

Official Transcript of Proceedings
NUCLEAR REGULATORY COMMISSION

Title: Advisory Committee on Reactor Safeguards
590th Meeting

Docket Number: (n/a)

Location: Rockville, Maryland

Date: Thursday, January 19, 2012

Work Order No.: NRC-1387

Pages 1-203

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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590TH MEETING

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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THURSDAY

JANUARY 19, 2012

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ROCKVILLE, MARYLAND

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The Advisory Committee met at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B3, 11545 Rockville Pike, at 8:30 a.m., J. Sam
Armijo, Chairman, presiding.

COMMITTEE MEMBERS:

- J. SAM ARMIJO, Chairman
- JOHN W. STETKAR, Vice Chairman
- HAROLD B. RAY, Member-at-Large
- SAID ABDEL-KHALIK, Member
- SANJOY BANERJEE, Member
- DENNIS C. BLEY, Member
- CHARLES H. BROWN, JR. Member
- MICHAEL L. CORRADINI, Member

1 COMMITTEE MEMBERS (CONT.)

2 DANA A. POWERS, Member

3 JOY REMPE, Member

4 MICHAEL T. RYAN, Member

5 STEPHEN P. SCHULTZ, Member

6 WILLIAM J. SHACK, Member

7 JOHN D. SIEBER, Member

8 GORDON R. SKILLMAN, Member

9

10 NRC STAFF PRESENT:

11 WEIDONG WANG, Designated Federal Official

12 CHAKRAPANI BASAVARAJU, NRR/DE/EMCB

13 GORDON CLEFTON, NRR

14 PAUL CLIFFORD, NRR/DSS

15 MICHELLE FLANAGAN, RES

16 ALLEN G. HOWE, NRR

17 TARA INVERSO, NRR

18 RALPH LANDRY, NRO

19 SAMUEL MIRANDA, NRR

20 MARTIN MURPHY, NRR/DE/EMCB

21 JASON C. PAIGE, NRR

22 BENJAMIN PARKS, NRR

23 WILLIAM RULAND, NRR

24 ANTHONY ULSES, NRR/DSS

25 LEONARD WARD, NRR

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1 ALSO PRESENT:

2 LIZ ABBOTT, FPL

3 CESARE FREPOLI, Westinghouse

4 STEVE HALE, FPL

5 MIKE KILEY, FPL

6 ED MONAHAN, Westinghouse

7 CARL O'FARRILL, FPL

8 SAM SHAFER, FPL

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

8:30 A.M.

CHAIR ARMIJO: Good morning. The meeting will now come to order. This is the first day of the 590th meeting of the Advisory Committee on Reactor Safeguards. During today's meeting, the Committee will consider the following: Turkey Point Units 3 and 4 Extended Power Update Application; Proposed Revision to 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors"; Future ACRS Activities and a Report of the Planning and Procedures Subcommittee; Reconciliation of ACRS Comments and Recommendations; Draft Report on the Biennial ACRS Review of the NRC Safety Research Program; and Preparation of ACRS Reports.

The meeting is being conducted in accordance with the provisions of the Federal Advisory Committee Act. Mr. Weidong Wang is the Designated Federal Official for the initial portion of the meeting.

We have received no written comments or requests for time to make oral statements for members of the public regarding today's sessions.

There will be a phone bridge line. To preclude interruption of the meeting, the phone will

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1 be placed on a listening mode during the presentations
2 and Committee discussion.

3 A transcript of portions of the meeting is
4 being kept and it is requested that the speakers use
5 one of the microphones, identify themselves, and speak
6 with sufficient clarity and volume so that they can be
7 readily heard.

8 I will begin with an item of current
9 interest. Dr. Stephen Schultz is now an official
10 member of the ACRS and we would like to welcome him on
11 board. Steve.

12 (Applause.)

13 Dr. Schultz has completed over 33 years of
14 service in the U.S. nuclear industry. He most
15 recently managed the Duke Energy Nuclear Design Team
16 providing nuclear core design and related engineering
17 services for seven PWRs. From 1977 to 1997, Dr.
18 Schultz served the Yankee Atomic Electric Company in
19 a variety of positions culminating in Vice President
20 for Engineering Services.

21 Dr. Schultz applies over 30 years of
22 nuclear executive and line management experience in
23 technical, regulatory, and resource management through
24 his employment with both Duke Energy and Yