a different section what it means.
10 VICE-CHAIRMAN WALLIS: Okay. We'll get to
11 that later on.
12 MR. MIRANDA: What you see so far, the
13 bottom bullet here, is taken straight from the GDC.
14 This is the language they use.
15 MEMBER BANERJEE: It's a question of how
16 you interpret that language, I guess.
17 VICE-CHAIRMAN WALLIS: It's a bit like the
18 Bible. "Thou shalt not do various things."
19 MEMBER APOSTOLAKIS: The GDCs were written
20 an long time ago.
21 VICE-CHAIRMAN WALLIS: I know, but they
22 have to be interpreted sometime.
23 MEMBER APOSTOLAKIS: Before rationalism.
24 (Off the record discussion.)
25 MR. MIRANDA: And finally, we're going to

1 take this opportunity with this revision to simplify
2 and clarify some of the items in the SRPs, especially
3 the acceptance criteria.
4 This is a summary of how we got here.
5 MEMBER BONACA: So you divide the AOOs
6 into two groups, water frequency and frequency.
7 MEMBER BANERJEE: But there is no
8 distinction made between those if they are combined.
9 MEMBER BONACA: They are, of course, in
10 the same. This is why I'm pointing it out because for
11 PWRs, you don't do that. The infrequent events you're
12 allowed to have some fuel damage.
13 MR. MIRANDA: That's right and that is not
14 the requirements. That came from ANS standard that
15 was written in 1973 and it was withdrawn in 1998. And
16 the SRPs had not recognized infrequent events. About
17 the closest we came to that was in Reg Guide 1.70. So
18 what we're doing in this revision is we're returning
19 to the regulations to the original definitions.
20 MEMBER APOSTOLAKIS: Of what used to be
21 moderate frequency and flow frequency now is AOOs.
22 MR. MIRANDA: That's right.
23 MEMBER ABDEL-KHALIK: So what would be the
24 current requirements for steam generator tube
25 ruptures? They started out as Condition 4. They

1 changed to Condition 3. And if you say you don't
2 recognize the ANS classification, what is the current
3 acceptance criteria for steam generator tube ruptures
4 with regard to fuel damage?
5 MR. MIRANDA: With regard to fuel damage
6 for tube ruptures since it's considered to be a
7 Condition 3 event which was what used to be a
8 Condition 3 event, it would now be considered an AOO
9 and there would be no fuel damage permitted.
10 MEMBER BANERJEE: That's how I understood
11 it.
12 MEMBER ABDEL-KHALIK: And that is the
13 current requirement?
14 MR. MIRANDA: Yes.
15 MEMBER BANERJEE: Does this just put into
16 the SRP what is current practice already?
17 MR. MIRANDA: Yes. As a matter of fact,
18 it does because if you look at the SRP currently, the
19 1996 version, you will find nowhere in there any
20 reference to Condition 2, 3, or 4 events or infrequent
21 events. Events in the SRP from '96 are either
22 incidence of moderate frequency or limiting faults.
23 So we're just formalizing what we already
24 have. It's not really a change and it's not a
25 relaxation by any means.

1 MEMBER APOSTOLAKIS: What is this?

2 MEMBER CORRADINI: That's the crazy font.

3 MR. MIRANDA: What? This?

4 MEMBER APOSTOLAKIS: Yes. This slide.

5 MEMBER CORRADINI: This is an eye chart

6 test.

7 VICE-CHAIRMAN WALLIS: Very strange font.

8 MEMBER CORRADINI: It's a crazy font.

9 MR. MIRANDA: You should be able to read

10 it in your handouts. But it doesn't matter. I'll go

11 through this and I'll tell you why it's up here and

12 how to get where I go from here.

13 (Off the record comments.)

14 MR. MIRANDA: First of all, we begin in

15 1971 with the GDCs and there are a number of GDCs like

16 this. I have picked Criterion 10 and this GDC reads,

17 "The reactor core and associated coolant control and

18 protection systems shall be designed with appropriate

19 margin to assure that specified acceptable fuel design

20 limits are not exceeded during any condition of normal

21 operation including the effects of anticipated

22 operational occurrences." So the bottom line there is

23 an AOO cannot, shall not, may not, actually shall not

24 exceed specified acceptable fuel design limits during

25 any condition of normal operation which is part of the

1 definition of an AOO.

2 In Reg Guide 1.70, 1972, it was issued and
3 that recognized incidence of moderate frequency, but
4 did not provide acceptance criteria. The acceptance
5 criteria come along in 1973 with the ANS standard for
6 PWRs which is issued on August 6th and there -- now
7 this language comes from this standard, it says, "A
8 single Condition 2 incident shall not cause
9 consequential loss of function of any barrier to the
10 escape of radioactive products." So a Condition 2
11 incident as defined in that standard is a condition of
12 moderate frequency, is a condition that may occur
13 during a calendar year of operation. So it's a subset
14 of AOOs.

15 In 1975, the first addition of the SRP was
16 issued and in there we have a problematic requirement,
17 actually it's a criterion, a problematic criterion
18 which we wish to address with this revision and this
19 criterion says, "An incident of moderate frequency in
20 combination with any single active component failure
21 or single operator error shall be considered and is an
22 event for which an estimate of the number of potential
23 fuel failures shall be provided for radiological dose
24 calculations." Then the ellipsis there refers to
25 Section 4.2 which deals with fuel evaluation models.

1 MEMBER ABDEL-KHALIK: Why is this
2 problematic?
3 MR. MIRANDA: Because we want to remove
4 it. We want to take this out. We discussed this in
5 the Subcommittee meeting.
6 MEMBER ABDEL-KHALIK: Yes, I understand.
7 But I think I'd like to understand the logic of why it
8 is problematic and why would you want to remove it and
9 whether or not removing it actually reduces margin.
10 MR. MIRANDA: Okay. That's coming up in
11 the next few slides.
12 MEMBER ABDEL-KHALIK: Okay.
13 MR. MIRANDA: And there the conclusion is
14 "There shall be no loss of function of any fission
15 product barrier other than the fuel cladding."
16 VICE-CHAIRMAN WALLIS: That's different
17 from -- Seventy-three says that loss of function of
18 any barrier and then 75, if there's a single failure
19 it allows you to have fuel damage.
20 MR. MIRANDA: Seventy-five allows --
21 MEMBER BANERJEE: Only the cladding.
22 VICE-CHAIRMAN WALLIS: Fuel cladding
23 damage.
24 MR. MIRANDA: It allows you to have fuel
25 cladding damage but it allows you to have that if you

1 have the combination of an AOO and single failure.

2 VICE-CHAIRMAN WALLIS: All right. The

3 combination.

4 MEMBER BANERJEE: And it also says

5 "limited number of fuel clad..."

6 MR. MIRANDA: That's right. That's also

7 a problem.

8 MEMBER CORRADINI: Maybe this was covered

9 in Subcommittee, but just to clarify. So the 75

10 language is not a Condition 2 AOO. What is it?

11 MR. MIRANDA: We believe that that's a

12 postulated accident and that's going to come up in the

13 next couple of slides.

14 MEMBER CORRADINI: So it's not a Condition

15 3 AOO?

16 MR. MIRANDA: Condition 3 doesn't exist.

17 It's an AOO.

18 MEMBER BANERJEE: On the ANS.

19 MR. MIRANDA: It's either an AOO or a

20 postulated accident.

21 MEMBER BANERJEE: This has nothing to do

22 with the ANS.

23 MEMBER CORRADINI: I understand.

24 MEMBER CORRADINI: But if you go back to

25 Slide 4.

1 MEMBER CORRADINI: I just wanted to
2 understand --
3 MEMBER BONACA: The sub-category there, I
4 mean, in past experience if you had an accident
5 Category II you never accepted fuel damage even with
6 a single failure.
7 MR. MIRANDA: Define single failure.
8 MEMBER BONACA: I'm sorry.
9 MR. MIRANDA: We need to define what
10 single failure is.
11 MEMBER BONACA: Single failure of the
12 component.
13 MR. MIRANDA: Excuse me?
14 MEMBER BONACA: Single failure of the
15 component. It was single failure, right, when you do
16 the analysis?
17 MR. MIRANDA: There are two definitions of
18 single failure and that's coming up in another slide.
19 MEMBER BONACA: I'm just trying to
20 understand. I thought there was a differentiation
21 between Category II and Category III. But in Category
22 III you would allow some fuel damage if you have a
23 single failure also assumed. There were single
24 failure. Category II you would not.
25 MR. MIRANDA: Okay. Single failure as is

1 most commonly defined and it's also in the GDC
2 definition section, A single act of failure is defined
3 as "a failure of a component in a protection system
4 that's required to mitigate an event." And it's a
5 design requirement actually. The protection system is
6 required to perform its intended function despite its
7 worst single act of failure.
8 MEMBER BONACA: So you four channels. You
9 never worry about that. That would be -- You never
10 assume failure. Unless you go to an ATWS, you never
11 assume the failure of the RPS.
12 MR. MIRANDA: You do assume failures. For
13 example, if you have a fluid system like an ECCS, for
14 example, and you have an accident, a LOCA or a steam
15 break, your worst single failure would be one train of
16 ECCS. So when you do your analysis, you take the
17 degraded performance of the ECCS. Now you're just
18 using one train and you show that even with the
19 degraded performance you achieve acceptable results
20 and that's the way single failure is normally defined.
21 It's part of the design criteria for the protection
22 systems.
23 A single failure can also be an initiating
24 event. It could be something like you're operating at
25 full power. Everything is fine and then all of a

1 sudden, a turbine stop valve closes. So now you have
2 a loss of load accident and the single failure is your
3 valve.
4 MEMBER BONACA: But it's the accident.
5 It's not the --
6 MEMBER CORRADINI: The AOO.
7 MEMBER BONACA: It's not a single accident
8 failure.
9 MEMBER BANERJEE: But I guess what the
10 bone of contention here is is this combination of that
11 with something like a stuck open relief valve or
12 something. Now with the current way the staff was
13 interpreting it, you would be allowed some limited
14 number of fuel cladding failures as long as no other
15 barrier failed and you're trying to remove that
16 requirement now because in part it's ambiguous. I
17 mean, what do you mean by "limited number"?
18 So there was a lot of discussion on this
19 issue. Maybe we should just let him continue because
20 I'm sure that the Committee will have discussion on
21 this issue as well. We never reached any sort of
22 agreement within the Subcommittee.
23 VICE-CHAIRMAN WALLIS: I'm not sure the
24 Subcommittee fully understood this at the time. So it
25 may take awhile.

1 MEMBER BANERJEE: Yes, it may take awhile.

2 MR. MIRANDA: I've done a little bit more

3 thought on this since last week and I have taken your

4 advice, Dr. Wallis, to show that this is a redundant

5 requirement.

6 VICE-CHAIRMAN WALLIS: Okay.

7 MEMBER BONACA: I know for one -- I'm

8 saying the confusion I have is from past experience

9 when you look at Category III for PWRs that included

10 steam line breaks. If you have a steam line break,

11 you're allowing some damage, some fuel damage, even

12 assuming worst single failure and accidents in the

13 Category II typically are really pretty frequent

14 events and you don't want to have any fuel damage.

15 You want to be able to restart the plant even if you

16 have a single failure and that's the way it's always

17 been interpreted at least for PWRs.

18 MR. WERMIEL: You're absolutely right.

19 MEMBER CORRADINI: Can you repeat that,

20 Mario? I thought I caught it. Can you just repeat it

21 again? I'm sorry.

22 MEMBER BONACA: What I was saying is that

23 under AOOs you have two categories. They were coming

24 from the ANSI standards and there was one incident of

25 moderate frequency. Now those are pretty frequent

1 events and like load reject, you may have loss. So
2 you want to be able to restart the plant without any
3 fuel damage even if you have a single failure of a
4 component.
5 Okay. Now for infrequence events, that
6 was a category that included steam line breaks which
7 is a much more rare events. It still is considered
8 frequent enough that it may happen in the life of the
9 plant because you may have a stuck open valve that
10 causes the same kind of event or a similar event for
11 that one. However, less frequent, you were allowed to
12 have some fuel damage again assuming a single failure.
13 So there was a different treatment that we've seen
14 between ANS Category II and the ANS Category III.
15 MR. MIRANDA: Okay. We're still having a
16 problem with the definition of single failure. I
17 would say that any time you actuate a protection
18 system you have to assume in the analysis the
19 performance of that system in the presence of a single
20 failure.
21 MEMBER BONACA: "The worst single failure"
22 it says. The regulation has always said "the worst
23 single failure" --
24 MEMBER APOSTOLAKIS: And independent of
25 the initiator, right?

1 MEMBER BONACA: I'm sorry.

2 MEMBER APOSTOLAKIS: Single failure has to
3 be independent of the initiator. The initiator itself
4 cannot count as a --

5 MEMBER BONACA: And you were supposed to
6 realize the worst single failure.

7 MEMBER APOSTOLAKIS: That's my
8 understanding.

9 MR. WERMIEL: We don't disagree with that.
10 That's absolutely correct. For AOOs and for
11 accidents, we always assume the worst single failure
12 concurrent with the event.

13 MEMBER BONACA: And that's why you did the
14 sensitivity analysis and that gave you an
15 understanding of the systemics.

16 MR. WERMIEL: Correct.

17 MEMBER BONACA: What was the worst thing
18 that you had to do and you could --

19 MR. WERMIEL: But what Sam is trying to
20 get to though is language in the standard review plan
21 that we're trying to remove that seems to be ambiguous
22 in that it seems to imply that for events that we
23 would classify as AOOs where fuel damage is not
24 permitted it would seem to allow that and that
25 language we believe is inappropriate because the

1 situation that you speak of, Dr. Bonaca, where we have
2 a steam line break and fuel damage is permitted is
3 classified as an accident.
4 VICE-CHAIRMAN WALLIS: Accident.
5 MR. WERMIEL: It's not an AOO.
6 MEMBER BONACA: That's right.
7 MR. WERMIEL: So we have a criterion for
8 limited fuel damage within specified acceptance
9 criteria.
10 MEMBER BONACA: If you have an accident,
11 would you put it then in Category IV, Limiting Faults?
12 MR. WERMIEL: We would, yes, but we only
13 have two categories. We only have AOOs and we have
14 accidents or limiting faults.
15 MEMBER BONACA: The reason why I'm asking
16 this question too is that we just reviewed this
17 technology neutral --
18 MR. WERMIEL: Framework, yes.
19 MEMBER BONACA: -- framework that they're
20 using the traditional ANS criteria of the incidence of
21 moderate frequency, AOOs, than infrequent events and
22 they don't call them AOOs and then they use limiting
23 fault.
24 MR. WERMIEL: Unfortunately, we are
25 dealing with a standard review plan that was intended

1 for application by reviewers to the operating fleet
2 and we had to cover as best we could with the language
3 that we had the situation that was used when those
4 plants were designed and built.
5 With the new reactors, we understand that
6 there will be this new framework and that there may be
7 some deviation. Remember. You are allowed to deviate
8 from the criteria of the standard review plan. For
9 example, I think when you talk about the ESBWR or you
10 meet with the ACRS for that standard design you will
11 find three categories of events. You will find
12 infrequent events. You will find a middle category
13 and you will find accidents.
14 So they have implemented this criteria
15 differently and since you're writing a rule applicable
16 to that design, there is no problem with that provided
17 the staff can agree that the categorization makes
18 sense and fits into the criteria that it would believe
19 to be appropriate. But the current fleet was really
20 designed with the two categories in mind.
21 MEMBER BANERJEE: I guess the argument put
22 forward to the Subcommittee was that there was a basis
23 in the regulations for these two categories. But
24 there wasn't a basis in the regulations for the
25 intermediate category. That's how I understood it.

1 MR. WERMIEL: And that's correct. There
2 isn't that I'm aware of anywhere in the GDC where you
3 don't have either permission for exceedance of a fuel
4 design limit or non-permission. It's only one or the
5 other in the way the GDC is currently worded and
6 that's how the categorization was basically developed
7 for the current operating plants.
8 VICE-CHAIRMAN WALLIS: The categorization
9 in the SRP seems to be based on frequency.
10 MR. WERMIEL: That's the primary input.
11 VICE-CHAIRMAN WALLIS: Is the decision
12 greater or less than 10^{-2} or something? Or what is
13 the borderline?
14 MR. WERMIEL: You can calculate it based
15 on the -- It talks about that's the intent for the
16 life of the plant.
17 VICE-CHAIRMAN WALLIS: When the plant is
18 relicensed two and three times. I mean, what is the
19 life of the plant?
20 MR. WERMIEL: These days it's 60 years for
21 those that have received a renewed license.
22 VICE-CHAIRMAN WALLIS: And this makes a
23 difference. This is how you decide whether it's one
24 or the other.
25 MR. WERMIEL: I think we decided

1 primarily on the categorization that's in the standard
2 review plan and that's based on operating experience.
3 VICE-CHAIRMAN WALLIS: Ah. So it's a
4 vague sort of thing. It could change from one to the
5 other as experience develops.
6 MR. MIRANDA: We have an example of that
7 with the tube rupture.
8 VICE-CHAIRMAN WALLIS: Yes. Sure.
9 MEMBER ABDEL-KHALIK: At the end of the
10 day, though, if your recommended change were to go
11 through, would the licensee still be required to
12 perform analyses for incidents of moderate frequency
13 in combination with any single act of failure?
14 MR. MIRANDA: We wanted to delete that.
15 We want to --
16 MEMBER ABDEL-KHALIK: I'm hearing two
17 different things.
18 MR. WERMIEL: The answer is yes.
19 Absolutely, they would. For any event, an AOO or an
20 accident, you always assume a single act of failure in
21 a mitigating system and it's the worst single act of
22 failure in the mitigating capability. We always
23 assume that.
24 MEMBER BONACA: That was the foundation to
25 understand the systemic. In absence of PRA or

1 whatever, you were doing this analysis to understand
2 the sensitivity to different components.
3 MEMBER ABDEL-KHALIK: I think it's
4 important for the record to reflect that the answer
5 that we just heard because that's inconsistent with
6 the indications that we heard in the earlier
7 presentation.
8 MR. MIRANDA: No, it isn't and if we can
9 go on, I'll show you why.
10 MEMBER BONACA: Let's go on.
11 MEMBER BANERJEE: Let's proceed, yes.
12 MR. MIRANDA: Okay. This is the statement
13 that we want to remove from the SRPs and here we see
14 "an incident of moderate frequency in combination with
15 any single act of component failure or single operator
16 error." So first of all, we have to deal with the
17 definition of "incident of moderate frequency" and
18 that is a Condition II event and with this revision,
19 it could also include Condition III events.
20 And "in combination with any single act of
21 component failure," single act of component failure
22 generally means a failure in a protection system. But
23 the way it's used here it means another initiating
24 event, another AOO, another Condition II or III event
25 because it's equated, for example, with a single

1 operator error which is another AOO. So what they're
2 doing here is they're combining AOOs. They are taking
3 two events at the time, two independent failures.
4 MEMBER BANERJEE: But what about the stuck
5 open safety or relief valve which is, I guess, the one
6 that's -- one of the things that are of concern here?
7 MR. MIRANDA: The way I've seen that used
8 and I think you're referring to Three Mile Island
9 that's --
10 MEMBER BANERJEE: That's a more complex
11 chain. I'm not.
12 MR. MIRANDA: But the key there is it is
13 a chain. The stuck open relief valve is a
14 consequential failure. It results from another
15 failure.
16 MR. WERMIEL: Sam, let me try. Let's take
17 Three Mile Island for example. The initiating event
18 was a loss of feedwater. That's an AOO. That event
19 should have led to no fuel damage because our criteria
20 assuming a single act of failure in the mitigating
21 system would not have permitted it. What happened
22 during the event? The PORV stuck open. Now you have
23 an event that started as an AOO becoming an accident.
24 VICE-CHAIRMAN WALLIS: So it's not an
25 acted failure. It's just another event.

1 MR. WERMIEL: What Sam is trying to say is
2 if you believe that is an act of failure then you
3 should have not allowed fuel damage to occur and what
4 we're saying is no. We want to clarify the language
5 that we wouldn't take a consequential failure or --
6 I'm using the wrong word. A second independent
7 occurrence that could actually be called an event
8 concurrent with the initial AOO because then you would
9 be allowed fuel damage and it wouldn't fit into the
10 AOO category. That's an accident.
11 VICE-CHAIRMAN WALLIS: What's the
12 difference between occurrence or a second event and a
13 single failure?
14 MR. WERMIEL: The single failure criterion
15 in the GDC talks about mitigating systems.
16 VICE-CHAIRMAN WALLIS: But the problem is
17 the mitigating system. It releases pressure and it
18 closed. So it failed, didn't it?
19 MR. WERMIEL: Yes.
20 VICE-CHAIRMAN WALLIS: A failure of a
21 mitigating system.
22 MR. WERMIEL: All we're trying to say is
23 such an event should not be considered an AOO. You
24 would categorize it as an accident and apply different
25 criteria.

1 VICE-CHAIRMAN WALLIS: If you have an AOO,
2 you supposed to consider failure of a mitigating
3 system.
4 MR. WERMIEL: Correct.
5 VICE-CHAIRMAN WALLIS: So I don't
6 understand the logic actually.
7 MR. WERMIEL: The PORV isn't part of the
8 mitigation for a feedwater transient.
9 MEMBER ABDEL-KHALIK: But that comes in
10 because the current SRP says "in combination with any
11 single act of component failure."
12 VICE-CHAIRMAN WALLIS: "Any single."
13 MEMBER ABDEL-KHALIK: Which means the
14 licensee has to do a series of sensitivity
15 calculations to identify.
16 MR. WERMIEL: Don't misunderstand me. The
17 licensee has analyzed for any such, all these, events
18 that we're talking about. If I had an feedwater
19 transient and the PORV stuck open, the capability for
20 the plant to cope with that given a single act of
21 failure on top on it is still there. But what Sam is
22 trying to say is the criteria for AOOs doesn't apply
23 to that kind of an event. The criteria for accidents
24 does and that means limited fuel damage. That's all
25 we're trying to say.

1 MEMBER APOSTOLAKIS: What you're saying is
2 that as they do the sensitivity analysis they find
3 that they cannot cope with this. So that's not AOO
4 anymore. It has to be moved to another category.
5 MEMBER BONACA: Limiting faults. I'm
6 trying to understand. You're talking about accidents,
7 but yet all you put out there was two categories.
8 MEMBER APOSTOLAKIS: He's moving to the --
9 MR. WERMIEL: It would move into the other
10 category. Such a situation where you have a feedwater
11 transient and a stuck open power operated relief valve
12 moves it into the other category. That's correct.
13 That's the staff's interpretation. It always has
14 been.
15 MEMBER BANERJEE: But now you also have a
16 requirement that an AOO should not escalate into the
17 other category.
18 MR. WERMIEL: That's correct.
19 MEMBER BANERJEE: I'm just trying to
20 grapple with this complexity in terms of what happens
21 if the AOO leads to something which moves it into the
22 other category.
23 MR. WERMIEL: Sam has an example that he
24 and I have talked about in the past. What we do is we
25 ask the licensee when we find such a situation to deal

1 with it, to find a way to preclude that occurrence
2 from happening. In other words, if you have to fix
3 the size of the aux feed system to prevent a
4 particular another event from happening on top of the
5 initial AOO, in other words, make it bigger, add more
6 flow, something like that, then maybe that's what they
7 need to do.
8 VICE-CHAIRMAN WALLIS: Let me ask you. If
9 TMI PORV had not stuck open, was it an AOO or was it
10 an accident?
11 MR. WERMIEL: It was an AOO. It was a
12 simple feed --
13 VICE-CHAIRMAN WALLIS: Two things
14 happened. They had loss of feedwater and then the aux
15 feedwater didn't work.
16 MEMBER BONACA: That wasn't even assumed
17 anyway.
18 VICE-CHAIRMAN WALLIS: That was assumed as
19 a failure.
20 MEMBER BONACA: Because PORV was never --
21 VICE-CHAIRMAN WALLIS: So the aux feed
22 failure would be one of these single failures in an
23 AOO case?
24 MR. WERMIEL: No. The auxiliary feedwater
25 system is designed and intended to be available --

1 VICE-CHAIRMAN WALLIS: It was not
2 available at TMI.
3 MR. WERMIEL: Then it was not.
4 MR. MIRANDA: It was not available due to
5 an operator error.
6 MR. WERMIEL: And there were reasons for
7 that.
8 MEMBER APOSTOLAKIS: What did you say,
9 Mario, just now?
10 VICE-CHAIRMAN WALLIS: I don't understand
11 at all.
12 MEMBER APOSTOLAKIS: Did you say it was
13 not analyzed?
14 MEMBER BONACA: The PORV was not analyzed
15 because it was not considered a component.
16 MEMBER APOSTOLAKIS: An active component.
17 MEMBER BONACA: And so therefore it was
18 never analyzed because it was not a mitigating system
19 of any --
20 MR. WERMIEL: Dr. Bonaca, that's not
21 entirely true. TMI had an analysis for a small break
22 loss of coolant accident which is what you have with
23 a stuck open PORV.
24 MEMBER APOSTOLAKIS: An initiator.
25 MR. WERMIEL: Yes, indeed.

1 MEMBER BONACA: -- as an consideration
2 failure.
3 MR. WERMIEL: As an accident, yes.
4 MEMBER CORRADINI: I guess I'm -- Somehow
5 this is, unless I misunderstood, a classification
6 issue.
7 MR. WERMIEL: That's all it is.
8 MEMBER CORRADINI: But Said asked an
9 important question that I want to re-ask because I
10 thought he asked regardless where you stick the IIIs,
11 now the IIIs have become IVs, so the greens are blues
12 and whatever, are you required to do the analysis in
13 all conditions because I don't know how you phrased it
14 but I heard a yes? So it seems to me then nothing has
15 changed from what is required by the licensee to
16 analyze what I call operational transients, AOOs,
17 versus what one will now classify as only accident.
18 MR. WERMIEL: Nothing has changed with
19 regard to the assumptions that are made in either case
20 and that assumption includes the limiting act of
21 failure in the mitigating system.
22 MEMBER BANERJEE: If we let Sam speak,
23 he's going to show us that the current criterion that
24 is redundant, right?
25 MR. MIRANDA: That's right and all we're

1 saying here is that what we want to eliminate, what we
2 want to take out of the SRPs, is this notion of
3 looking at AOOs two at a time and AOO is analyzed and
4 it's shown that it does not violate acceptable fuel
5 design limits. Taking two AOOs at one time according
6 to the SRP will permit some level of fuel damage.
7 MEMBER BONACA: The language however is
8 confusing because AOOs has always been consider the
9 initiator.
10 MR. MIRANDA: That's right.
11 MEMBER BONACA: "Failure to assume" means
12 any possible single failure that the system --
13 MEMBER APOSTOLAKIS: In addition.
14 MR. MIRANDA: That's right.
15 MEMBER BONACA: Because you have a number
16 of systems coming, mitigating systems, and you are
17 assuming the failure of one or the other. There are
18 others. When you talk about AOOs, it implies you're
19 assuming two independent.
20 MR. MIRANDA: That's correct.
21 MR. WERMIEL: That's what we want.
22 MR. MIRANDA: That's right. And that's
23 what we want to address here.
24 MEMBER APOSTOLAKIS: But coming back to
25 your point earlier, you said that the valve of the

1 pressurizer was not considered as a failure because it
2 is not part of a mitigating system.
3 MEMBER BONACA: The interesting thing was
4 this, that when you were realizing another pressure
5 transient it was always felt that the PORV was a
6 relief function of some type. It gave you some relief
7 because it opened up and kept your pressure below the
8 limit. Therefore, it was no model because it wasn't
9 viewed as -- It was simply a model. The only place it
10 was modeled was for a small break LOCA as an
11 initiator.
12 MR. MIRANDA: Yes.
13 MEMBER BONACA: And that was a fundamental
14 flaw in the approach that wasn't in the accident
15 analysis that if something was viewed to be something
16 that helps you and in this particular case it was
17 helping you maintain pressure below the big pressure
18 limit, then you would not model it and it gave you a
19 mind set that said that you never consider it as a
20 single failure, for example, if you lose the loss of
21 feedwater.
22 MEMBER APOSTOLAKIS: But according to
23 this, it should have been considered because any
24 single act of failure.
25 MEMBER BANERJEE: But this is what they

1 want to remove, right?

2 MEMBER APOSTOLAKIS: Right. But at that

3 time it was enforced.

4 MEMBER BANERJEE: It was enforced.

5 MR. MIRANDA: Okay.

6 VICE-CHAIRMAN WALLIS: You're going to

7 show us it's redundant.

8 MEMBER BANERJEE: Which is why we spent

9 hours talking about this as you can imagine.

10 MR. MIRANDA: Okay. Single failure.

11 CHAIRMAN SHACK: You have to 12:00 noon

12 today.

13 MEMBER BANERJEE: I know.

14 MR. MIRANDA: The issue is the definition

15 of what a single failure is.

16 MEMBER BANERJEE: Once you have it, I

17 think that's it.

18 MEMBER CORRADINI: We won't.

19 MEMBER APOSTOLAKIS: Let the guy move on.

20 MR. MIRANDA: The single failure, the

21 traditional definition, is what we find in the GDC and

22 this is a single failure in a protection system and

23 it's a design requirement. The protection system has

24 to perform its function despite a single failure.

25 MEMBER BONACA: Can I just simply

1 interject again? Your language, I mean you're talking
2 protection system. There is only system that could be
3 called a protection system, reactor protection system.
4 You're referring to ECCS. You're referring to ATWS
5 system. They are mitigating systems.
6 MR. MIRANDA: Protection system with a
7 small "p." Yes.
8 MEMBER BONACA: That's what confusing me.
9 MEMBER APOSTOLAKIS: Call them safety
10 functions.
11 VICE-CHAIRMAN WALLIS: I don't understand
12 the term -- A relief valve is a protection system
13 against over pressure.
14 (Several speaking at once.)
15 MR. MIRANDA: That's right. If it's
16 safety qualified, yes.
17 MEMBER BONACA: All I'm trying to say is
18 that there is a language that has been established for
19 40 years --
20 VICE-CHAIRMAN WALLIS: I'm just going to
21 throw up hands and say you guys must know what you're
22 doing.
23 MR. MIRANDA: This slide indicates that
24 there are two ways you can look at a single failure
25 and since the previous slide doesn't tell you what a

1 single failure, it's a single act of failure, any
2 single act of failure. Normally, you would expect to
3 interpret that as the single failure in a protection
4 system. But the way it's used in that paragraph
5 indicates to us that it's an equivalent of an AOO.
6 It's an initiating event. A single operator error is
7 also an initiating event.
8 VICE-CHAIRMAN WALLIS: It's something
9 beyond your original intent when you define "single
10 failure."
11 MR. MIRANDA: It's also a single failure
12 in terms of an AOO.
13 MEMBER APOSTOLAKIS: But my understanding
14 was a single failure was not an initiating event.
15 MEMBER KRESS: That's correct.
16 MEMBER APOSTOLAKIS: A single failure
17 criterion, it is not an initiating event. It's a
18 postulated addition of failure that you have to
19 postulate and demonstrate a few things.
20 MEMBER KRESS: Yes.
21 MEMBER APOSTOLAKIS: So this is a new
22 interpretation to me.
23 MR. MIRANDA: It's not new, if you look at
24 Chapter 15.
25 MEMBER APOSTOLAKIS: The way it was

1 interpreted?

2 MEMBER MAYNARD: We're mixing a lot of

3 different languages here.

4 MEMBER CORRADINI: Right.

5 MEMBER MAYNARD: It is confusing. I'm

6 following it but it is very difficult because we are

7 mixing like Mario said on reactor on the protection

8 systems and single failures. We're kind of jumping in

9 several different areas.

10 MEMBER BONACA: But the question is when

11 we say "single failure" do we ever mean a failure that

12 actually initiates an AOO? In my mind no.

13 (Chorus of no's.)

14 MR. MIRANDA: No, except in this paragraph

15 .

16 MR. WERMIEL: Yes, I agree. We didn't

17 mean that. However, our understanding is that people

18 have interpreted this language that we want to remove

19 differently than what you just said, Dr. Apostolakis.

20 MEMBER APOSTOLAKIS: Right. But it seems

21 to me --

22 MR. WERMIEL: This has been the

23 traditional interpretation because this comes right

24 out of the GDC.

25 MEMBER APOSTOLAKIS: Right. So the second

1 bullet is their unusual interpretation.

2 MR. WERMIEL: It's not that unusual. It's

3 unusual and it's not right.

4 MR. MIRANDA: If you look at Chapter 15,

5 take any accident that's described in Chapter 15, the

6 first or second paragraph usually says something like

7 "The following is an analysis of the loss of load

8 event and loss of load event can be caused by..." and

9 it's operator error, closing of the turbine stop

10 valve, tripping of the condenser and so on. They have

11 various causes for that event. These are the

12 initiating events and only these are single failures.

13 It's a single failure of a component, usually a

14 control system component or a valve.

15 MEMBER APOSTOLAKIS: Yes, it is a single

16 failure but it's not "the" single failure the

17 regulations are referring to. That's the point.

18 MEMBER ABDEL-KHALIK: Let me give you an

19 example.

20 MEMBER BONACA: But the single failure is

21 you have loss of feedwater or you have --

22 MEMBER ABDEL-KHALIK: Let me give you an

23 example. You have loss of feedwater. That's an

24 anticipated event. If everything works out okay, the

25 plant will shut down. No damage. Okay. You have

1 loss of feedwater and you have one of the aux
2 feedwater pumps fail. That's an assumed single
3 failure. Correct.
4 (Off the record comments.)
5 MEMBER APOSTOLAKIS: Correct.
6 MEMBER ABDEL-KHALIK: That is not an
7 initiating event. That's the assumed single failure.
8 MR. MIRANDA: And that would be in the
9 analysis.
10 MEMBER ABDEL-KHALIK: In that particular
11 case given the redundancy in the aux feedwater system,
12 again the plant will demonstrate that there is no fuel
13 failure.
14 MR. MIRANDA: Right. Exactly right.
15 MEMBER ABDEL-KHALIK: But the licensee is
16 required to assume many other single failures and
17 identify the worst single failure that can possibly
18 happen in combination with a loss of feedwater and for
19 that particular combination that licensee is required
20 to show that only limited fuel damage occurs.
21 MEMBER APOSTOLAKIS: Right.
22 MEMBER ABDEL-KHALIK: Now you want to
23 remove that requirement and in my mind, that is a loss
24 of margin.
25 MR. MIRANDA: I can give another example.

1 MR. WERMIEL: It isn't the loss of margin
2 at least not in my mind because those other failures
3 that you speak of have been analyzed in other events
4 or under other categories. It's been accounted -- And
5 that's where Sam gets into this idea of the redundant
6 criteria. It has already been accounted for in the
7 analysis of other events or other accidents.
8 MEMBER ABDEL-KHALIK: If one would start
9 with a clean sheet of paper, there is no way for a
10 licensee to identify those events that you're talking
11 about according to your classification.
12 MR. WERMIEL: There is because we have the
13 standard review plan which talks about those events
14 and those accidents that we believe form the basis
15 upon which the plant should be designed.
16 MEMBER BONACA: Let me expand on what Said
17 said. Okay? So you assume the loss of -- You assume
18 they have loss of feedwater and then you assume that
19 one of their trains of feedwater doesn't work. That's
20 why you have redundant systems. If you had, for
21 example, a design just as an example where you have a
22 common header by any reason and you will have these
23 two trains possibly isolated, you would have to assume
24 the failure of both trains because they would be
25 controlled by a single valve.

1 (Off the record discussion
2 simultaneously.)
3 MEMBER BONACA: That's what you would have
4 to do. So you would find that your design is so poor
5 that somehow you had a valve out there in the header
6 and that valve can close and deny all those -- and you
7 would have to assume -- So again, it doesn't matter if
8 you analyze that kind of condition in a different
9 event for the loss of feedwater that is the limiting
10 condition that you have to assume.
11 MR. MIRANDA: I don't want to change any
12 of that. No.
13 MEMBER CORRADINI: Can I just get a
14 clarification because Said asked a very particular
15 question and I want to make sure I understood the
16 answer. His point is that what you're going to remove
17 is you're going to remove the licensee to do this sort
18 of analysis and your answer is back is true, but the
19 licensee would have done that analysis for another
20 reason anyway.
21 MR. MIRANDA: Yes.
22 MEMBER BANERJEE: Where would he have done
23 it?
24 MR. WERMIEL: I'll go back to my example.
25 I had loss of feedwater transient and the power

1 operated relief valve on the primary side sticks open.
2 He would have analyzed the sticking open of the
3 primary relief valve as part of the analysis for small
4 break loss of coolant accident and he would show
5 mitigation capability for that event given a single
6 act of failure. But he wouldn't combine that event
7 with the feedwater transient at the same time.
8 MEMBER BONACA: That's an initiator, but
9 at TMI what you had you had an accident and all ended
10 up in a LOCA.
11 MR. WERMIEL: Correct, and the LOCA has
12 been analyzed.
13 MEMBER BANERJEE: But you are looking at
14 different sequences here, right?
15 MR. WERMIEL: The problem that I have with
16 this entire discussion is I wouldn't know how to
17 decide what combination of events and things like that
18 I want to combine.
19 MEMBER ABDEL-KHALIK: But that's the job
20 of the licensee.
21 VICE-CHAIRMAN WALLIS: The whole problem.
22 That's the whole problem.
23 MEMBER ABDEL-KHALIK: Because the
24 regulation says any single failure. So the licensee
25 has to do sensitivity analyses, look at all the single

1 failures and then come up with the worst single
2 failure and that's the one for which they should show
3 these criteria for that.
4 MR. WERMIEL: In the Appendix A, the
5 single failure criterion is defined in the definitions
6 and it talks about a single failure in the mitigation
7 systems. It doesn't talk about an unrelated single
8 failure concurrent with an event.
9 MR. MIRANDA: I would like to give you two
10 examples to illustrate the difference between what
11 we're talking about.
12 MR. WERMIEL: It's clear.
13 MR. MIRANDA: First of all, the
14 traditional definition of single failure, look for
15 example at a steam line break. A steam line break
16 requires the operation of several protection systems.
17 You need a reactor trip, for example. The reactor
18 trip, there's a single failure in the reactor trip
19 that assumed the reactor trip nevertheless occurs
20 because it's designed to work that way.
21 We have a single failure in the safety
22 injection system. Say we lose one train of the safety
23 injection system. We have safety injection
24 nevertheless at a lower rate perhaps. Nevertheless we
25 have it because it's designed that way. So here you

1 have an accident with two single failures assumed in
2 two different protection systems and that's the way
3 it's analyzed.
4 What we're trying to eliminate here in
5 this SRP revision is the requirement to consider a
6 completely unrelated failure. For example, I've just
7 seen recently a submittal by a licensee operating a
8 combustion engineering plant where they take two
9 events they have following this provision, following
10 this SRP criteria and what they did there was they
11 looked at a loss of off-site power event and they said
12 the loss of off-site power event will produce a very
13 low D&BR. It's one of the events that will reduce
14 thermal margin considerably.
15 And then they combine that with a rod
16 withdrawal at power event because that's another event
17 that will reduce thermal margin considerably. The two
18 events are unrelated but they assume that they occur
19 simultaneously. Physically, it's not even possible
20 because --
21 MEMBER BANERJEE: And what do they come to
22 the conclusion with?
23 MR. MIRANDA: They concluded that the loss
24 of off-site power combined with a rod withdrawal at
25 power still meets the fuel design limits in this case.

1 MEMBER BONACA: The example you made, it
2 is just a gross application of that. I've
3 never seen it before.
4 MR. MIRANDA: This happens a lot. We see
5 combined AOOs like this a lot usually from combustion
6 engineering plants by the way where they combine AOOs
7 and the AOOs are completely independent, unrelated and
8 in this example I gave you not even physically
9 possible.
10 MEMBER BANERJEE: But why do they do that?
11 There must be a reason, right?
12 PARTICIPANT: To get this language.
13 MR. MIRANDA: That's right.
14 MEMBER BANERJEE: No, there is a reason --
15 Are they trying to do something like bump it up a
16 category so they can allow fuel failure? What is the
17 real -- There must be a reason. Nobody is an idiot.
18 (Laughter.)
19 MEMBER BANERJEE: Let's assume they're
20 smart guys.
21 MR. MIRANDA: They expect the NRC staff to
22 be looking for analyses such as this. In this case,
23 they didn't need to bump it up. If they had to, if
24 they had some fuel failures, they would have been able
25 to take some. In this case, they didn't have to. But

1 they submitted this analysis because they figured we
2 expected to see it.
3 MEMBER BONACA: I still take objection
4 with your language. You gave us the example of steam
5 line break. You talk about protection systems or two
6 protective actions. The first one is the protection
7 system, the RPS. They have a scram. If you take the
8 failure of the scram, you're going to ATWS. It's a
9 different category and you don't want to even look at
10 it.
11 MR. MIRANDA: But the point is you can't
12 the failure of the scram. To get a failure of a
13 scram, you need a common mode failure to get to ATWS.
14 MEMBER BONACA: Then you said there is
15 another protection system which is the self-injection
16 system. Initially, it was called the mitigating
17 system and not protection. Protection is the RPS.
18 That's traditional language. I'm only saying I hope
19 that in the SRP you are not changing language which
20 has been established for 40 or 50 years now and
21 everybody has been operating with it, I mean, just
22 because it's confusing.
23 MR. MIRANDA: Okay. But you get the --
24 VICE-CHAIRMAN WALLIS: Have you shown this
25 redundance yet?

1 MR. MIRANDA: No.

2 VICE-CHAIRMAN WALLIS: That's what you

3 were going to show me.

4 MR. MIRANDA: No, I'm still getting there.

5 VICE-CHAIRMAN WALLIS: That's what I'm

6 waiting for.

7 MEMBER BONACA: All right. Let's go.

8 VICE-CHAIRMAN WALLIS: If it's redundant,

9 I don't care whatever this argument -- all that's

10 going on here. If it's redundant, throw it out.

11 MEMBER BONACA: We are trying to clarify.

12 MEMBER BANERJEE: I think it's hard to

13 prove it's redundant.

14 VICE-CHAIRMAN WALLIS: It's hard to prove

15 it's redundant.

16 MEMBER BONACA: If the clarification is

17 obfuscation because you're using a different language,

18 we are not accomplishing the objective of what we

19 have. We're just clarifying, right?

20 MR. MIRANDA: Yes.

21 MEMBER BONACA: Okay. Go ahead.

22 MR. MIRANDA: When I talk about protection

23 systems, I'm talking about any system that's used in

24 response to an event to protect the plant and it could

25 be a reactor trip or it could be ECCS.

1 MEMBER BONACA: -- the language --

2 MR. MIRANDA: The first bullet is from the
3 GDCs and we saw this before. Finally, it says "Fuel
4 design limits are not exceeded during any condition of
5 normal operation." That's the GDC. And we know that
6 an AOO is a condition of normal operation. Therefore,
7 we know that the combination of AOOs, two independent,
8 random AOOs is not a condition of normal operation.
9 So we could say "a condition that is not of normal
10 operation may cause fuel design limits to be
11 exceeded." Are we agreed?

12 So when we say a condition that is not of
13 normal operation that may cause fuel design limits to
14 be exceeded is exactly the same as the requirement,
15 the first bullet. It's the same statement only it's
16 in the contra-positive. We just take the second
17 condition, normal operation. We negate it, put it at
18 the front, "a condition that is not of normal
19 operation" and we negate the first proposition, "fuel
20 design limits are not exceeded." Now they may be
21 exceeded. It's the contra-positive. If A is B, then
22 not B is not A.

23 MEMBER ABDEL-KHALIK: Let me give you a
24 specific example again. Let's go back to the example
25 I talked about. You have loss of main feed and then

following that the single failure is failure of a single aux feed pump. Okay?

MR. MIRANDA: Right.

MEMBER ABDEL-KHALIK: This is an un-event. The plant is designed. You have three aux feed water pumps. The response, there is no damage.

MR. WERMIEL: And that's an AOO.

MEMBER ABDEL-KHALIK: Let's say you remove this requirement and the designer would interpret this as "Okay. I don't need redundancy in aux feed water pumps." He's starting from a white sheet of paper. He has only one aux feed water pump and therefore you lose your main feedwater pump. If you were to lose the aux feedwater pump then this becomes a total loss of feedwater event. Right?

MR. WERMIEL: Yes.

MEMBER ABDEL-KHALIK: Which is analyzed as a Condition III or as an accident, total loss of feedwater, a feed and bleed event.

MR. WERMIEL: No.

MEMBER ABDEL-KHALIK: It is not?

MR. WERMIEL: No.

MEMBER ABDEL-KHALIK: Total loss of feedwater is not analyzed.

MR. WERMIEL: No.

1 VICE-CHAIRMAN WALLIS: One generator.

2 MR. WERMIEL: No. There is no provision

3 that I am aware of that credits "feed and bleed" for

4 a loss of feedwater event.

5 MEMBER ABDEL-KHALIK: If you had only --

6 My concern -- Let me tell you that the bottom line --

7 MR. WERMIEL: I hope not anyway.

8 MEMBER ABDEL-KHALIK: Hold on. The bottom

9 line for my concern is by doing this you're sort of

10 removing one of the incentives for equipment

11 redundancy.

12 MR. WERMIEL: No, I disagree because Sam

13 was trying to say and I'll say it again there is

14 nothing in what Sam is talking about that negates the

15 requirement of the GDC for redundancy, single failure

16 capability in the mitigation systems. Nothing.

17 MEMBER APOSTOLAKIS: What is it that we

18 are removing when you say we're removing this?

19 MR. WERMIEL: It's the language that Sam

20 had up on one of your very first slides, I believe,

21 Sam.

22 MR. MIRANDA: Actually, it's the bottom

23 bullet right here. "The combination of two AOOs may

24 cause clad damage." That's the piece.

25 MEMBER BONACA: But you said something

1 else which was important before that they would be
2 independent, unrelated AOOs. That's a fundamental
3 issue.
4 MR. WERMIEL: But that's the point. The
5 point that Sam is saying is the interpretation of the
6 language that we would like to remove has been that --
7 And he gave you the example of the combustion
8 engineering plants that you have these two independent
9 AOOs that are not only unrelated but sometimes can't
10 even physically happen being interpreted as part of
11 the licensing basis for some plants. We want to
12 clarify that.
13 MEMBER ABDEL-KHALIK: But that's an
14 interpretation which is inconsistent with the language
15 that says "an incident of moderate frequency in
16 combination with any single act of component
17 failure..."
18 MR. WERMIEL: Okay. I'll go back to Sam's
19 example. If I take that language on the CE plant,
20 I've had this feedwater transient, let's say, and I
21 now have -- Let's think. You gave the example even
22 better. They were totally unrelated events.
23 MR. MIRANDA: The example I gave which is
24 one I just saw yesterday was a loss of off-site power
25 in combination with a rod withdrawal at power.

1 MR. WERMIEL: Right. You can't have a rod
2 withdrawal at power and a loss of off-site power
3 because you can't withdraw the rod if you have no
4 power.
5 MEMBER BANERJEE: But let's say that's the
6 sort of exception, a silly one, but in order to avoid
7 people doing some, let's say, silly analyses, you're
8 removing a criteria which I guess we don't understand
9 all the implications of it. This is what I think what
10 you're encountering. If the implications were very
11 clear and let's say that what you said that most
12 likely this will get analyzed in some other way, then
13 if it is analyzed in some other way the issue that's
14 troubling is does it matter what the sequence is of
15 how that happens because you said that it will be
16 analyzed as a small break LOCA or something.
17 Now does that mean that if the PORV is
18 open as just as an example due to some AOO being an
19 initiating event, is that equivalent to analyzing it
20 as a small break LOCA with a single failure? Maybe it
21 is. But one has a different sequence from the other
22 and I don't know if that sequence matters.
23 MR. WERMIEL: Remember what the "criteria
24 for an AOO" includes and that's the frequency of the
25 occurrence of what we're talking about. I indicated

1 to Dr. Wallis that there's some experience base that
2 supports the frequency. A sudden opening of the PORV
3 in and of itself it creates a small break LOCA and I
4 don't think a sudden opening of the PORV is an
5 anticipated operational occurrence. I don't think
6 under the normal life of plant we would expect or
7 anticipate that a power operated relief valve would
8 just suddenly open. That should not happen. So that
9 would not be considered an AOO. That would be
10 classified as an accident.
11 MEMBER BONACA: As an initiating event.
12 MEMBER BANERJEE: That's what I was going
13 to say, initiating.
14 MR. WERMIEL: Initiating events are
15 accidents or AOOs.
16 MEMBER ABDEL-KHALIK: But an operator
17 action that would render aux feed unavailable is a
18 single failure.
19 VICE-CHAIRMAN WALLIS: It happened at TMI.
20 It just was that the valves were not closed.
21 MR. WERMIEL: And we hope that we've dealt
22 with that particular problem through other ways
23 because the criteria, the general design criteria, are
24 specific to the systems designs themselves. The
25 operator is governed by procedures, by technical

1 specifications, by other things and we believe those
2 control his or her actions sufficiently so that those
3 kinds of events are unlikely.
4 VICE-CHAIRMAN WALLIS: About three hours
5 on this at the Subcommittee meeting. I don't think
6 we've clarified things very much.
7 MEMBER APOSTOLAKIS: But it seems to me
8 that what they're saying is not that obscure. If you
9 go to slide 9, it says "remove the language which
10 states that combined AOOs may lead to fuel clad
11 damage." And I was told earlier that there is a list
12 of these AOOs somewhere.
13 MR. MIRANDA: Yes. It's in Chapter 15.0.
14 MEMBER APOSTOLAKIS: So that's very clear,
15 is it not, that you can't take two of those and say
16 that's an AOO?
17 MEMBER BANERJEE: But that's not what
18 they're saying. They're saying --
19 MEMBER APOSTOLAKIS: But that's what
20 they're removing.
21 MEMBER BANERJEE: No.
22 MEMBER ABDEL-KHALIK: They are removing
23 more than that.
24 MEMBER BANERJEE: More than that.
25 MEMBER APOSTOLAKIS: And what is the

1 additional language?

2 MEMBER BANERJEE: It doesn't have to be an

3 AOO.

4 VICE-CHAIRMAN WALLIS: Slide 6.

5 MEMBER BANERJEE: Any single failure is

6 being removed.

7 MEMBER APOSTOLAKIS: But that's not what

8 he said.

9 MR. MIRANDA: No.

10 MR. WERMIEL: No. The single failure in

11 the mitigating system is not being removed.

12 MEMBER APOSTOLAKIS: Yes. That's my

13 understanding.

14 MR. WERMIEL: It can't be. It's in the

15 general design criteria.

16 MEMBER APOSTOLAKIS: Right.

17 MEMBER BONACA: Right.

18 MEMBER APOSTOLAKIS: So you are still

19 doing the sensitivity analysis that Said mentioned.

20 MR. WERMIEL: Yes.

21 MEMBER APOSTOLAKIS: But this specific

22 thing of assuming two AOOs being also anticipated

23 operational occurrence is not allowed.

24 MR. WERMIEL: That's right.

25 MEMBER APOSTOLAKIS: It's very simple.

1 MEMBER ABDEL-KHALIK: Where is that
2 sensitivity analysis identified in the SRP as someone
3 is reviewing?
4 MEMBER APOSTOLAKIS: It's part of the GDC.
5 MR. WERMIEL: When you read the criteria
6 associated with any anticipated operational occurrence
7 or any accident, it talks about the criteria under
8 which those events are to be analyzed and Dr.
9 Apostolakis characterized it as a sensitivity
10 analysis. I would characterize it as the assumptions
11 that go into the development of that particular
12 analysis. Included with that are things like loss of
13 off-site power, single failure, a number of things.
14 MEMBER APOSTOLAKIS: Slide 6 is not
15 removed. Is that correct?
16 MEMBER ABDEL-KHALIK: Slide 6 is removed.
17 VICE-CHAIRMAN WALLIS: Is removed. That's
18 what they want to remove.
19 MEMBER BANERJEE: That's what they want to
20 remove.
21 MEMBER APOSTOLAKIS: I thought --
22 (Several speaking at once.)
23 MEMBER BANERJEE: We wouldn't have been
24 arguing so long if they were not trying to remove
25 that.

1 VICE-CHAIRMAN WALLIS: They want to remove
2 this.
3 MEMBER APOSTOLAKIS: That's why I'm
4 confused. I thought in slide 9 they state what is an
5 AOO. That's what they're doing.
6 MEMBER BANERJEE: They are removing that.
7 MEMBER APOSTOLAKIS: And they just told us
8 that the GDC requirement of assuming an act of failure
9 is not removed.
10 MR. WERMIEL: What we're saying, Dr.
11 Apostolakis, is in order to make it clear that we're
12 categorizing events into these two categories, this
13 language we believe confuses that categorization. We
14 want to take it out. Along with the assumption of
15 those two categories is the assumed single act of
16 failure in the mitigation system for those events and
17 that includes AOOs and that includes accidents.
18 CHAIRMAN SHACK: I can't find in the new
19 guidance statement that says anything about any single
20 act of failure in the mitigation.
21 VICE-CHAIRMAN WALLIS: That's right. I
22 looked at that.
23 MR. WERMIEL: If you go to the SRP section
24 that talks about it, I believe you'll find reference
25 to the appropriate GDC.

1 CHAIRMAN SHACK: That's what I'm trying to
2 look for.
3 VICE-CHAIRMAN WALLIS: Where is it?
4 CHAIRMAN SHACK: I can't find it. If you
5 can guide me to it, then that might settle this whole
6 discussion.
7 MR. WERMIEL: It had better be there.
8 CHAIRMAN SHACK: But it isn't apparent to
9 me where it is. It has to meet the requirement of the
10 GDC for AOOs and maybe buried in that is the single
11 failure requirement. But I would like to see a
12 specific statement that says consider a single factor
13 in any mitigating system.
14 MEMBER ABDEL-KHALIK: Right. When you're
15 reviewing look for this.
16 MEMBER CORRADINI: That makes sense.
17 MR. WERMIEL: If it's not there, we'll add
18 it in and that's a promise because that's always been
19 the assumption.
20 MR. MIRANDA: Every STP section has a
21 statement in there that says "The reviewer shall look
22 at the mitigation systems that are accredited in the
23 analysis."
24 CHAIRMAN SHACK: Can you tell me the page
25 in this particular section?

1 MR. WERMIEL: Yes, find it.

2 CHAIRMAN SHACK: That's what I'm looking

3 for.

4 MR. WERMIEL: If it's not in this section,

5 perhaps it's in the section associated with a

6 particular AOO. Do we have an SRP section for one AOO

7 handy? We don't?

8 MR. MIRANDA: I don't have --

9 MR. WERMIEL: I will take that as a look-

10 up. We will make absolutely sure, positively sure,

11 that every accident and every AOO --

12 (Off the record discussion.)

13 CHAIRMAN SHACK: Certainly this is an

14 overall section. This seems like the place where it

15 ought to be.

16 MR. WERMIEL: That language ought to be in

17 there, too. I agree.

18 CHAIRMAN SHACK: And maybe it is, but I

19 can't find it.

20 MR. WERMIEL: I have my SRP scribe here

21 and I will make absolutely sure that he goes back and

22 checks 15.0 and every associated section in Chapter

23 15.0 and there's a bunch of them to assure that the

24 mitigation system single act of failure, worst case

25 single act of failure.

1 VICE-CHAIRMAN WALLIS: It doesn't seem to
2 be here.
3 MR. WERMIEL: Worst case because that's
4 what the GDC says is not lost.
5 MEMBER APOSTOLAKIS: Exactly.
6 MEMBER ABDEL-KHALIK: If you explicitly
7 include in that SRP, I'm happy.
8 (Off the record comments.)
9 MR. WERMIEL: We will do it.
10 VICE-CHAIRMAN WALLIS: I have a different
11 question here. In this SRP, it talks about Condition
12 III events. I thought they had been abolished.
13 MR. WERMIEL: Which?
14 VICE-CHAIRMAN WALLIS: I thought II and
15 III were all combination together.
16 MR. WERMIEL: I thought we had done that.
17 Did we miss something?
18 MEMBER APOSTOLAKIS: II and III are.
19 MR. WERMIEL: Which SRP are you looking
20 at?
21 MR. MIRANDA: Yes, which one is that?
22 VICE-CHAIRMAN WALLIS: On page 6, it talks
23 about Condition II and Condition III events and
24 they're quite different.
25 MR. WERMIEL: Did we miss something?

1 CHAIRMAN SHACK: Yes. It's reflecting
2 back on what licensees may have in their own
3 categorization.
4 VICE-CHAIRMAN WALLIS: Acceptance
5 criteria, Conditions II and III.
6 MR. MIRANDA: We're also saying in this
7 Chapter 15.0 that licensees that have used this
8 categorization in the past, Conditions II, III and IV
9 events, if they wish to continue using it, they may.
10 We're not going to try to back-fit them.
11 MEMBER BANERJEE: Right. We discussed
12 that. Yes.
13 (Off the record comments.)
14 CHAIRMAN SHACK: Gentlemen, we do have a
15 problem in the sense that we have interviews scheduled
16 at lunchtime.
17 VICE-CHAIRMAN WALLIS: Right.
18 CHAIRMAN SHACK: I guess the question is
19 do we need to continue this discussion after lunch or
20 is this something that we need to hear the language.
21 MEMBER APOSTOLAKIS: The question in my
22 mind is all we need to see the SRP after the
23 revisions.
24 CHAIRMAN SHACK: Yes, and if you can look
25 at it over lunch and find the language for us.

1 MR. WERMIEL: I found some.

2 CHAIRMAN SHACK: Okay.

3 MR. WERMIEL: In Section 15.0, page 9, the

4 second full paragraph from the top of the page.

5 VICE-CHAIRMAN WALLIS: Where are we here?

6 Where do I find it?

7 MR. WERMIEL: I'll quote from the

8 document. "The reviewer ascertains that the applicant

9 has evaluated the effects of single act of failures"

10 and there's a reference "and operator errors." And

11 that "the licensee's application contains sufficient

12 detail to permit independent evaluation of the

13 adequacy of systems as they relate to the..."

14 VICE-CHAIRMAN WALLIS: This is part of

15 Section B, Analysis Acceptance Criteria for Postulated

16 Accidents. It's not AOOs that he's talking about.

17 MR. WERMIEL: Ah-ha. If we need to add

18 similar language to cover AOOs we'll do that.

19 MEMBER APOSTOLAKIS: I think after lunch -

20 -

21 MEMBER BANERJEE: That would remove a lot

22 of our concerns.

23 MR. WERMIEL: And you know what? It

24 should be clear that that language applies to both,

25 accidents and AOOs.

1 MEMBER APOSTOLAKIS: Come back after lunch
2 and tell us exactly what sentence you would add where.
3 MR. WERMIEL: Sure.
4 MEMBER APOSTOLAKIS: That's going to work.
5 MEMBER ABDEL-KHALIK: I think that will do
6 it.
7 MR. WERMIEL: We will do that.
8 MEMBER APOSTOLAKIS: Okay. Great.
9 MEMBER BANERJEE: It will make us all
10 happy.
11 MR. WERMIEL: We'll do that.
12 (Off the record comments.)
13 MEMBER BANERJEE: This was the point we
14 were at at the end of the Subcommittee meeting. All
15 they needed to do is add that language.
16 VICE-CHAIRMAN WALLIS: You tried very
17 hard, George.
18 MEMBER APOSTOLAKIS: Glad I could be of
19 service.
20 (Laughter.)
21 (Off the record comments.)
22 CHAIRMAN SHACK: We're going to recess for
23 lunch until 1:30 p.m. Off the record.
24 (Whereupon, at 12:08 p.m., the above-
25 entitled matter recessed to reconvene at 1:31 p.m. the

1 same day.)

2 CHAIRMAN SHACK: We can come back into

3 session.

4 Sanjoy, do you want to continue our

5 discussion of the standard review plan?

6 MR. BANERJEE: Sure. I think the staff

7 were going to come back with some wording suggestions.

8 So --

9 CHAIRMAN SHACK: Or at least point out to

10 us where the wording was.

11 MR. MIRANDA: After the last meeting with

12 the subcommittee, I made some changes to SRP Chapter

13 15, Part 0, and the changes are in the copy that you

14 have now, and they are indicated in italics. There's

15 also a strikeout on page 7 in response to Dr. Wallis'

16 observation that something in there was a definition

17 and not --

18 MR. BANERJEE: Maybe you could just

19 briefly lead us through this.

20 MR. MIRANDA: Sure.

21 MR. WALLIS: So these are all at the end

22 rather than being in context? They're all at the end,

23 the changes, aren't they?

24 MR. MIRANDA: Well, if you look at page

25 8 --

1 MR. BANERJEE: What about 15.2? Some
2 strikeout there. Are these significant?
3 MR. MIRANDA: No, they're not. I put
4 those in just to make it more clear, that this is in
5 reference to what I mentioned this morning, that
6 licensees that have condition two, three, and four
7 events in your licensing basis, they continue to use
8 those.
9 MR. BANERJEE: Okay, right. Carry on.
10 CHAIRMAN SHACK: Is there language you
11 wish to point out that covers the concern that we were
12 discussing this morning, I guess, is where we were
13 really hung up.
14 MR. BANERJEE: Yeah.
15 MR. WALLIS: Also, AOO is defined as an
16 accident which doesn't result in sufficient damage to
17 preclude resumption of plant operation.
18 MR. MIRANDA: Yes, and that's also in --
19 MR. WALLIS: That's a much better
20 definition than all of this frequency stuff. It's a
21 workable definition.
22 MR. MIRANDA: And it's noted in the GDCs
23 as well.
24 MR. WALLIS: I didn't see that before. I
25 like the way you put that in.

1 MR. MIRANDA: Thank you.

2 On page 9, under assume protection system
3 actions, the new text is in italics. It says, "The
4 performance of each credited protection system is
5 required to include the effects of the most limiting
6 single active failure. This verifies satisfaction of
7 the GDC criteria that required protection systems to
8 adequately perform their intended safety functions in
9 the presence of single active failures."

10 MR. ABDEL-KHALIK: But that's under Part
11 B. That's under Part B, which starts on page 7.

12 MR. WALLIS: It has to do with accidents,
13 doesn't it?

14 MR. ABDEL-KHALIK: Right.

15 MR. WALLIS: That's accidents. How about
16 the AOOs?

17 MR. BANERJEE: Yeah, I thought you were
18 going to add something under AOOs. That was sort of
19 the --

20 MR. WALLIS: There's nothing in the AOO
21 section that talks about this additional failure.

22 MR. BANERJEE: Section A rather than B.

23 MR. MIRANDA: There was another reference
24 to it. I'm trying to find it.

25 MR. BANERJEE: Well, at 15.10 there is the

1 review of verifies that the applicant has specified --

2 MR. WALLIS: That is still accidents,

3 isn't it?

4 MR. BANERJEE: Yeah, it's still on the

5 accidents and has included the effects of single

6 active failures. So that's page 10 towards the middle

7 in italics.

8 MR. WALLIS: It's very confusing because

9 you have capital B as a heading, and then you have

10 Subsections little I, and then you have -- then it

11 goes to three. Is that part of Subsection B or is

12 that a new thing?

13 And then there's Subsections A and B in

14 Part 6 and so on.

15 MR. MIRANDA: Frankly, I have to admit

16 that I don't know how these things are numbered.

17 They've been changed so many times, and we've had at

18 least six people involved in making these changes,

19 but --

20 MR. WALLIS: Okay. So they aren't

21 subsections of B.

22 MR. BANERJEE: No.

23 MR. WALLIS: No, they are separate things.

24 MR. BANERJEE: Yeah, under four and six,

25 I guess.

1 MR. WALLIS: It is clear that four applies
2 both to accidents and to AOOs?
3 MR. MIRANDA: That was my intention. It
4 applies to protection systems. It has always applied
5 to protection systems. We talk about single active
6 failure. We are talking about a failure in a
7 protection system and, therefore, it applies --
8 MR. APOSTOLAKIS: Not a protection system.
9 Safety system.
10 MR. MIRANDA: Safety system.
11 MR. BANERJEE: Yeah.
12 MR. APOSTOLAKIS: Protection system is a
13 specific system.
14 MR. BONACA: Right, right, and by the way,
15 this is all in the text, however. Page 15.09-9 talks
16 about protection systems.
17 MR. BANERJEE: It's in the text, but I
18 mean, as you pointed out, the usage is more related
19 just to the SCRAM systems.
20 MR. BONACA: SCRAM systems?
21 MR. BANERJEE: Yeah.
22 MR. BONACA: The other system is the
23 communication systems.
24 CHAIRMAN SHACK: The typical protection
25 system functions include trips, closures, ECC.

1 MR. BONACA: That's why there is the
2 issue, I mean, because there is a definition there.
3 CHAIRMAN SHACK: But I guess if you read
4 the headings carefully enough, the heading 2(a) and
5 (b) and then the heading 3 and 4; so four does apply
6 to everything.
7 MR. ABDEL-KHALIK: But just to avoid any
8 confusion, it would be easier if you explicitly state
9 that, this sentence in italics. If you start that
10 sentence by saying, "In evaluating the response to
11 both AOO and postulated accidents," comma, "the
12 performance of each credited protection system is
13 required to include," et cetera.
14 And that would be totally unambiguous.
15 MR. MIRANDA: Before the words "the
16 performance of each credited system," put that in.
17 MR. ABDEL-KHALIK: Before that so that
18 evaluating the response to both AOOs and postulated
19 accidents, comma.
20 CHAIRMAN SHACK: That addresses your
21 concern?
22 MR. MIRANDA: Yes, it does. Thank you.
23 MR. BANERJEE: And I guess on page 10 for
24 use in mitigating transient or accident conditions you
25 really mean mitigating AOOs and postulated accident,

1 just to be very clear. Just before that stuff in
2 italics on page 15.010.
3 MR. MIRANDA: Okay. For use in mitigating
4 transient or accident conditions.
5 MR. BANERJEE: Yes. You use the word AOOs
6 and postulated accidents, don't you? I mean, just to
7 be --
8 MR. MIRANDA: Mitigating AOOs, false
9 postulated accidents.
10 CHAIRMAN SHACK: And just to keep the
11 terminology consistent throughout the documents,
12 right.
13 MR. BANERJEE: Yeah, so that there's no
14 ambiguity.
15 MR. MIRANDA: Okay.
16 MR. BANERJEE: So would that satisfy the
17 committee then?
18 MR. WALLIS: We're not going to revisit
19 what was taken out and why?
20 MR. BANERJEE: Well, effectively they're
21 saying that they took out something which was
22 ambiguous.
23 MR. WALLIS: That's redundant or
24 ambiguous.
25 MR. BANERJEE: Yeah.

1 CHAIRMAN SHACK: But I think the paragraph
2 that's in addresses our concern that we didn't wan tot
3 lose when that paragraph disappeared.
4 MR. WALLIS: Well, why did we spend so
5 long this morning?
6 CHAIRMAN SHACK: Well, let's not discuss
7 history here because the paragraph was not there.
8 MR. APOSTOLAKIS: Because entropy
9 increases.
10 MR. BANERJEE: Well, this is the first
11 time we've seen the changed wording. So shall we then
12 conclude?
13 CHAIRMAN SHACK: I think we can conclude
14 this section. I think everybody is happy.
15 MR. BANERJEE: All right. Thank you very
16 much. Very helpful.
17 CHAIRMAN SHACK: And we want to move on to
18 our next topic, which is final results of the chemical
19 effects head loss test related to the resolution of
20 the PWR sump performance issues, and I'm going to have
21 to ask Mario to chair this portion of the meeting
22 since I have a conflict of interest that Argonne has
23 been involved in work in this area.
24 And, Graham, you're going to lead us
25 through it, I assume.

1 MR. WALLIS: I think so, although Sanjoy
2 chaired the meeting.
3 MR. BANERJEE: I'm quite happy to have
4 Graham lead us through this.
5 MR. WALLIS: I thought that would be the
6 case.
7 Well, you're aware of the sump issue, GSI-
8 191. It's several years old. Over the last few years
9 RES has conducted research in various areas. This
10 has been reported to this committee, and we have
11 written several letters about it, which you may
12 recall.
13 Now, last year we were told that research
14 would stop around the end of the first half of the
15 year. So the end of the spring, and what remained was
16 to write up the formal reports of that research.
17 Now, we had seen the results of the
18 research and we had already discussed it, and in
19 looking at the final reports, it seems ot me that most
20 of the major points we'd already discussed in our
21 letters, but there are a few areas which we haven't
22 heard about, and we're going to be informed about
23 these today. There has been further activity.
24 I believe it's the feeling of the
25 subcommittee that these activities sufficiently

1 extensive or complete to warrant a letter from the
2 committee at this time, and that was, I think, also
3 the inclination of the staff at the subcommittee
4 meeting. And of course, we can decide that at the
5 appropriate time.
6 So I'd like to invite the staff to go
7 ahead and make their presentation.
8 MR. SHAW: If I may, Dr. Wallis.
9 MR. WALLIS: Yes.
10 MR. SHAW: Let me begin. My name is Tony
11 Shaw. I'm the Branch Chief of the Mechanical and
12 Structural Engineering Branch in the Office of
13 Research.
14 This research work was conducted in my
15 branch. This is a follow-up from last week's briefing
16 to the Thermal Hydraulics Subcommittee, and the
17 purpose of today's briefing is to give the full
18 committee an update of what we have done on research
19 related to resolution of Generic Safety Issue 191.
20 And most of the material like you
21 mentioned before was briefed in front of the committee
22 earlier several times, and so today we'll focus on the
23 update of the research activities you have that your
24 full committee may not have heard before. So we'll do
25 that.

1 And we're not requesting a letter from the
2 ACRS. This is really for information for the full
3 committee.
4 Today's briefing will consist of several
5 parts. Mr. Erv Geiger will kick off to provide
6 overview of all the research associated with the
7 information of the informed resolution of GSI-191.
8 He will follow by discussion of the
9 surrogate test being conducted at Argonne National
10 Lab. That's Dr. Shack's support. That's to test a
11 surrogate material that Westinghouse is proposing to
12 use in their test regarding that head loss in sump.
13 That will be followed by Bill Krotiuk.
14 His test run at PNNL, again, regarding head loss on a
15 sump screen, as well as the enhanced head loss
16 correlation he has developed based on the most recent
17 data, including those data generated from PNNL.
18 And at the end we will discuss in more
19 detail the peer review process and the PIRT process we
20 have employed with regard to the sump research, and
21 that as directed by the subcommittee last week, we
22 would like to focus the majority of today's time on a
23 peer review. We expect to spend at least half of the
24 total time focused on peer review. The rest of the
25 time will be occupied by Erv Geiger and Bill Krotiuk[s

1 review.

2 So with that I would like to turn that

3 over to Erv Geiger.

4 MR. GEIGER: Thank you, Tony.

5 Hi. Erv Geiger. I'm with the Office of

6 Nuclear Regulatory Research, and I would like to thank

7 the committee fore giving us this opportunity to

8 discuss the results of our research for GSI-191, and

9 we'll also inform you of some additional testing we

10 had done since we had last provided a presentation.

11 Some background. The GSI-191 was

12 established to assess the potential for debris in the

13 containment to be Grade ECCS and containment spray

14 system performance during loss of coolant accidents.

15 And as part of that effort two ECCS

16 performance degradation issues were identified for

17 investigation, and they were to decrease in the

18 available MPSAs for the ECCS/CSS pumps due to debris

19 accumulation on the screen and also some work

20 integration of components due to --

21 MR. WALLIS: Now, the second one of those,

22 have you done any work on downstream effects recently?

23 MR. GEIGER: Well, the one that we had

24 done was the throttle valves.

25 MR. WALLIS: That's right, but I think the

1 committee was very interested in effects on the core
2 or the other components inside the reactor vessel.
3 MR. GEIGER: I understand that's of great
4 interest to the committee. However, research at this
5 point has not been commissioned to do research. I
6 think ACRS is conducting --
7 MR. WALLIS: We had recommended it in our
8 letter.
9 MR. GEIGER: NRR is conducting it. NRR is
10 conducting quite a bit of work on that as a separate
11 effort, and I think they will be presenting that in a
12 later presentation.
13 MR. SHAW: Dr. Wallis, this is Tony Shaw
14 again.
15 I believe that topic will be part of the
16 discussion that Rob Tregoning will offer. The issue
17 came up through the peer review, and it will go
18 through the PIRT process. So Rob will --
19 MR. WALLIS: Well, the peer review --
20 MR. SHAW: He says it's not correct.
21 MR. WALLIS: He says no?
22 MR. TREGONING: Rob Tregoning, Office of
23 Research.
24 The issues that you raised, there was some
25 separate study that was undertaking, some scoping

1 calculations done by Research as well as an effort in
2 coordination between industry and NRR. We don't have
3 that on the agenda for today, but I'm presuming in May
4 when NRR comes back that that will be a point of
5 discussion.
6 Mike wants to follow up.
7 MR. SCOTT: This is Mike Scott, NRR.
8 We do plan to talk to you in May about how
9 we're doing on that issue, but there is a topical
10 report on the subject that we're to receive in May.
11 So we probably won't have too much to tell you in May.
12 At a later meeting we'll have more to say.
13 MR. WALLIS: Well, I think what we have
14 learned is the RES does not have an active program on
15 this subject.
16 MR. GEIGER: Correct.
17 MR. WALLIS: Thank you.
18 MR. GEIGER: Then subsequently chemical
19 effects was identified as a potential ECCS performance
20 degradation phenomenon. So we did some research on
21 that.
22 So the objectives of the research were to
23 determine if chemical reaction products could form in
24 a representative sump pool environment and examine
25 independently the effects of chemical precipitates or

1 particulates in combination with insulation fiber on
2 the sump screen.
3 Examine the variables affecting the debris
4 bypass of sump screens and study effects of those
5 bypasses on the throttle valve clogging. And then we
6 characterized the transport of coatings in water.
7 We had presented much of these research
8 results in detail in several ACRS presentations in
9 2006, and the effort resulted in 11 NUREG CR reports,
10 and there are two NUREG reports and there are two
11 technical letter reports not on this topic.
12 The detailed GSI-1 research presentations,
13 I guess, that have been made previously and the
14 current presentation is going to focus mostly on
15 recent work that had been completed since the last
16 meeting.
17 MR. WALLIS: Now, you've written lots of
18 NUREGs.
19 MR. GEIGER: I'm sorry?
20 MR. WALLIS: I say you've written lots of
21 NUREGs --
22 MR. GEIGER: Yes.
23 MR. WALLIS: -- on separate topics. Some
24 day it might be good to have a NUREG that throws it
25 all together and says this is the state of our

1 knowledge, which is useful, not just what's being
2 done, but extract from it what is actually of use for
3 solving the problem.
4 MR. GEIGER: Well, there's a great deal of
5 detail in a lot of these reports, and as you noted,
6 the reports are very detailed and perhaps there would
7 be some value. I agree there could be some value in
8 summarizing the results of all that research into
9 this. That may be something we may look at.
10 MR. WALLIS: And think about that, right.
11 MR. GEIGER: Yes.
12 MR. SHAW: May I add something? This is
13 Tony Shaw again.
14 We do have -- Erv is in the process of
15 drafting what we call RIS, a research information
16 letter, REAL (phonetic). We'll send to NRR.
17 MR. WALLIS: That will fulfill this
18 function then.
19 MR. SHAW: That's exactly right. It will
20 summarize everything, a brief description of each
21 research project and the reports.
22 MR. GEIGER: Okay.
23 MR. APOSTOLAKIS: We can't read that.
24 That's okay.
25 MR. GEIGER: I'm not sure why. That's

1 interesting.

2 MR. APOSTOLAKIS: We have a file copy.

3 Don't worry about it.

4 MR. GEIGER: Okay. Well, I'm sorry.

5 So the significant findings of our

6 research, I guess the important issue to remember is

7 that the major accomplishments are that we did

8 demonstrate that gelatinous precipitates could form in

9 the sump pool during LOCA.

10 MR. WALLIS: Gelatinous? There were

11 precipitates, but is the word "gelatinous" appropriate

12 here?

13 MR. CORRADINI: Is that a fancy word for

14 "gooey"?

15 (Laughter.)

16 MR. CORRADINI: Well, I've seen that word

17 used.

18 PARTICIPANT: Sticky?

19 MR. GEIGER: Non-Newtonian? I'm sorry.

20 MR. WALLIS: Well, a lot of them seem to

21 be particulates. I'm not sure how gelatinous they

22 were.

23 CHAIRMAN SHACK: I mean, the aluminum

24 oxyhydroxides could be relatively characterized as

25 gelatinous. The calcium phosphates --

1 MR. WALLIS: The calcium phosphates are
2 not.
3 CHAIRMAN SHACK: -- as we heard are not.
4 MR. WALLIS: And small quantities of
5 precipitates whether gelatinous or not --
6 (Laughter.)
7 MR. WALLIS: -- pose significant head
8 loss.
9 MR. GEIGER: I think where it came from is
10 that what was identified as the PMI. We saw some
11 gelatinous material. What was this?
12 MR. WALLIS: Well, I thought that, in
13 fact, Argonne didn't see anything, but it still
14 clogged the screen.
15 MR. GEIGER: Well, that, too.
16 MR. BANERJEE: Invisible.
17 MR. GEIGER: Well, not without
18 magnification. If we had magnification we might have
19 seen something.
20 Okay, and then the head loss testing with
21 CALSIL also demonstrated that particulates deposited
22 in and throughout the fiber bed could cause a pressure
23 drop.
24 Coatings are concerned, and we
25 demonstrated that coatings really did not transport

1 under the velocity conditions that we studied. So
2 that could be applied somewhat depending on the plans,
3 too.
4 MR. WALLIS: As long as they're big
5 enough.
6 MR. GEIGER: Yes. There were chips, not
7 particulates.
8 MR. WALLIS: Right.
9 MR. GEIGER: We would think that
10 particulate falls in a separate category.
11 And the screen bypass experiments
12 demonstrated that NUKON and CALSIL, even reflective
13 metal insulation could actually get through and bypass
14 sump screen. We tested between 1/16 inch and 1/8 inch
15 opening sizes, and all of those depending, of course,
16 on the size and the characteristics of how the
17 insulation was broken up, but there was quite a bit
18 that bypassed, and some of these could actually
19 accumulate in the throttle valves which were close
20 tolerance, like the throttle valves. That potentially
21 could cause problems.
22 So our accomplishments and the path
23 forward. Right now the planned GSI-191 research
24 projects are complete. Those are the ones that have
25 been pretty much in the works for the last couple of

1 years.

2 The research results are being used in

3 making regulatory decisions. For instance,

4 evaluations of the industry testing on the sump

5 screens, and the industry activities are being

6 monitored to identify any new issues that come up as

7 a result of their testing.

8 And work is continuing on the evaluation

9 of the NUREG 1861 peer review comments, and Robert

10 Tregoning will go into more detail on this later in

11 his presentation, and staff will identify any future

12 research needs to insure an acceptable resolution to

13 GSI-191 as they may come up during the testing and

14 maybe as an outcome of the --

15 MR. WALLIS: When you say that you mean

16 that you're waiting for NRR to identify these needs

17 or --

18 MR. GEIGER: Well, we're looking at what

19 may come out of the NUREG, the peer review comments if

20 we need to go there.

21 MR. WALLIS: So this is based mostly on

22 the peer review of these new research needs?

23 MR. GEIGER: Peer review, and also in

24 discussions with NRR. They had indicated that

25 depending on where the industry testing needs, there

1 may be a request for additional research.

2 MR. WALLIS: Okay. So you'll be

3 responding to something?

4 MR. GEIGER: Yes, we'll respond to that.

5 Right now we're not out looking at -- because we're

6 not looking at the tests and so on. So we're not

7 aware of what the outcomes are.

8 MR. APOSTOLAKIS: Can you give me more

9 information on these regulatory decisions that you are

10 making? Evaluating somebody's testing is not really

11 a regulatory decision, is it? I mean, are you asking

12 the industry to do anything?

13 MR. GEIGER: Well, the industry is -- as

14 an outcome of some of this testing we have done and

15 also the testing they have done, they have identified

16 certain issues that are for sump clogging, potentially

17 clogging sumps or head loss testing, a loss of head

18 loss on the MPSH.

19 So what they have done is they're looking

20 at -- they're taking measures to mitigate those.

21 MR. APOSTOLAKIS: Sure.

22 MR. GEIGER: So there may be buffer

23 replacements. There may be requests for not using any

24 buffers. There are a number of issues. So that's

25 where we are using. We're going to -- some of this

1 information will inform the decisions to their
2 requests.
3 MR. APOSTOLAKIS: So if they propose a
4 remedy, then you will use these results to evaluate
5 whether that makes sense.
6 MR. GEIGER: Yes.
7 MR. APOSTOLAKIS: So you're more in a
8 review mode then.
9 MR. GEIGER: We're in a review mode, and
10 it's basically NRR looking at all of these tests
11 because they are actually looking at a large number of
12 the vendor tests and identifying issues as to how
13 much, you know, settlement, how much transports and
14 what the clogging issues are.
15 One of the things is that there are so
16 many variables in sump screen designs now, you know.
17 They're not all perforated plates now. They have many
18 different designs. So just attacking any one or
19 researching further on any one design may not solve
20 the other problems, but there are some generic issues
21 here that would address all of these.
22 So I guess NRR could speak more to that,
23 but that's pretty much how much I know about it right
24 now. Okay?
25 MR. ABDEL-KHALIK: Have the results of

1 this research affected the methodology of any accident
2 analyses?
3 MR. GEIGER: I don't have any information
4 to address that. I'm not sure if it's inputting NRR.
5 CHAIRMAN SHACK: They're putting in new
6 hardware.
7 MR. GEIGER: Yeah, they're all putting in
8 -- well, right now what it -- well, one of the items
9 they're doing is everybody is putting in larger sump
10 screens, and they're looking at how much debris
11 actually accumulates on those sump screens and they're
12 doing pressure drop calculations pretty much based on
13 their specific plan chemistries.
14 MR. BANERJEE: But they're also evaluating
15 what to do to control the chemistry.
16 MR. CORRADINI: But to get to Said's
17 point, so they put in new hardware. They then have to
18 assess how much gets stuck on the hardware. Then they
19 must have to do different LOCA analyses for the
20 recirculation phase to decide how much --
21 MR. ABDEL-KHALIK: And modify the analysis
22 of record.
23 MR. SCOTT: This is Mike Scott, NRR.
24 If I could try to respond to that, it is
25 correct to say that the industry has been made aware

1 of the conclusions that have been derived from these
2 various NUREGs. They're all publicly available on our
3 sump performance Website, and we have discussed them
4 with the industry.
5 It would also be correct to state that the
6 results of the various research projects that are
7 documented in these NUREGs have been considered and
8 are being considered by NRR staff in our ultimate
9 review of the generic letter responses, as well as in
10 the audits that we are now in the process of doing.
11 Whether the industry has incorporated or
12 let me say the extent to which the industry has
13 incorporated the NUREGs will be more visible to us as
14 we continue to observe testing, continue to do audits
15 and review the generic letter responses. At this
16 point we're not fully sure how far that has gone.
17 MR. CORRADINI: Can I translate that? So
18 they've been --
19 (Laughter.)
20 MR. CORRADINI: I'm trying to understand
21 it. That's very extensive. I'm just trying to
22 understand.
23 So to the extent that you've done the
24 research, you've made it publicly available, it's
25 unclear how individual utility licensees are going to

1 use it to either put in either new hardware or
2 evaluate how that hardware performs.
3 MR. SCOTT: Okay.
4 MR. CORRADINI: Is that what I heard?
5 MR. SCOTT: Well, there's more than one
6 answer to that. First of all, the hardware has
7 largely been put in or is being put in in terms of
8 much larger strainers, and that was done with the
9 knowledge up front that the issues were not fully
10 resolved. And all of the utilities who put in their
11 hardware knew that there was a chance that they would
12 be making additional changes if the problems to be
13 discovered later or to be evaluated later bore out the
14 need for that.
15 And in particular, chemical effects has
16 been a major issue, and chemical effects testing is
17 only now starting to be performed by the vendors as a
18 whole.
19 You mentioned utility specific. I would
20 say it's more vendor specific. Each vendor has a
21 method that they sell to their customer utilities.
22 Now, each utility's configuration is different, but
23 they're probably going to buy the methodology that
24 each vendor provides.
25 Now, what we haven't fully evaluated yet

1 is those methodologies, particularly as related to
2 chemical effects. The information has not been made
3 available to us yet. It's just now being made
4 available. So they have presumably used some of this
5 information, but I can't validate for sure that they
6 have.
7 MR. POWERS: I can assure you that they
8 have.
9 MR. WALLIS: Well, can I ask a different
10 question? He asked if industry is using this
11 information. Are you using this information other
12 than in sort of a qualitative sense knowing which
13 questions to ask industry? Are you making any
14 predictions with NRR about the performance of these
15 screens?
16 MR. SCOTT: Are we making predictions?
17 No, I would not say --
18 MR. WALLIS: Using the results of the
19 research to predict anything, yeah.
20 MR. SCOTT: I would not say that our
21 method involves predicting the performance. Now, as
22 you may recall, Dr. Wallis, from last week's
23 discussion, NRR evaluated the research reports, and
24 we developed a document where we described the uses
25 that we were putting them to. I wouldn't say that

1 we're using them to predict because that has not been
2 part of the process.
3 MR. WALLIS: No, but you're learning which
4 questions to ask and what to look for and that sort of
5 thing.
6 MR. SCOTT: Those documents are informing
7 those questions, yes.
8 MR. ABDEL-KHALIK: But eventually at the
9 end of the day the analyses of record will reflect
10 this additional knowledge and wisdom that has been
11 gained by this process that may impact the methodology
12 and/or the results of the analyses.
13 MR. SCOTT: We are continuing to develop
14 review guidance in certain areas, and these documents
15 will inform that development. So they will ultimately
16 be incorporated as appropriate by the staff in our
17 review of the submittals that we get from the
18 industry.
19 MR. MAYNARD: There's nothing that
20 requires the utilities or even the staff to use the
21 NUREG results. There are other things that are
22 available. So we still have to demonstrate compliance
23 with the regulations and the rules. The NUREGs
24 provide information and provide methodologies or
25 things that could be used, but it's not the only thing

1 that has to be used by the staff or by the licensee,
2 right?
3 MR. SCOTT: That's certainly correct.
4 Each licensee will need to show to us that they have
5 satisfactorily addressed this issue. They can use
6 whatever method they want as long as they can justify
7 it. That's true.
8 MR. GEIGER: I think what it boils down to
9 is that we're not designing the resolution for the
10 licensees. It's up to them.
11 So our follow-on presentations, as
12 previously mentioned, there's a technical letter
13 report where we did some follow-up studies at Argonne
14 National Laboratory to examine WCAP surrogates and
15 also sodium tetraborate solutions.
16 And we did complete our pressure drop
17 calculation methods for pressure drop across sump
18 screens, and then we're going to present, I guess, our
19 approach to the resolution of the peer review
20 comments.
21 With that I'll go on to the next. Are
22 there any questions?
23 MR. WALLIS: Thank you very much.
24 Is this the time to ask Dr. Shack to put
25 on a different hat and move up to the front?

1 MR. GEIGER: Yes, if Dr. Shack would
2 please come up.
3 Okay. We did some additional follow-on
4 testing on a WCAP surrogate, and sodium tetraborate
5 buffer to develop some more knowledge in the area.
6 MR. POWERS: Is it fair to ask what a
7 blacksmith knows about sodium tetraborate?
8 MR. WALLIS: Well, I was tempted to ask
9 for his qualifications, but I think we can pass over
10 that.
11 MR. GEIGER: The background, we did some
12 surrogate testing, and some licensees are conducting
13 a sump screen head loss testing using the Westinghouse
14 recommended procedures for producing these surrogates.
15 And also for the buffer testing, the ICET
16 and head lost testing indicated that sodium
17 tetraborate appeared to be a less problematic buffer
18 than some of the other buffers like sodium hydroxide
19 and trisodium phosphate under certain sump
20 environments. Not all of course.
21 So some licensees may elect to change
22 these buffers to sodium tetraborate.
23 MR. WALLIS: You say some licensees are
24 using Westinghouse surrogates.
25 MR. GEIGER: Yeah, not everybody.

1 MR. WALLIS: Presumably those are the ones
2 who have chemical effects which would be covered by
3 the surrogate. Are there any that were using
4 different surrogates?
5 MR. GEIGER: Should I speak, Mike, or do
6 you want to address that?
7 MR. WALLIS: I just wonder if the
8 Westinghouse surrogate has some faults, let's say.
9 MR. LU: this is Shanlai Lu from NRR.
10 MR. WALLIS: Alternative surrogate to be
11 used?
12 MR. LU: Actually that's the entire whole
13 thing is being even studied by the industry at this
14 point, and they may use the W --
15 MR. WALLIS: It's being reevaluated?
16 MR. LU: Yes, some of the WCAP, the
17 surrogate (unintelligible) are mounted so large, and
18 they cannot label it with (unintelligible) loss beta.
19 So they are looking into that.
20 MR. POWERS: I have certainly heard that
21 the surrogate grows the wrong phase of either aluminum
22 hydroxide or oxyhydroxide.
23 CHAIRMAN SHACK: I'll discuss that a
24 little bit.
25 MR. GEIGER: So the objectives of the

1 surrogate testing were to evaluate the head loss
2 performance of the WCAP surrogate precipitate relative
3 to precipitates generated during the earlier NRC
4 sponsor testing for chemical effects head loss, and
5 then the buffer testing was just to examine the
6 solubility of the aluminum in --
7 MR. WALLIS: And the question that we
8 asked of the subcommittee is what's the confidence
9 with which we can say that any of these surrogates or
10 precipitates represent what happens in a sump.
11 MR. GEIGER: And I know we discussed that
12 before, and I think in thinking more about it, the way
13 it looks, what we have proven, you know, we had
14 intended to run these tests longer, but what we had
15 proven was that even if we had any precipitates,
16 aluminum precipitates of aluminum, if you used even a
17 little bit above the saturation limit -- I'm sorry --
18 not the saturation limit, but if these precipitates
19 would occur, you would immediately have high head loss
20 across the screen.
21 So although we didn't prove that, yes,
22 these were identical to or very similar to what you
23 would expect if the precipitate generated over a 30-
24 day period or whatever. What it did demonstrate is
25 that if anybody, in fact, did use these Westinghouse

1 precipitates.

2 As soon as they ran their test, if they

3 had a fiber bed under sum screen, they would

4 experience head loss.

5 MR. WALLIS: Well, when we get to the peer

6 review we'll find that the chemists had lots of

7 comments about all kinds of chemical things which

8 could be going on in the sump and all kinds of

9 different sorts of precipitates, and whether you were

10 getting the right precipitate and so on.

11 So it would seem that at least those peer

12 reviewers had a lot of questions about the reality of

13 some of these surrogates.

14 MR. GEIGER: That may be, but if you just

15 look at, I guess, the practical point, if any vendor

16 is testing the surrogates, as soon as they put in a

17 little bit of surrogate, it's going to affect their

18 test program. So they're going to have to go look for

19 something else to do. I mean, that's where it comes

20 out to what did we prove, is that if you use

21 Westinghouse surrogates, you're immediately going to

22 show that you're affecting your head loss.

23 Whether we fully understand how or whether

24 their tests are going -- you know if they're realistic

25 or not, what we can say is that they, in fact, show

1 that if you have a fiber bed with this aluminum
2 precipitate -- so they may look at then alternate
3 testing, which I understand they are, to, I guess, use
4 other methods for predicating or maybe developing the
5 precipitates over a longer period in the sump itself.
6 But I think there are other approaches
7 they will have to follow.
8 I think Dr. Shack is going to go over the
9 test results.
10 CHAIRMAN SHACK: I just want to discuss
11 some of the work that we did at Argonne, following up
12 on some of this work.
13 Just a quick background, again, to address
14 Dr. Wallis' question. Again, you know, you'll hear
15 more from the peer review, but, again, the ICET-1 or
16 the ICET series of tests at Los Alamos were an attempt
17 to get a reasonable complexity of the environment. I
18 mean, you know, they simulated sort of prototypic
19 amounts of the various materials.
20 You know, we're certainly not complete,
21 but it's a rather complex chemical environment, is
22 what it was, and from those tests we identified a
23 number of products that could affect head loss. One
24 important class of those products are these aluminum
25 hydroxides, oxyhydroxides. We won't worry too much

1 about the exact chemical form that they're taking in.
2 And one of the results that's interesting
3 to this, you know, the tests at Los Alamos were
4 intended to be somewhat conservative. The amount of
5 dissolved aluminum that you're going to have in
6 solution will, of course, depend on the area of
7 aluminum that you have and the volume of the sump that
8 you're dissolving into.
9 The values used in the ICET test probably
10 weren't bounding. There may be a few plants that
11 actually have higher values, but they have a higher
12 aluminum-to-sump volume ratio than many of the plants
13 that you're going to have. So they're fairly
14 conservative from there.
15 So we would expect most plants to have
16 lower dissolved aluminum levels with the corresponding
17 buffers than we found in the ICET tests where we found
18 350 ppm of dissolved aluminum in the sodium hydroxide
19 environment and 50 ppm of dissolved aluminum in the
20 sodium tetraborate environment.
21 Now, when we ran our first series of head
22 loss tests at Argonne, we found that 350 ppm of
23 aluminum and a sodium hydroxide environment as we
24 cooled the environment down, we dropped Jello on the
25 bed and got very, very high head loss. If we did it

1 even with 100 ppm of dissolved aluminum in that sodium
2 hydroxide environment and we cooled down, we got very
3 high head loss.
4 So that doesn't indicate that you can't
5 live with the sodium hydroxide thing, but at least for
6 these aluminum to volume ratios you were getting large
7 head losses.
8 MR. CORRADINI: Can I ask you a
9 clarification?
10 So you mixed it to the solubility limit of
11 the aluminum? I don't understand. The 350 ppm was
12 just a chosen number?
13 CHAIRMAN SHACK: That was what came out of
14 the chemical test at Los Alamos. When you cooked this
15 thing at 160 degrees for 30 days, which represents the
16 sump environment, they dissolve aluminum up to the 350
17 ppm level.
18 As we cool it down, we, in fact, will
19 reach a solubility limit, and we'll form a
20 precipitate, but you know, these are the dissolved
21 aluminum levels that we got out of the ICET tests.
22 MR. CORRADINI: So under the cooking
23 recipe, that's not at its limit. That's not saturated
24 yet.
25 CHAIRMAN SHACK: That's not saturated, no.

1 You can get a lot of aluminum into these solutions.

2 The interesting thing, again, from our

3 first series of head loss tests with the 50 ppm of

4 aluminum, which we think is conservative for many

5 plants, we ran for 11 days at 70 to 80 degrees, and we

6 produced no measurable increase in head loss. We at

7 the last moment upped that dissolved aluminum level to

8 100 ppm and our head loss immediate rose up. So

9 somewhere between 50 and 100 ppm of aluminum with the

10 STB we got head loss.

11 So there was interest in looking back at

12 with this anomalous test can we repeat these results

13 because it sort of impressed.

14 And, again, as Erv mentioned, industry has

15 proposed a surrogate approach where you prepare the

16 aluminum oxyhydroxide separately. In the Argonne

17 loop, our loop doesn't look anything like a sump

18 screen. You know, ours is really to look at the

19 potential for essentially local chemical effects on a

20 fiber bed to induce head loss.

21 If you really want to do a prototype test,

22 you have to do a different kind of geometry. They

23 can't wait 11 days, you know, circulation in their

24 large flume. so they have to come up with surrogates,

25 and what they proposed to do was make a conservative

1 assumption that all of the dissolved aluminum would
2 end up as a precipitate and they would add that much
3 precipitate to the solution conservatively bounding
4 the result, and you know, if they could demonstrate
5 that they could live with that they could live with
6 that, they would be home free.
7 There are a number of questions here.
8 They form their solution or their precipitates from
9 acidic solutions at high concentrations. Would they
10 have properties to the actual precipitate which forms
11 in a basic solution at a much lower concentration?
12 MR. WALLIS: And of course, the peer
13 reviewers, amongst other things, said that there might
14 be all kinds of small particles in the sump that could
15 act as nucleation centers and things like that.
16 MR. CORRADINI: Yes.
17 MR. WALLIS: Which you don't have.
18 MR. CORRADINI: You recall with that 50
19 ppm of aluminum in the sodium tetraborate, we tried to
20 make that precipitate. We added nanoparticles. I
21 mean, you know, our solutions are dirty anyway. You
22 know, this is a lab loop. We toss in the NUKON, which
23 has, you know, got crap all over it. We then added
24 nanoparticles to try to get it to precipitate. We
25 bumped the pH down a couple of tenths of a unit to try

1 to make it precipitate. It just wouldn't come out.
2 So there was something there.
3 Our follow-on test program says that we're
4 going to prepare these surrogates as the industry
5 proposed and test their head loss properties to see if
6 they were comparable to the kind of head losses we got
7 with our more realistic precipitate products.
8 We wanted to do another head loss test
9 with this 50 ppm of aluminum and the sodium
10 tetraborate to do it and to slowly increase our
11 concentrations above the 50 ppm just to get a better
12 feel for the margins that you have.
13 And we wanted to look at the solubility
14 and precipitation of these products from aluminum
15 sodium tetraborate things in small tests just to get
16 a better understanding of when we did get
17 precipitation.
18 MR. ABDEL-KHALIK: So what limits the
19 maximum concentration of aluminum in the STB case to
20 50 ppm? Is it just time?
21 CHAIRMAN SHACK: No, it reaches that limit
22 in about 15 days, and then it doesn't seem to go up in
23 the ICET-5 test. Whether there's -- again, there
24 doesn't seem to be precipitate forming at those
25 temperatures in the tests. Whether there's a

1 passivation reaction that occurs on the surface of the
2 aluminum, you k now, it's not clear, but, again, we're
3 looking at a very empirical sense that we have a very
4 large aluminum-to-volume ratio, and it's just limited
5 at that, at 15 days, and it sat there for about 15
6 days at about that level for the 30-day test time.
7 The surrogate product that we formed,
8 again, from the ICET tests, we knew that one of the
9 characteristics and one of the reasons we got such
10 high solubilities with the products were amorphous
11 forms of these. The aluminum hydroxides come in a
12 variety of forms. The amorphous forms have
13 solubilities that are orders of magnitude higher than
14 the crystalline forms.
15 Now, again, in order to do the analysis of
16 the form, we couldn't quite -- the surrogate if we
17 followed their recipe gave us a solution that was too
18 fine and too dispersed for us to do the analysis. So
19 we couldn't actually find out whether their particles
20 were crystalline or not.
21 So what we did was we buggered it. You
22 know, we violated the rules for making the surrogate,
23 but as we tried to go down, the chemical reactions
24 were giving us crystalline forms as we tried to go
25 more and more to the surrogate limits. We could still

1 see the crystalline forms here, but because the
2 particles were so small we couldn't really do it, but
3 we think that we're getting a crystalline product.
4 This whole thing turned out to be kind of
5 moot because when we went off and ran the first head
6 loss test, we took the amount of precipitate that you
7 would get if you just essentially took five ppm of the
8 dissolved aluminum and assume that that precipitated
9 out of the solution. So we're not arguing that five
10 ppm of aluminum would do this, but say if 50 ppm were
11 the solubility limit and you dissolved 55 ppm into
12 solution and five came out, that was the amount of
13 surrogate product we had.
14 Here's our head loss test. We start here
15 at time zero. We add the NUKON, and so we get this
16 little sort of .2 psi pressure drop across the NUKON
17 bed.
18 Here is where we added the surrogate, and
19 it takes about 15 seconds to get from the place where
20 we added the surrogate for the surrogate to reach the
21 bed and the head loss just went up.
22 MR. WALLIS: A factor of 30 or something.
23 CHAIRMAN SHACK: The limit of the loop,
24 and again, you know, we don't see any particular bed
25 forming on top of this.

1 MR. WALLIS: But if the pressure drop went
2 up by a factor of 30 and the flow rate went down by a
3 factor of 30, that's a factor of 1,000 in resistance.
4 CHAIRMAN SHACK: You know, and again,
5 we've only reached the limit of the head loss
6 capability of this test. We don't know what the real
7 increase in head loss was. But, again, I think the
8 conclusion from this is that you don't want to reach
9 the solubility limit. You know, if you begin to
10 precipitate stuff, you don't need a model to tell you
11 how the chemical product is going to --
12 MR. WALLIS: If you have a fiber bed
13 covering the screen.
14 CHAIRMAN SHACK: Yes, if you have a fiber
15 bed.
16 MR. POWERS: You're telling me we should
17 take the trisodium phosphate out and put EDTA in,
18 right?
19 CHAIRMAN SHACK: Now, if we go to the
20 sodium tetraborate loop test, again, we're back here
21 with our 50 ppm of aluminum, which, again, we think is
22 a conservative amount for most plants. We were
23 running at 80 degrees this time, and the lowest
24 temperature we can run depends on the weather at
25 Argonne at this point.

1 If we were running it now, we could do a
2 lot better, but at this time 80 degrees was about our
3 limit.
4 We ran for 22 days at 50 ppm and nothing
5 happened basically. We couldn't see any increase in
6 head loss. You can see the temperature going up here
7 as we add aluminum to essentially beef up the ppm, we
8 first raise the temperature so that we don't form a
9 precipitate immediately on doing it. We raised the
10 temperature, add a little bit of dissolved aluminum to
11 get it up five or ten ppm and then bring the
12 temperature back down.
13 We went to 60 ppm and if there's any
14 increase in head loss here, it's very small. At about
15 70 ppm, we begin to see the head loss increase even at
16 120. As we come down to 80 degrees or so, we see the
17 head loss going up. Again, as we go to 80 ppm at high
18 temperature we still see it going up. We come down to
19 100 and it's going up. And we come down to 80 and
20 it's going up.
21 So somewhere between 50 and 80 ppm we've
22 reached the solubility limit here and precipitated
23 enough product to make a substantial decrease in the
24 head loss.
25 When we look at the measurements from the

1 solution, the amount of solution that we've actually
2 removed and formed a precipitate on the bed
3 corresponds to something like three to seven ppm,
4 which is not too far from the five ppm that we did
5 with the surrogate. So if the surrogate isn't an
6 exact replicate, it's not a bad one, but the message
7 is that it doesn't really take very much of this
8 precipitate to give you a big head loss. You don't
9 want to precipitate stuff.
10 MR. WALLIS: Is the message also that
11 sodium tetraborate is somewhat better than some of the
12 other buffers?
13 CHAIRMAN SHACK: Sodium tetraborate,
14 again, for a given aluminum-to-sump volume ratio with
15 the sodium tetraborate buffer, you don't seem to
16 dissolve enough aluminum, and you keep it in solution,
17 which is where you'd like to have it, and so from that
18 point of view it does seem somewhat benign.
19 I don't want to talk too much about the
20 small scale sodium tetraborate tests. Again, Dana
21 asked what a blacksmith is doing with the chemistry
22 here, and this blacksmith is very puzzled by many of
23 the things that go on because one of the amazing
24 things here is the amount of supersaturation we can
25 get in these solutions.

1 You know, from a pH and a chemical
2 standpoint, why the sodium tetraborate is really
3 different from the sodium hydroxide solutions isn't
4 clear to me. We have boric acid in both cases. You
5 know, we can argue about boron complexing of the
6 aluminum, but there's plenty of borate in the sodium
7 hydroxide solutions, too, because we've got, you know,
8 4,000 ppm of boric acid added. You know, there are
9 sodium atoms. The pH is about, you know -- but for
10 some reason, whether it's solubility or the
11 precipitation kinetics are just slow, the stuff
12 doesn't come out.
13 We have, you know, sort of 85 to 90 ppm in
14 the bulk solution here, and out of that only three to
15 ten ppm is actually removed from solution. So, you
16 know, a lot of it is staying in the thing.
17 When we did our long term tests, we think
18 the long term equilibrium concentration of aluminum in
19 these sodium tetraborate solutions at 80 degrees F. is
20 about 50 to 55 ppm. So if you wait long enough with
21 an 85 ppm solution, it should precipitate out. But,
22 again, we're talking 30-day kind of time intervals,
23 and it seems to stay saturated for that length of
24 time.
25 And, again, my conclusion is whether this

1 is a true difference in solubility or somehow we just
2 have a difference in sluggishness of precipitation, we
3 don't really know.
4 Our basic conclusions here is that when we
5 have a fiber bed present, you don't have to
6 precipitate very much in the way of these aluminum
7 oxyhydroxides to get a big head loss. So you have to
8 avoid reaching the saturation limit.
9 Again, for aluminum area and sump volume
10 ratios equal or less than that into the ICET; we don't
11 think that you're going to get amounts of precipitate
12 that will cause significant head loss in sodium
13 tetraborate buffered solutions for temperatures 70
14 degrees or more over the time of interest.
15 MR. WALLIS: That's an interest
16 indication, but presumably to prove it out, you would
17 need a somewhat more lengthy research program or
18 something? You've got indication that that's the
19 case, right?
20 CHAIRMAN SHACK: We've got two tests.
21 We've doubled the database.
22 MR. WALLIS: That's right. Doubled? In
23 this case you've taken zero and had one, haven't you,
24 in the case --
25 CHAIRMAN SHACK: No, no. We had the

1 earlier head loss test with the sodium tetraborate
2 that gave us roughly the same result, that we could
3 live with 50 ppm.
4 MR. WALLIS: Oh, okay.
5 CHAIRMAN SHACK: We ran it for 11 days
6 that time. We've run it for 22 now.
7 MR. WALLIS: So you have doubled it, I
8 guess.
9 CHAIRMAN SHACK: We have doubled it.
10 MR. WALLIS: But there's no uncertainty
11 evaluation.
12 MR. POWERS: You call out aluminum
13 oxyhydroxide. Do you really see those?
14 CHAIRMAN SHACK: Pardon me?
15 MR. POWERS: Do you really see
16 oxyhydroxides?
17 CHAIRMAN SHACK: No.
18 MR. POWERS: Aren't you just seeing
19 hydroxides?
20 CHAIRMAN SHACK: We don't know what we
21 really see.
22 MR. POWERS: I think you really just have
23 hydroxides in there. I don't think you get warm
24 enough to get oxyhydroxides.
25 CHAIRMAN SHACK: The Westinghouse people

1 think that we -- we said that it was aluminum
2 hydroxides when we did it. The Westinghouse people
3 said it oxyhydroxides. I figured that sort of covered
4 everything.
5 MR. POWERS: Well, one of the reasons that
6 you get peculiar precipitation kinetics is that in a
7 basic solution aluminum wants to sit in a tetrahedral
8 coordination, and the oxyhydroxide goes into an
9 octahedral coordination.
10 CHAIRMAN SHACK: But, again, both the
11 sodium tetraborate and the sodium hydroxide solutions,
12 you know, they're slightly basic.
13 MR. POWERS: Yeah, but when you change
14 coordination spheres, that's why you get sluggish
15 precipitations.
16 MR. GEIGER: Thank you very much.
17 I knew we'd run into trouble with the
18 schedule if I asked Dr. Shack to present this, but I
19 guess we have one hour for the next two presentations.
20 So Krotiuk will.
21 MR. WALLIS: That doesn't mean that you
22 have to spend an hour.
23 MR. GEIGER: No, no. Well, what I was
24 saying is that I think of primary interest is the peer
25 review. So what we're going to try to do is hurry up

1 so that we can dedicate more time to the peer review.
2 MR. WALLIS: That's fine. Please go
3 ahead.
4 MR. KROTIUK: I'm going to be talking
5 about some testing and modeling that has been done to
6 look at the pressure drop across the re-bed (phonetic)
7 that has some accumulation of fibers and particulates,
8 and it's a situation that exists for -- we're looking
9 at a situation that does not have any chemical
10 reaction.
11 A lot of this information has bene
12 previously presented, and so I'm just going to try to
13 highlight the areas where the information has not been
14 previously presented.
15 First, let me just talk about the head
16 loss testing. The head loss testing was done at PNNL,
17 and it was intended to characterize the pressure drop
18 for various debris, types and distributions and to
19 determine the effects of fluid temperature on head
20 loss.
21 And what we tried to do also is that we
22 tried to introduce better diagnostic techniques, in
23 other words, to measure bed thickness and pressure
24 drop and mass accumulation in the beds themselves, and
25 ultimately we wanted to use this information to

1 develop an improved calculational method for pressure
2 drop.
3 This work is complete, and it has been
4 published.
5 Just to summarize the testing that was
6 done, basically there was a large tests loop where the
7 testing was performed with temperature control, and we
8 had an optical triangulation technique to measure the
9 bed height during the testing. We also pressurized
10 the loop to maintain gas in solution so that we did
11 not have any two phase flow type of conditions, and we
12 also introduced a filtration system to make sure that
13 what we had in the debris bed was not added to or
14 changed as we were doing testing.
15 There was a secondary loop that we had
16 that was a benchtop loop, and it enabled us to do
17 testing much more quickly, to give a sensitivity type
18 of information that we could then use in developing
19 the test matrix that was actually used for the large
20 test.
21 The test matrix itself was constantly
22 changing with input from the benchtop loop and just
23 assessment of the data as it went along.
24 We performed a fair number of tests, as
25 indicated here. We had tests using a screen and a

1 perforated plate alone without the accumulation of any
2 debris. We performed CALSIL only tests where CALSIL
3 was deposited on the plate or the screen.
4 NUKON only test fibers, and a combination
5 of NUKON and CALSIL, which was a very interesting
6 area.
7 And then we did very little tests, but we
8 did some tests with coatings.
9 I'll just go to the conclusions of the
10 testing. One, with all of the testing that we did, we
11 did find that the NUKON only debris head loss tests
12 were relatively repeatable. In other words, if we had
13 two tests that had the same loadings of the NUKON only
14 debris, the pressure drops that we would measure for
15 a given velocity through the bed was very close and
16 repeatable.
17 That was not the case with the NUKON-
18 CALSIL beds because after we had the fiber bed made,
19 which was the NUKON, and we the CALSIL, about the same
20 amount for different tests, we would sometimes get
21 different results. And so that seemed to indicate
22 that the pressure drop was affected by the CALSIL or
23 the particulate distribution in the fiber bed.
24 Regarding CALSIL only tests, we tried to
25 perform a number of them in both the benchtop loop and

1 the large loop, but we were never successful in
2 creating a complete CALSIL only test bed.
3 Just further conclusions. We did find
4 that the pre-preparation did influence pressure drop,
5 in other words, how we prepared the fibers and the
6 CALSIL particulates, how we ground it up and
7 introduced it into the loop.
8 The more important thing though was even
9 more than the debris preparation, was the loading
10 sequence. We did find that if we used a pre-mixed
11 mixture of NUKON and CALSIL we obtained pressure drops
12 that were lower than what we would get if we, say,
13 introduced NUKON and then built a fiber bed and then
14 introduced the CALSIL after.
15 MR. WALLIS: On that topic, PNNL said that
16 the range that they could get with the different ways
17 of putting the same stuff in was three orders of
18 magnitude. That comes right out of their report.
19 It wasn't clear to me, thinking back at
20 your subcommittee presentation, that your theory ever
21 predicted such a wide change in the range and
22 possibility, depending on the arrangement of the bed.
23 Three orders of magnitude is an enormous
24 range for the same constituents.
25 MR. KROTIUK: And the way I tried to

1 introduce that with the modeling was that it was
2 differences, but it probably wasn't of that order of
3 magnitude.
4 MR. WALLIS: It was quite mysterious. It
5 was actually when they put the CALSIL in first, and it
6 sort of went part way around the loop and then came
7 back.
8 MR. KROTIUK: Yeah. The worst case is
9 when they added the CALSIL in first and sort of got a
10 mixture going in the loop. Then they built a fiber
11 bed, and then the CALSIL deposited on the surface or
12 within the fiber bed; that was actually the highest
13 pressure drop.
14 let me address the modeling.
15 MR. WALLIS: That's all right. Just by
16 the way.
17 MR. KROTIUK: Right. One thing, because
18 we had the optical triangulation measurements of
19 thickness, we did see the bed contract and relax with
20 changes of approach velocity, and generally, for most
21 cases, the pressure drop decrease would increase
22 temperature of the fluid, which is consistent with the
23 classical theory.
24 MR. WALLIS: Not always.
25 MR. KROTIUK: Not always because, again,

1 the pressure drop would be affected, especially the
2 NUKON-CALSIL. It was primarily for the NUKON-CALSIL
3 beds because the distribution of the CALSIL within the
4 fiber bed itself could affect the pressure drop.
5 Now, let's just go to the head loss
6 modeling, and basically what I used was the data from
7 the PNNL testing and data from other tests also, the
8 LANL and some of the Argonne testing to come up with
9 a model that would try to be able to predict pressure
10 drop, and this is published in the NUREG.
11 Okay. Let me just go over the model a
12 little bit. The hypothesis of my model was this. I
13 used a classical form of the performance media
14 equation with some modifications and changes that's
15 documented in the NUREG, but basically what I tried to
16 say is that for a case where we had a bed that was
17 composed of one kind of material, in fiber or
18 particulate, that we could use a single homogeneous
19 control volume to calculate pressure drop across that
20 debris bed.
21 If the bed was composed of two types of
22 materials, for instance, fibers and particulates, then
23 I postulated that you could have various types of
24 configurations. One is that you could have a
25 homogeneous mixture of particles and fibers within the

1 bed. You could have a situation where the fibers are
2 on one part of the bed and you have particles mixed
3 with fibers on another part, and I'll call these sort
4 of a saturated condition. It's not really correct,
5 but that's my terminology.
6 And then there could be a situation where
7 you have particles mixed with fibers and then
8 particles that are deposited on top of the particle
9 fiber portion of the bed. And what I tried to do is
10 develop a methodology whereby I could develop a lower
11 bound and an upper bound pressure drop calculation,
12 and basically what I found is that if you used a
13 homogeneous approach for a particle fiber bed that you
14 had your lower limit for pressure drop, and the hard
15 part was to try to come up with a methodology to
16 calculate the upper limit.
17 And I came up with a two volume approach
18 whereby I actually did pressure drop calculations,
19 say, for instance, in this case where I had the
20 pressure drop calculations across the saturated
21 particles in the fiber bed and then across the fiber
22 bed itself.
23 The expansion and contraction of the bed
24 itself was considered. Initially I assumed an
25 irreversible process and then subsequently everything

1 else was elastic.

2 And let me just quickly go over the
3 conclusions. One is that the one volume model, the
4 homogeneous model, was always successful in producing
5 a comparative or maybe conservatively higher pressure
6 drop for NUKON only tests, and I looked at the PNL
7 testing, some ANL testing, and some LANL testing, and
8 generally that conclusion was always present. The
9 methodology was good for a bed composed of one debris
10 type.

11 For the NUKON-CALSIL tests, the one volume
12 approach, homogeneous mixture of NUKON-CALSIL, always
13 predicated a lower limit for the pressure drop.

14 The methodology that I developed to
15 calculate the upper limit using the two volume
16 approach for a NUKON-CALSIL bed only worked about 75
17 percent of the time in being to predict comparative or
18 conservatively higher pressure drops. It predicted
19 lower pressure drops for about 25 percent of the tests
20 that I had looked at.

21 And I found that the discrepancies
22 primarily existed for cases where the CALSIL layer on
23 top of the fiber was very thin, and the methodology
24 that I developed to predict this thickness of the
25 CALSIL was very sensitive in that range, when you had

1 low masses and low thicknesses, and that if you had
2 small errors in your determination of that thickness,
3 you could have substantial differences in pressure
4 drop calculations.
5 MR. WALLIS: You got this layer by some
6 kind of an unusual correlation.
7 MR. KROTIUK: Yes. It was completely an
8 empirical correlation.
9 MR. WALLIS: There should be some
10 accounting. We suggested that you simply put all of
11 the particles on the top.
12 MR. KROTIUK: Yes. Okay, and I looked at
13 that. Okay? If you want, I'll just say what happened
14 when I looked at that.
15 MR. WALLIS: It will be interesting if you
16 have some results.
17 MR. KROTIUK: Yes, I looked at a fair
18 number of cases, and basically what I found, if you
19 assume that it's all the CALSIL on the top of the
20 fiber bed, that you definitely did bound all the test
21 results.
22 MR. WALLIS: But a much higher pressure
23 drop.
24 MR. KROTIUK: But much, I mean,
25 significantly higher, by orders of magnitude such

1 that, you know --

2 MR. WALLIS: It's a bit like what we just

3 saw with aluminum at Argonne.

4 MR. KROTIUK: Right. It just went up, you

5 know. A measurement may have been, say, ten feet of

6 water and we were predicting now 180 feet of water.

7 So I looked at it, and that's what I've so

8 far concluded, and that's as far as I've taken it.

9 The methodology that we developed was

10 successful in predicting bed thicknesses that were

11 comparative to all of the test data for all of the

12 tests that were looked at, and the calculation method

13 generally predicts the higher pressure drops at the

14 lower temperature, which is consistent with the

15 classical theory.

16 MR. WALLIS: As a result of viscosity.

17 MR. KROTIUK: That's because of viscosity,

18 changes in the fluid. Okay?

19 MR. WALLIS: And this work is finished

20 now.

21 MR. KROTIUK: At this point, yes. I'm

22 looking a little bit more at the suggestion, but it's

23 primarily done, yes.

24 MR. WALLIS: So if industry were to use

25 something like this or to try to use something like

1 this, presumably it would require some fairly
2 extensive validation or something like that? Maybe an
3 improvement of this exponential correlation.
4 MR. KROTIUK: Yeah.
5 MR. WALLIS: So there's more work required
6 before it's something you can rely on.
7 MR. KROTIUK: As I said before in the
8 subcommittee meeting, I'm not really totally happy
9 with that empirical correlation, but it's the best I
10 could come up --
11 MR. WALLIS: Well, it shows that something
12 better can be done than the existing perhaps.
13 MR. SCOTT: This is Mike Scott.
14 If I can add also, as you all may recall,
15 we've informed the licensees in our SE that the head
16 loss correlations are only to be used for scoping.
17 Now, we didn't of course have this one at the time,
18 but the earlier 6224 was only to be used for scoping,
19 and that the screen sizes are to be based on testing.
20 MR. WALLIS: Yes. Thank you.
21 Are we ready to move on?
22 MR. KROTIUK: Yes.
23 MR. WALLIS: Okay. Thank you very much.
24 Are there any questions from the committee, any more?
25 (No response.)

1 MS. TORRES: Good afternoon. My name is
2 Paulette Torres. I represent the Office of Research.
3 Next to me is Mr. Robert Tregoning, and we are both
4 going to present the results of the peer review of
5 Generic Issue 191 chemical effects research.
6 The main objective of the peer review, the
7 first one was to review the technical adequacy of
8 research activity related to the chemical effects on
9 PWR sump pool environment. These research projects
10 addressed by the reviewers include the integrated
11 chemical effect testing conducted at Los Alamos, the
12 ICET follow-up testing and analysis also conducted at
13 Los Alamos, the chemical speciation provision
14 conducted at the Center of Nuclear Waste Regulatory
15 Analysis, and the chemical head loss testing conducted
16 at Argonne National Lab.
17 The second objective, which was to
18 recommend research improvements and identify important
19 technical issues for consideration, was added to the
20 peer review when it became obvious early in the
21 process that many of the issues being raised were
22 outside the scope of the previous and ongoing NRC
23 research program. The second objective during the
24 initial peer review scope made the review more
25 comprehensive.

1 MR. APOSTOLAKIS: How much time did you
2 give them to review this? How much time did they have
3 to review these documents?
4 MS. TORRES: A month.
5 MR. BANERJEE: Enough, enough.
6 MS. TORRES: Yeah, they started around --
7 MR. APOSTOLAKIS: There is never enough.
8 MR. BANERJEE: They did a great job.
9 MR. TREGONING: We have a kickoff meeting
10 last October. We gave them initial documents starting
11 in last August. We had them write a preliminary
12 report last November, and we had a follow-on meeting
13 in March, and then their final reports were due to us
14 in May or June. So about nine months.
15 MR. WALLIS: Well, how much of that time
16 were they paid for is the real job. If they were paid
17 to do two hours' work in nine months, that's not a
18 very big report. Presumably what matters is how many
19 hours did they put in.
20 MR. APOSTOLAKIS: That's right. Calendar
21 time really doesn't mean much, but if Professor
22 Banerjee says they did a good job --
23 MR. BANERJEE: You will stick.
24 MR. WALLIS: Well, George, the peer review
25 is about twice as thick as the report itself.

1 MR. APOSTOLAKIS: Why is it so difficult
2 to get -- how much time did they actually spend? You
3 don't know that unless you go to --
4 MR. TREGONING: Well, it varied by the
5 reviewer. We had five different reviewers, but I
6 think you can see by the nature and the quality and
7 the depth of the report that some of them spent quite
8 substantial amounts of time, including running
9 analyses, scoping calculations. You know, so these
10 were very extensive peer reviews.
11 MR. APOSTOLAKIS: They were paid.
12 MR. TREGONING: Of course.
13 MR. APOSTOLAKIS: Don't say of course.
14 MR. TREGONING: Of course.
15 MR. APOSTOLAKIS: Some organizations don't
16 pay.
17 MR. BANERJEE: Well, my impression of it
18 was -- in fact, I read the peer review very
19 thoroughly, and my impression was that it was above
20 and beyond the call of duty on some of their parts.
21 Not all of them; two or three of them.
22 MR. TREGONING: I'll say when we got the
23 peer reviewers together, there was quite a bit of
24 synergy, and they fed off each other, which is not
25 uncommon, and as ideas got bounced back and forth, you

1 know, there's a big of one-upmanship, and a guy would
2 want to go back and do some calculations to see if his
3 issue was --
4 MR. WALLIS: They certainly hear an awful
5 lot of different names of various crystal forms of all
6 sorts of substances.
7 MR. APOSTOLAKIS: Okay. Thank you.
8 MR. POWERS: This is just showing off on
9 the part of chemists. So yeah.
10 MR. BANERJEE: Some of them were chemists.
11 MS. TORRES: The Office of Research had
12 recommendations for the peer reviewer selection from
13 NRC staff, laboratories, the ACRS itself. The peer
14 review consisted of five members, and they provided a
15 range of technical expertise, such as filtration,
16 analytical and experimental chemistry, corrosion,
17 electrochemistry, and gel formation.
18 The group possessed diversity of
19 experience. They were selected from nuclear and
20 chemical industry, the academia, and national
21 laboratories.
22 NUREG 1861 satisfied the first objective
23 discussed earlier, which was review the technical
24 adequacy of RES activities related to chemical effects
25 in PWR sump pool environment. The NUREG 1861 was

1 published December 2006. It describes the chemical
2 effects peer review assessment process and summarizes
3 each reviewer's significant findings.
4 The final assessment reports from each
5 peer reviewer are compiled as appendices to the NUREG
6 report, and the review is not a consensus review.
7 Each reviewer was asked to provide an individual
8 evaluation based on their particular area of
9 expertise.
10 The PIRT process was used to satisfy the
11 second objective, which was recommend research
12 improvement and identify important technical issues
13 for consideration. The same issues contained in NUREG
14 1861 were evaluated using the PIRT process to provide
15 a balanced evaluation and ranking of the issues for
16 further consideration.
17 MR. WALLIS: -- is a different report, is
18 yet another report?
19 MR. TREGONING: Yes.
20 MR. BANERJEE: It is not completed yet, or
21 is it?
22 MR. TREGONING: That's correct. It's not
23 completed.
24 MS. TORRES: A summary of the PIRT process
25 will be discussed by Mr. Robert Tregoning.

1 MR. TREGONING: Thank you, Paulette.

2 There's always a question about why you do

3 a PIRT and when you do a PIRT. Quite often you may do

4 a PIRT when you're embarking on a new technology area,

5 like the Trisco fuel assessment.

6 Here we actually did the PIRT somewhat

7 midstream, but actually the timing was, I thought,

8 particularly good because we had done a body of work.

9 We had learned some various important lessons, but we

10 had a number of open questions and issues. Plus we

11 were transitioning in this mode where we wanted to

12 evaluate what issues might remain, and as we continued

13 to work with the industry to move forward, we wanted

14 to make sure that we were comprehensive in our

15 assessment.

16 So that was one reason for doing the PIRT.

17 The other reason, as stated on this slide, early on in

18 the peer review process a lot of the comments that we

19 were getting from the peer reviewers were well outside

20 the scope of the original NRC sponsored research. So

21 really the idea behind the PIRT was to use the process

22 to identify and rank some of the issues being raised

23 by the peer reviewers with respect to the post-LOCA

24 chemical effects.

25 As Paulette mentioned, the peer review

1 itself --

2 MR. WALLIS: This first bullet, actually

3 that's right. The peers raised points which hadn't

4 yet been addressed by the NRC. So it's clear that the

5 scope of the sump column is broader than has actually

6 been addressed by your research program to date, or

7 appears to be from the peer review, anyway.

8 MR. TREGONING: The issues for

9 consideration are certainly broader. I would agree

10 with that.

11 And as you read, of course, when you do

12 peer review, these were all intended to be independent

13 peer reviews. So the PIRT process we wanted to use to

14 bring at least some sort of consensus, not true

15 consensus, but at least get some ideas of what the

16 group together thought about importance and --

17 MR. WALLIS: After doing their review.

18 MR. TREGONING: This was in parallel.

19 MR. WALLIS: In parallel.

20 MR. TREGONING: They had done a

21 substantial -- we did the PIRT at the last meeting we

22 held. So they had reviewed all of the reports for

23 about six months, and they had completed their

24 preliminary assessment reports.

25 But it was about the time when they were

1 preparing their final documents. That's why a lot of
2 the issues you see in that peer review 1861 document,
3 many of the same issues were raised and discussed in
4 the PIRT, if not all of them.
5 So the PIRT really provides a natural way
6 to characterize, identify, and rank the issues that
7 some of them raised individually within the NUREG.
8 So the objective of the PIRT, and again,
9 we really had a broad objective as you do in most
10 PIRTs, is we were looking for all chemical phenomena
11 which could lead to deleterious ECCS performance and
12 also possibly damage reactor fuel due to inadequate
13 heat removal in the post-LOCA environment.
14 I at least want to cover the PIRT
15 evaluation criteria because I think it's important to
16 know what the reviewers were looking at, and these
17 evaluation criteria really mimic many of the phenomena
18 that need to be addressed within GSI-191, the sump
19 clogging issue.
20 But the difference here is the focuses on
21 the chemical phenomena that would most likely affect
22 these various things, both sump clogging --
23 MR. WALLIS: As long as they don't clog
24 the sump until they become physical.
25 MR. TREGONING: Right, yes.

1 MR. BANERJEE: But it's the chemistry that
2 leads to the physics in this case, right?
3 MR. TREGONING: I knew you would haggle
4 with my definition here.
5 MR. WALLIS: Well, you can't forget the
6 physical.
7 MR. TREGONING: Of course not, of course
8 not. But the notion here that I wanted to stress,
9 there's a lot of the physics that has been considered
10 throughout this process.
11 MR. WALLIS: Affected by the chemistry.
12 MR. TREGONING: Of course. So what we
13 really wanted to focus on was how the chemical
14 environment and chemical considerations might affect
15 an interplay with the physics that are involved. But
16 I couldn't get all of that on one line on the slide.
17 So, again, we're looking for sump screen
18 clogging effects, things that might degrade downstream
19 component performance, diminished heat transfer, or
20 affect structural integrity.
21 MR. POWERS: I was curious what you mean
22 by "affect structural integrity."
23 MR. TREGONING: Things like large scale
24 corrosion of support structures.
25 MR. POWERS: Those are very dramatic

1 chemical effects

2 MR. TREGONING: Well, yeah, and to be

3 honest, given the time scale, to be honest, none of

4 the issues really -- that was a minor one. In fact,

5 just for information, that was initially not one of

6 the evaluation criteria, but the PIRT peer reviewers

7 wanted to add that one themselves. So just to make

8 sure they were comprehensive.

9 MR. POWERS: That would do it.

10 MR. TREGONING: Of course. So when we did

11 the PIRT, to categorize the issues, we broke the post-

12 LOCA cooling into four distinct time periods. Four

13 time periods we used to represent different

14 operational phases within the post-LOCA environment

15 and also identify time scales associated with

16 important chemical phenomena.

17 So the four that we looked at were the

18 debris generation phase, which lasts about zero to 30

19 seconds during the blow-down event; ECCS injection; a

20 direct ECCS injection, I should add, which again 30

21 seconds to about the onset of recirculation, which is

22 variable depending on the plant, but 20 minutes is a

23 typical number that you see there.

24 And then short term and long term ECCS

25 recirculation. Now, there was no reason to break up

1 short term and long term ECCS recirculation. However,
2 we know a lot of the margins that licensees have to
3 deal with. They're minimum right at the onset of
4 recirculation.
5 So we wanted to identify phenomena that
6 might be working early in the process, and we again
7 arbitrarily cut it off at 24 hours, and then look at
8 phenomena that might be at play much later, 24 to 30
9 days.
10 And we cut the exercise off at 30 days,
11 although many of these phenomena, again, would
12 continue to transpire as long as the mission time
13 would need to occur.
14 Now, the PIRT approach was very standard.
15 We had brainstorming issues. We brainstormed within
16 all of these four time periods, and then we had the
17 experts individually rank issues with respect to
18 importance, and we just used a three level
19 classification scheme, high, medium and low, and then
20 also knowledge also three level, known, partially
21 known and unknown.
22 The way we did the PIRT, while we had them
23 do their initial PIRT individually, we did come back
24 after we accumulated all of the results and had a
25 feedback session because as you might imagine, some

1 issues some people ranked high, some people ranked
2 low, and we tried to understand the reasons for the
3 disparity in the results.
4 Was it just difference in technical
5 opinion or in an understanding of what the issue was?
6 So we also had some feedback. We had several
7 conference calls where we addressed issues and tried
8 to reconcile areas where we had differences of
9 opinion.
10 I'm not going to go over all of the PIRT
11 results because, again, we're still preparing that,
12 and you'll be seeing something on that within the next
13 few months, I would expect. But I do want to touch on
14 some of the issues that were raised not only by the
15 PIRT, but then also within the NUREG 1861.
16 The issues can be grouped a number of
17 ways. I've chosen seven categories. Again, there's
18 nothing unique about these, but a lot of the issues
19 fall within one of these seven categories.
20 Underlying containment pool chemistry.
21 Again, by "underlying," I mean the containment pool
22 chemistry that's formed as a result of the reactor
23 break. So not so much chemicals that get added in
24 after the break, but the initial chemistry that's
25 formed upon the break.

1 Radiological considerations; physical,
2 chemical, biological debris source terms; core solid
3 species precipitation; agglomeration and settling.
4 And, again, I wanted to emphasize with the
5 agglomeration and settling that the emphasis here is
6 on chemical effects and how they may affect
7 agglomeration and settling.
8 Organics and coatings, and then downstream
9 performance of pumps, heat exchanger reactor core.
10 So with --
11 MR. BANERJEE: Would you include the
12 temperature gradient effects that they refer to?
13 MR. TREGONING: Yes. In fact, you've
14 caught my next slide already.
15 So what I've done here, all I've done for
16 your consideration, I picked ten items, ten issues.
17 Ten is a good number, and these were issues that were
18 important. They were raised either individually or as
19 a part of the PIRT process.
20 But I also wanted to span all of the
21 different categories that we talked about. So the one
22 that you've mentioned, Dr. Banerjee, is this ECCS
23 thermal cycle effects under solid species
24 precipitation.
25 So what I'm going to do now, I'm just

1 going to talk about these ten very briefly to describe
2 and define what the issue is. Okay? So that's what
3 I'm going to do on the next two slides.
4 So the first phenomena, containment debris
5 mixture effects. The idea here is that different
6 debris characteristics, and that could be the mass,
7 the mixture, the constituents of the debris as well as
8 the compositions of debris.
9 MR. WALLIS: Several reviewers talked
10 about scrubbing of CO_2 out of the containment
11 atmosphere. It doesn't appear here, but it's not a
12 kind of containment contributor to the sump.
13 MR. TREGONING: Well, that was an
14 interesting one because that was one that early on in
15 the review process got a lot of attention, and there
16 were some calculations that were done on that. And
17 later on when we had the PIRT, it actually came out
18 being of relatively low importance.
19 MR. WALLIS: So it was less than --
20 MR. TREGONING: Yes. so initially it was
21 highlighted as being a potential concern, but that was
22 one that, again, some of the individual peer reviewers
23 actually followed up and addressed that concern to
24 help inform their PIRT evaluation.
25 MR. BANERJEE: And the aging of the

1 concrete and structures, that was also minor effect,
2 yeah.
3 MR. TREGONING: That's a more important
4 effect, and the notion there was that would introduce
5 carbonates into the containment pool environment. I
6 think some calculations were done though, and at the
7 risk of speaking out of turn, there's other
8 contributions of carbonates that may actually
9 overwhelm those contributions. So that was some of
10 the consideration that went into this.
11 And as Dr. Shack mentioned, it's a dirty
12 environment. So there are cations, anions floating
13 around the containment pool.
14 Again, I'm not trying to be exclusive
15 here. There are other things that are still
16 important. I've just picked ten somewhat randomly,
17 and like I mentioned earlier, I wanted to pick ten to
18 sort of fill --
19 MR. BANERJEE: These are the ten highest
20 ranked?
21 MR. TREGONING: Not necessarily. They
22 were ten highly ranked. Like I said, I wanted to give
23 coverage in all of these areas. Okay? So these
24 aren't necessarily the top ten that we need to work
25 down, but these are ten that were ranked highly that

1 are somewhat representative, and they were issues that
2 were raised by a number of the peer reviewers, so not
3 just one peer reviewer.
4 So briefly, let me define these. Again,
5 I define the containment debris mixture effects; pH
6 variability, and this was with respect to the initial
7 variability within the reactor coolant system as well
8 as the evolution in pH that evolves in the post-LOCA
9 process.
10 We've seen in many cases the effect that
11 pH can have dramatically on chemical environment and
12 precipitation that occurs.
13 Radiolysis effects, specifically the
14 effect of core radiation fields on the formations of
15 radicals, primarily hydrogen peroxides and the notion
16 that that can effect the readout potential, which can
17 then fundamentally affect the types of chemical
18 products and precipitants that could form.
19 Another issue was radiolytic conversion of
20 nitrogen. This is certainly not a new issue, but it's
21 one that within this context there was concern that
22 the nitric acid that was formed during this may
23 actually alter the containment pool pH.
24 MR. POWERS: When they thought about that,
25 did they give consideration to the radiolytic attack

1 along your cable insulation?

2 MR. TREGONING: They did, although that

3 was the one -- that was an aspect that was

4 specifically considered in ICET because we added -- at

5 least I added hydrochloric acid to simulate the

6 breakdown of cabling insulation within ICET.

7 I think those are amounts -- Bill might

8 correct me -- but I think it was around 100 ppm or so,

9 and I think there was some thinking that the nitric

10 acid effect may actually be a bigger effect

11 You don't think so?

12 MR. POWERS: Small effect, typically.

13 MR. TREGONING: Okay.

14 MR. POWERS: Well, it depends on what your

15 dose rate is and your containment.

16 MR. TREGONING: Right.

17 MR. POWERS: But my recollection is that

18 if you use two mega rads per hour for your equipment

19 qualification for an ECCS in a PWR, that's my

20 recollection, and that's a healthy enough dose rate.

21 Of course, it depends on how much cable you have in

22 the containment.

23 Some of these containments have enough

24 cable.

25 MR. TREGONING: Right. Okay. Well, thank

1 you. That's good information to have.

2 The other area was crud release, and I

3 think that's important to define what we mean by crud,

4 and these are essentially the iron and nickel

5 corrosion oxides from RCS piping that are released

6 during the hydrolic thermal transient due to the LOCA.

7 And the idea that the crud release itself

8 could create a radiolytic environment on the sump

9 screen debris beds that could affect subsequent

10 reactions. So you'd have some percentage of that

11 which would settle out, but you could have some crud

12 that makes its way to the screen and actually affect

13 the reactions that go on right at the sump screen.

14 Some other issues that I've chosen to

15 highlight is the silica concentration and the idea

16 that we at least need to consider the presence of

17 silica both in the RCS and the water storage systems.

18 The idea that it can combine with certain cations to

19 form species with retrograde solubility, of course,

20 that's particularly of concern because you want to

21 make sure that you don't have plating on the reactor

22 fuel or other hot surfaces.

23 And that also of course silica also

24 provides another source for precipitation as well.

25 Thermal cycle effects, which Dr. Banerjee

1 referred to. The idea that there's at least two
2 thermal gradients throughout each cycle that a volume
3 of water goes through during ECCS recirculation.
4 There's cooling that occurs when it goes across the
5 heat exchanger, and then there's subsequent heat-up
6 when it gets near to the fuel cladding surface.
7 And there was concern about precipitation
8 under both of those types of environments, where the
9 high temperature would cause species with retrograde
10 solubility to precipitate out while the heat exchanger
11 would cause normal precipitates due to solubility
12 considerations.
13 And also co-precipitation would affect
14 what would go on there as well.
15 Quiescent settling of precipitates. This
16 was the idea that the nominal low flow rates within
17 the containment pool may allow many chemical species
18 to settle out or may allow them to grow, to become
19 larger particles, more stable particles because they
20 don't have the hydrodynamic forces that would tend to
21 keep them small.
22 Coating decomposition and leaching, again,
23 they were two different effects. One was classical
24 leaching from sump coatings, and ones that were raised
25 were lead based paints, which I think are in some of

1 the older containments, phenolics and PVC, and then
2 also hydrothermal hydrolysis that would essentially
3 depolymerize some polymeric materials, and you could
4 actually get gels forming from that depolymerization
5 process.
6 MR. POWERS: If you look at the work
7 that's gone on in Canada, they would insist loudly
8 that what you leach from the paint is the folic, and
9 that the ketone that comes out of there gets converted
10 radiolytically into an organic acid.
11 MR. TREGONING: Yes, I'm aware of some of
12 that work, and that's something that we'll certainly
13 be looking at moving forward.
14 MR. POWERS: I don't know whether it's
15 true or not, but they will insist it very loudly.
16 MR. TREGONING: Yes.
17 MR. POWERS: And God help you if you're
18 talking to them and don't bring it up.
19 MR. ABDEL-KHALIK: Some plants are talking
20 about changing their normal operating water chemistry
21 to operate in a high pH regime to reduce AOA
22 likelihood of axial offset. How much would an
23 increase in the normal operation pH affect the post-
24 LOCA pH in the sump?
25 MR. TREGONING: Well, right now initially

1 there'd be an effect in terms of the initial
2 conditions at the break, but because of the amount of
3 buffering that's used overall, my expectation would be
4 it would be a second order effect at least with
5 respect to longer term pH in the sump pool.
6 MR. BANERJEE: I suppose one way to deal
7 with this, which I'm sure industry is looking at is to
8 either change the buffers or maybe remove some of
9 them, in which case, I guess, that would have more of
10 an effect, right?
11 MR. TREGONING: Yes. If there was no
12 buffer, then, yes, you're driven by the chemistry of
13 the RCS plus the injection system at that point.
14 MR. MAYNARD: Probably more so by your
15 refueling water storage tank volume, and that's going
16 to be a larger volume, and it's going to influence
17 your pH more than the RCS pH itself.
18 MR. BANERJEE: Right.
19 MR. CORRADINI: So maybe you said it at
20 the beginning and I missed it. These are just
21 examples of phenomena to consider. These are not the
22 high importance phenomena nor the unknown phenomena.
23 MR. TREGONING: No.
24 MR. CORRADINI: These are just example.
25 MR. TREGONING: They're examples, but --

1 MR. BANERJEE: All of them are unknown.

2 MR. TREGONING: -- they're examples that

3 in the PIRT process were identified as being of high

4 importance to consider.

5 MR. CORRADINI: But not necessarily

6 unknown in terms of a knowledge base to evaluate their

7 effect.

8 MR. TREGONING: Right. What I haven't

9 done is, again, there were separate rankings for

10 knowledge state, and there's two types of knowledge

11 state. There's knowledge state with respect to the

12 basic physics, and then there's knowledge state with

13 what actually exists within a given, let's say, a

14 single plant environment.

15 So there's two types of knowledge that you

16 really have to look at when you're evaluating these

17 things, but, no, what I haven't done in this is

18 indicate ones that we thought we had particularly I'll

19 say a low level of knowledge state on.

20 MR. POWERS: Well, when we looked at the

21 TMI sump, we saw a lot of copper. Obviously we were

22 corroding out copper wires and things like that. Did

23 the experts comment on copper coming into the sump?

24 MR. TREGONING: You know, we talked about

25 copper, and because of TMI, of course, copper was

1 something that was considered in the ICET test. We
2 never saw much copper though actually within that ICET
3 test.
4 So when we went through the PIRT we
5 identified all of the different metallic components
6 that could cause corrosion, that could corrode and
7 then, you know, lead to ionic species contribution to
8 the sump pool environment. And copper was considered,
9 but again, I think based on ICET and other
10 considerations it hasn't been a driving consideration
11 at this point.
12 MR. POWERS: Well, I know that certainly
13 on the TMI sump we definitely had lots of copper in
14 there.
15 MR. TREGONING: Right.
16 MR. POWERS: And I know it definitely has
17 a huge effect on aqueous radiochemistry. Now, whether
18 it affects any of this stuff or not, I have --
19 MR. TREGONING: Well, I have to be care --
20 learned a lot of lessons from TMI, but it was
21 certainly not prototypical in terms of how post-LOCA
22 cooling would be expected in an ECCS.
23 MR. CORRADINI: Why is that? Because it
24 was a small break and you'd only get these sorts of
25 deleterious effects when you have a large break and a

1 lot of break-up of the insulation?

2 I assumed just the opposite, that TMI

3 might be very representative.

4 MR. TREGONING: Well, they pooled cooling

5 water from the Susquehanna River. So that was one

6 thing that was certainly not prototypical, and the

7 other thing that you have to remember, and I think

8 others may correct me, others more knowledgeable, but

9 by the time they actually had got in to evaluate what

10 was in the sump, some time had passed.

11 MR. POWERS: We were doing it within days

12 of the accident. I was getting samples within nine

13 hours.

14 MR. TREGONING: So you were even seeing

15 high copper then.

16 MR. POWERS: Oh, yeah, very early.

17 MR. TREGONING: Within days.

18 MR. POWERS: Very early in the accident.

19 MR. TREGONING: What do you attribute the

20 high copper to?

21 MR. POWERS: It's just cables are being --

22 electrical cables are being collated.

23 MR. TREGONING: Okay. Because the

24 interesting thing, again, when we ran the ICET test,

25 we didn't see large amounts of copper, by and large.

1 MR. POWERS: Yeah. Well, see, you weren't
2 running a radiolytic solution over copper wires there
3 and having it drip down into the containment sump.
4 MR. TREGONING: Okay. You know, that's
5 something we probably at least need to follow up on.
6 MR. POWERS: Well, I don't know that.
7 And, in fact, they bring up lead based paint and lead
8 is interesting because it will form a hydroxide
9 that's kind of amorphous and ugly and things like
10 that. I just wondered if they had commented on the
11 copper. I don't know that it's a major contributor.
12 By far and away the biggest contributor
13 was aluminum oxide. I mean there was sludge
14 everywhere, in the sump very critically.
15 MR. TREGONING: In the samples.
16 MR. POWERS: Yeah. You had a gradation,
17 and it was mud at the bottom of the sump.
18 MR. CORRADINI: So if I might just go
19 back, you kind of said something that kind of
20 triggered my interest.
21 So you said TMI wasn't representative. I
22 mean, has the staff thought about what makes it
23 atypical versus typical in these various areas of
24 concern in terms of timing and chemicals present and
25 various particulate?

1 Because it would just seem to me given the
2 fact that we've been lectured that large breaks are a
3 low probability event and small breaks are a probable
4 event and all of this, it seems to me TMI might be a
5 very representative sampling of how I might go into a
6 large recirculation phase for a very long time.
7 Granted, they may have handled it
8 differently than the typical bad accident, but it
9 would seem to me -- so am I missing something in that?
10 MR. TREGONING: I think Tom Hafera from
11 NRR is going to address that question.
12 MR. HAFERA: Tom Hafera from the plant
13 staff.
14 Recognize, okay, many plants on small
15 break LOCA don't even go into sump recirculation mode.
16 They cool down, depressurize, and go right into
17 shutdown cooling mode.
18 Small break LOCAs don't generate a lot of
19 debris. They don't transport a lot of debris. They
20 don't create a lot of mixture of debris. Really TMI
21 was a very unique event. You know, TMI, they pumped
22 river water, and I thought that was pretty much well
23 documented, that the majority of the source of some of
24 their chemical concerns were from when they pumped the
25 Susquehanna River into the containment.

1 MR. CORRADINI: Okay.

2 MR. HAFERA: I don't know. Maybe we can
3 produce an updated document or a document to tell us
4 that, but the staff, we're certainly considering all
5 of these things, and we evaluate LOCAs in many ways,
6 not just small breaks, but large breaks, and we're
7 typically finding that the small breaks are not as
8 limiting. Let's just say it that way.

9 MR. CORRADINI: Thank you.

10 MR. TREGONING: And there have been other
11 experiences where we've have plants go into
12 recirculation mode that we've been able to learn
13 lessons that we thought were probably more realistic.

14 Well, again, Tom should have stayed up
15 there, but you know, Barsaback (phonetic) is -- just
16 looking for operating experience questions, especially
17 with BWRs.

18 MR. BANERJEE: Sump clogging.

19 MR. HAFERA: Well, clearly, Rob mentioned,
20 yes, BWRs. We have seen that there is actual
21 operating experience in the boiling water reactors
22 based on their containment designs, the fact that they
23 have a suppression pool or a tourist that's maintained
24 in a turbulent, how flow rates are much higher and
25 suppression pools and turbulence are much higher.

1 The post LOCA flows are actually directed
2 there versus the pressurized water reactors, this
3 large building containment that's open, typically
4 large areas of very low flow velocity where debris can
5 be settled out.
6 And plus, the other one is that they're
7 designed typically to blow the debris to the upper
8 levels of containment. So to then get the debris from
9 the upper levels down, all of these issues, you know,
10 get factored in, now, recognizing that the strainer is
11 nothing more than a subcomponent of the RHR system and
12 it supports operability of the RHR system to meet 5046
13 criteria.
14 MR. TREGONING: To get back to your
15 original copper question, Dr. Powers, we did discuss
16 it. I can go back and pull some of that information
17 up. I'm not at liberty unfortunately right now. So
18 I can do that if you're interested.
19 MR. POWERS: It's not worth pursuing very
20 far.
21 MR. WALLIS: I'm worried if you're going
22 to meet your deadline of time here.
23 MR. TREGONING: It depends on the amount
24 of questions. I've only got --
25 MR. WALLIS: Three, thirty, is it?

1 MR. TREGONING: Yeah, I think so. I think
2 so.
3 The other thing we got from the peer
4 reviewers, we got issues, but they also gave us
5 recommendations on how to proceed with testing and
6 analyzing some of these issues, and I wanted to at
7 least -- these are mainly contained not within the
8 PIRT process, but these were mainly documented in the
9 NUREG itself. So I wanted to make sure that I
10 summarized these.
11 A number of them indicated that small
12 scale testing can be used to effectively evaluate the
13 effects of key variables, especially looking at
14 quantifying variables affecting solubility, addressing
15 temperature cycling effects, and also evaluating
16 specific combinations of materials not in the ICET
17 test.
18 There was a lot of --
19 MR. BANERJEE: As hydrogen peroxide, I
20 take it.
21 MR. TREGONING: Yes, potentially. And by
22 materials I'm thinking other insulation materials or
23 other materials that you would find in containment as
24 well because there's a whole suite of materials out
25 there that the ICET by its nature was not able to

1 simulate.

2 There was a lot of discussion about the
3 analytical modeling work that we had done. I think
4 the general consensus is the work that we had done,
5 didn't fully exploit the existing capabilities of
6 available codes. Again, we had done thermodynamic
7 equilibrium calculations, and many of the reviewers
8 thought that we really needed to either explicitly or
9 implicitly consider the effects of kinetics, and then
10 also potentially that we could use these codes to
11 incorporate and address some of the radiological
12 considerations.

13 However, I have to mention this last
14 bullet since this has been a point of discussion
15 several times both within the NRC and then also at
16 ACRS meetings. A number of the reviewers recognize
17 directly in their reports that modeling the chemistry
18 at the sump screen from first principles is highly
19 challenging because of the fact that it's expected to
20 be non-equilibrium and the numbers of different types
21 of reactions that are expected to go on over the
22 mission time, 30 days.

23 So a number of the reviewers thought that
24 trying to develop a code at this point was probably
25 well beyond the existing capabilities of any of these

1 commercial codes and would certainly be a state of the
2 art exercise.
3 So I think a number of the reviewers
4 really recognized the challenge of that.
5 MR. WALLIS: The debris on the bed itself
6 is a very good reactor. I mean, they're flowing fluid
7 through it all the time and bringing it into contact
8 with --
9 MR. TREGONING: Yeah.
10 MR. WALLIS: And that was in there.
11 MR. TREGONING: And that's exactly the
12 point.
13 MR. WALLIS: Bed reactor.
14 MR. TREGONING: Yeah, and then if you've
15 got --
16 MR. WALLIS: And the sump within the bed.
17 You've got this very good atmosphere for chemical
18 reactions.
19 MR. TREGONING: Right. So how are we
20 moving forward with the issues that we got from the
21 peer review? This slide I'm going to talk about a
22 general path forward, and then I'm going to give some
23 examples of dispositioning the items that I raised
24 earlier. These are just examples of disposition.
25 This isn't any -- and it's based on my proposal. So

1 it's not an official disposition at this point
2 certainly.
3 The issues that have been raised,
4 certainly we'll be communicating this information to
5 both the vendor teams and the licensees that are
6 evaluating chemical effects, and we want to do that in
7 a way to facilitate resolution of the generic letter
8 responses.
9 As I mentioned earlier, currently working
10 on documenting the PIRT process and summarizing the
11 important issues identified in the PIRT.
12 Now, this initial document will not deal
13 with disposition, but it will simply document the PIRT
14 process and then the results from the process.
15 And then individually we'll we looking --
16 MR. BANERJEE: This was sort of finished
17 at least with the peer reviewers about a year ago,
18 right?
19 MR. TREGONING: No, not quite a year. We
20 finished the PIRT about last July of so.
21 MR. BANERJEE: Okay, and so why is it sort
22 of taking so long? Is it because not much effort is
23 going into this right now?
24 MR. TREGONING: Documenting a PIRT process
25 can be fairly lengthy because, again, the process

1 itself, as well as summarizing the issues, you've got
2 to draw on a lot of sources. So we've had to enlist
3 the peer reviewers at various points in time to help
4 fill out the document. So it's just taking the some
5 to put the document together.
6 However, you know, the initial push was to
7 get the documents out there, including the NUREG with
8 their peer review comments so that they would be
9 available publicly, and we always expected that the
10 PIRT process would lag slightly behind that process.
11 MR. WALLIS: Finished in July if it's not
12 documented, and they're still working on it.
13 MR. TREGONING: They finished the
14 assessments in July.
15 MR. POWERS: If you're ever been through
16 these things, there's lots of meetings and agonizing
17 over filling out of charts and things like that, but
18 then somebody has to go through all of that junk and
19 try to make sense out of it.
20 MR. CORRADINI: And write it up.
21 MR. POWERS: And write it up, then send it
22 back to the experts and see if their write-up agrees
23 and where it doesn't, fix that. And of course, one
24 guys says it's blue and the other guy says there's no
25 change and it's green, and so there's quite an

1 iteration. I mean it essentially doubles the --

2 MR. WALLIS: So they're still working on

3 it then. There is --

4 MR. BANERJEE: Is that iteration going on

5 or is it a dead duck right now?

6 MR. TREGONING: There's been some of that

7 iteration. The document itself though is still in

8 preparation at this point. But there has been

9 iteration certainly as Dr. Powers indicated to make

10 sure things are being captured appropriately.

11 MR. MAYNARD: A lot of times during the

12 writing and the summary you almost go through another

13 review process. I mean it's open to the question.

14 MR. BANERJEE: Right. If that's going on,

15 it's fine, but I'm trying to get the real

16 understanding of whether this is a very active area or

17 one where sort of interest has waned or let's say

18 activity has waned and sort of this decline right now.

19 MR. SHAW: No. In fact, interest has

20 never been higher certainly.

21 MR. BANERJEE: Interest is high.

22 Activity?

23 MR. TREGONING: Yeah, activity is.

24 Interest and activity are quite often correlated.

25 MR. BANERJEE: They are in this case?

1 (Laughter.)

2 MR. BANERJEE: Are they actually in this

3 case?

4 MR. TREGONING: Yes, they are correlated,

5 as one might expect.

6 MR. WALLIS: What's the zero per month if

7 it's active?

8 MR. TREGONING: I'm sorry?

9 MR. BANERJEE: So how many people are

10 working on this right now? Let's ask it straight.

11 MR. TREGONING: How many staff or how many

12 peer reviewers? I mean --

13 MR. BANERJEE: Staff, peer reviewers,

14 whatever.

15 MR. TREGONING: You know, I think there's

16 probably at least three staff that are involved in the

17 PIRT in one form or another..

18 MR. BANERJEE: What fraction of -- I mean,

19 I'm just trying to understand what fraction of time is

20 involved in one form or another.

21 MR. TREGONING: What are you really trying

22 to find out.

23 MR. BANERJEE: I'm really trying to find

24 out whether, as I said, is this an active area or has

25 it been basically dropped or partially dropped.

1 MR. TREGONING: One thing I will say is
2 that you've seen all of the activities that we've had
3 in the GSI area. We've been incredibly active as a
4 group in terms of publishing and disseminating
5 information and then working with NRR on evaluating
6 the industry's path forward and making sure that
7 they're informed and making sure that our evaluations
8 are informed.
9 So it's a continual process, and with any
10 process we juggle all of our priorities and
11 commitments appropriately. So, yes, it's active, but
12 also I would say in the same token that, yes, we're
13 doing multiple things at the same time.
14 MR. POWERS: Just a brief idea, Rob. How
15 many people do you think were attending the session
16 for the American Nuclear Society meeting in
17 Albuquerque for this?
18 I mean, we filled the room.
19 MR. TREGONING: Yeah. No, it was a good
20 turnout.
21 MR. POWERS: The biggest room we had for
22 concessions and we filled it.
23 MR. WALLIS: But this wasn't a discussion
24 of research results, was it?
25 MR. TREGONING: Yes.

1 MR. WALLIS: It was?

2 MR. TREGONING: Yeah.

3 MR. POWERS: Mike Scott gave an
4 outstanding introduction and Rob held forth for two
5 hours, I guess.

6 MR. TREGONING: Well too long.

7 MR. WALLIS: No, he's very good at that.
8 We know.

9 (Laughter.)

10 MR. WALLIS: Two minutes.

11 MR. TREGONING: I'm not quite sure if
12 that's a compliment or not.

13 MR. POWERS: It wasn't.

14 MR. TREGONING: I don't think it is.

15 (Laughter.)

16 MR. TREGONING: I'll take it as one, but
17 I know you didn't intend it as one.

18 Okay, and I'm almost done here. So we'll
19 be dispositioning individual items and when we do the
20 dispositioning, we'll be looking at where the industry
21 is moving forward as mitigation. We'll be considering
22 in more detail specific plant conditions, and as
23 necessary, we'll be doing literature review scoping
24 calculations, and then identifying anything that needs
25 either targeted follow-on industry sponsored or NRC

1 sponsored research.

2 I really think that issues are going to

3 fall within three categories, and if I look at my ten

4 here, I think many of the issues, and I think we're

5 seeing that already, are already being explicitly

6 considered in the resolution. And of the ten I've

7 listed, at least five of them, again, are currently

8 part of the resolution plan.

9 The challenge that we've got there is to

10 make sure that with respect to the chemical effects,

11 that we're either conservatively or realistically

12 evaluating those effects. So that's still a challenge

13 that we've had certainly.

14 Several of the issues that they raised do

15 actually promote favorable chemical effects, and of

16 the ten that I listed, there's one that clearly falls

17 within that arena, and that's quiescent settling of

18 precipitates, and again, I think with those issues

19 that there will be opportunities that will be

20 available to utilize those attributes in the

21 resolution of the generic letter.

22 MR. POWERS: Nobody specifically said the

23 words Oswald Ripening?

24 MR. TREGONING: Oh, yes. We had a lot of

25 discussion of Oswald Ripening in the peer review.

1 And then there will be a host of other
2 issues that will require some pencil sharpening and
3 some additional consideration, and of the ten I think
4 there's four of those that probably will very easily
5 fall within that mix.
6 And this one I just wanted to -- again, we
7 got some very good testing and analysis
8 recommendations, and I want to give the notion here
9 that we are utilizing these recommendations and not
10 just us, but there was questions earlier about how is
11 the industry utilizing these information, and not only
12 is industry explicitly using some of the information
13 that's coming out of the research, but the strategies
14 as well.
15 So the small scale single effect type
16 testing, I think you've seen some of that in some of
17 the surrogate testing work that ANL did, presented a
18 little bit here today. Industry has used that
19 approach in developing chemical source terms, and
20 again, it could be an important techniques for
21 considering plant specific issues.
22 There's no plans to develop a
23 comprehensive chemical effect head loss code, again,
24 following up from the previous slide. However, we
25 certainly do believe that codes are valuable for

1 addressing specific chemical effects phenomena, things
2 like solubility, radiological considerations, and then
3 predictions of precipitated species.
4 So there is certainly codes will play a
5 role here, and we expect that codes will see use to
6 evaluate some of these issues as we continue to move
7 forward.
8 So the conclusions. The peer review
9 attempted to comprehensively consider chemical
10 effects, and again, when I talk about the peer review
11 here, I'm talking about both the NUREG and the PIRT.
12 They identified several chemical issues for
13 consideration. The next step that we'll be working to
14 is disposition specific issues. We're going to
15 disposition these issues the same way we've been
16 dispositioning all the issues that get raised with
17 respect to the generic letter. So there will be
18 nothing unique or unusual about the disposition
19 process.
20 And I mentioned earlier that as we go
21 through issue resolution, we'll make sure that we need
22 to consider the industry mitigation strategies,
23 specific plant conditions, and using scoping analyses
24 as appropriate to identify any remaining issues that
25 may need some more in depth study.

1 And, again, there's a recognition that the
2 peer reviewers provided some valuable recommendations
3 for addressing any issues that do remain.
4 MR. WALLIS: When you disposition these
5 issues, are you going to go back to some of the peer
6 reviewers and say this is how we dispositioned your
7 issue? Do you agree with what we did? Are you going
8 to do anything like that?
9 MR. TREGONING: I don't want to commit.
10 I think we certainly may.
11 MR. WALLIS: It might be worth considering
12 for a few things.
13 MR. TREGONING: Sure. Depending on the
14 complexity of the issue, I think bouncing off the peer
15 reviewers saying, "Hey, this is what we did. Do you
16 think that this is an appropriate strategy?" I think
17 that would be particularly appropriate.
18 And I just want it noted for the record
19 that we started ten minutes late.
20 MR. WALLIS: I was going to say you did a
21 very good job here.
22 MR. TREGONING: And that we finished
23 almost more than five minutes on time or before our
24 time.
25 MR. POWERS: Recognize, of course, that

1 the committee holds you to blame for any of the
2 deficiencies of start time or finish time.
3 MR. TREGONING: Can I have a motion to
4 take the ten minutes extra and apply it to a
5 subsequent presentation?
6 MR. POWERS: No.
7 MR. WALLIS: So now it is time to ask the
8 committee if you want to ask Rob anything else, make
9 any other observations.
10 MR. POWERS: I wanted to understand just
11 a little more on the concern over crud. The amount of
12 mass from crud is not very high. The only concern I
13 could think of is the dose that you're getting from
14 it, but the dose is already high.
15 MR. TREGONING: A couple of things with
16 respect to the crud. The mass isn't high. I mean,
17 we've heard things around 100 ppm, but there are
18 several things that potentially are added. You're
19 adding the radiological consideration to the loop.
20 You're also creating additional co-precipitation
21 sites.
22 MR. WALLIS: You're adding iron that you
23 didn't have before.
24 MR. TREGONING: Well, you're adding iron
25 and nickel certainly.

1 MR. POWERS: You're tearing up the ying-
2 yang here with the iron everyone.
3 MR. WALLIS: This is iron in --
4 MR. TREGONING: We didn't get as much iron
5 as you would think in the ICET testing.
6 MR. POWERS: You will have iron
7 everywhere.
8 CHAIRMAN SHACK: I mean, iron in a pH 9
9 environment, you know, that's pretty benign on iron.
10 MR. POWERS: Yeah, but there's iron
11 everywhere.
12 MR. WALLIS: What form does it have?
13 MR. POWERS: Ferric oxide and ferric oxy
14 and hydroxide.
15 MR. ABDEL-KHALIK: Ferrite, nickel
16 ferrite.
17 MR. POWERS: Almost none.
18 MR. TREGONING: But the other thing with
19 the crud is having that iron in there, depending on
20 the redox and the amount of oxidation potential of the
21 environment will determine the types of species that
22 you might get that could form, you know, as --
23 MR. POWERS: Or catalytically to compose
24 all of your hydrogen peroxide for you.
25 MR. TREGONING: Well, yes, and another

1 consideration, again, even though the dose is much
2 lower than in the core, but that if you got it
3 trapped, if you had crud that actually made it through
4 and trapped on the sump screen --
5 MR. POWERS: You've got gap release in
6 this sump. That's a pretty fair dose right there. I
7 mean what you get from the crud is largely manganese
8 and Cobalt 60. And that kind of pales in comparison
9 to the cesium.
10 MR. TREGONING: Well, I think we may be
11 enlisting you to disposition certain of these issues
12 as well. So --
13 MR. WALLIS: Okay. Are we through? We
14 are through.
15 MR. BANERJEE: One thing which is still
16 open is when are you coming? Mike had said that you
17 are coming back in May or June. Is that still a date?
18 PARTICIPANT: Tentative date is May 16th.
19 MR. BANERJEE: I just wanted to verify.
20 MR. SCOTT: We plan to come back in the
21 middle of May, yes.
22 MR. BANERJEE: Middle of May?
23 MR. SCOTT: Yes.
24 MR. BANERJEE: All right. Thanks.
25 MR. WALLIS: Which is quite soon.

1 MR. BANERJEE: So you'll have some idea of
2 what industry is doing and things like that?
3 MR. SCOTT: The research guys can confirm
4 this. I believe that we're going to, as one of the
5 items we're going to talk about in May, we'll give you
6 a progress report on this, right?
7 MR. TREGONING: Yes, we will have a
8 progress report on this certainly, but I think his
9 question was more --
10 MR. WALLIS: Well, will May be the time
11 when we'll be ready to advise the Commission about how
12 you are doing about actually resolving the issue?
13 Will that be the time or will we have to wait a little
14 longer?
15 MR. TREGONING: I'm sorry, Graham. What
16 was your question?
17 MR. WALLIS: Well, the Commission, I
18 think, would like opinion from us about how well you
19 are doing in resolving this GSI. They've asked us to
20 keep track of things and help them from time to time.
21 Will maybe the time when you sort of said,
22 "This is where we are and we're on track and
23 everything is going well," and so on and so on and so
24 on, we can write the Commission that that's the case,
25 or should we wait a little longer until we've got some

1 more evidence?

2 MR. SCOTT: Let me tell you I've been kind

3 of devoting a little thought as to what we would come

4 talk to you about. For example, there are two key

5 topical reports out there, one being the downstream

6 effects ex vessel and the other being the chemical

7 effects WCAP. Those documents, the RAIs have already

8 gone out on, and we expect to have gotten responses to

9 those by May. So we plan to come in and have both the

10 staff and hopefully the owner's group give you an

11 update on where we stand with review of those

12 documents.

13 We will, as I mentioned earlier this

14 afternoon, we will only just have -- well, actually by

15 the time we're talking to you in May, we will not yet

16 have received the in vessel topical report. So the

17 jury will still be out on that issue.

18 The chemical effects testing that I know

19 we're all interested in will be in progress then in

20 some cases. We hope to bring you an update on some

21 hopefully results on what's going on with chemical

22 effects. Whether --

23 MR. BANERJEE: This is industry testing,

24 right?

25 MR. SCOTT: Yes, that's correct. Whether

1 that would then put you in a position to give us
2 another report card on how we're doing, it might still
3 be a bit premature, but that's the sort of subject I
4 thought you might find of interest to hear from us on
5 in May, and if you all have any different subject
6 areas you'd like to hear about, maybe we should talk
7 about them.
8 MR. WALLIS: That's fine. I think what
9 you're going to tell us about is fine. It's just that
10 if you could bring it up to the point where we could
11 reach some conclusion, that would perhaps be good.
12 MR. SCOTT: Sure. I understand. I don't
13 think that in May we're going to be at a real high
14 confidence level yet that we know whether the chemical
15 effects are all going to be resolved by 12/31/07 or
16 not. I don't think we're going to have enough
17 information at that time. We'll tell you what we know
18 certainly, but we may not be far enough along in May
19 to be able to give a complete picture of that.
20 MR. WALLIS: Okay. Thank you.
21 I'm ready to hand it back to the chair.
22 Is that okay with everybody?
23 In that case I will do so. Thank you very
24 much, everyone who presented.
25 MR. BANERJEE: So we will take a break now

until five of four.

(Whereupon, the foregoing matter went off the record at 3;39 p.m. and went back on the record at 3:56 p.m.)

CHAIRMAN SHACK: Our next topic is the technology-neutral framework and related matters. I'll ask Dr. Kress if he will lead us through this.

MR. KRESS: Okay. Yesterday we had a future plant design subcommittee to review this issue. Practically everybody here was there. So I guess this part of the meeting is just for you, Sanjoy. You're the only one that wasn't there yesterday.

MR. BANERJEE: I was trying to teach without success.

MR. KRESS: Oh, okay. But anyway --

MR. POWERS: So was Mary.

MS. DROUIN: I thought we had a successful meeting yesterday.

MR. KRESS: I thought it was a very good meeting, and it supposed to help us maybe respond to an SRM. We were tasked by the Commission to make a recommendation on the relative merits of going ahead and continuing and finishing this approach versus the development of a framework specific for a given design.

1 I don't know if I captured the exact
2 words, but it's something like that. So we were
3 tasked with that, and perhaps this meeting will help
4 us respond.
5 Plus I consider this as a fine opportunity
6 for the committee to provide feedback to the staff on
7 the framework, how we think they're doing and if we
8 have any areas where we think this framework needs to
9 be improved or refined. This is the good chance to
10 let them know because they intend to publish the
11 framework, which by the way the framework is the
12 NUREG. Those two are identical. So they would like
13 to publish it soon. So it's a chance to give any
14 feedback we may have on that, in addition to
15 developing a response to the SRM.
16 I think if I read the subcommittee right,
17 and I think I do, there was some indication that
18 framework work on it may be stopped, and I think we
19 would prefer that there at least be continued work on
20 it in some way. Maybe it's cleaning it up a little
21 and then doing an application, specific application to
22 benchmark it.
23 But anyway, having said that, I'll turn it
24 over to Mary and let her lead us through this. I
25 don't know if Farouk wants to make these comments.

1 MR. MONNINGER: Good afternoon, Mr.
2 Chairman, fellow ACRS members. May name is John
3 Monninger. I'm from the NRC's Office of Nuclear
4 Regulatory Research. I'm the Deputy Director for
5 Probabilistic Risk and Applications.
6 I want to thank you very much for taking
7 the time and allow us to have the opportunity to
8 present the framework to you. We've been working, you
9 know, very closely with the ACRS, with the other
10 offices within the NRC, NRR, and the new NRO in this.
11 In addition to that, with stakeholders out there.
12 You know, this has been a very important
13 project for us for the past three years, and
14 essentially what it was meant to do was to pool
15 together, you know, the various policy and technical
16 issues that have been identified throughout the years,
17 through such policy documents as the NRC's safety goal
18 policy, the advanced reactor, the severe accident
19 policy statement, and to pool these together for
20 guidance for, you know, future reactors, for
21 regulating future reactors.
22 You know, in development of this project
23 we had multiple meetings, multiple stakeholder
24 workshops to solicit input and guidance from the
25 industry out there.

1 One of the things I think is important
2 with where we are in this project is to be cognizant
3 of the fact that, you know, we have been working on it
4 for several years, and we've made some significant
5 accomplishments in it. And approximately, you know,
6 a year or so ago they passed the Energy Policy Act,
7 and you know, there's a notion that, you know, it's a
8 changing environment out there, and what we would like
9 to do is recognize the future efforts that are coming
10 down the road, in particular, you know, the
11 development of the licensing under the licensing
12 strategy for the next generation of nuclear power
13 plants.
14 And the question is, you know, how could
15 we use what we've done in the past and potentially
16 feed into those projects.
17 So with that in mind, you know, I'll turn
18 it over to Mary Drouin. She's been the lead project
19 manager on this project sine its inception.
20 MR. POWERS: John, before Mary starts, let
21 me ask you a question more pertinent to what our job
22 is than yours. Is it not true that consistency is an
23 attribute of good regulation and that without a
24 framework it would be difficult to have a consistent
25 regulatory structure?

1 MR. MONNINGER: Consistency,
2 predictability, I mean, is paramount. I mean to not
3 only the agency's success, but you know, any potential
4 future.
5 MR. POWERS: So, I mean, it seems to me
6 that this is an absolutely essential activity for the
7 staff to undertake in order to carry out the
8 Commission's mission in a consistent and predictable
9 fashion.
10 MR. MONNINGER: Yes.
11 MS. DROUIN: Thank you, John.
12 My name is Mary Drouin with the Office of
13 Research. We're here today to try and provide with
14 you what our status and plans are with regard to this
15 thing that we've come to call the technology neutral
16 framework, where we are with it and where we go.
17 I want to very quickly go through the
18 history, and when I say quickly, because I'm not going
19 to take you through the myriad of SECY papers and
20 SRMs. There's been a lot of communication and reports
21 that have been developed during this program. Tell
22 you where we are now and as you're aware we did issue
23 -- there was an ANPR that was issued very directly
24 related to the framework. Give you some of the
25 feedback of the stakeholder comments, and then where

1 we plan to go.

2 The program, you know, did get initiated

3 back in January of 2003. When you go and look at the

4 RES advanced reactor research plan, that's where it

5 was first recognized, the need for the framework.

6 And it got to some of the things that you

7 just brought up Dana, you know, the need for

8 consistency, stability, and predictability. It was

9 recognized right away that, of course, you can license

10 these new advanced reactors under the current Part 50.

11 We've never said you couldn't, but if you are looking

12 for a more efficient way to do it and trying to be

13 consistent and maintain, you know, the agency's goal

14 of being predictable and stable was to have this

15 framework because you had the Part 50. That is very

16 LWR focused.

17 You do have unique characteristics and

18 the issues associated with the advanced non-LWRs that

19 aren't addressed by the current Part 50. So do you

20 deal with these in a consistent manner or do you deal

21 with them each time a new license comes in?

22 But probably to me the more bigger thing

23 is, you know, the PRA. Do we now move forward in

24 using Dr. Wallis's, your words yesterday of a new era?

25 Do we now make that step to the new era of bringing

1 risk and bringing a probabilistic approach to how we
2 license these plants?
3 And that grew out of the various policy
4 statements that we had sent to the Commission back in
5 2003 asking should we be using a probabilistic
6 approach. That was one of those seven policy issues
7 and the Commission came back and said to proceed
8 forward.
9 And that has probably been the single most
10 challenging thing because there are so many nuances
11 and technical challenges associated with that. When
12 do you want to start using that PRA in terms of your
13 licensing basis and not going, you know, risk based?
14 So the program was initiated to develop,
15 you know, and those were the words used back then,
16 risk informed, you know, performance based structure
17 that could support the various different reactor
18 technologies.
19 We have completed the work on the
20 framework. That doesn't mean that in terms of
21 implementation and understanding how it's applied, but
22 in terms of the framework itself, you know, we do plan
23 to publish it this summer, and we're looking for a
24 June target frame.
25 Also we talked about this in quite some

1 detail yesterday. You know, in the past we've used
2 the word risk informed, but in terms of this framework
3 we've changed the terminology to be risk derived
4 because, again, we're not starting with a set of
5 regulations that are already out there and coming in
6 and revising them using risk.
7 We're trying to start in developing
8 regulations from a blank sheet of paper where risk and
9 your PRA results and insights are integrated from the
10 bottom up.
11 And as John indicated in developing the
12 framework, we tried to bring into play all the
13 expectations from the various policy statements from
14 the Commission, the severe accident, the advanced
15 reactor, the PRA, and the safety goals more
16 explicitly.
17 So getting to where are we right now. The
18 Commission came back in several SRMs. In fact, it
19 wasn't a single SRM. So if we didn't get the message
20 the first time, they reminded us on two other
21 occasions for the staff to issue an advanced notice
22 for proposed rulemaking, and in the SRM they asked the
23 staff to provide its recommendation on whether and if
24 so, how to proceed with rulemaking.
25 Also in the SRM they didn't just ask us to

1 come up with the ANPR, but in the ANPR itself and I've
2 used the words directly from the SRM, is that we
3 should seek stakeholder input in areas such as whether
4 the effort is premature, whether the NRC should focus
5 on developing technology specific frameworks for non-
6 LWRs, and then what priorities should be given for the
7 various non-LWR technologies.
8 And they also indicated that we should
9 facilitate stakeholder input, hold public meetings and
10 start that very quickly after the ANPR was issued.
11 The ANPR was issued in May. When we
12 issued the ANPR -- and if you haven't read the ANPR,
13 it was quite detailed -- I believe we had something
14 like 70 questions in the ANPR dealing with precisely
15 the things that the Commission asked us to, but then
16 it got into a lot of detail, trying to get into some
17 of the technical aspects of the framework.
18 But in looking at, you know, answering the
19 Commission question of whether the effort is
20 premature, should it focus on developing technology
21 specific, what priorities, we did have very specific
22 questions in the APR. For example, we had should the
23 regulations be technology neutral, technology
24 specific. If technology specific, which technology?
25 You know, is it premature?

1 But here was just a few examples of the
2 questions that we did have in the ANPR seeking
3 stakeholder input so that we could come back and be
4 responsive to the Commission when we go back to them.
5 Also, in the ANPR, the ANPR noted that the
6 framework, because as I said we had a lot of questions
7 specifically on the details in the framework, and that
8 the framework would be on the Web site. It was on the
9 Web site at the same time we published the ANPR.
10 The ANPR also said that we would update
11 the framework because at the time that the ANPR was
12 out, we were still working on some things, trying to
13 wrap up some final stuff. So we did alert the public
14 that in July we would have the final version of the
15 framework, which is the version that you all have,
16 that you all have been looking at.
17 We held a public meeting in July. Then we
18 held a two-day workshop in September. We received --
19 I didn't bring it with me today, but comments from the
20 organization you see in there from Areva. Some of the
21 organizations as you see, like ASME, NEI, ANS, sent in
22 two sets of comments. They sent in some early
23 comments like the September time frame, and then they
24 sent in a lot more detailed comments in December
25 because you have to recognize the ANPR was issued in

1 May. It was opened until December the 29th.

2 The challenge has been that the bulk of

3 the comments came in in December. We actually still

4 did receive some in January, and when you have 70

5 questions there and they wrote detailed responses to

6 all of these 70 questions, it has been a real

7 challenge, and we're still ciphering through these

8 comments trying to get a sense of them.

9 But if I go back to what the Commission

10 asked us to respond to in terms of should it be

11 technology specific, is it premature, we have gotten

12 through those and gotten a sense of what the

13 stakeholder comments are, and so that's what we've

14 tried to summarize, you know, in the next couple of

15 slides.

16 MR. KRESS: You need to add EPRI to that

17 list.

18 MS. DROUIN: EPRI did not submit a formal

19 comment.

20 MR. KRESS: They were part of the --

21 MS. DROUIN: No, they did not.

22 MR. KRESS: Okay.

23 MS. DROUIN: They may have issued

24 something on their own.

25 MR. KRESS: Yeah, we've seen something

1 that we thought --

2 MS. DROUIN: But they did not submit

3 something under the ANPR.

4 MR. KRESS: Okay. I wondered about that.

5 MR. APOSTOLAKIS: But in that report they

6 comment on the framework, but you don't have to

7 respond to those, right?

8 MS. DROUIN: That's correct.

9 MR. APOSTOLAKIS: The question of whether

10 it's premature, it seems to me, was not well posed.

11 What does it mean it's premature? I think the

12 impression I got from the Commission as far as at

13 least some of them is that if we were to pursue this,

14 we would not be doing something else, and in that

15 sense, you know, the question is whether we should be

16 spending money on this versus building up stuff to do

17 license renewals or whatever.

18 MS. DROUIN: Right.

19 MR. APOSTOLAKIS: So premature, it seems

20 to me, is a question that is not -- is it directly

21 from the SRM?

22 MS. DROUIN: If you got back, I didn't

23 write the whole question. I was trying to just give

24 you a sense here that we did pursue this in trying to

25 get input from the stakeholders.

1 There is more to the question than just
2 that. The question had context around it.
3 MR. APOSTOLAKIS: Did the Commission use
4 the word "premature"?
5 MS. DROUIN: Oh, in theirs back here.
6 MR. APOSTOLAKIS: The SRM?
7 MS. DROUIN: The SRM, yes. Those were
8 their exact words, whether this effort is premature.
9 MR. APOSTOLAKIS: Okay.
10 MS. DROUIN: I didn't try and paraphrase.
11 But when we asked the question, you know, we had more
12 to the question. I'm rambling here.
13 This was the exact wording.
14 MR. APOSTOLAKIS: I understanding.
15 MS. DROUIN: But there were more questions
16 associated with that to try and explain, you know --
17 MR. APOSTOLAKIS: What they mean.
18 MS. DROUIN: -- what they mean so that we
19 don't just get a yes or a no.
20 MR. APOSTOLAKIS: Because in an absolute
21 sense, the people are designing other factors.
22 They're coming up with all sorts of designs, and of
23 course, what you say here, if it becomes a rule, would
24 have an impact. So it can't be premature from that
25 point of view.

1 But anyway, we'll see what some of the
2 wise members of the public said.
3 MS. DROUIN: Okay. And the problem is,
4 you know, we've had to kind of synthetize these, that
5 you know, they're answers when exactly, you know,
6 mapped. So we tried to stand back and see, well, what
7 were they saying.
8 So I've tried to give you some exact
9 quotes here, and here are you some examples. You
10 know, you should move forward with developing a risk
11 informed. Supports the NRC efforts. Supports a
12 regulatory framework. We had one comment that says
13 you depart too much, but I wanted to give you the
14 whole -- the whole quote is about two paragraphs, but
15 I wanted to pick out the real sense of it, and their
16 issue was they felt that we had totally departed in
17 addressing common cause failure.
18 And I'll be real honest. I'm not sure the
19 way they got that impression because --
20 MR. APOSTOLAKIS: Who made this comment?
21 MS. DROUIN: This comment was made by --
22 he made it twice, and when I say he made it twice, he
23 sent it in under his own name, and then he sent it in
24 as ANS member so that he could get it in. I'm trying
25 to remember his name.

1 Eileen, do you remember the gentleman's
2 name?
3 MR. APOSTOLAKIS: It was an individual
4 then.
5 MS. DROUIN: Well, he sent it in under the
6 ANS logo as the ANS. I think he was chair of a
7 working group or something.
8 MR. APOSTOLAKIS: But did the ANS form a
9 committee or a group that debated these comments?
10 MS. DROUIN: I have no idea how it came
11 about, but I can tell you that when you look at their
12 comments, it is word for word exactly the same when he
13 sent it in under his own personal name.
14 MR. APOSTOLAKIS: And by the law you have
15 to respond to this?
16 MS. DROUIN: I'm going to let Eileen
17 explain better what we have to do.
18 MR. APOSTOLAKIS: What's the answer?
19 MS. DROUIN: I'm going to let her so that
20 you get the right answer.
21 MS. McKENNA: This is Eileen McKenna, NRR
22 staff on rulemaking.
23 For an ANPR, the obligation of how we
24 respond to the comments is a little different. We're
25 really responding to the Commission at this point.

1 They asked us for the range of views. We don't have
2 the same obligation as we do in a rulemaking to give
3 a point by point response. So we're going to be
4 looking at the comments more collectively in giving
5 our feedback to the Commission of what -- because they
6 asked us what were the stakeholder comments and making
7 sure we covered the range of views, but we don't have
8 to do a point by point: Commenter A said this and
9 here's our response. Commenter B said this and here's
10 our response.
11 MS. DROUIN: But you will evaluate the
12 comments presumably before you send them up.
13 MS. McKENNA: Well, certainly, yes, I
14 agree. We do evaluate them and I think as Mary
15 indicated, too, some of the comments were more
16 technical with respect to the framework, and we
17 evaluate those in a different context than those that
18 were specific to the advanced notice of should we be
19 doing rulemaking and if so, what kind of rulemaking.
20 Is it neutral, specific and on what time frame?
21 And those are the comments that we owe
22 back to the Commission with respect to the ANPR.
23 MS. DROUIN: Right, and we talked about
24 this a little bit yesterday because, you know, what
25 Irene said is exactly right. You know, in terms of

1 what we're going to give back to the Commission is
2 related back to their request here on this viewgraph.
3 So there were questions that were in the
4 ANPR that addressed that precisely. But we also
5 had -- I think that summed up to like eight questions
6 out of the entire 70 questions. So we had like 60
7 questions that dealt more with technical stuff in the
8 framework, and those are, you know a lot more
9 challenging to go through and understand.
10 Now, it is not our intent, as I said
11 yesterday, to go through and respond to those one by
12 one, but what we're trying to do is get the sense of,
13 you know, what were their issues or problems with the
14 various technical aspects of the framework and we are
15 going to put an appendix to the framework that at a
16 very high level is going to say, okay, in terms of
17 like we've got a bunch of observations. It doesn't
18 require any change to the framework.
19 Comments, we're going to summarize at a
20 high level the comments that deal more with
21 implementation, but we're not making any changes to
22 the framework based on those. That will depend on
23 what happens in the future in terms of how the
24 framework may or may not be implemented.
25 Questions that we just disagree with and

1 we may have a short summary of why we disagree and I
2 think that's about it. I can't remember. There's
3 five categories, but we're going to summarize that at
4 a high level in an appendix, but we're not going
5 through a one-by-one point of the comments.
6 I just had to do that on another program,
7 and it's a very laborious thing to do.
8 Okay. Let's go back two.
9 So on the three things that the Commission
10 asked us to look at, those were generally -- you know,
11 I could have given you more, but they were all of the
12 nature, you know, move forward or support, and the one
13 negative that we got was this.
14 We got those exact words twice.
15 MR. BONACA: With no further explanation.
16 MS. DROUIN: I'm sorry?
17 MR. BONACA: With no further explanation
18 than that. I mean, so I don't understand it. I mean,
19 why is this being raised? Do you understand what the
20 comment is about?
21 MS. DROUIN: Wait. I'm pressing the wrong
22 button.
23 That's why I tried to add more, because
24 when I read the whole comment and trying to understand
25 why they were saying it departs too far from using the

1 deterministic approach.

2 What I finally understood is that they had

3 a feeling. They don't explain it, but they had the

4 feeling that we're not addressing common cause

5 failures. That was the sense I got.

6 MR. APOSTOLAKIS: Well, he probably means

7 also that we have a long experience with deterministic

8 defense in depth type methods, and why are you

9 changing? That really is his objection.

10 MR. BONACA: But it's so specific about

11 common cause failure.

12 MR. APOSTOLAKIS: Well, that comes later,

13 after three dots and three dots.

14 MS. DROUIN: Right, but that was really

15 the essence when you read the comment.

16 Okay. Whether we should be technology

17 neutral, technology specific, there was no consensus

18 here, and --

19 MR. WALLIS: Is there some kind of a

20 percentage though? I mean, did 90 percent say one and

21 ten --

22 MS. DROUIN: No, no.

23 MR. WALLIS: -- percent say the other?

24 MS. DROUIN: No, and that's why I wanted

25 back on the previous one. They were all supportive,

1 and you had this one negative that he did it twice.

2 MR. WALLIS: So on this one --

3 MS. DROUIN: On this one it was truly no

4 consensus.

5 MR. WALLIS: It was 33 percent for each?

6 MS. DROUIN: The best I would say would be

7 yes.

8 MR. APOSTOLAKIS: But I really have a

9 problem with that, and I hope when you write to the

10 Commission, you consider this. This is not an issue

11 to be decided on a democratic vote.

12 MR. KRESS: No, that's right.

13 MR. APOSTOLAKIS: It is not. There has to

14 be some logic behind the argument and so on, like the

15 issue of consistency that Dana raised and so on. To

16 say that some people said this, some people said that,

17 I mean, it's a true statement, but I don't know that

18 that's what you should be written to the Commission

19 because I don't know how much time these people spent

20 thinking about it. I don't know what kind of

21 information they had, you know, how many people really

22 understand the regulatory structure and what it's

23 trying to do and the benefits of risk informing the

24 regulations.

25 I mean, you know, somebody might have sat

1 down and said, "I'll show you. You know, you are risk
2 informing, taking away the margins." It doesn't make
3 sense to me to report percentages here.
4 MR. MONNINGER: Well, I think behind all
5 of the questions, the questions that were asked were
6 not just yes and noes. It was, you know, should it be
7 this and why, so we would always ask for them to
8 provide the basis. So this is just a high level
9 summary, but I assume, I would hope that they provided
10 the basis behind it, too, and we would have to --
11 MR. APOSTOLAKIS: If someone gave you
12 reasons that you find legitimate, then I think you
13 should report them, but if they just wrote down, you
14 know, you should --
15 MR. WALLIS: If Mary has a rationale and
16 if they don't shoot it down, why should she listen to
17 them? If she has a really good rationale for doing
18 something --
19 MR. APOSTOLAKIS: No, but in this case,
20 you guys are supposed to be neutral, right? And
21 report to the Commission what these people said.
22 You're not supposed to take your --
23 MR. MAYNARD: I'm not sure I
24 fully understand their task, but I think it's
25 interesting to know what the views are, but I think

1 what's important for this particular question is what
2 does the regulatory believe is the most appropriate
3 way to move forward.
4 I think it's more important what rationale
5 that the staff has and what do they believe is the
6 best way to move forward for regulating licensing a
7 new technology. It's nice to get the views from the
8 others, but this is one of the things the
9 regulators --
10 MR. APOSTOLAKIS: The Commission knows
11 what the staff thinks. This is a specific question to
12 the staff to find out what other people think. So the
13 way it will be presented to the Commission, what other
14 people thin, I think is very important, and the worst
15 thing you can do is to go with percentages.
16 MR. WALLIS: That's before they saw your
17 design. This is just preliminary reaction to the idea
18 really.
19 MS. DROUIN: Well, I don't know that this
20 is preliminary because there has been a lot of
21 interaction on this program with the public.
22 MR. WALLIS: Do you think they really look
23 at the details?
24 MS. DROUIN: I don't think that sometimes
25 that people use the words "consistently" in terms of

1 what they mean, and people may use the word
2 "regulation," and I've noticed that particularly with
3 the public, they'll use that very loosely, nd they may
4 use regulatory guide when they're saying regulation
5 and vice versa.
6 People have not been clean in their uses
7 of the words. And I think that has caused part of the
8 problem.
9 MR. WALLIS: Well, when you're trying to
10 do something visionary, you're really stuck by using
11 this kind of method, and I'm thinking of the
12 development of computers when they were first
13 developed. All of the experts said there will be no
14 market for computers.
15 That's absolutely wrong, but some
16 visionary came along and designed these things and
17 they worked and they're everywhere now. So you've got
18 to be the visionary here.
19 MR. KRESS: Besides, you've put a lot of
20 energy and thought in this, and that's worth a lot
21 more than somebody who sat down maybe at one time --
22 MR. APOSTOLAKIS: Also, I mean, this is
23 clearly a case of expert opinion elicitation. If the
24 expert who submits the opinion is, say, a responsive
25 organization, like NEI, which tries to build some sort

1 of consensus among its members, they at least have a
2 debate with each other. Then I would pay more
3 attention.
4 Areva, it seems to me, is a respectable
5 organization. So I'd like to know what they say. If
6 they say premature, forget it, I'd like to know that.
7 MS. DROUIN: Well, I'll tell you what
8 Areva said.
9 MR. APOSTOLAKIS: Okay.
10 MS. DROUIN: Areva was -- they're one of
11 the ones that was the first one.
12 MR. APOSTOLAKIS: They what?
13 MS. DROUIN: They were one of the ones
14 that were in the first bullet.
15 MR. APOSTOLAKIS: Right.
16 MR. WALLIS: They set technology to
17 regulations, and they were truly meaning the word
18 "regulation."
19 MR. APOSTOLAKIS: Because they took the
20 time to understand what it means.
21 MS. DROUIN: And that the implementing
22 guidance should be technology specific.
23 MR. APOSTOLAKIS: Right. That's very good
24 information.
25 MS. DROUIN: That was where Areva was.

1 MR. APOSTOLAKIS: You see it depends very
2 much on who says what, but to have one random
3 individual sit down in front of his or her machine and
4 start typing, you know, that doesn't make sense to me.
5 You might as well as them what the frequency of a
6 large LOCA is.
7 (Laughter.)
8 MR. BANERJEE: Might have a more realistic
9 idea.
10 MR. ABDEL-KHALIK: Have the people who
11 advocated the second position provided any rationale
12 for such a position?
13 MS. DROUIN: They all provided rationale.
14 The question is could you understand their rationale,
15 and that's what we're struggling -- that's what
16 personally I'm struggling with because sometimes I
17 don't understand the rationale.
18 I don't know if I agree or disagree with
19 them. I'm just trying to understand what they're
20 trying to communicate to me.
21 MR. BANERJEE: Can you ask them for
22 clarification?
23 MR. WALLIS: Well, the last one is kind of
24 stupid because you have to have some regulation for
25 future reactors. So what are you going to do? Just

1 say it's too premature to decide. You --

2 MR. APOSTOLAKIS: That was my problem,

3 too. What's premature? It doesn't mean --

4 MS. DROUIN: Well, you had about three or

5 four saying it was too premature.

6 MR. APOSTOLAKIS: Out of how many, by the

7 way? How many?

8 MS. DROUIN: NEI indicated it was too

9 premature and then you had other saying, who when they

10 submitted their comments, their comments were a one-

11 pager, and they said we support NEI's position.

12 MR. APOSTOLAKIS: No, but in that case I'm

13 sure those guys because it's NEI, they knew that if

14 resources went to this, they wouldn't go somewhere

15 else, and they know what's coming according to rumor

16 at the end of this year.

17 So for them the word "premature" didn't

18 really mean much. They knew that the agency has

19 limited resources.

20 MR. BONACA: But what confuses me is that

21 since everybody knows that any new plant will have to

22 have a full PRA to support the design of it, what's

23 premature about some guidance on how to use it?

24 I mean even if this stands alone as a

25 document --

1 MR. CORRADINI: But can't we just
2 interpret this just in a straightforward manner, which
3 is some indicated too premature to decide and,
4 therefore, the default is deterministic with the PRA
5 being some sort of information on --
6 MS. DROUIN: No, no, no. That's not what
7 this is. This is too premature to decide whether it
8 should be technology neutral or technology specific.
9 MR. CORRADINI: Oh.
10 MS. DROUIN: That's what these responses
11 are to.
12 MR. WALLIS: Oh, so it's one or the other.
13 MR. KRESS: The trouble I have with that
14 is generally things that are specific are derived from
15 the general, and the technology neutral thing is the
16 general, and the specific is derived directly from
17 that. I don't understand the verses myself.
18 MS. McKENNA: Well, I think somewhat it's
19 a balancing question in terms of whether you write the
20 regulation at the very pure, neutral level and then
21 have everything else in guidance where it's less
22 binding, you know, or are we able to do that at a
23 regulation level versus putting going a little further
24 down and being more specific to, say, a gas cooled
25 technology in the regulations.

1 You may still need implementing guidance
2 to talk about one kind of gas cooled reactor versus
3 another, but I think that's why there's some of this
4 people aren't sure, you know. How can we really write
5 it at the neutral in a complete and understandable
6 way, putting a little more of the specifics in.
7 MS. DROUIN: I think across all of these
8 questions, I think it goes back to if you look at many
9 things that we're doing, for example, on Part 50 and
10 risk conforming it and what we should be doing next.
11 You hear quite often, well, let's wait and see. They
12 want to wait and see how is that implemented, how is
13 it going to work out. So I think you're seeing a lot
14 of the same, similar hesitation here. They don't know
15 really what this means yet.
16 MR. CORRADINI: What the implications are.
17 MS. DROUIN: Right. So I'm hesitant to
18 come in, commit myself to a very specific, you know,
19 whether it should be technology neutral or whether,
20 you know, we should be a separate regulation or the
21 other.MR. KRESS: I think without an actual rule here;
22 is that what you're thinking?
23 MS. DROUIN: That's why, you know,
24 yesterday in part of the presentation we tried to give
25 you some examples that if you turn the crank here and

1 you created, you know, these regulations, to give you
2 a feel here's what we're talking about, and so I think
3 people have not seen that. So, you know, we're all
4 scared of the unknown. You know, I'm not really sure
5 what this is you're going to give me. So, you know,
6 I like the devil I have, you know, than a new devil.
7 MR. WALLIS: But the devil you have
8 doesn't apply to new reactors, especially if you don't
9 look at water reactors.
10 MS. DROUIN: But I know I can still use
11 that devil. I know that I can license a plant under
12 current Part 50. It can be done.
13 MR. POWERS: We've done it twice.
14 MS. DROUIN: We've done it.
15 MR. KRESS: Yeah, it can be done.
16 MR. CORRADINI: More than twice.
17 MR. POWERS: Actually more than twice, but
18 for the specific regulations that we have, twice.
19 MR. CORRADINI: Twice.
20 MS. DROUIN: You know, the problem is that
21 this is a Catch-22 because, you know, going down
22 you're talking about resources.
23 MR. CORRADINI: So let me just ask one
24 other question. Instead of just looking at the
25 written comments, in these workshops that you had,

1 what was the feedback you got verbally from the same
2 sort of responsible organizations. Similar comments?
3 MS. DROUIN: Yes. We didn't see --
4 MR. CORRADINI: Similar discussions?
5 MS. DROUIN: Nothing surprised us.
6 MR. CORRADINI: Okay, fine.
7 MS. DROUIN: Nothing surprised us.
8 MR. CORRADINI: right.
9 MS. DROUIN: Well, I shouldn't say that.
10 That one negative about, you know, that we're not
11 dealing with common cause failures.
12 MR. CORRADINI: The reason I'm asking it
13 relative to the workshop, because then you can have
14 some give-and-take and explore and understand what
15 their thinking was.
16 MS. DROUIN: Yes.
17 MR. CORRADINI: That's what I'm asking.
18 Okay.
19 MR. BANERJEE: So was there a sense
20 originally that the current regulations would lead to
21 designs that are too conservative for new reactors?
22 Why was there a reason for initiating this ? What was
23 the reason?
24 MS. DROUIN: That we initiated this whole
25 program?

1 MR. BANERJEE: Yeah.

2 MS. DROUIN: Let's go back to --

3 MR. BANERJEE: Well, leaving aside the --
4 I mean, I'm trying to understand why the Commissioners
5 may have asked for this unless there was a thought
6 that there was something wrong with the current
7 regulations.

8 MR. ELTAWILA: Professor Banerjee, this is
9 Farouk Eltawila from Research.

10 The Commission did not direct the staff to
11 develop the technology near term framework. It was
12 the staff initiative to start this activity, and we
13 started this activity and took on in the past three
14 years and we engaged the stakeholder. So that's all
15 the staff initiative.

16 The only thing that the Commission
17 directed us is to proceed with the advanced notice for
18 rulemaking, and that's because the effort was taking
19 too long and we needed to make a decision whether we
20 are going to proceed this way or we're going to change
21 the course.

22 MR. WALLIS: So why did the staff initiate
23 it? Somebody initiated this thinking it was a good
24 idea.

25 MR. ELTAWILA: Staff initiated this work

1 because we were faced a few years ago with the
2 potential for non-light water reactor application that
3 was going to proceed on a very accelerated schedule,
4 the Exelon application, and so on.
5 So we started this activity to try to get
6 some experience about how to come up with the set of
7 regulation that can be used for this non-light water
8 reactor.
9 And as Mary indicated, we were proceeding.
10 We are going to do either using Part 50 or if we have
11 this information available at that time we could have
12 used it.
13
14 MR. BANERJEE: But if you apply Part 50 in
15 the regulations as they stand, does that lead to a
16 very conservative design or is it -- I'm trying to
17 understand.
18 MR. ELTAWILA: No, you can still if you
19 have a peer -- you don't have to be a conservative
20 designer. You can be a best estimate and you can be
21 risk informed, you know. We have all of the
22 technology that we can apply for existing regulation.
23 For example, the Exelon or PBMR right now
24 have proposed a risk based approach to identifying the
25 design basis requirement for the plant, and we can

1 look at an approach like that and from that define
2 what belonged to the design basis and what belonged to
3 beyond design basis. You don't have to be
4 conservative. You have to apply if you have best
5 estimate methodology and you PRA, you can come with a
6 realistic requirement.
7 MR. BANERJEE: Within the current
8 regulations.
9 MR. APOSTOLAKIS: But, Sanjoy, one of the
10 criticisms that a lot of people have raised over the
11 years is regulatory instability, inconsistencies, and
12 all sorts of things.
13 When in doubt, blame he NRC.
14 (Laughter>0
15 MR. APOSTOLAKIS: So here is the stuff
16 coming back saying, you know, not in response to that
17 in particular, but saying, "Look. We have this new
18 generation of designs that may come. How can we have
19 a self-consistent framework? And also it's a matter
20 of resources. I mean, if you develop a set of
21 regulations for the PBMR and something else for their
22 gas cooled fast reactor or something else and
23 something else, then they don't come in. What do you
24 do?
25 They are under pressure from the Senate to

1 be ready.

2 MR. BANERJEE: But the question I am

3 asking: do you need to develop a new set of design

4 specific regulations or are the current regulations

5 sufficient and interpretation of these is what's

6 needed.

7 MS. DROUIN: Well, I think you missed --

8 Farouk hit on a very key thing, and if you go back,

9 you know when this was started, the thinking about

10 this in 2002 and there were several things that

11 happened at that time. We had the sense from industry

12 that they were going to be not just one but a lot of

13 applications coming in for these advanced non-light

14 water reactors, not just one, and that it was going to

15 happen on a fairly short time frame.

16 At the same time that was giving us that

17 indication, NEI came in with IO-202 also supporting

18 that, and so when you look at that, you know, like we

19 said, you can't do it under Part 50, but if you have

20 multiple applications coming in, you're doing it on a

21 case-by-case basis, and you quickly will go into an

22 unstable, inconsistent because you're having to

23 revisit each time the application comes in. Each one

24 is open to litigation on an individual basis.

25 So it was trying to get to those key

1 things of predictability, instability, and when you're
2 having to revisit for each application each time and
3 each time you're open to litigation, then you haven't
4 achieved that.
5 Now, would you want to go down that path
6 if it was just one application coming in? But at the
7 time the sense was that it was going to be numerous.
8 MR. KRESS: And, Sanjoy, be realistic. To
9 license one of these things under the current Part 50,
10 you have to make substantial revisions. You have to
11 have a whole new set of design basis accidents and
12 ways to evaluate them and figures of merit, and you
13 have to go though and figure out which don't apply and
14 get the exemptions from them. It's a major revision
15 to those. It's not just a simple --
16 CHAIRMAN SHACK: But, I mean, it's an ad
17 hoc thing. I mean you make these --
18 MS. DROUIN: That's the point.
19 CHAIRMAN SHACK: They make them over
20 again. There's always the completeness issue. I
21 mean, these regulations were really developed with a
22 light water reactor in mind and, you know, maybe it's
23 complete; maybe it isn't, but I think there's a
24 substantial reason to --
25 MR. BANERJEE: I think you've answered my

1 question.

2 MR. ELTAWILA: I think the current

3 regulation is developed for light water reactor, but

4 Mary always reminds that most of regulation is

5 technology neutral unless you got to Part 50 and 5046

6 and become technology specific. So if you used the

7 exemption process I really don't think we're going --

8 I'm not advocating that we're not going to be far off.

9 It has been done in the past, and you can achieve the

10 consistency that you want, and you can achieve a

11 realistic assessment, you know.

12 So I don't think it is as bleak as that we

13 are trying to portray it here.

14 CHAIRMAN SHACK: Well, especially under

15 Part 52 where you are going to produce a PRA.

16 MR. ELTAWILA: A PRA, that's correct,

17 yeah.

18 MS. DROUIN: That's right, and as I said

19 yesterday, the real challenge and I thought I

20 reiterated today was not the technology neutral

21 aspect. The real challenge in all of this was making

22 it -- and I'm going back to the new word we've coined

23 -- risk derived. You know, that to me is the real

24 decision on the table. Are we trying to go, you know,

25 take the NRC regulatory structure to that next step?

1 And if the answer is no, now a lot of
2 people will probably shoot me here, but if the answer
3 is no, then there is no point in proceeding with this
4 framework because the heart and soul of the framework
5 is creating this new risk derived thing, using
6 Graham's words of, yes, they're going into the new
7 era.
8 We're not prepared to go to that.
9 MR. WALLIS: Let me ask you something
10 else, too. I think you ought to have another motive,
11 which is not only to be able to handle to this new
12 area, but be able to handle it more effectively,
13 efficiently, and maybe have simpler regulations
14 because these regulations have been stacked on top of
15 each other over the years.
16 And if you took a new look at it, you
17 might decide you don't have to have DBAs and you don't
18 have to have this and that. You can do it in a better
19 way.
20 MS. DROUIN: I don't disagree, but if
21 that's what you wanted, if that was the goal, then I
22 would never develop this framework this way.
23 MR. WALLIS: No, you wouldn't. You'd do
24 a better one.
25 (Laughter.)

1 MS. DROUIN: Of course, it would always be
2 better, but the approach would have been quite
3 different if that's what I was trying to achieve.
4 MR. WALLIS: But you've carried along a
5 lot of the baggage of the old regulations.
6 MR. ELTAWILA: But the bottom line, if you
7 want to hear what is the staff recommendation, is that
8 what's important as Eileen indicated, we are going to
9 be informed with the information, the public comments,
10 and we are going to make our recommendation to the
11 Commission based on the staff assessment, ACRS views,
12 and that, you know, the public comment.
13 The bottom line, and I think if you read
14 through all these comments, and Mary, correct me --
15 read them more than me -- is that the bottom line,
16 it's much sure to go and for a technology neutral
17 framework, spend some time trying to get some
18 experience behind applying that methodology for non-
19 light water reactor and then at that time decide
20 whether you want to go to rulemaking or not. That's
21 the bottom line. So it's not, again, set completely
22 or --
23 MS. DROUIN: That's correct. That's
24 correct.
25 MR. APOSTOLAKIS: Graham, they are only

1 publishing a NUREG. In the meeting we had yesterday
2 and today, they raised some of the issues that depart
3 from the current way of doing business. By the time
4 the rulemaking process begins, that may be all these
5 ideas will be folded into it.
6 So I see this as a good first step that
7 says here is a way of developing a technology neutral
8 framework. Then all sorts of ideas will come up and
9 say, you know, you're really following this whole
10 thinking of such-and-such. So maybe we should
11 consider.
12 So ultimately there will be a sound
13 approach in my view. This is not the end. By far
14 it's not the end. So we are in the process, but at
15 least we have something now that is specific and we
16 can comment on it.
17 MR. WALLIS: I think you have to have a
18 sales pitch, too. You have to have a sales pitch
19 which says there's a new set of framework. We'll do
20 this, this, and this, which are very big advantages
21 over the present system. You have to have some
22 measure of advantage and success and some motivation
23 for adopting it which can sell it to the Commission
24 and the industry and the public. And I haven't really
25 seen that. It's all a kind of vague promise that

1 somehow this is going to be good.

2 Not that I don't think it is good. I just

3 think you haven't got that document, that sales pitch.

4 MR. BANERJEE: Until a concrete case comes

5 up that will be very difficult.

6 MR. APOSTOLAKIS: But the problem, Sanjoy,

7 is that when the concrete case comes up, the

8 applicants will not even want to hear about this.

9 MR. WALLIS: That's right. They just want

10 to know do we win or not.

11 MR. APOSTOLAKIS: I don't want to suffer

12 through this. Let's go with Part 50, and here is a

13 list of 3,000 exemptions that we would like to see.

14 MR. ELTAWILA: But that's not what we are

15 doing. But that's not what we are doing. For

16 example, under PPMR, they are developing a technology

17 specific risk informed type of regulatory framework

18 that we can license the plant on, and we're working on

19 that one.

20 Also under our cooperation with Department

21 of Energy on the NGNP as John indicated, we are going

22 to be developing an option for the Commission that

23 part of that option will be a risk informed framework

24 for licensing an NGNP.

25 The same thing will happen with the GNEP

1 global nuclear energy partnership. There will be
2 efforts underway again to be risk informed. So all of
3 these things, and once we --
4 MR. BANERJEE: What parts of GNAP are you
5 including?
6 MR. ELTAWILA: This is the debate that's
7 going on, and I don't want to get into the details of
8 that because that's is NMSS' responsibility, but GNEP
9 is because of the debate right now whether we focus on
10 the advanced burner reactor or you focus on the whole
11 process itself, from the recycling to the burner, to
12 the processing and so on, the chemical separation.
13 MR. CORRADINI: So can I repeat what you
14 said to us, Farouk, a bit differently? And that is
15 that you are planning to test portions of the
16 framework relative to the PBMR as the white paper
17 thing, and you're thinking of testing portions of the
18 framework relative to the NGNP and beyond, depending
19 on what things start coming up that you have to or
20 that the staff has to consider.
21 MR. ELTAWILA: To insure, I think that is
22 right, but to insure also to address Dr. Power's
23 question, to insure that they are consistent, we did
24 not leave any holes.
25 So the framework will inform our decision

1 or our review process of this proposed approach.

2 MR. BANERJEE: The framework will

3 encompass separation plants as well as reactors?

4 MR. ELTAWILA: Again, you're talking about

5 GNEP.

6 MR. BANERJEE: yes.

7 MR. ELTAWILA: We're really at the very,

8 very initial stage right now of discussing. There

9 will be a commission paper going very soon to provide

10 different option for the Commission.

11 MR. CORRADINI: It's not even clear that

12 there will be a GNEP.

13 MR. ELTAWILA: Yeah, so it's very early.

14 But the point here is that we have at least two

15 applications right now that we can test this approach,

16 the NGNP and PPMR.

17 MR. MAYNARD: Well, I think what has been

18 done is good, and I think this is a necessary process.

19 I also believe that some of the comments made by the

20 members yesterday -- and we'll probably talk about it

21 again -- would be some good enhancements to the

22 process.

23 I'm a little uncomfortable with just

24 saying this is enough for now or we're just going to

25 put this as a guide because if we don't start on

1 rulemaking some time soon, if anybody does come up
2 with an application, then we are really pretty much
3 going to be tied to the existing regulations using
4 this process for exemptions because you're not going
5 to put a new rule in that's going to cover
6 certification within the time frame that a new
7 proposal is going to come in to be reviewed.
8 So we've either got to start on something
9 fairly soon or we've got to say that this process is
10 just going to be used for exemptions to the existing
11 process.
12 MR. BONACA: One point I would like to
13 make. Why would you believe that somebody would come
14 in and say just license under Part 50? I mean,
15 they're all coming in with PRA. They're all using PRA
16 to do reasonably one way something similar to what
17 we've done under this program, I mean, and they are
18 going to identify sequences based on PRA. That's what
19 they're doing.
20 And so, you know --
21 MR. CORRADINI: Well, I guess -- can I
22 just try an example at you? Let's just take the NGNP.
23 So DOE is the applicant then. So in comes DOE, right?
24 I think they're the applicant. They might be.
25 No? Then who is the applicant for --

1 MR. ELTAWILA: We don't know yet.

2 MR. CORRADINI: Okay. So somebody is the
3 applicant, yet to be determined, potentially between
4 Areva, Westinghouse, and I can't remember the other
5 grouping, GA, and they'll come in and they'll say,
6 "Okay. If it's going to be under Part 50, we're going
7 to run the PRA, but we're going to take what we know
8 to be the case at Fort St. Vrain. Here are the set of
9 DBAs that were at Fort St. Vrain. It's an indirect
10 cycle. So there's no steam potentially put ingress
11 into the core, but there may be other water ingress
12 accidents.

13 We're going to come up with a set of
14 potential accident scenarios, and we're going to do
15 the PRA, and we'll show you all of the bad stuff that
16 we don't want to consider and don't have a containment
17 or so low that they're over here, right?

18 Then the staff is still going to have to
19 go through the same sort of analysis with that PRA and
20 that set of accidents and argue through this and
21 decide potentially using this framework, what they
22 calculate to be these things, and if all of these
23 things over here on the right-hand side start drifting
24 to the left and they have to be considered as part of
25 the DBA.

1 So that's when you said test. I felt good
2 because if they're truly going to test it with this,
3 at least they're moving down a path. I guess that was
4 my interpretation of what.
5 MR. WALLIS: How about this division of
6 new reactors or whatever it is called? They're going
7 to do something, aren't they, all of those people?
8 They need tools in order to do something. Do they
9 need this tool?
10 MR. ELTAWILA: The Office of New Reactor?
11 MR. WALLIS: New Reactor.
12 MR. ELTAWILA: These all are live water
13 reactors, Graham. The office are all for live water
14 reactors, and the --
15 MR. WALLIS: The regulations?
16 MR. ELTAWILA: I'm sorry?
17 MR. WALLIS: They're just going to use
18 existing regulations?
19 MR. ELTAWILA: Existing Part 52 that's
20 applied to them. Yeah, that's correct.
21 MR. APOSTOLAKIS: But wait a minute now.
22 I mean, they must use existing regulations. It's not
23 their choice. They must, and PRA and existing
24 regulations play a supporting role.
25 MR. WALLIS: Well, are they crying?

1 They're not crying for this thing then.

2 MR. APOSTOLAKIS: I don't know what they

3 want.

4 MS. DROUIN: This program was never meant

5 to support the current light water reactors, even the

6 advanced light --

7 MR. WALLIS: Will support something more

8 in the future?

9 MS. DROUIN: But I don't know of -- yes.

10 MR. MAYNARD: I suspect this started

11 primarily because of PMBR, and with the emphasis that

12 a few years ago it was getting and the sales pitch

13 that there's going to be a bunch of these coming --

14 MS. DROUIN: That's exactly right.

15 MR. MAYNARD: -- it's a new technology,

16 and how are we going to license it?

17 That has kind of fallen off, but this

18 question still comes in, is if there's a new

19 technology that comes forward, how would the NRC

20 proceed with licensing and certifying that new design?

21 What would be the staff's recommendation

22 right now if one came in? Is it to be licensed under

23 the existing regulations?

24 MR. APOSTOLAKIS: Sure, yes.

25 MS. DROUIN: Absolutely.

1 MS. McKENNA: I think part of it that was
2 mentioned earlier is the time frame. If somebody
3 tomorrow dropped an application on our desk, we would
4 be using the Part 50 requirements and do the best we
5 can.
6 If somebody tells us in five years I'm
7 going to send you a gas cooled application that looks
8 something like this, then the agency would have to
9 decide am I going to spend the effort now to try to
10 come up with some new requirements so that when I get
11 that application I'll be able to handle it in a more
12 straightforward manner or am I going to say, well, no,
13 I'll just sit back and wait till the application comes
14 and I'll do my best with Part 50.
15 It somewhat goes to the question of, well,
16 if there's one of these that's coming in, is it worth
17 writing a whole new set of requirements for this one
18 design versus we're going to get six different kinds
19 of gas cooled reactors, and maybe we want to spend
20 some effort to figure out, at least migrate ourselves
21 a little bit away from light water to some other form.
22 And this is why it's a real challenge for
23 us, because of the timing. Yes, we know it takes a
24 finite -- you know, we talked yesterday of how many
25 years it would take to get from A to B, and you kind

1 of like do you spend your resources now on the
2 presumption that somebody might come or do you wait a
3 little longer and see who comes and then spend them
4 and then are you in time?
5 And those are the challenges we've been
6 wrestling with for the last year.
7 MS. DROUIN: And that's, you know, what we
8 said, that back in 2002 it looked like it was going to
9 be multiple. It didn't look like it was just one. It
10 looked like it was multiple.
11 MR. APOSTOLAKIS: But, Mary, isn't the
12 only place where you really depart from existing
13 regulation the choice of the LBEs? You really do
14 something new there. Everywhere else you're using
15 difference in depth. You're using the protective
16 strategies. We're doing a lot of that stuff, most of
17 it.
18 MS. DROUIN: Well, I think the protective
19 strategies is a departure, not a huge departure, but
20 I do think it's a departure, but the big departure is
21 the risk part, and that's what I've said all along.
22 MR. APOSTOLAKIS: But I mean the choice of
23 the licensing basis events is really something new.
24 MS. DROUIN: Right. That's the risk part,
25 yes.

1 MR. APOSTOLAKIS: Because, you know,
2 everything else you can go to the existing
3 regulations. In fact, even in your FC curve, you go
4 through pains to show that you chose this because it's
5 in the EPA or the --
6 MS. DROUIN: But the point is you're
7 choose, you know, those events. We are not
8 predescribing those DBAs.
9 MR. APOSTOLAKIS: No.
10 MS. DROUIN: We're using the PRA to help
11 decide what those are.
12 MR. APOSTOLAKIS: And that's what I'm
13 saying.
14 MS. DROUIN: That's a fundamental
15 departure.
16 MS. DROUIN: It's a fundamental departure.
17 Everything else exists already.
18 MR. WALLIS: The measure of success is
19 still vague because you don't have that cumulative
20 probability curve.
21 MR. APOSTOLAKIS: No, but that's a detail.
22 MR. ABDEL-KHALIK: If no one comes up with
23 a non-LWR design in the next 50 years, would
24 proceeding with development of a new regulatory
25 framework based on this framework be a worthwhile

1 thing to do for LWRs?

2 MR. CORRADINI: If there were nothing but

3 those.

4 MR. ABDEL-KHALIK: Correct. If we were to

5 take these ideas and proceed to develop a Part 53,

6 knowing that nothing will come up before the

7 Commission other than LWRs. There might be

8 evolutionaries, slight variation.

9 MR. CORRADINI: Well, which LWRs?

10 MR. ABDEL-KHALIK: Would that be a

11 worthwhile exercise?

12 MS. DROUIN: I would say no.

13 MR. CORRADINI: I had a feeling that was

14 going to be --

15 MS. DROUIN: And the reason that I would

16 say no is that I think that you don't have to go and

17 create a new Part 53 to take advantage of a lot of the

18 concepts in the framework for current LWRs. I think

19 you can use those concepts with a lot of the current

20 Part 50 there by going in and changing a lot of the

21 regulatory guidance, not the rules in and of

22 themselves. I don't think you need to go create this

23 whole new regulatory structure.

24 And so to me when I talk about a Part 53,

25 that's what we were talking about, a whole new body.

1 I don't think you need to do that. I do think you can
2 take advantage and fix some things in the current Part
3 50, not fix, but revise to take advantage of stuff
4 that's in the framework, but I would not personally
5 say go create this whole new Part 53.
6 MR. BANERJEE: This would be an
7 alternative methodology?
8 MS. DROUIN: That's my personal opinion.
9 I want to really make sure that that's personal.
10 MR. BANERJEE: But would this be an
11 alternative methodology?
12 MR. CORRADINI: Or an alternative opinion
13 from the staff?
14 MS. McKENNA: One of the reasons we call
15 it Part 53 was to separate, say we were to leave
16 existing Part 50 alone and remake a new part.
17 MS. DROUIN: That's right.
18 MS. McKENNA: So it could be there as an
19 alternative as opposed to saying we're going to
20 replace Part 50 with some new set of requirements
21 which then causes a problem because we have plants
22 that are already licensed as one set of requirements
23 and we want them to remain.MR. ABDEL-KHALIK: I mean,
24 the question is whether this new Part 53 would be so
25 clearly defined and so well streamlined that anybody

1 coming up for licensing would opt to follow that route
2 other than, you know, following this hodge-podge
3 process that evolved over the past 50 years.
4 MR. WALLIS: May starts off with this
5 great objective, and then she puts in all the stuff
6 which looks like what we do today. That doesn't mean
7 to say that the amount of work is going to decrease or
8 anything.
9 So what's the advantage?
10 MS. DROUIN: Well, I don't agree that
11 we've totally taken everything we do today. I don't
12 agree with that statement.
13 MR. WALLIS: You've taken an awful lot of
14 stuff just like what we do today.
15 MR. CORRADINI: In fact, you could just,
16 I mean, take Graham's point and Said's point and push
17 it harder and push it harder and say remember that
18 when I asked you yesterday after where did you test
19 this, and you said, "Oh, we test it with the current
20 LWR."
21 Okay. It seems to me that if I did that,
22 then I tested with an ALWR, and I provided that you
23 found some things that make it better or different,
24 and you would change what you would consider.
25 You could push the point even harder and

say, "Well, now I have a known quantity. I have a known technology" -- at least he thinks it's known enough -- "that I can do the analysis of the SC curve and actually get some efficiencies on how you do the whole licensing," which is what I think Said's point was.

And now you're actually dealing with an animal that you know versus the animal you don't know, which of all things worries me most about the neutral framework relative to these new plants where I'm not sure about the numbers.

MS. DROUIN: Right, and as I said, when we did test it against a known LWR we did find some things. You know, that plant against which we tested would have been licensed a little bit differently, and in my opinion now you have to understand that the plants are safe. Under this new process if it had been licensed, we'd be safer? I think so. To me the answer would be yes. If we had imposed a few more things on them, that would have made them safer.

Now, they would have been able to relax some things that I don't think would have degraded the safety. It was getting rid of things that didn't need to be done, and it would have imposed things that would have made it safer.

1 MR. APOSTOLAKIS: If it is that we only
2 get LWR, this frame work would revise or replace in
3 some meaningful way the existing 5046?
4 I mean, we're trying to risk inform it as
5 a rule.
6 MS. DROUIN: Yes, it would.
7 MR. APOSTOLAKIS: It would.
8 MS. DROUIN: Yes, it would.
9 MR. APOSTOLAKIS: It would.
10 MS. DROUIN: Yes.
11 MR. APOSTOLAKIS: And it would in a manner
12 that would be consistent with the result of the
13 regulations.
14 MS. DROUIN: But do you need to create
15 this whole new Part 53 to do that?
16 MR. APOSTOLAKIS: Well, I don't know
17 because now we are focusing -- I mean every time we
18 look there is a whole list of other regulations that
19 are affected by changing this, and we have to make
20 sure that there is consistency and so on. This one
21 presumably would guarantee that consistency.
22 So there are benefit so this.
23 MS. DROUIN: I don't disagree there's
24 benefits. I'm just coming from a gut feel for what
25 would be the resources to go and create -- you know,

1 let's just say we're never going to deal with anything
2 but LWRs.
3 MR. CORRADINI: But you don't have a night
4 job, do you? Sorry.
5 (Laughter.)
6 MR. CORRADINI: Sorry. That was uncalled
7 for. I apologize.
8 MS. DROUIN: But John.
9 MR. WALLIS: Well, I would like to see a
10 comparison between what we do today and what you are
11 having. Your design and your design, the new design
12 saves half of the work for the utility, saves 50
13 percent or 90 percent of the work for the government,
14 you know, gives better measures of things, focused
15 more on things that really matter. It increases
16 public safety, it does all of these things. It has
17 certain ways in which it's better than what we do
18 today.
19 That would really he,p me a lot. What's
20 the payoff for adopting it?
21 MR. ABDEL-KHALIK: Regardless of the --
22 MR. WALLIS: Regardless of the technology.
23 MR. BANERJEE: Reduces the number of ACRS
24 meetings.
25 MR. WALLIS: Reduces there, increases our

1 pay because we're more efficient in things like that.
2 You have to do that.
3 MS. DROUIN: Well, I think we have done
4 that. You know, we may not have expressed it or
5 talked about it in detail to the ACRS, but you know,
6 we've gone through that.
7 MR. WALLIS: Well, it seems to have the
8 same number of DBAs and the same amount of work, and
9 it has all the same requirements as far as I can make
10 out. Defense in depth looks much the same as it did
11 before. So what's different?
12 MS. DROUIN: Oh, I don't think defense in
13 depth looks at all because right now you don't know
14 what defense in depth is. There's no definition of
15 defense in depth.
16 MR. ABDEL-KHALIK: There you have it.
17 This framework has clarified something that --
18 MR. APOSTOLAKIS: One, one, seven, four
19 hasn't --
20 MS. DROUIN: You've got to be careful. We
21 have said that, you know, we have defense in depth,
22 but we can't come in and precisely say what it is.
23 What we say in 1.174, that if you do these things
24 you're going to grade defense in depth, whatever that
25 is, but you can't go and precisely say that these are

1 the things that are what defense in depth is.

2 MR. APOSTOLAKIS: In the discussion there

3 are six bullets.

4 MS. DROUIN: I know, the six principles.

5 MR. KRESS: I think Mary is right.

6 MS. DROUIN: And if you go back to one of

7 the things that --

8 MR. APOSTOLAKIS: I think there are too

9 many hypotheticals right now. So why don't we go on?

10 MS. DROUIN: Well, I'm there.

11 (Laughter.)

12 MS. DROUIN: Sorry.

13 MR. APOSTOLAKIS: The thing that worries

14 me though is how you're going to present to the

15 commission what you learned from this exercise with

16 the stakeholders. That would be very crucial. You

17 know, the words you're using and so on because --

18 MR. MONNINGER: We have a May paper due to

19 the Commission on this and we have another, at least

20 one more meeting with the ACRS to present that paper.

21 So at this stage, you know, we store digesting,

22 evaluating, strategizing on our plan four, but we do

23 owe that paper to the Commission, and we are scheduled

24 to brief ACRS on that paper.

25 MR. APOSTOLAKIS: So you will brief us at

1 the May meeting?

2 MR. MONNINGER: Yes.

3 MS. DROUIN: Right. That's if you look at

4 the last slide, but we do plan -- Eileen plans to come

5 back, and I get to sit over there.

6 MR. APOSTOLAKIS: So at the end of May

7 that it is due?

8 MS. DROUIN: Yes.

9 MR. APOSTOLAKIS: So if we make any

10 comments then, they are not really going to be --

11 MR. WALLIS: So you're going to publish

12 this thing and recommend that no more work be done and

13 the rulemaking not be pursued. So you're essentially

14 saying stop work.

15 MR. ELTAWILA: The rulemaking is deferred

16 until we learn something from the application of the

17 approach to non-light water reactor. It's not not

18 pursued; deferred. Because I think the question the

19 Commission asked us, should we go for rulemaking at

20 this time, and we were recommending to defer any

21 rulemaking on the technology neutral framework.

22 MR. APOSTOLAKIS: Is there any way we can

23 see what you plan to send to the Commission at a

24 subcommittee meeting before the May 4 committee

25 meeting so you will have a chance to respond to any

1 possible comments?

2 MS. McKENNA: Well, and I think we are

3 trying to give you a little preview of where we think

4 we're headed now in terms of this is the kind of

5 recommendation that we're moving to in terms of

6 deferring the rulemaking. So the paper will be

7 speaking to, okay, we had the ANPR. We got the

8 comments, there will be some summary or analysis of

9 the comments. Then there would be and this is the

10 staff recommendation and why we're making this

11 recommendation, that we will learn things from the

12 pebble bed and see how the NPNG goes and that we don't

13 see the need to launch into rulemaking right now, that

14 we're kind of reserving that recommendation until we

15 have a little more information.

16 And so that's the kind of paper that we

17 would expect.

18 MR. WALLIS: Well, if you write down these

19 two green things, my indication is to say, "Well, I

20 don't need to worry about this. I mean, here's a

21 NUREG and it's out there and nothing is going to

22 happen. So why should I do anything?"

23 MR. APOSTOLAKIS: Why don't you actually

24 say or recommend to try this framework on the white

25 papers of the PBMR that you have? That would keep the

1 effort going, giving you valuable experience.

2 The statement, all activities to be

3 terminated, is terrible.

4 MR. ELTAWILA: I think the word

5 "terminated" is definitely a strong word. I think

6 Mary in her verbal discussion said the technology

7 neutral framework completed and cannot be advanced any

8 further than that. What we are right now, we are in

9 the application or exercising of the approach, of the

10 framework. So we don't have any additional technology

11 neutral framework, development work to be done.

12 MR. WALLIS: Well, it may surprise you.

13 I sometimes work with industry on new products, you

14 know, and when we develop some new thing, we do a lot

15 of research and we look at all of the engineering.

16 You have to make a decision. Are you going to go from

17 that stage to develop an actual thing you put in your

18 factory and make things?

19 And when you have a statement like this,

20 it indicates to me you're killing a project. Is that

21 really what you want to do?

22 MS. DROUIN: Go ahead, John.

23 MR. MONNINGER: I mean, the notion was,

24 you know, the notion is to take what we have learned

25 with this and to see how with some of the more

1 concrete specific designs out there how can we advance
2 these concepts.
3 The notion was the staff has worked on
4 this; we have worked on this for several years, and
5 it's still very conceptual. So that was our belief,
6 not knowing exactly what the Commission wanted, but
7 our belief that the Commission wanted to advance some
8 of the conceptual concepts, move it into potential
9 rulemaking, and really flush this thing out.
10 And our hope is to really flush this thing
11 out, you work through some pilot designs,
12 applications, et cetera, as opposed to continuing to
13 work in the conceptual framework. I mean, we've been
14 working the conceptual piece for three, four years,
15 and now it's time, you know.
16 MR. KRESS: But that was for activities
17 related to the framework.
18 MR. WALLIS: The conceptual frame doesn't
19 get you a design. You have to then look at the
20 advantages and disadvantages of how you implement it,
21 and that's the next step, and you're just saying stop
22 that.
23 MS. DROUIN: Right, and remember that
24 yesterday I tried to explain that the word "framework"
25 here means NUREG 1860. That's all it means.

1 MR. APOSTOLAKIS: I would eliminate that
2 and say the next step is to look at the PBMR white
3 papers and experience with NG --
4 MR. WALLIS: Right, and see if it works,
5 see how it works.
6 MR. APOSTOLAKIS: Yeah. I mean right now
7 the best opportunity you have to exercise this is
8 these whit papers, right?
9 MS. DROUIN: Yes.
10 MR. APOSTOLAKIS: Because you have nothing
11 on the NGNP. So put that the first sub-bullet and
12 then say that further experience will be gained with
13 NGNP and GNEP.
14 MS. DROUIN: And it's my understanding
15 that that will be in the paper.
16 MR. APOSTOLAKIS: But the first sub-
17 bullet --
18 MS. DROUIN: Exactly how it will be I'm
19 not real sure.
20 MR. APOSTOLAKIS: The first sub-bullet
21 really should not be there.
22 MR. WALLIS: You put the bullet there
23 hoping we'd disagree with it, didn't you?
24 (Laughter.)
25 MR. KRESS: I think it's a face saving

1 clause.

2 MR. APOSTOLAKIS: What is face saving?

3 MR. KRESS: That terminology. I'm not

4 going to say any more than that.

5 MS. DROUIN: But, you know, we've tried to

6 clarify what we mean by that, you know. The NUREG

7 1860, you know, we're publishing it, you know, and a

8 we, you know, try this out with these white papers and

9 everything, you know, we may come back at some time

10 and say, you know, does it make sense maybe to update

11 it.

12 But right now, you know, we don't see that

13 because it is a conceptual document. The details of

14 it would not show up in the framework. That would

15 show up in a different document. So it's not that you

16 aren't going to try and apply or understand further

17 the details of how they would work, but I don't think

18 that the details of it -- in my mind they would not

19 show up in this document. It wouldn't be the right

20 place for it.

21 MR. ABDEL-KHALIK: But wouldn't it be a

22 better statement to replace that first statement by

23 saying that the concepts outlined in the framework

24 will be test piloted against the white paper

25 application for the PPMR --

1 MS. DROUIN: We agree we could have --

2 MR. ABDEL-KHALIK: -- as your first

3 statement? And that means that --

4 MS. DROUIN: We could have written the

5 statement better.

6 MR. ELTAWILA: I think we could have.

7 Yeah, Mary is right.

8 MS. DROUIN: We could have written it

9 better.

10 MR. APOSTOLAKIS: Good.

11 MR. BONACA: Now, framework is a

12 structure. So is this a structuralist approach or --

13 (Laughter.)

14 MR. CORRADINI: Is that an insider joke?

15 MR. POWERS: A structuralist report.

16 We'll lose our status if it's not structuralist.

17 MS. DROUIN: And that puts the fear of God

18 in me, Dana. I can't lose my status with you.

19 MR. KRESS: I think this is a good spot to

20 turn it back to you.

21 CHAIRMAN SHACK: Has everybody made their

22 comments?

23 MR. KRESS: I think we're happy. We made

24 a lot yesterday.

25 CHAIRMAN SHACK: Yes.

1 MR. KRESS: And I think staff knows how we
2 feel about it all, and so the meeting is turned back
3 to you, Mr. Chairman.
4 CHAIRMAN SHACK: Well, thank you, Mary,
5 for another excellent presentation and for putting up
6 with us again for two days in a row.
7 And we'll go off the record now. That
8 will be the last thing we need to do.
9 (Whereupon, at 5:08 p.m., the meeting in
10 the above-entitled matter was concluded.)
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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: Advisory Committee on Reactor Safeguards 540th Meeting

Docket Number: n/a

Location: Rockville, MD

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

Charles Morrison
Official Reporter
Neal R. Gross & Co., Inc.

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

15.0 INTRODUCTION—TRANSIENT AND ACCIDENT ANALYSES

REVIEW RESPONSIBILITIES

Primary - Organizations responsible for review of transient and accident analyses

Secondary - None

The evaluation of the safety of a nuclear power plant requires analyses of the plant's responses to postulated equipment failures or malfunctions. Such analyses help to determine the limiting conditions for operation, limiting safety system settings, and design specifications for safety-related components and systems to protect public health and safety. These analyses are a focal point of the license amendment request (LAR), design certification (DC), and combined license (COL) reviews.

I. AREAS OF REVIEW

The specific areas of review are as follows:

1. Categorization of Transients and Accidents

   The reviewer ensures that the applicant's selection and assembly of the plant transient and accident analyses represent a sufficiently broad spectrum of transients and accidents, or

USNRC STANDARD REVIEW PLAN

This Standard Review Plan, NUREG-0800, has been prepared to establish criteria that the U.S. Nuclear Regulatory Commission staff responsible for the review of applications to construct and operate nuclear power plants intends to use in evaluating whether an applicant/licensee meets the NRC's regulations. The Standard Review Plan is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide an acceptable method of complying with the NRC regulations.

The standard review plan sections are numbered in accordance with corresponding sections in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants (LWR Edition)." Not all sections of Regulatory Guide 1.70 have a corresponding review plan section. The SRP sections applicable to a combined license application for a new light-water reactor (LWR) are based on Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

These documents are made available to the public as part of the NRC's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Individual sections of NUREG-0800 will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience. Comments may be submitted electronically by email to NRR_SRP@nrc.gov.

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initiating events.

Initiating events are categorized according to expected frequency of occurrence and by type. Categorization by frequency of occurrence provides a basis for selection of the applicable analysis acceptance criteria for each initiating event. Categorization of initiating events by type provides a basis for comparison between events, which makes it possible to identify and evaluate the limiting cases (i.e., the cases that can challenge the analysis acceptance criteria).

A. Categorization According to Frequency of Occurrence

Each initiating event is categorized as either an anticipated operational occurrence (AOO) or as a postulated accident.

AOOs, as defined in Appendix A to 10 CFR Part 50 (Ref. 1), are those conditions of normal operation that are expected to occur one or more times during the life of the nuclear power unit.

The SRP uses the term AOOs to refer to the events that are categorized in Regulatory Guide 1.70 (Ref. 2) and in Regulatory Guide 1.206 (Ref. 3) as incidents of moderate frequency (i.e., events that are expected to occur several times during the plant's lifetime) and infrequent events (i.e., events that may occur during the lifetime of the plant).

Incidents of moderate frequency and infrequent events are also known as Condition II and Condition III events, respectively, in the commonly used, oft-cited but unofficial American Nuclear Society (ANS) standards (Refs. 4 and 5). The reviewer will continue to evaluate applications, according to the categorizations and acceptance criteria of References 4 and 5, for licensees that have these categorizations in their licensing bases~~. For these licensees, the reviewer will also examine applications~~, *or if they wish,* according to the categorizations and acceptance criteria of this SRP section~~ for initiating events that are designated as AOOs, as defined here~~. The reviewer will evaluate new applications (i.e., those pertaining to plants that are not yet constructed) according to the categorizations and acceptance criteria of this SRP section.

The following are some examples of AOOs in pressurized-water reactor (PWR) and boiling-water reactor (BWR) designs:

- Inadvertent control rod or rod group withdrawal (PWR and BWR)
- Loss or interruption of core coolant flow, excluding reactor coolant pump locked rotor (PWR)
- Inadvertent moderator cooldown (PWR and BWR)

- Inadvertent chemical shim dilution (PWR)
- Depressurization by spurious operation of an active element, such as a relief valve (PWR and BWR)
- Blowdown of reactor coolant through a safety valve (PWR and BWR)
- Loss of normal feedwater (PWR and BWR)
- Loss of condenser cooling (PWR and BWR)
- Steam generator tube leaks (PWR)
- Reactor-turbine load mismatch, including loss of load and turbine trip (PWR and BWR)
- Control rod drop (inadvertent addition of absorber) (PWR)
- Single error of an operator (PWR and BWR)
- Single failure of a control component (PWR and BWR)
- Single failure in the electrical system (PWR and BWR)
- Minor reactor coolant system (RCS) leak or loss of reactor coolant such as from a small ruptured pipe or from a crack in a large pipe (PWR and BWR)
- Minor secondary system break (PWR)
- Loss of offsite power (PWR and BWR)
- Operation with a fuel assembly in an improper position (PWR and BWR)
- Inadvertent blowdown of RCS (BWR)
- Loss of feedwater heating (PWR and BWR)
- Trip of any or all recirculation pumps (BWR)
- Inadvertent pump start in a hot recirculation loop (BWR)
- Condenser tube leak (BWR)
- Startup of an idle recirculation pump in a cold loop (BWR)

- Reactor overpressure with delayed scram

The individual event sections of the SRP address specific AOOs and their appropriate variations (e.g., design-specific variations).

Anticipated transients without scram (ATWSs) are AOOs in which a reactor scram is demanded but fails to occur because of a common-mode failure in the reactor scram system. ATWS events, therefore, are AOOs that postulate complete failure of the required (single-failure proof) protection system. As such, they are beyond the design basis, and consequently, ATWS events are addressed separately (see SRP Section 15.8 and Ref. 6).

Postulated accidents are unanticipated occurrences (i.e., they are postulated but not expected to occur during the life of the nuclear power plant).

Postulated accidents are also known as Condition IV events in the unofficial ANS standards (Refs. 4 and 5).

The following are some examples of postulated accidents in PWRs and BWRs of current designs:

- Major rupture of a pipe containing reactor coolant up to and including double-ended rupture of the largest pipe in the reactor coolant pressure boundary (PWR and BWR)
- Ejection of a control rod assembly (PWR)
- Control rod drop accident (BWR)
- Major secondary system pipe rupture up to and including double-ended rupture (PWR and BWR)
- Single reactor coolant pump locked rotor (PWR)
- Seizure of one recirculation pump (BWR)

The sections of the SRP dealing with the individual events address specific postulated accidents and appropriate variations (e.g., design-specific variations).

B. Categorization According to Type

AOOs and postulated accidents are also categorized according to type. The type of AOO or postulated accident is defined by its effect on the plant. For example, one type of AOO or postulated accident will cause the RCS to pressurize and possibly jeopardize RCS integrity. Another type will cause the RCS to depressurize and possibly jeopardize fuel

cladding integrity. It is useful to categorize and organize analyses of AOOs and postulated accidents according to type, so that analysts can compare them on common bases, effects, and safety limits. Such comparisons can help to identify limiting events and cases for detailed examination and eliminate nonlimiting cases from further consideration.

AOOs and postulated accidents can be grouped into the following seven types (Ref. 2):

(1) Increase in heat removal by the secondary system
(2) Decrease in heat removal by the secondary system
(3) Decrease in RCS flow rate
(4) Reactivity and power distribution anomalies
(5) Increase in reactor coolant inventory
(6) Decrease in reactor coolant inventory
(7) Radioactive release from a subsystem or component

The review of AOOs and postulated accident analyses, within a type, can (and should) encompass a variety of cases, each designed to produce effects or results that challenge designated safety limits. For example, one case study of the turbine trip event, an AOO that causes a decrease in heat removal by the secondary system, can be designed to yield a high peak RCS pressure, and another case study of the same AOO can be designed to yield a low, minimum thermal margin. The former case tests the safety limit for RCS pressure boundary integrity, while the latter case tests the safety limit that protects fuel cladding integrity.

The reviewer considers the possible case variations of AOOs and postulated accidents presented to verify that the licensee has identified the limiting cases. The reviewer evaluates licensees' claims that individual AOOs and postulated accidents are limiting or nonlimiting, or bounded by other AOOs and postulated accidents, with particular attention to the bases used for comparison. Comparison of AOOs to other AOOs within a type, for example, is easily justified. Comparison of AOOs of one type to postulated accidents of another type requires closer scrutiny and more justification from the licensee.

2. Analysis Acceptance Criteria

If the risk of an event is defined as the product of the event's frequency of occurrence and its consequences, then the design of the plant should be such that all the AOOs and postulated accidents produce about the same level of risk (i.e., the risk is approximately constant across the spectrum of AOOs and postulated accidents). This is reflected in the general design criteria (GDC), which generally prohibit relatively frequent events (AOOs) from resulting in serious consequences, but allow the relatively rare events (postulated accidents) to produce more severe consequences.

The reviewer will consider the results of licensees' analyses and evaluations of individual

initiating events to ascertain whether the licensee has satisfied the applicable analysis acceptance criteria for each of the events. The licensee may propose the use of alternate acceptance criteria appropriate to the particular plant design and operation (e.g., for new reactor design applications). In such cases, the reviewer will consider the alternate criteria and determine whether they are equivalent, in function and consequences, to the current criteria (see below).

A. Analysis Acceptance Criteria for AOOs

The following are the specific criteria necessary to meet the requirements of GDC for AOOs:

i. Pressure in the reactor coolant and main steam systems should be maintained below 110 percent of the design values in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Ref. 7).

ii. Fuel cladding integrity shall be maintained by ensuring that the minimum departure from nucleate boiling ratio (DNBR) remains above the 95/95 DNBR limit for PWRs and that the critical power ratio (CPR) remains above the minimum critical power ratio (MCPR) safety limit for BWRs.

The reviewer applies a third criterion, based on the ANS standards (Refs. 4 and 5), to ensure that there is no possibility of creating a postulated accident with the frequency of occurrence of an AOO. Some of the questions that licensees must answer to justify making plant modifications without advance review (see 10 CFR 50.59) by the NRC staff reflect this concern.

iii. An AOO should not generate a postulated accident without other faults occurring independently or result in a consequential loss of function of the RCS or reactor containment barriers.

For licensees that have the categorizations of References 4 or 5 (i.e., ANS Condition II, III, and IV events) in their licensing bases, the reviewer will apply the following acceptance criteria:

(1) Condition II events

(a) Same as Criterion 1 (above), for AOOs.

(b) Same as Criterion 2 (above), for AOOs.

(c) By itself, a Condition II incident cannot generate a more serious incident of the Condition III or IV category without

other incidents occurring independently or result in a consequential loss of function of the RCS or reactor containment barriers.

(2) Condition III events

(a) No more than a small fraction of the fuel elements in the reactor are damaged, although sufficient fuel element damage might occur to preclude resumption of operation for a considerable outage time.

(b) For PWRs, the release of radioactive material may exceed guidelines of 10 CFR Part 20, but shall not be sufficient to interrupt or restrict public use of those areas beyond the exclusion radius.

For BWRs, the offsite release of radioactive material is limited to a small fraction of the guidelines of 10 CFR Part 100, which may be the result of the failure of a small fraction of the fuel elements in the reactor.

(c) A Condition III incident shall not, by itself, generate a Condition IV fault or result in a consequential loss of function of the RCS or reactor containment barriers.

(3) Condition IV events

ANS Condition IV events are postulated accidents. The reviewer will apply the acceptance criteria for postulated accidents (below) to evaluate Condition IV events.

B. Analysis Acceptance Criteria for Postulated Accidents

Unlike an AOO, a postulated accident could result in sufficient damage to preclude resumption of plant operation. A list of the basic criteria necessary to meet the requirements of GDC for postulated accidents appears below. Individual sections of the SRP may specify additional criteria pertaining to certain postulated accidents.

i. Pressure in the RCS and main steam system should be maintained below acceptable design limits, considering potential brittle as well as ductile failures (Ref. 7).

ii. Fuel cladding integrity will be maintained if the minimum DNBR remains above the 95/95 DNBR limit for PWRs and the CPR remains above the

MCPR safety limit for BWRs. If the minimum DNBR or MCPR does not meet these limits, then the fuel is assumed to have failed.

iii. The release of radioactive material shall not result in offsite doses in excess of the guidelines of 10 CFR Part 100.

iv. ~~A postulated accident might cause sufficient damage to preclude resumption of plant operation.~~

~~v.~~ A postulated accident shall not, by itself, cause a consequential loss of required functions of systems needed to cope with the fault, including those of the RCS and the reactor containment system.

For loss-of-coolant accidents (LOCAs), the following analysis acceptance criteria of 10 CFR 50.46 also apply:

i. The calculated maximum fuel element cladding temperature shall not exceed 2200 °F.

ii. The calculated total oxidation of the cladding shall nowhere exceed 0.17 times the total cladding thickness before oxidation.

iii. The calculated total amount of hydrogen generated from the chemical reaction of the cladding with water or steam shall not exceed 0.01 times the hypothetical amount that would be generated if all of the metal in the cladding cylinders surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react.

iv. Calculated changes in core geometry shall be such that the core remains amenable to cooling.

v. After any calculated successful initial operation of the emergency core cooling system (ECCS), the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

3. Plant Characteristics Considered in the Safety Evaluation

The reviewer ensures that the application contains the key plant parameters considered in the safety evaluation (e.g., core power, core inlet temperature, reactor system pressure, core flow, axial and radial power distribution, fuel and moderator temperature coefficient, void coefficient, reactor kinetics parameters, available shutdown rod worth, and control rod insertion characteristics). The reviewer checks that the range of values for plant parameters is representative of fuel exposure or core reload, and that the range is sufficiently broad to cover the

predicted fuel cycle ranges, to the extent practicable, based on the fuel design and acceptable analytical methodology at the time of the LAR, DC, or COL application. The reviewer also ensures that the application specifies the permitted fluctuations and uncertainties associated with reactor system parameters and assumes the appropriate conditions, within the operating band, as initial conditions for transient analysis.

4. Assumed Protection System Actions

The reviewer ensures that the application lists the settings of all the protection system functions that are used (i.e., credited) in the safety evaluation. Typical protection system functions include reactor trips, isolation valve closures, and ECCS initiation. *The performance of each credited protection system is required to include the effects of the most limiting single active failure. This verifies satisfaction of the GDC criteria that require protection systems to adequately perform their intended safety functions in the presence of single active failures.* The reviewer also ascertains that the application lists the expected limiting delay time for each protection system function and describes the acceptable methodology for determining uncertainties (from the combined effects of calibration error, drift, instrumentation error, and other factors) to be included in the establishment of the trip setpoints and allowable values specified in the plant technical specifications.

5. Evaluation of Individual Initiating Events

The reviewer ensures that the application includes an evaluation of each initiating event, using the format in Subsection I.6 of this SRP section. For initiating events that are determined to be not limiting, the reviewer may evaluate qualitative justifications and conduct comparisons with the corresponding, more limiting initiating events.

6. Event Evaluation

A. Identification of Causes and Frequency Classification

For each initiating event evaluated, the reviewer ensures that the application includes a description of the occurrences that can lead to the event and a categorization of the event as either an AOO or postulated accident. The reviewer also checks for clear definitions of the analysis acceptance criteria appropriate to the specific nature of the initiating event, as well as the event's categorization.

B. Sequence of Events and Systems Operation

The reviewer verifies that the application addresses the following considerations for each initiating event:

i. Step-by-step sequence of events, from event initiation to the final stabilized condition (i.e., identification on a time scale of each significant occurrence, including flux monitor trips, insertion of control rods,

attainment of primary coolant safety valve set points, opening and closing of safety valves, generation of containment isolation signals, and containment isolation) and identification of all operator actions credited in the transient and accident analyses for consequence mitigation

ii. Extent to which normally operating plant instrumentation and controls are assumed to function

iii. Extent to which plant and reactor protection systems are required to function

iv. Credit taken for the functioning of normally operating plant systems

v. Credited operation of engineered safety systems

vi. Assurance of consistency between the safety analyses and the emergency response guidelines/emergency procedure guidelines or emergency operating procedures with respect to the operator response (including action time) and available instrumentation

The reviewer verifies that the applicant has specified only safety-related systems or components for use in mitigating transient or accident conditions, *and has included the effects of single active failures in those systems and components.* The reviewer may consider the licensee's technical justifications for the operation of nonsafety-related systems or components (e.g., when they are used as backup protection and when they are not disabled, except by a detectable, random, and independent failure).

The reviewer ascertains that the applicant has evaluated the effects of single active failures (Ref. 8) and operator errors and that the licensee's application contains sufficient detail to permit independent evaluation of the adequacy of systems, as they relate to the subject events.

C. Core, System, and Barrier Performance

i. Evaluation Model

The reviewer ensures that the applicant has discussed the evaluation model used and any simplifications or approximations introduced to perform the analyses and identified digital computer codes used in the analysis. If the analysis uses more than one computer code, the applicant should describe the method used to connect the codes. The reviewer verifies that the applicant has discussed the important output of the codes under "results" with emphasis on the input data and the extent or range of variables investigated and that the applicant has included detailed descriptions of

evaluation models and digital computer codes or listings by referencing documents that are available to the NRC.

The reviewer ensures that the applicant has provided a table listing the titles of topical reports (TRs) that describe models or computer codes used in transient and accident analyses and listed the associated NRC safety evaluation reports approving those TRs. The reviewer checks that implementations of NRC-approved models or codes are within the applicable ranges and conditions and that the applicant has demonstrated compliance with each of the conditions and limitations imposed by the NRC staff in its safety evaluation reports that approve the TRs.

ii. Input Parameters and Initial Conditions

The reviewer verifies that the applicant has (1) identified the major input parameters and initial conditions used in the analyses; (2) included the initial values of other variables and parameters in the application if they are used in the analyses of the particular event under study; (3) ensured that the parameters and initial conditions used in the analyses are suitably conservative; and (4) discussed the bases (including the degree of conservatism) used to select the numerical values of the input parameters.

iii. Results

The reviewer ensures that the applicant has presented the results of the analyses, including key parameters as a function of time during the course of the transient or accident. The following are examples of parameters that should be included:

- Neutron power
- Thermal power
- Heat fluxes, average and maximum
- RCS pressure
- DNBR or CPR, as applicable
- Core and recirculation loop coolant flow rates for BWRs
- Coolant conditions, including inlet temperature, core average temperature (for PWRs), core average steam volume fraction (for BWRs), average exit and hot channel exit temperatures, and steam volume fractions

- Temperatures, including maximum fuel centerline temperature, maximum clad temperature, or maximum fuel enthalpy
- Reactor coolant inventory, including total inventory and coolant level in various locations in the RCS
- Secondary (power conversion) system parameters, including steam flow rate, steam pressure and temperature, feedwater flow rate, feedwater temperature, and steam generator inventory
- ECCS flow rates and pressure differentials across the core, as applicable
- Containment pressure
- Relief and/or safety valve flow rate
- Flow rate from the RCS to the containment system, if applicable
- Pressurizer water volume (for PWRs)

In addition, the discussion of the results should emphasize the margins between the predicted values of various core parameters, as well as the values of those parameters that would represent limiting acceptable conditions.

II. ACCEPTANCE CRITERIA

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. 10 CFR Part 20, "Standards for Protection Against Radiation"
2. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (especially 10 CFR 50.46 and Appendix A)
3. 10 CFR Part 100, "Reactor Site Criteria"
4. 10 CFR Part 52, "Early Site Permits; Standard Design Certification; and Combined Licenses for Nuclear Power Plants"

The following GDC from Appendix A to 10 CFR Part 50 are relevant to SRP Section 15:

1. GDC 2, as it relates to the seismic design of structures, systems, and components (SSCs)

whose failure could cause an unacceptable reduction in the capability of the residual heat removal system.

2. GDC 4, as it relates to the requirement that SSCs important to safety be designed to accommodate the effects of and be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accident conditions, including such effects as pipe whip and jet impingement.

3. GDC 5, as it relates to the requirement that any sharing among nuclear power units of SSCs important to safety will not significantly impair their safety function.

4. GDC 10, as it relates to the RCS being designed with appropriate margin to ensure that specified acceptable fuel design limits are not exceeded during normal operations including AOOs.

5. GDC 13, as it relates to instrumentation and controls provided to monitor variables over anticipated ranges for normal operations, for AOOs, and for accident conditions.

6. GDC 15, as it relates to the RCS and its associated auxiliaries being designed with appropriate margin to ensure that the pressure boundary will not be breached during normal operations, including AOOs.

7. GDC 17, as it relates to the requirement that an onsite and offsite electric power system be provided to permit the functioning of SSCs important to safety. The safety function for each system (assuming the other system is not working) shall be to provide sufficient capacity and capability to ensure that the acceptable fuel design limits and the design conditions of the reactor coolant pressure boundary are not exceeded during an AOO and that core cooling, containment integrity, and other vital functions are maintained in the event of an accident.

8. GDC 19, as it relates to the requirement that a control room be provided from which personnel can operate the nuclear power unit during both normal operating and accident conditions, including a LOCA.

9. GDC 20, as it relates to the reactor protection system being designed to initiate automatically the operation of appropriate systems, including the reactivity control systems, to ensure that the plant does not exceed specified acceptable fuel design limits during any condition of normal operation, including AOOs.

10. GDC 25, as it relates to the requirement that the reactor protection system be designed to ensure that specified acceptable fuel design limits are not exceeded for any single malfunction of the reactivity control system, such as accidental withdrawal of control rods.

11. GDC 26, as it relates to the reliable control of reactivity changes to ensure that specified

acceptable fuel design limits are not exceeded even during AOOs. This is accomplished by ensuring that the applicant has allowed an appropriate margin for malfunctions such as stuck rods.

12. GDC 27 and 28, as they relate to the RCS being designed with an appropriate margin to ensure that acceptable fuel design limits are not exceeded and that the capability to cool the core is maintained.

13. GDC 29, as it relates to the design of the protection and reactivity control systems and their performance (i.e., to accomplish their intended safety functions) during AOOs.

14. GDC 31, as it relates to the RCS being designed with sufficient margin to ensure that the boundary behaves in a nonbrittle manner and that the probability of propagating fracture is minimized.

15. GDC 34, as it relates to the capability to transfer decay heat and other residual heat from the reactor so that fuel and pressure boundary design limits are not exceeded.

16. GDC 35, as it relates to the RCS and associated auxiliaries being designed to provide abundant emergency core cooling.

17. GDC 55, as it relates to the isolation requirements of small-diameter lines connected to the primary system.

18. GDC 60, as it relates to the radioactive waste management systems being designed to control releases of radioactive materials to the environment.

19. GDC 61, as it relates to the requirement that the fuel storage and handling, radioactive waste, and other systems that may contain radioactivity be designed to ensure adequate safety under normal and postulated accident conditions.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

Subsection I.2 of this SRP section discusses general acceptance criteria, and SRP Chapter 15 subsections discuss specific acceptance criteria for transients or accidents.

III. REVIEW PROCEDURES

The reviewer will select and emphasize material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

To evaluate the LAR, DC, or COL application, the reviewer verifies that the applicant has performed the applicable transient and accident analyses needed to demonstrate conformance to the regulations.

SRP Chapter 15 subsections discuss specific review procedures for transients or accidents.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

SRP Chapter 15 subsections discuss the statements and conclusions of evaluation findings for transients or accidents.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications docketed six months or more after the date of issuance of this SRP section.

The referenced regulatory guides contain implementation schedules for conformance to parts of the method discussed here.

VI. DEFINITIONS

Term	Definition
anticipated operational occurrences (AOOs)	Conditions of normal operation that are expected to occur one or more times during the life of the nuclear power unit and include but are not limited to loss of power to all recirculation pumps, tripping of the turbine generator set, isolation of the main condenser, and loss of all offsite power (Ref. 1). AOOs are also known as Condition II and III events (Refs. 4 and 5).
anticipated transient without scram (ATWS)	AOO followed by the failure of the reactor trip portion of the protection system specified in GDC 20 (Ref. 1), because of common-mode failure.
common-mode failure	The result of an event which, because of dependencies, causes a coincidence of failure states of components in two or more separate channels of a redundancy system, leading to the failure of the defined system to perform its intended function.
critical power ratio (CPR)	That power in the assembly that will cause some point in the assembly to experience boiling transition, divided by the actual assembly operating power.
departure from nucleate boiling (DNB)	The DNB acceptance criterion for an AOO is met when there is a 95 percent probability at a 95 percent confidence level (the 95/95 DNB criterion) that DNB will not occur, and the fuel centerline temperature stays below the melting temperature.
design basis	Information that identifies the specific functions to be performed by a structure, system, or component of a facility, and the specific values or ranges of values chosen for controlling parameters as reference bounds for design. These values may be (1) restraints derived from generally accepted state of the art practices for achieving functional goals, or (2) requirements derived from analysis (based on calculation and/or experiments) of the effects of a postulated accident for which a structure, system, or component must meet its functional goals.
design-basis accidents	Postulated accidents that are used to set design criteria and limits for the design and sizing of safety-related systems and components.

Term	Definition
design-basis events	Conditions of normal operation, including AOOs, design-basis accidents, external events, and natural phenomena, for which the plant must be designed to ensure functions of safety-related electric equipment that ensures the integrity of the reactor coolant pressure boundary; the capability to shut down the reactor and maintain it in a safe shutdown condition; or the capability to prevent or mitigate the consequences of accidents that could result in potential offsite exposures.
general design criteria (GDC)	Reference 1 lists the GDC. ~~Those that apply to~~ *The GDC that mention* AOOs are 10, 13, 15, 17, 20, 26, 29, 60, and 64. ~~GDC that apply to~~ *The GDC that mention* postulated accidents are 4, 16, 17, 22, 27, 28, 31, 41, 51, 61, and 64.
loss-of-coolant accident (LOCA)	A postulated accident that results in the loss of reactor coolant at a rate in excess of the replacement capability of the reactor coolant makeup system.
MCPR safety limit	This limit ensures that during normal operation and during AOOs, at least 99.9 percent of the fuel rods in the core do not experience transition boiling.
minimum critical power ratio (MCPR)	The smallest CPR that exists in the core for each class of fuel.
overpressurization	The condition that occurs when pressure exceeds the design pressure of the component of interest by more than 10 percent, in accordance with the ASME Code (Ref. 7).
postulated accidents	Unanticipated conditions of operation (i.e., not expected to occur during the life of the nuclear power unit). Postulated accidents are also known as Condition IV events (Refs. 4 and 5).
single failure	An occurrence that results in a component's loss of capability to perform its intended safety functions (Ref. 1).

VII. REFERENCES

1. Appendix A to 10 CFR Part 50, "General Design Criteria for Nuclear Plants."

2. Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants."

3. Regulatory Guide 1.206, "Combined License Applications for Nuclear Power Plants (LWR Edition)."

4. ANS 51.1, "Nuclear Safety Criteria for the Design of Stationary Pressurized Water

Reactor Plants" (replaces ANSI N18.2), 1983 *(withdrawn in 1998).*

5. ANSI/ANS-52.1-1978, "Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants" *(withdrawn in 1998)*

6. 10 CFR 50.62, "Requirements for Reduction of Risk from Anticipated Transients Without Scram (ATWS) Events for Light-Water Cooled Nuclear Power Plants."

7. ASME Boiler and Pressure Vessel Code, Section III, "Nuclear Power Plant Components," Article NB-7000, "Protection Against Overpressure," American Society of Mechanical Engineers.

8. SECY-77-439, "Single-Failure Criterion," August 1977 (ADAMS Accession No. ML060260236).

9. 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities."

10. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

PAPERWORK REDUCTION ACT STATEMENT

The information collections contained in the Standard Review Plan are covered by the requirements of 10 CFR Part 50 and 10 CFR Part 52, and were approved by the Office of Management and Budget, approval number 3150-0011 and 3150-0151.

PUBLIC PROTECTION NOTIFICATION

The NRC may not conduct or sponsor, and a person is not required to respond to, a request for information or an information collection requirement unless the requesting document displays a currently valid OMB control number.

SRP Section 15.0
Description of Changes

This SRP section was administratively updated in accordance with NRR Office Instruction, LIC-200, Revision 1, "Standard Review Plan (SRP) Process." The revision also adds standard paragraphs to extend application of the updated SRP section to prospective submittals by applicants pursuant to 10 CFR Part 52.

Change 1.

Chapter 15 events are categorized as either anticipated operational occurrences (AOOs) or postulated accidents. This categorization of events is to be used in new applications, and may be used by current licensees, if they so choose. Current licensees also have the option of continuing to use the RG 1.70 categorization (events of moderate frequency or Condition II, infrequent events or Condition III, and limiting faults or Condition IV).

Anticipated Transients Without Scram (ATWS) are considered separately (see SRP Section 15.8).

Acceptance criteria are specified, and examples of events are listed for each of the event categories.

Rationale:

Currently, there are three event categories: incidents of moderate frequency (Condition II), infrequent incidents (Condition III), and limiting faults (Condition IV), are defined in RG 1.70 and in two standards that were issued by the American Nuclear Society (ANS). Both standards: ANS 51.1-1983, Nuclear Safety Criteria for the Design of Stationary Pressurized Water Reactor Plants, and ANSI/ANS-52.1-1983, Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants, were withdrawn in 1998.

The number of event categories is reduced from three to two. The two event categories are defined in 10 CFR 50, Appendix A, and in RG 1.206. AOOs are defined as incidents that are expected to occur one or more times during the life of the nuclear power unit. Postulated accidents are defined as incidents that are not expected to occur; but are postulated because of the potential for the release of significant amounts of radioactive material.

The table summarizes and compares the categorization systems.

ANS standards	*RG 1.70*	*10 CFR 50*	*This SRP version*
Incidents of moderate frequency (Condition II)	*Incidents of moderate frequency (expected to occur several times during the plant lifetime).*	*Incidents that are expected to occur one or more times during the life of the nuclear power unit*	*AOOs*

Infrequent Events (Condition III)	*Infrequent events (may occur during the lifetime of the plant).*	*Incidents that are expected to occur one or more times during the life of the nuclear power unit*	*AOOs*
Limiting faults (Condition IV)	*Limiting faults (not expected to occur but postulated because of the potential for the release of significant amounts of radioactive material).*	*Postulated accidents (not expected to occur but postulated because of the potential for the release of significant amounts of radioactive material).*	*Postulated accidents (not expected to occur but postulated because of the potential for the release of significant amounts of radioactive material).*
ATWS	*special case, regulated by 10 CFR 50.62*		

Since RG 1.70, the format for Safety Analysis Reports (SARs), distinguishes between incidents of moderate frequency, infrequent incidents, and limiting faults, and licensees have written their SARs according to this format, the NRC staff will continue to review license amendment requests that are based upon the event categorization and acceptance criteria of RG 1.70 (i.e., consistent with licensees' current licensing bases). The NRC staff will also review license amendment requests according to the event categorization and acceptance criteria of this SRP version, if the applicants so choose. New license applications will be reviewed according to the event categorization and acceptance criteria of this SRP version.

Acceptance criteria and event categories are linked by the principle of constant risk, i.e., frequent events must not result in serious consequences, whereas rare events may produce relatively severe consequences. Therefore, acceptance criteria are specified, in SRP Section 15.0, together with the event categories, and examples of events for each category.

This change bases the acceptance criteria of the SRP events on 10 CFR Part 50, Appendix A; not on two ANS standards that were withdrawn in 1998.

Change 2.

One of the acceptance criteria for Condition II events requires that a Condition II event be prevented from developing into a more serious Condition III or IV event, without the occurrence of other, independent faults. There is a similar criterion for Condition III events, that prohibits Condition III events from becoming Condition IV events. These criteria are retained for plants with licensing bases that allude to RG 1.70, and ANS 51.1 (for PWRs) or ANSI/ANS-52.1-1983 (for BWRs). A reference to RIS 2005-29 is added, for further information.

For new applications and for licensees that wish to adopt the event categorization scheme of SRP Section 15.0, this criterion is updated, to require that AOOs be prevented from developing into postulated accidents, without the occurrence of other, independent faults.

Rationale:

If the risk of an event is defined as the product of the event's frequency of occurrence and its

consequences, then the plant should be designed such that all events, AOOs and postulated accidents alike, produce about the same level of risk. This is reflected in the GDC, which generally prohibit relatively frequent events (i.e., the AOOs) from resulting in serious consequences; but allow the relatively rare events (i.e., the postulated accidents) to produce more severe consequences.

This acceptance criterion, which is found in the aforementioned ANS standards, prevents the initiation of a serious event (e.g., a postulated accident) with the (higher) frequency of occurrence of a less serious event (e.g., an AOO). In other words, this acceptance criterion establishes a barrier that blocks the migration of an event into a more serious category.

This concern is reflected in some of the questions licensees must answer to justify making plant modifications without prior NRC staff review (10 CFR 50.59). Licensees, all of whom are presumed to be operating plants that are designed according to the principle of constant risk, who wish to make changes to their plants, without prior NRC review, are required to satisfactorily answer the questions of 10 CFR 50.59. These questions pertain to the effects of implementing licensees' changes, particularly with respect to the frequencies of occurrence and consequences of licensing basis events. If an anticipated change can alter the frequency of occurrence and/or the consequences of one or more licensing basis events, then it must be reviewed by the NRC staff.

This acceptance criterion is retained, since it's important to plant design and analysis, and it's addressed in the regulations (10 CFR 50.59, promulgated in 1999). The revised portions of the SRP Section deal with the categorization of licensing basis events according to frequency of occurrence, and the acceptance criteria for each of the event categories.

Change 3.

Delete the requirement that an event's category shifts to the next, more serious category, when it's combined with the coincident occurrence of a single failure.

Rationale:

This requirement is not the same as the acceptance criterion that prohibits an event from developing into a more serious event, without the occurrence of other, independent faults, since the single failure is considered to be an independent fault.

An AOO, when combined with a single failure (e.g., another AOO), is no longer an AOO, since its probability of occurrence is significantly reduced (i.e., its probability of occurrence is the product of the probabilities of occurrence of the two AOOs). The combined event, therefore, is a postulated accident; subject to the acceptance criteria of postulated accidents.

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Protecting People and the Environment

Standard Review Plan 15.0 - Introduction

Samuel Miranda

NRR – Reactor Systems

March 8, 2007

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SRP Chapter 15.0

- AOOs are conditions of normal operation which are expected to occur one or more times during the plant lifetime
- Acceptance criteria for AOOs
- An AOO shall not cause acceptable fuel design limits to be exceeded

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Summary of changes

- Apply GDC definitions of AOOs and postulated accidents
- Add acceptance criteria
- Simplify and clarify acceptance criteria for AOOs

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ANS	RG 1.70	10 CFR 50, App A
II	Incidents of moderate frequency: could occur in a year	AOOs: one or more events in plant lifetime
III	Infrequent events: could occur in the plant lifetime	AOOs: one or more events in plant lifetime
IV	Limiting faults: not expected to occur	Postulated accidents: not expected to occur

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1971 10CFR§50, App A, General Design Criteria (Feb 20)
Criterion 10—Reactor design. The reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

1972 RG 1.70, Standard Format and Content, (Feb)

1973 ANSI N18.2-1973, Nuclear Safety Criteria for Design of PWRs (Aug 6)
A single Condition II incident shall not cause consequential loss of function of any barrier to the escape of radioactive products.

1975 NUREG-75/087 SRP, Rev 0 (Nov 24)
An incident of moderate frequency in combination with any single active component failure, or single operator error, shall be considered and is an event for which an estimate of the number of potential fuel failures shall be provided for radiological dose calculations. .... There shall be no loss of function of any fission product barrier other than the fuel cladding.

1996 NUREG-0800, Draft 3 (Apr)

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SRP sections for AOOs state:

- An incident of moderate frequency in combination with any single active component failure, or single operator error, shall be considered and is an event for which an estimate of the number of potential fuel failures shall be provided for radiological dose calculations. .... There shall be no loss of function of any fission product barrier other than the fuel cladding.

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Single failure: two views

- Results in the loss of capability of a component to perform its intended safety function (GDC)
- Results in an accident or AOO

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Simplify & clarify AOO acceptance criterion

- … fuel design limits are not exceeded during any condition of normal operation – GDC 10 (1971)
- An AOO is a condition of normal operation
- The combination of two AOOs is not a condition of normal operation
- A condition that is not of normal operation may cause fuel design limits to be exceeded
- A combination of two AOOs may cause clad damage – SRP (1975 and 1996)

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Simplify & clarify AOO acceptance criterion

- Remove the language which states that combined AOOs may lead to fuel clad damage
- Current SRP acceptance criteria already address fuel clad damage for postulated accidents

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Constant Risk Principle

- If risk is defined as the product of an event's frequency of occurrence and its consequences, then the plant shall be designed such that risk is approximately constant across the range of AOOs and postulated accidents.

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Standard Review Plan (SRP) 15.9 – BWR Stability

Dr. Tai L. Huang (NRR/DSS/SRXB)
Dr. Jose March-Leuba (ORNL)

ACRS Full Committee Meeting
March 8, 2007

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Introduction and Regulatory Perspective

- SRP 15.9, BWR Stability
  - New section of NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants"
    - Previously in SRP 4.4, "Thermal-Hydraulic Design"
  - Applicable to:
    - Operating plants
    - New plants
    - Extended operating domains

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Background

- BWR Stability
  - Has potential of violating Specified Acceptable Fuel Design Limits (SAFDLs)
  - Affects day to day operation of BWRs

- Regulatory requirements based on 10CFR50, Appendix A, General Design Criteria
  - GDC 10: Reactor designed such that fuel design limits are not exceeded during normal, abnormal, and Anticipated Operational Occurrences (AOOs)
  - GDC 12: Power oscillations either not possible OR reliably and readily detected and suppressed

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SRP 15.9 is a Separate SRP on BWR Stability

- Long Term Solutions have a dedicated protection system function
- Stability can have significant impact on operation (e.g., exclusion regions)
- Specialized calculations required
- Specific guidance provided for issues identified and resolved in operating reactors (e.g., Long Term Solutions)
- Generic criteria that are applicable to new fuels, extended operating domains, and new reactors is provided

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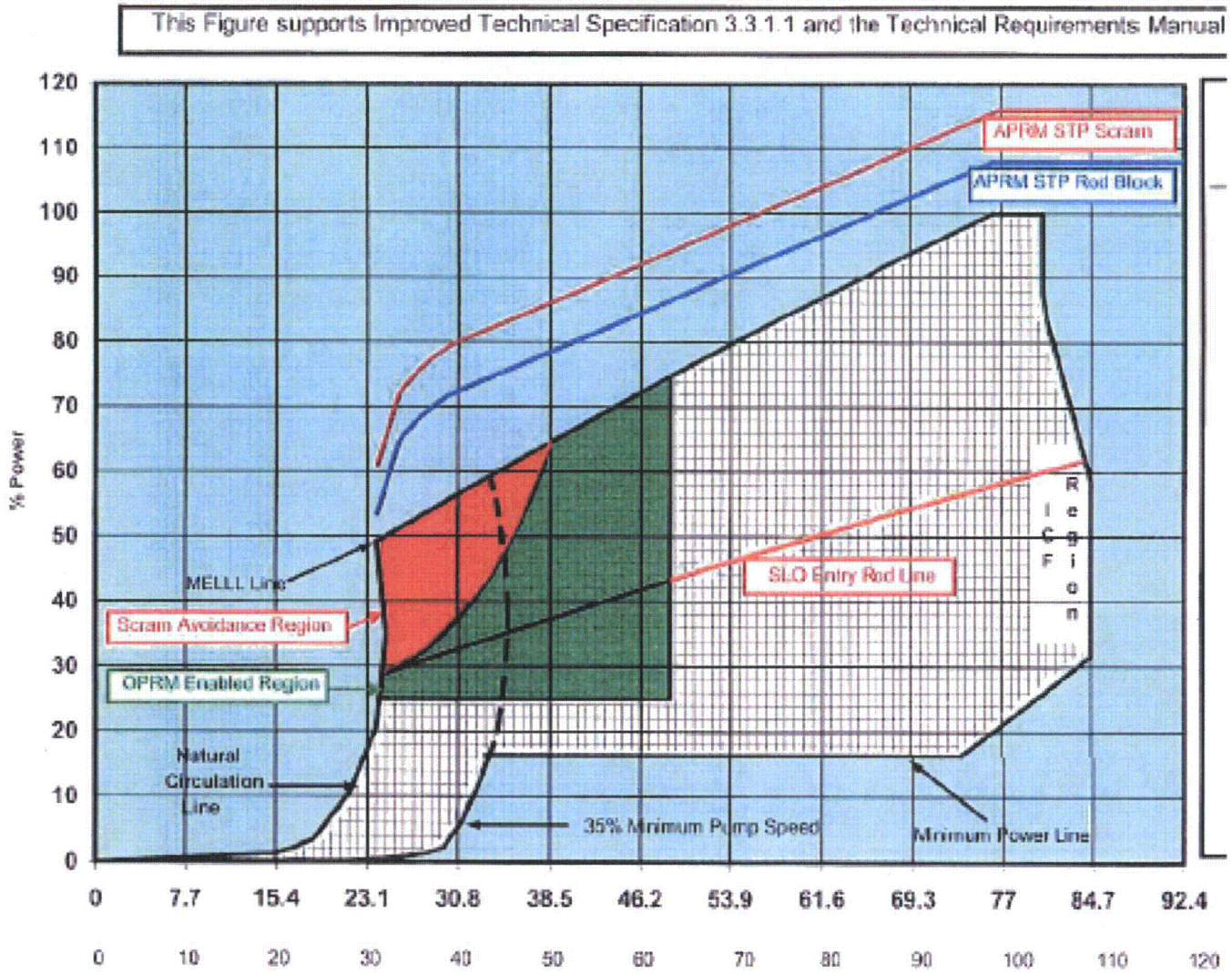
Regulatory History & BWR Events

- VY Event/Test + PB tests
- GL 86-02 (GESIL 380 operating limitations for detection & suppression are acceptable to demonstrate compliance w/ GDC 10 & 12)
- LaSalle Event: IN 88-39
- NRC Bulletin 88-07 (Required plants w/o auto trip capability to manually scram if dual recirc pump trip occurs)
- GE Part 21 1988 (MCPR might be violated if 10% APRM swing is used as criteria for manual scram)
- NEDO 31960 (1991-93)
- WNP-2 Event: IN 92-74 (Columbia)
- GL 94-02 (Req'd Long term sol'n)
- INPO SER 07-00
- GE Part 21 - DIVOM
- Plant-Specific DIVOM Guidelines
- NMP-2 Event 2003
- LTS-III Parameter Settings Insensitive
- Perry Event 2004

BWR Fleet has Stability Awareness



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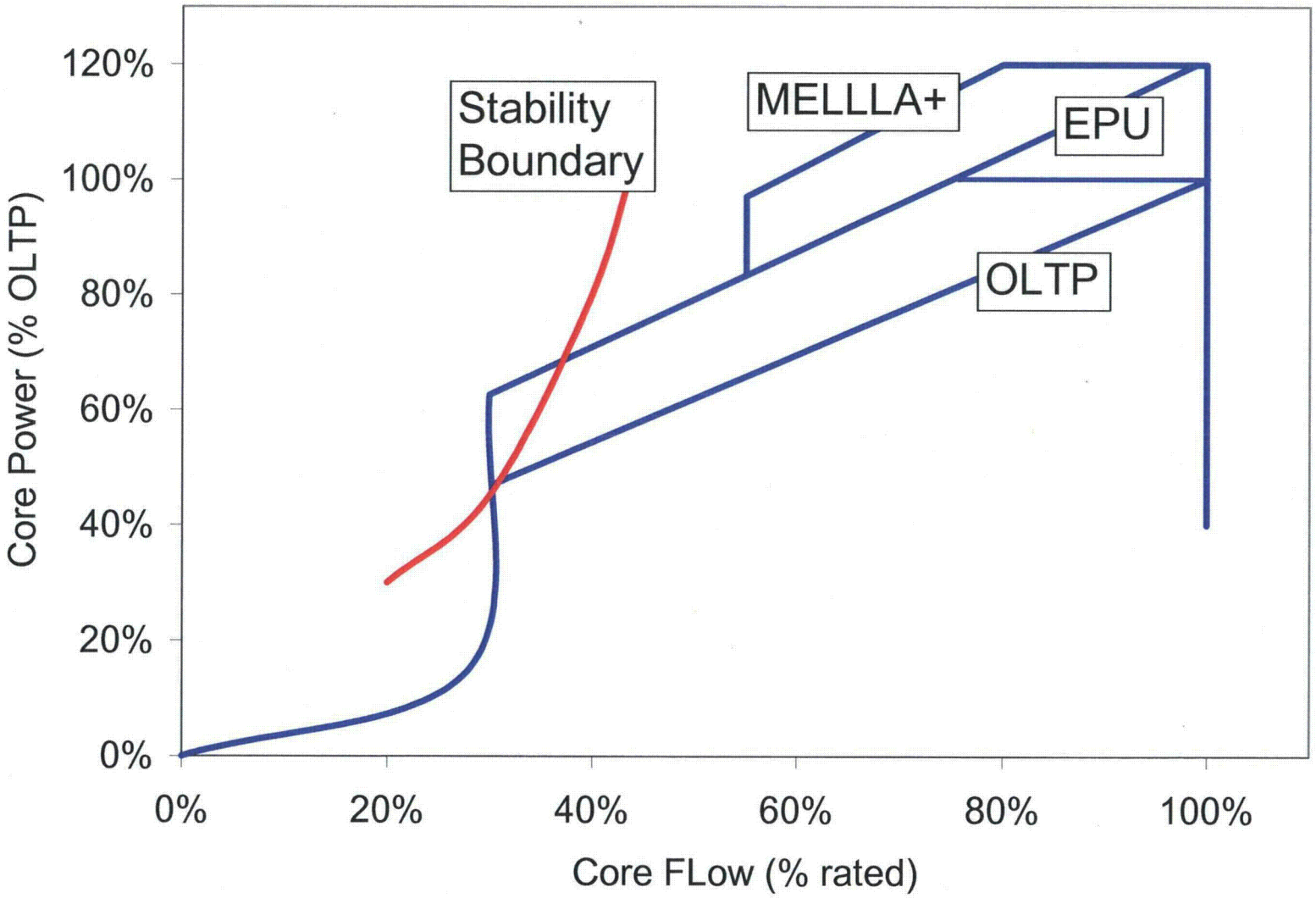
SRP 15.9 Areas of Review

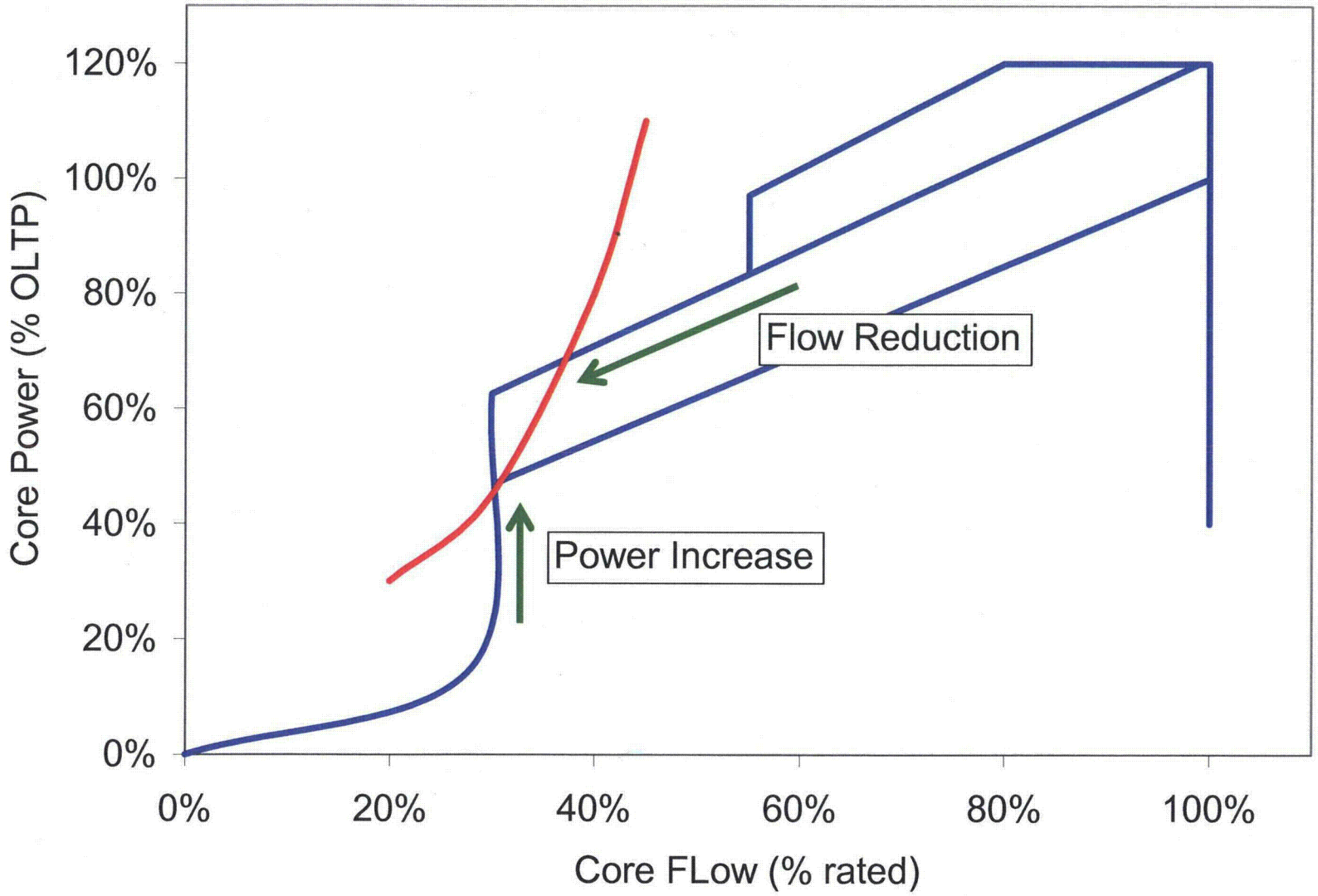
- Density-Wave instability modes
  - Core-Wide
  - Regional
  - Channel

- Other instability modes
  - Control system instabilities
  - Design-dependent modes (e.g. startup instabilities in passive BWR chimneys)

Density Wave Instability is a Low-Flow High-Power Event



Two Types of Instability Events



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SRP 15.9 Implementation: Long Term Solutions

- Prevention (anticipatory scram)
  - Option E1A
- Detect & Suppress (scram if oscillations detected)
  - Option II
  - Option III
- Mixed
  - Option ID
- All options developed by BWROG and publicly available
  - Documented in NEDO-31960A "BWR Owner's Group Long-Term Stability Solutions Licensing Methodology," Nov 95
- Options for expanded operating domains
  - DSS/CD (GE proprietary – approved)
  - EO3 (Areva proprietary – under review)

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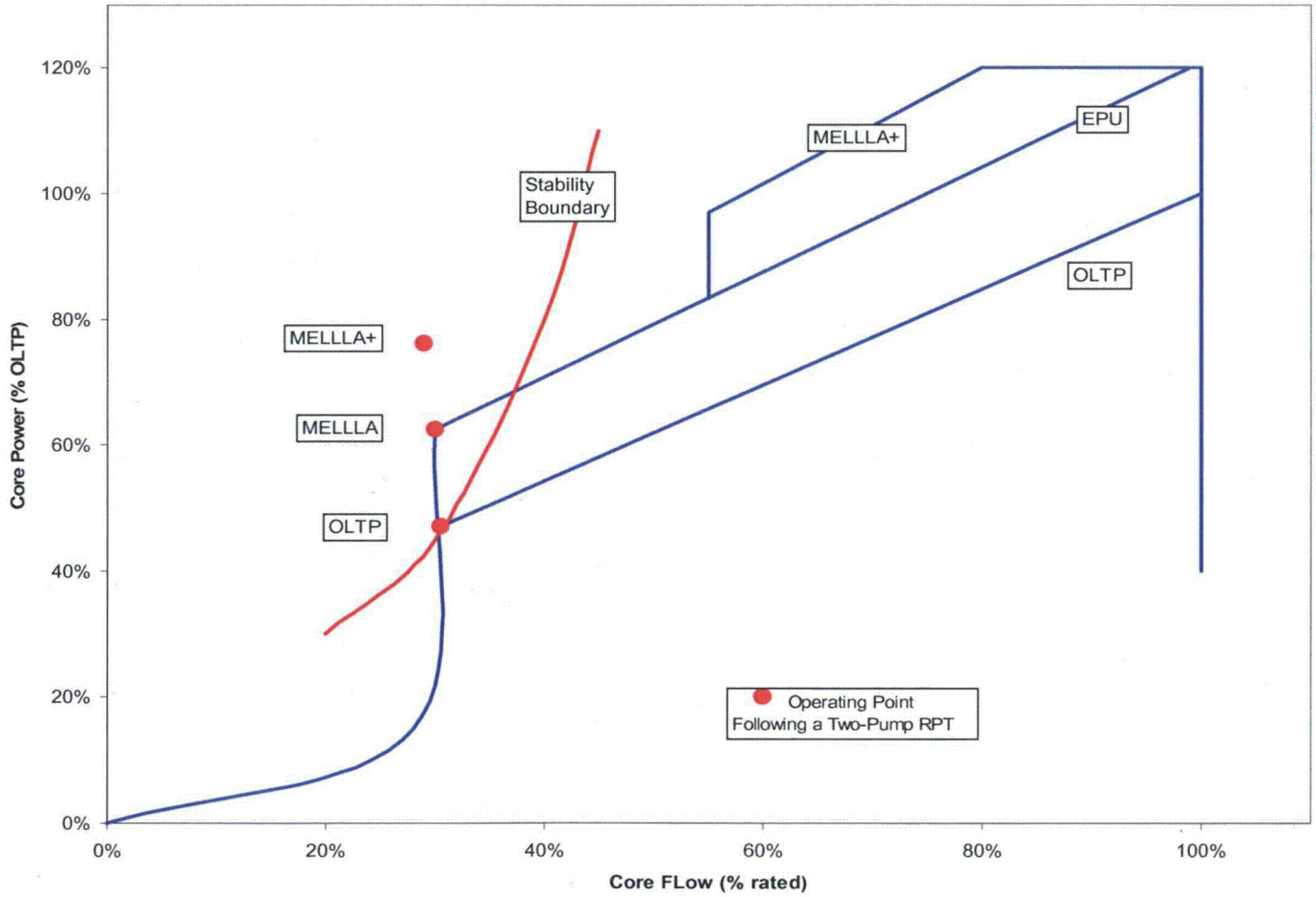
Extended Operating Domains Pose New Challenges to BWR Stability



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Modifications Based on Sub-Committee Review on 2/28

- Defined the term "reasonably prompt" as
  - "accomplished within the two minutes allowed for operator action in the demonstration calculations"
- Clarified the use of "approved" methodologies.
  - "In cases when an approved methodology is not available, the staff may accept the use of other methodologies based on results of audits or preliminary reviews"
- Corrected typographical errors

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SRP 15.9 Summary

- The staff concludes that
  - SRP 15.9 provides adequate guidance and criteria on long term solutions for
    - Operating reactors
    - New reactors
    - Future design changes
    - Operating domain changes
  - ATWS/Stability is properly covered under 15.8

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Backup Slides
ATWS/Stability

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ATWS/Stability

- There are many types of ATWS events
- ATWS/Stability is a particular class of ATWS event where
  - Condenser is available (non-isolation)
  - Very cold water is fed into the vessel
  - Extreme amplitude oscillations develop (>1000% power oscillations)
  - Dryout and cladding failure occur
- ATWS/Stability is a serious concern because it is the default transient evolution (hands-off) in some plants

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ATWS/Stability Was Deemed Unacceptable

- Main issue was that existing EPGs directed the operator to let the event grow
- Extensive study by industry, staff, with ACRS involvement resulted in EPG Rev 4
- ATWS/Stability Mitigation Actions:
  - Early boron injection if oscillations develop
    - Prior to EPG Rev 4, boron was only injected if the suppression pool was expected to over-heat
  - Immediate water level reduction below the feedwater spargers
    - Pre-heats core-inlet coolant
    - Condenses vessel steam

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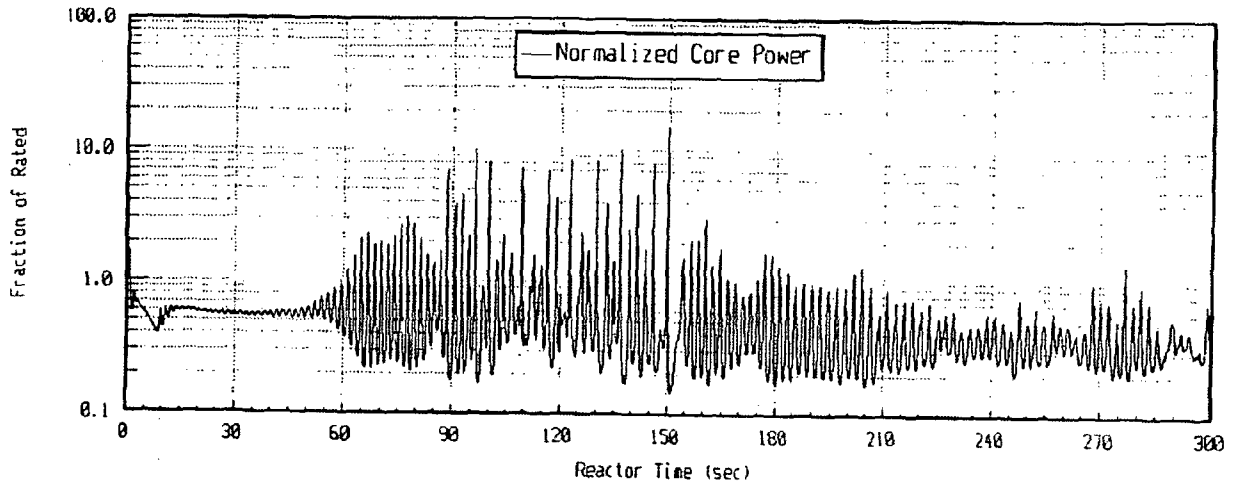
Effectiveness of Mitigation Actions has been Demonstrated by Analysis



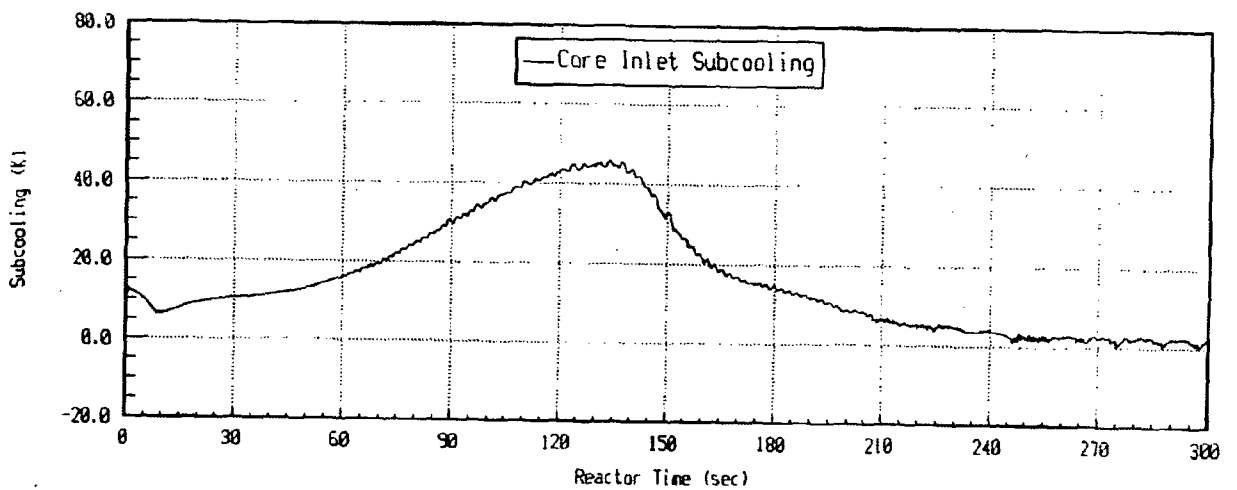


Figure 4-4. Level Control below Feedwater Sparger – Core Power and Inlet Subcooling

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ATWS/Stability Summary

- ATWS/Stability is a class of ATWS events that may impact core coolability, if unmitigated
- ATWS/Stability affects primarily plants with large bypass capacity and motor-operated feedwater pumps
- BWROG EPG's Rev 4 and greater (e.g. EPG/SAGS Rev 2) incorporate effective mitigation actions
  - Water level reduction
  - Early boron injection
- Plant audits confirm that EPGs are correctly implemented in EOP's or EOI's
- Plant simulator events show operator awareness

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Industry Actions to Manage Alloy 82/182 DM Buttweld Susceptibility to PWSCC

Alex Marion
NEI

ACRS
March 8, 2007

Overview

- Background: MRP-139
- Industry Response to PZR Weld Indications at Wolf Creek
- Refined FEA Analysis
- Ongoing meetings with NRC

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MRP-139: Overview

- Provides **mandatory** guidance for the volumetric and visual inspection of dissimilar metal butt welds in PWR primary systems
- Developed using a structured approach
  - Safety assessment (deterministic and probabilistic)
  - Assessment of margins between onset of leakage and critical crack sizes
  - Considered previous industry and regulatory guidance and operating experience
- Review and approval process
  - Third party review
  - Resource assessment
  - Implementation planning
  - Extensive industry review
  - Unanimous approval by the MRP executive committee

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MRP-139: Inspection Guidelines

- Develop an inspection regime that will manage potential degradation well in advance of any structural integrity problem
  - Unlike IGSCC in BWRs, PWSCC in PWRs has been slower to initiate.
- Obtain a baseline of the DM butt weld using ASME Section XI Appendix VIII demonstrated techniques
- Begin baseline examination sequence with higher temperature welds
- Establish aggressive implementation schedules
  - Implementation delays to be addressed through the Materials Initiative Deviation process
    - Document in site Corrective Action Program, executive approval, independent expert review, deviation sent to MRP for peer awareness

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MRP-139: Implementation Schedule

Issued in August 2005

- **Perform first volumetric inspection Alloy 82/182 according to the following schedule**
  - **By 12/31/07 - all welds associated with the pressurizer and exposed to pressurizer-like temperatures**
  - By 12/31/08 - welds ≥ 4" NPS and ≤ 14" NPS and exposed to temperatures equivalent to the hot leg
  - By 12/31/09 - welds > 14" NPS and exposed to temperatures equivalent to the hot leg
  - By 12/31/10 - welds exposed to temperatures equivalent to the cold leg (including smaller-diameter HPI welds)

- By 12/31/07 – evaluate all Alloy 82/182 welds to determine the amount of coverage for axial and circumferential flaws

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Wolf Creek PZR Weld Indications

- Ultrasonic examinations at Wolf Creek in Fall 2006 found indications in pressurizer Alloy 600 dissimilar metal butt welds
- Examinations were being performed per MRP-139 requirements

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Industry Activities and Status

- White Paper on Implications of Wolf Creek inspection results
  - Key Safety Assessment Assumptions
  - Field Experience Summary
  - Review of Wolf Creek Findings
- Completed MRP-139 Implementation Survey
- NRC Public Meetings – November & December 2006
- ACRS Materials and Metallurgy – March 6, 2007

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Industry Actions

MRP-139 PZR Implementation Survey

Summary Statisitcs - Nozzle & Plant Tallies

Count Group	Description	# Nozzles ***	% Total	Cum %	Plants **
All Nozzles w/ A600/82/182	Total Nozzles w/ A600/82/182	279	100%		50
	Total As-Found (unmitigated) Baseline Inspections (complete and planned)	47	17%		19
Mitigations Complete and Planned	Total Mitigations through Dec 2006	68	24%	24%	15
	Total to be Mitigated Spring 2007	64	23%	47%	12
	Total to be Mitigated Fall 2007	62	22%	70%	13
	Total to be Mitigated Spring 2008	54	19%	89%	10
	Total to be Mitigated Fall 2008 *	1	0.4%	89%	1
Baseline Inspections Complete and Planned	Total Inspected through Dec 2006	85	30%	30%	21
	Total to be Inspected Spring 2007	68	24%	55%	13
	Total to be Inspected Fall 2007	71	25%	80%	14
	Total to be Inspected Spring 2008	54	19%	99.6%	10
	Total to be Inspected Fall 2008 *	1	0.4%	100%	1
Status January 1, 2007	Total Inspections Remaining	194	70%		38
	Total Pending Required Overlays	177	63%		34
Optional Mitigations Planned through Spring 2008 - PDI Exam Previously Completed (not counted above)		7	3%	92%	3

* Inspection completed but with PDI / MRP-139 coverage limitation due to safe end material

** Number of individual plants represented in the nozzle count for this item. *Since activities may occur during multiple outages,* adding cells in this column could result in double counting.

*** Nine nozzles in eight plants contain A600 safe-ends and have two associated DM buttwelds (designated above by a "(2)" in the appropriate plant nozzle cells) so the total number of susceptible welds is nine more than the total number of nozzles. As of January 1, 2007, nine of those welds in five nozzles have complied with the baseline inspection requirement and of those, four additional welds not included in the counts above have met MRP-139 baseline inspection requirements. Therefore, a total of 90 welds have met baseline inspection requirements and a total of 51 welds were inspected in the as-found condition.

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Advanced Finite Element Analysis

Refined Crack Growth Calculations

- Objective:
  - Determine margin between leakage and rupture
- Approach:
  - Provide reasonable assurance that sufficient time exists between onset of leakage and pipe rupture in order to support existing plans to implement MRP-139 pressurizer weld inspections

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Advanced Finite Element Analysis

Conservatism of Semi-Elliptical Crack Shape Assumption

- CONSERVATISM
  - Crack shape remains a semi-ellipse as it grows through the weld thickness
- REFINEMENT
  - Allow the stress intensity factor at each point along the crack front to guide development of the crack shape
  - Repeat recent evaluations of Wolf Creek indications
  - Perform sensitivity studies
  - Incorporate peer review efforts with the goal of reaching consensus within the industry and with the regulator regarding the appropriateness of the refined crack growth calculations.

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Advanced Finite Element Analysis

Phase I Calculations

- Crack growth calculation transmitted to NRC under MRP-2007-003 will be revised to explicitly consider the effect of a changing crack shape on the crack area at the time of through-wall penetration.
- Crack area will be compared to the area that is calculated to result in rupture for normal operating and faulted conditions.
- Results will provide a good comparison between the more refined changing crack shape methodology and the more conservative semi-elliptical shape assumption.

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Advanced Finite Element Analysis

Phase II Calculations

- Calculations will be performed to investigate a wide range of input assumptions:
  - Weld diameter
  - Weld thickness
  - Piping loads
  - Welding residual stress
  - Initial crack size
  - Initial crack shape
- Time from through-wall penetration to rupture will not be calculated based on constant semi-elliptical shape.
  - Method accounts for the change in shape of the through-wall profile based on the stress intensity factor calculated at each node on the crack front.
- Analysis will include peer review by fracture mechanics, materials, and corrosion experts within the industry and the regulator.

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Summary

- Industry Materials Initiative is effective
  - Aggressive baseline inspection program per MRP-139
  - 70% of PZR DM welds to be inspected or mitigated by 12-31-07
  - MRP-139 inspection plans remain valid
- Working with NRC to perform further analysis to show reasonable assurance of through-wall leakage prior to rupture even considering indications such as those at Wolf Creek
  - Analysis complete late June
  - First technical meeting with staff yesterday
    - Good initial exchange and general agreement on approach
    - Periodic conference calls and follow-on meetings scheduled

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Conclusions

- Acceleration of the implementation schedule unnecessary
  - Fact remains that, given all the welds worldwide, only four very small leaks
- From a risk viewpoint, essentially no difference between now and Spring 2008 for first exams
- Industry will monitor Spring 2007 outage season inspection results
- Enhanced leakage monitoring implemented as a compensatory measure until inspection / mitigation complete

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ACRS Briefing on Dissimilar Metal Weld Issues Resulting from Wolf Creek Inspection Results

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Ted Sullivan, NRR

&

Al Csontos, PhD, RES

March 6, 2007

Background

- February 2, 2007 ACRS briefed on Wolf Creek pressurizer nozzle welds
  - Inspection findings – 5 flaws in three nozzles
  - NRC fracture mechanics analysis results
    - little or no time b/w leakage and rupture for relief nozzles cases analyzed

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NRC Conclusions

- NRC staff does not consider Wolf Creek indications anomalous
- Inspections/mitigations need to be accelerated for some plants
- Enhanced RCS leakage monitoring with action levels to shut down and visually inspect welds necessary until inspections/mitigations completed

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NRC Analyses

- NRC staff discussed fracture mechanics analyses and results at Feb 2, 2007 meeting
- Leakage analyses for cases with time b/w leakage and rupture - not discussed previously
- Additional regulatory activities since the last meeting

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Flaw Evaluation Summary

- Surge nozzle results:
  - Leakage predicted to occur 1-2.2 years after discovery
  - All cases show at least 6 months b/w leakage and rupture
- Relief nozzle results:
  - Leakage predicted to occur 1.9-2.6 years after discovery
  - 20/24 cases show leakage and rupture occur simultaneously
    - Surface cracks unstable before growing throughwall
- Safety nozzle results:
  - Leakage predicted to occur 2.6-8.0 years after discovery
  - 8/24 cases show leakage and rupture occur simultaneously

Leak Rate Analyses

- Purpose: estimate through wall crack (TWC) leakage
- Used the NRC validated SQUiRT (Seepage Quantification on Upsets in Reactor Tubes) model for leak rate calculations
- Assumptions:
  - Idealized equivalent TWC
  - Crack opening displacement (COD):
    - Dependent on PWSCC morphology parameters
    - Calculated with GE-EPRI estimation scheme
    - WRS does not affect COD
  - Subcooled liquid and 100% steam where appropriate
  - No restraint of pressure induced bending
- Calculated leak rate as a function of crack size

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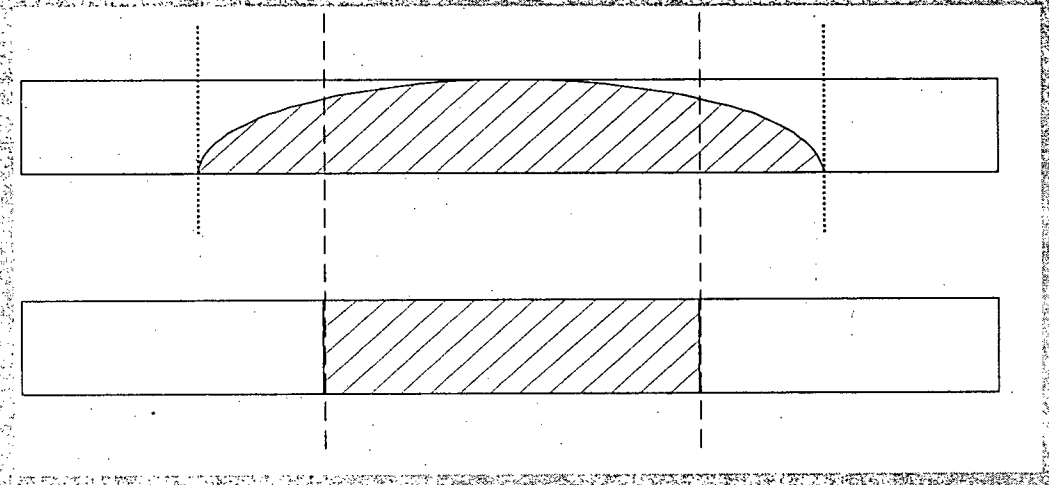
Equivalent Through-Wall Crack

- Idealized TWC - OD length equal to the ID surface crack length projected radially to the outside surface (red lines)
- Equivalent TWC size equates the TWC size to the final surface crack area



Leak Rate Summary

- Surge nozzle: 0.2 – 3.1 gpm
- Relief nozzle:
  - 2.3 gpm for no weld residual stress case
  - Remainder of cases predict rupture
- Safety nozzle: 0.2 – 10.4 gpm
- Factors not addressed in the leak rate analysis:
  - Pressure induced bending for long cracks in stiff systems can limit leak rate significantly
  - WRS can also limit leak rate by rotating crack faces
  - Non-idealized (realistic) TWC will leak less than idealized

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Regulatory Activities

- PWRs fall in following categories
  - Plants without Alloy 82/182 pressurizer nozzle welds
  - Plants that have already inspected or mitigated
  - Plants that plan to inspect or mitigate in 2007 outages
  - Plants that planned to inspect or mitigate in 2008 outages

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Regulatory Activities

- Agreements reached with licensees to:
  - Implement enhanced leakage monitoring until nozzles inspected or mitigated
  - Complete inspection/mitigation during 2007
    - Plants may inspect in 2008 pending results of advanced industry analyses

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Additional Regulatory Activities

- If industry's advanced analyses provide reasonable assurance to NRC staff that PWSCC will remain stable and not lead to rupture without significant time from the onset of detectable leakage, plants with 2008 outages will not have to shutdown in 2007

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Additional Regulatory Activities

- Licensee agreements contained in commitment letters
- Commitments will be confirmed through NRC Confirmatory Action Letters

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NRC Comments on Advanced Industry Analyses

- NEI provided project plan for advanced industry analyses by letter dated February 14, 2007
- NRC provided comments to industry by letter dated March 5, 2007
- NRC and industry had a productive meeting on March 7, 2007 and reach general agreement on the framework for the project
- NRC staff will actively interact with industry to provide timely input on plans and progress

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Conclusions

- NRC staff analyses indicate some flaws have no margin between leak and rupture
- NRC staff concluded that inspections/mitigations need to be accelerated for some plants
- NRC staff also concluded that to address possible leaking flaws, enhanced RCS leakage monitoring frequency, action levels and actions needed to be put in place
- NRC received commitments from licensees addressing these actions, as appropriate

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Conclusions

- Industry pursuing additional analyses to address NRC staff concerns regarding rupture without prior evidence of leakage
- NRC staff will be following industry work closely
- If NRC staff concludes that additional analyses provide reasonable assurance of safety, plants with outages planned in 2008 will be able to avoid 2007 outages

Framework for Future Plant Licensing

Presented to

Advisory Committee on Reactor Safeguards

Farouk Eltawila, (301) 415-7499
John Monninger, (301) 415-0257
Mary Drouin, (301) 415-6675
Office of Nuclear Regulatory Research

March 8, 2007

Purpose of Today's Briefing

- Provide ACRS the status and plans with regard to the "Framework for Future Plant Licensing"
  - Referred to as the "Technology-Neutral Framework"

Outline

- History
- Status
- ANPR
- Stakeholder comments
- Next steps

History

- January 2003: RES Advanced Reactor Research Plan recognized the need for a licensing framework for advanced reactors
- Current regulatory structure
  - Focused on LWRs with limited application to non-LWRs
    - Advanced reactors will have design and operational issues different from LWRs
    - Contain specific requirements not applicable to advanced reactor designs
  - Evolved with limited insights from PRAs and severe accident research
    - PRA and PRA insights will be an integral part of licensing advanced reactors
- Program initiated to develop a risk-informed, performance-based regulatory structure that could be technology-neutral to support future licensing

Status

- Initial work (development of the "Framework") complete
  - Documented in NUREG-1860, to be published
- Framework provides guidance and criteria for creating a "risk-derived" and performance-based regulatory structure that can be implemented on either a technology-neutral or a technology-specific basis
- Framework integrates Commission's expectations as addressed in various policy statements
  - Severe Accident, Advanced Reactors, PRA, Safety Goals

ANPR

- Commission directed the staff to:
  - issue to issue an Advanced notice of Proposed Rulemaking (ANPR)
  - provide its recommendation on whether and, if so, how to proceed with rulemaking
- Commission also requested the staff, in the ANPR, to seek stakeholder input in areas such as:
  - whether this effort is premature
  - whether NRC should be focusing on developing technology-specific frameworks for non-LWRs
  - what priorities should be given for various non-LWR technologies
- Commission indicated that the staff should facilitate stakeholder participation, hold public meetings and workshops starting soon after the ANPR is issued

ANPR

- ANPR issued in May 2006 requesting stakeholder comment
- ANPR included detailed questions in seeking stakeholder input; example questions
  - Should the regulations be technology-neutral or be technology-specific?
  - If technology-specific, which technology?
  - Is it premature to initiate rulemaking for non-LWR technologies?
  - If premature, when should such an effort be undertaken?
- ANPR noted that Framework was available on NRC public website and an updated version with additional information would be placed on the Website in July 2006
- Public meeting held July 2006
- Public workshop in September 2006

Stakeholder Comments

- Stakeholder comments received from:
  - AREVA
  - ASME (two sets)
  - Strategic Teaming and Resource Sharing (STARS)
  - Nuclear Energy Institute (two sets)
  - American Nuclear Society (two sets)
  - Pebble Bed Modular Reactor (Pty) Ltd. (two sets)
  - Westinghouse
  - IEEE Power Engineering Society
  - GE Energy Nuclear
  - Nuclear Equipment Quorum
- High level comments
  - Overall views
  - Technology-neutral versus technology-specific
  - How to proceed forward

Stakeholder Comments

Risk-Informed and Performance-Based "Part 53"

- Example comments
  - "should move forward with developing a risk-informed and performance based..."
  - "supports the NRC's efforts to improve ... its regulations by establishing ... a comprehensive set of risk-informed and performance-based..."
  - "support a regulatory framework that would establish a comprehensive set of risk-informed and performance-based..."
  - "departs too far from the approximately 3000 reactor years experience gained using the deterministic approach ... the significant area of departure ... in addressing common cause failure..."

Stakeholder Comments

Technology-Neutral vs Technology-Specific

- Mixture of views
  - Some supported technology-neutral regulations with technology-specific implementing guidance
  - Some supported technology-specific regulations
  - Some indicated too premature to decide

Stakeholder Comments

How to proceed forward with regard to rulemaking

- Gain experience first with design certification of a non-LWR using Framework approach
- Use a multi-year phased approach to rulemaking
- Use a Step approach
  - Develop a preliminary draft rule
  - Upon receipt of non-LWR application, publish the draft rule for information
  - Review and approve non-LWR design using Part 50/52
  - Evaluate draft rule against non-LWR design
  - Publish draft rule for comment

Next Steps

- Framework, NUREG-1860, to be published early summer 2007
- Staff preparing SECY paper to respond to Commission direction to "provide its [staff] recommendation on whether and, if so, how to proceed with rulemaking"
  - Generic activities related to the Framework complete
  - Framework concepts to be tested/piloted on specific reactor technologies
  - Evaluating the need to defer rulemaking until experience is gained with NGNP and GNEP
- Staff will brief ACRS at May full-committee meeting

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Overview of Research Conducted to Inform the Resolution of GSI-191

Ervin Geiger
Office of Nuclear Regulatory Research

540th ACRS Meeting

March 8, 2007

Background

- GSI-191 was established to assess the potential for debris to degrade emergency core cooling system (ECCS) and Containment Spray System (CSS) performance during a loss-of-coolant accident (LOCA).
- Two ECCS performance degradation phenomena were initially identified for investigation.
  - Decrease in available ECCS/CSS pump NPSH due to debris accumulation on the ECCS sump screen(s)
  - Degradation of down-stream ECCS components by debris bypassing the sump screen(s)
- Subsequently, "chemical effects" was identified as a potential ECCS/CSS performance degradation phenomenon.

Research Objectives

- Determine if chemical reaction products formed in representative sump-pool environments.
- Examine, independently, the effect of chemical precipitates or particulate, in combination with insulation fiber, on sump screen head-loss.
- Examine variables affecting debris bypass of sump screens and study effect of bypassed insulation material on throttle valve clogging.
- Characterize the transportability of coating chips in water.

Previous ACRS Briefings on GSI-191 Research

- Research activities have yielded 11 NUREG/CR Reports, 2 NUREG Reports and 3 Technical Letter Reports
- Detailed GSI-191 research presentations have been made in previous ACRS meetings.
- Current presentations focus on most recent information.

Significant Research Results

- Chemical effects tests demonstrated that:
  - Gelatinous precipitates could form in the sump pool during the post-LOCA circulation phase.
  - Small quantities of precipitates, in combination with an insulation fiber bed, can cause significant head-loss across ECCS sump screens.
- Head-loss tests with cal-sil demonstrated that particulate deposited on a fiber laden sump screen can produce a significant pressure drop.
- Coating transport tests in water demonstrated that transport of coating chips may not be a significant concern.
- Screen bypass experiments demonstrated that NUKON, Cal-Sil, and reflective metallic insulation (MRI) fragments, depending on size and shape, readily penetrated screens with 1/16" to 1/4" opening sizes.
- Downstream effects tests on globe-type throttle-valves demonstrated that flow performance of valves with small clearances may be affected by bypassed debris.

Accomplishments and Path Forward

- Planned GSI-191 research projects are complete.
- Research results are being used in making regulatory decisions (e. g., evaluation of industry testing).
- Industry activities are being monitored to identify emerging issues.
- Work is continuing on the evaluation of NUREG-1861 peer review comments.
- Staff will identify any future research needs to ensure the acceptable resolution of GSI-191.

Presentations of Recent Projects

- Technical Letter report on "Follow-on Studies in Chemical Effects Head-Loss Research: Studies on WCAP Surrogates and Sodium Tetraborate Solutions"

- Development of a pressure Drop Calculation Method for Debris-Covered Sump Screens (NUREG-1862)

- Peer Review of GSI-191 Chemical Effects Research Program (NUREG-1861)

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WCAP Surrogate and Sodium Tetraborate Buffer Testing Argonne National Laboratory

Ervin Geiger
Office of Nuclear Regulatory Research
W. J. Shack
Argonne National Laboratory

540th ACRS Meeting
March 8, 2007

Research Motivation

- Background
  - Surrogate Testing: Some Licensees are conducting sump-screen head-loss testing using Westinghouse WCAP-16530-NP recommended procedures for producing surrogate precipitates.
  - Buffer Testing: ICET and head-loss testing indicate that sodium tetraborate (STB) appears to be a less problematic buffer than sodium hydroxide or trisodium phosphate (TSP) in certain sump environments. (Some licensees may elect STB buffer replacement as a means of addressing chemical issues).

Motivation (continued)

- Objectives
  - Surrogate Testing: Evaluate the head-loss performance of WCAP surrogate precipitates relative to the precipitates generated during earlier NRC sponsored tests (Chemical Effects/Head-Loss)
  - Buffer Testing: Examine the solubility of aluminum in STB buffered environments in the range of interest.

Argonne NATIONAL LABORATORY

... for a brighter future

Follow-on Chemical Effects Tests

W. J. Shack

March 8, 2007

U.S. Department of Energy

THE UNIVERSITY OF CHICAGO

Work Sponsored by the US Nuclear Regulatory Commission

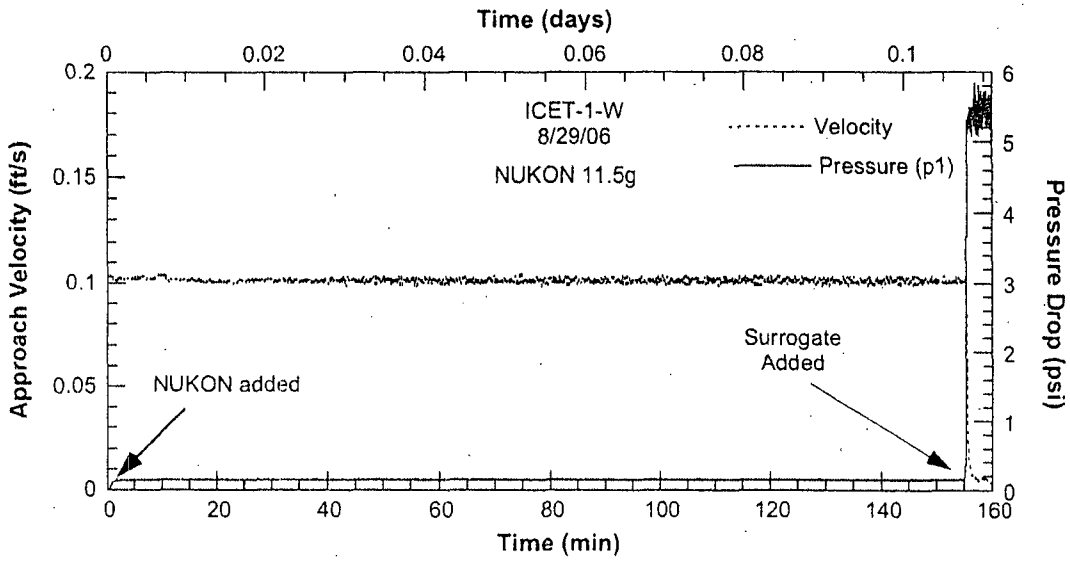
Background

- From ICET–1 & 5, NaOH buffer (pH ≈ 9.5) gives 350 ppm dissolved Al, sodium tetraborate (STB) buffer (pH ≈ 8.3) gives 50 ppm dissolved Al
  - Because of high Al / sump volume ratio in ICET, many plants would be expected to have lower dissolved Al levels with corresponding buffers
- Head loss tests with 350 ppm Al / NaOH gives very high head losses very rapidly as solution cools to 75–80°F; even with 100 ppm Al / NaOH high head losses developed after about 5 days at 70–80°F
- Head loss test with 50 ppm Al / STB resulted in no significant head loss after ≈11 days at 70–80°F; increase of dissolved Al to 100 ppm induced rapid increase in head loss
- Industry proposed a surrogate approach where aluminum oxyhydroxide would be prepared separately and added in appropriate amounts
  - Approach conservatively assumes all dissolved Al precipitates
  - Would precipitates formed from acidic solutions at relatively high concentrations have properties similar to those of actual precipitate from basic solution at lower concentration?

Follow-on test program

- Prepare surrogates as proposed by industry and test head–loss properties
- Conduct long–term head loss test with 50 ppm Al / STB to confirm previous results; increase concentrations above 50 ppm to better determine margins
- Study solubility and precipitation of aluminum oxyhyroxides from Al / STB solutions in small–scale tests

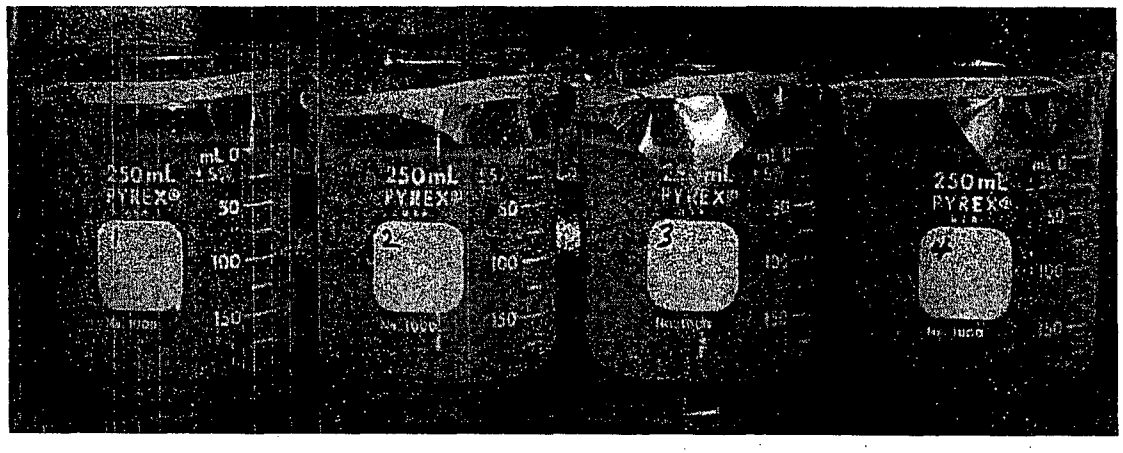
Surrogate tests

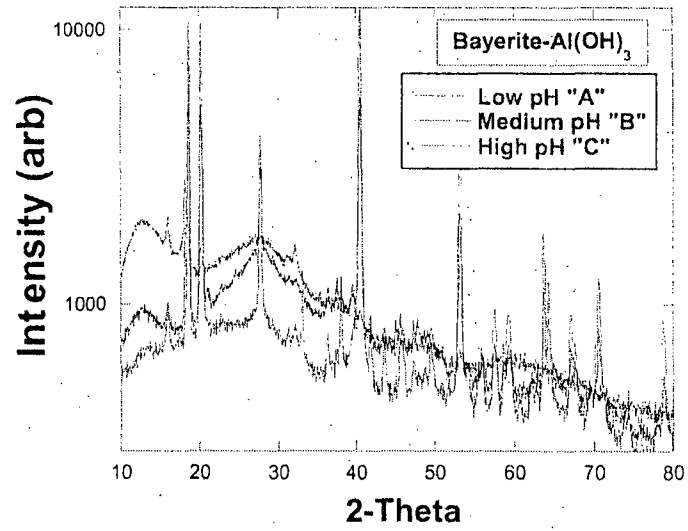


Surrogate product may be crystalline rather than amorphous

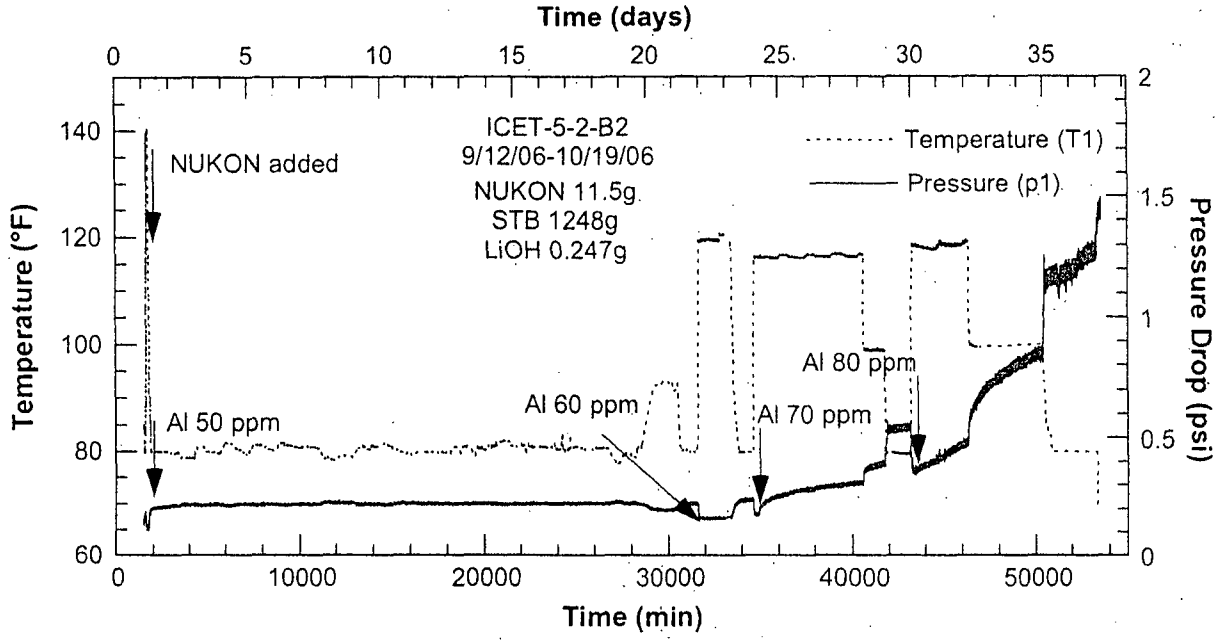
Precipitates are much more concentrated than in 100 ppm loop test

Surrogate product equivalent to 5 ppm Al precipitated on fiber bed sufficient to plug loop; difficult to use bounding approach for precipitation





Sodium Tetraborate Loop Test



- Test ran for ≈ 22 days with 50 ppm Al at ≈ 80°F with no noticeable increase in head loss
- Al concentration of ≈ 70 ppm produced some increase in head loss; ≈ 80 ppm significant increase in head loss
- Amount of Al actually removed from solution is 3–7 ppm, reasonably consistent with the results of the surrogate tests that precipitation of small amounts of Al sufficient to cause significant head loss

Small scale sodium tetraborate tests

- Two types of tests performed
  - Solubility test where concentrations of Al were slowly increased and formation of precipitates checked visually and by sampling for inductively coupled plasma (ICP) analysis
  - Precipitation kinetics test where a highly oversaturated solution is held at constant temperature for a long time
- In the solubility test tiny amounts of translucent precipitate were observed when the concentration was increased from 50 to 55 ppm in the solutions at 80°F. In the precipitation kinetics test the measured concentration after 134 days at 70–80°F was 55 ppm.
- Precipitation kinetics are slow. At 80°F at nominal levels of 85–90 ppm both the small–scale solubility tests and the loop tests suggest that only 3–10 ppm of Al is actually removed from solution (at least in terms of precipitate particles > 0.22μm) over a time scale of the test.
- Solubilities in terms of pH and temperature appear much higher than observed in Al / NaOH solutions even with boric acid additions. Not clear whether this is a true difference in solubility or due to sluggishness of precipitation

Conclusions

- When a fiber bed is present, formation of aluminum oxyhyroxides corresponding to ≈ 5 ppm dissolved Al can produce very high head losses.
- For Al area / sump volume ratios equal to or less than that used in the ICET tests, it is unlikely that amounts of precipitate sufficient to cause significant increases of head loss in fiber beds will form in sodium tetraborate buffered solutions for temperatures > 70°F over the time scales of interest

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Testing and Modeling of Pressure Drop Across a Porous Medium Debris Bed on a PWR Sump Screen

William Krotiuk
Office of Nuclear Regulatory Research
ACRS Meeting
March 8, 2007

Head Loss Testing

- Project Title: Head Loss Testing
  - Confirmatory PWR sump screen head loss (pressure drop) testing using typical insulation insulation and coating debris
- Contractor: Pacific Northwest National Laboratory
- Objectives:
  - Characterize bed pressure drop to debris type and distribution, and to fluid temperature.
  - Provide temperature measurement and control, in situ bed thickness measurement, and debris bed constituent mass measurements.
  - Provide data to improve pressure drop calculational method.
- Status:
  - Testing complete, NUREG/CR-6917 published 2/2007

Head Loss Testing

- Large Test Loop
  - 6-inch diameter cross section
  - Temperature control to 90ºC (195ºF)
  - In situ debris bed height measurement using optical triangulation technique
  - Pressurized (150 psig max.) to maintain gas in solution
  - Filtration system removes suspended particles (>10 μ m) after bed formation
- Bench Top Loop
  - 4-inch diameter cross section
  - Used to perform scoping and sensitivity testing

Debris Constituents	Number of Tests Performed
5-Mesh Screen Only (Large Loop)	2
Perforated Plate Only (Large Loop)	3
CalSil Only (Large and Bench Top Loops)	11
NUKON Only (Large and Bench Top Loops)	90
NUKON and CalSil combined (Large and Bench Top Loops)	45
Ameron's Amercoat 5450 alkyd topcoat (AA) (Large Loop)	3
Ameron's Dimetcote 6 inorganic Zn primer w/ Amercoat 90 epoxy topcoat (Large Loop)	1

Head Loss Testing Conclusions

- Nukon-only debris bed tests yielded relatively repeatable results.
- Increases in CalSil mass in Nukon/CalSil debris beds did not yield consistent increases in pressure drop.
  - CalSil distribution in bed affected pressure drop.
- Complete CalSil-only test beds could not be formed.
- Debris preparation can influence bed pressure drop (Δp).
- Loading sequence of Nukon and CalSil during bed formation strongly influences bed pressure drop and constituent distribution.
  - CalSil particles can concentrate on bed surface.
- Debris beds contract and relax with changes in approach velocity.
- For most cases, pressure drop decreased with increased temperature.
  - Results can be influenced by debris bed history, such as flows and temperatures, which can affect constituent debris distribution in bed.

Head Loss Modeling

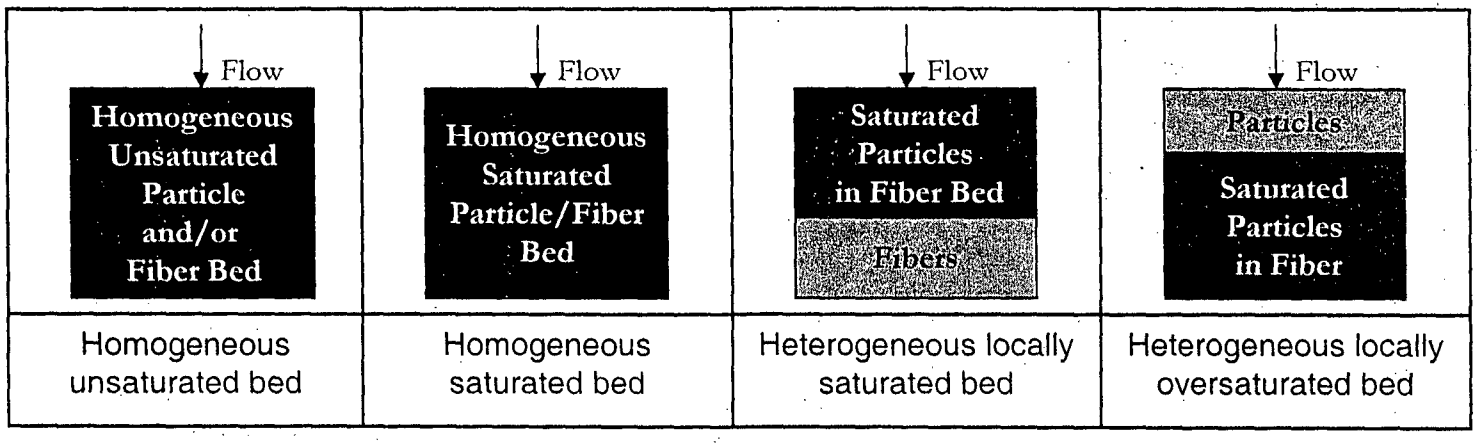
- Project Title: Head Loss Modeling
  - Develop improved model to conservatively calculate PWR sump screen pressure drop across particulate/fiber insulation debris beds.
- Objective:
  - Improved model should conservatively predict Δp across and compression of insulation, and provide insight on how variations in debris concentrations can affect Δp .
- Status:
  - NUREG-1862 published 2/2007

Head Loss Modeling

- Δp calculation based on classical form of porous medium (Ergun) equation.

- Two modeling methods developed.
  - A single homogeneous control volume
    - Best estimate Δp for bed with one debris type
    - Lower bound Δp for bed with two debris types
  - Two control volumes for heterogeneous debris distribution
    - Upper bound Δp for bed with two debris types

- Bed compression/expansion model assumes irreversible compression followed by elastic compression or expansion.



Head Loss Modeling Conclusions

- One-volume Homogeneous Model
  - Nukon-only test predictions provide comparative or conservatively higher pressure drops for all PNNL, ANL and LANL/UNM test data.
  - Nukon/CalSil test predictions provide pressure drops lower than test data.

- Two-volume Heterogeneous Model
  - Nukon/CalSil test predictions generally provide comparative or conservatively higher pressure drops for 75% of PNNL or LANL/UNM tests .
    - Prediction comparative or higher for larger CalSil saturation thicknesses.
    - Predictions adequate, in correct order of magnitude, for smaller CalSil saturation thicknesses.
      - Small inaccuracies in CalSil thickness predictions can result in large changes in Δp.
      - Correlation for calculating the particle saturated layer thickness can be improved especially for smaller CalSil thicknesses.

- Bed thickness predictions for all cases are comparative to test data.

- The calculational method generally predicts higher pressure drops at lower temperatures which is consistent with classical theory.

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Chemical Effects Peer Review

Paulette Torres
Robert L. Tregoning
NRC

Advisory Committee on Reactor Safeguards
March 8, 2007

Peer Review Objectives

1. Review technical adequacy of RES-sponsored activities related to chemical effects in PWR sump pool environments
   - Integrated Chemical Effects Testing (ICET): NUREG/CR-6914
   - ICET Follow-up Testing and Analysis: NUREG/CR-6915
   - Chemical Speciation Prediction: NUREG/CR-6912
   - Chemical Effects Head Loss Testing: NUREG/CR-6913

2. Recommend research improvements and identify important technical issues for consideration

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Peer Review Selection

- Recommendations from industry, ACRS, academia, laboratories, NRC staff
- Provide range of technical expertise
- Possess diversity of experience

Name	Affiliation	Area of Technical Expertise
John Apps	Senior Scientist, Earth Sciences Division, Lawrence Berkeley National Laboratory	▪Geochemical modeling ▪Gel formation and characterization ▪Chemical speciation modeling ▪Nuclear waste isolation
Wu Chen	Senior specialist, Dow Chemical Co.	▪Fluid/particle separation ▪Industrial filtration processes
Calvin Delegard	Senior Scientist, Pacific Northwest National Laboratory	▪Experimental testing and analysis ▪Analytical Chemistry ▪Nuclear materials safeguards
Robert Litman	Analytical Chemist, Radiochemistry Laboratory Basics	▪Analytical Chemistry ▪Metallic/corrosion processes ▪Nuclear industry experience
Digby Macdonald	Professor and Director of Center for Electrochemical Science and Technology, Penn. State University	▪Electrochemistry and thermodynamics ▪Metallic/corrosion processes ▪Experimental testing and analysis

Peer Review Products

- NUREG – 1861: Published December, 2006
  - Main body summarizes individual peer reviews.
  - Five individual peer review reports provided as appendices.
    - Review of NRC-sponsored research
    - Other significant findings
  - No consensus sought nor derived from inputs by staff in NUREG.

- Phenomena Identification and Ranking Table (PIRT) Exercise

Chemical Effects PIRT

- Apparent early in peer review that many issues were beyond the scope of original NRC-sponsored research.
- **Motivation**: Use PIRT process to identify and rank issues related to post-LOCA chemical effects.
- **Objective**: Identify chemical phenomena (solids, films, precipitates, effects, etc.) which lead to deleterious emergency core cooling system performance and possible reactor fuel damage due to inadequate heat removal in a post-LOCA environment.
- **Evaluation Criteria**: Evaluate chemical phenomena most likely to
  - Contribute to sump screen clogging
  - Degrade downstream component performance
  - Diminish core heat transfer
  - Affect structural integrity

PIRT Approach

- Partitioned ECCS post-LOCA cooling into four time periods that capture different operational phases and/or important phenomena
  - Debris Generation (0 to 30s)
  - ECCS Injection (30s to onset of recirculation)
  - Short-term ECCS recirculation (onset of recirculation to 24 hours)
  - Long-term ECCS recirculation (24 hours to 30 days)
- Evaluated the post-LOCA mission time out to 30 days
- Brainstormed issues for consideration within each time period
- Ranked issues with respect to importance (high, medium, low) and knowledge state (known, partially known, unknown)

PIRT Results: Issue Characterization

- Issues identified can be grouped based on chemical processes or phenomena.

1. Underlying Containment Pool Chemistry
2. Radiological Considerations
3. Physical, Chemical, & Biological Debris Source Terms
4. Solid Species Precipitation
5. Agglomeration and Settling: Chemical Effects
6. Organics & Coatings
7. Chemical Effects on Downstream System Performance: Pumps, Heat Exchangers, Reactor Core

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Selected PIRT and Peer Review Issues

- Underlying Containment Pool Chemistry
  1. Containment debris mixture effects
  2. pH variability
- Radiological Considerations
  3. Radiolysis effects on redox potential
  4. Radiolytic conversion of nitrogen
- Physical, Chemical, & Biological Debris Source Terms
  5. Crud release
  6. RCS silica concentration
- Solid Species Precipitation
  7. ECCS thermal cycle effects
- Agglomeration and Settling: Chemical Effects
  8. Quiescent settling of precipitates
- Organics & Coatings
  9. Coating decomposition and leaching
- Chemical Effects on Downstream Systems
  10. Erosion/corrosion of ECCS pumps

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Issue Description

Phenomenon/Issue	Description
Containment debris mixture effects	Different debris characteristics (e.g., total mass, mixture constituents, compositions) could alter containment pool chemistry and affect debris bed capture efficiency of chemical/physical products.
pH variability	Initial containment chemistry variable throughout RCS fuel cycle and also evolves post-LOCA.
Radiolysis effects on redox potential.	The effects of core radiation field on the formation of radicals and reactive compounds (e.g., H_2O_2) can fundamentally affect types of chemical products and precipitates.
Radiolytic conversion of nitrogen	Radiolytic conversion of nitrogen from ambient containment air into nitric acid may reduce the containment pool pH.
Crud release	Fe, Ni corrosion oxides (crud) from the RCS piping are released due to hydraulic shock of the LOCA. Crud release creates a radiolytic environment on sump screen debris bed which may affect subsequent reactions; particulate in containment pool may also enhance coagulation.

Issue Description, cont.

Phenomenon/Issue	Description
RCS silica concentration	Presence of silica in water storage systems and the RCS may combine with Mg, Ca, or Al to form species with retrograde solubility, or affect the total mass of material precipitating.
ECCS thermal cycle effects	Fuel cladding surface may cause species with retrograde solubility to precipitate out and bind to these surfaces. Species with normal solubility profiles may precipitate in heat exchanger. Co-precipitation effects may also be important.
Quiescent settling of precipitates	Quiescent flow regions within containment pool may allow larger, more stable particles/precipitates to form.
Coating decomposition and leaching	• Leaching of submerged coatings (e.g., Pb-based paints, phenolics, PVC) may contribute species to the containment pool. • Hydrothermal hydrolysis could partially de-polymerize polymeric materials, producing particles and/or gels.
Erosion/corrosion of ECCS pumps	Chemical byproducts cause erosion or corrosion of tight tolerance pump internals (bearings, wear rings, impellers, etc.).

Peer Reviewer Testing & Analysis Recommendations

- Multiple small scale tests can efficiently evaluate effects of key variables.
  - Quantify relevant variables affecting solubility
  - Evaluate temperature cycle effects
  - Evaluate contributions of specific materials not in ICET
- Current analytical modeling efforts do not fully exploit existing capabilities of available codes.
  - Additional consideration of reaction rates (kinetics)
  - Incorporation of radiological considerations
- Various reviewers recognized that modeling sump screen chemistry is highly challenging in light of expected continued non-equilibrium reactions (e.g., hydrolysis, polymerization, coagulation, precipitation) over mission time (≈ 30 days).

Peer Reviewer Issues: General Path Forward

1. Communicate information to vendor teams and licensees currently evaluating chemical effects to facilitate GL 2004-02 resolution
2. Document PIRT process and summarize important issues identified in PIRT
3. Disposition specific issues individually, based on, for example
   - Industry mitigation strategies
   - More detailed consideration of plant conditions
   - Literature review and scoping calculations
   - Targeted follow-on industry-sponsored and/or NRC-sponsored research.

Peer Reviewer Issues: Example Disposition of Specific Issues

- Several issues already being explicitly considered in GL 2004-02 resolution.
  1. Containment debris mixture effects
  2. pH variability
  3. Thermal cycle effects within heat exchanger and reactor core.
  4. Erosion/corrosion of ECCS pumps
  5. Coating decomposition and leaching
  - Current challenge is to either conservatively or realistically evaluate effects on ECCS performance.
- Several issues promote favorable chemical effects.
  6. Quiescent settling of precipitates
  - Opportunities exist to utilize these attributes in resolution.
- Some remaining issues may need additional consideration.
  7. Radiolysis effects on redox potential
  8. Radiolytic conversion of nitrogen into nitric acid
  9. Crud release
  10. RCS silica concentration

Consideration of Peer Review Testing & Analysis Recommendations

- Smaller scale, single-effect type testing is an efficient approach for understanding variability and importance of key chemical effects.
  - Strategy has been used to evaluate many issues raised by ICET.
  - ANL followed approach in surrogate testing.
  - Industry-sponsored research used approach to evaluate chemical source terms.
  - Technique could be important for considering plant-specific issues.
- Development of a code to predict chemical effects head loss contribution, or debris bed chemistry, is not practical at this time.
  - Complex situation currently beyond capabilities of existing codes.
- Use of codes are most applicable for addressing specific chemical effects phenomena
  - Retrograde and standard solubility
  - Radiological considerations
  - Prediction of precipitated species

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Conclusions

- Peer review attempted to comprehensively consider chemical effects in containment pool environments.
- Peer reviewers identified many chemical issues for consideration in GL 2004-02 resolution.
- The next step is to disposition specific issues.
- Disposition process will be consistent with general resolution of technical issues related to GL 2004-02.
- Issue resolution should consider industry mitigation strategies, specific plant conditions, and scoping analysis (as appropriate) to identify candidate issues for additional study.
- Peer reviewers also provided valuable recommendations for addressing any remaining issues.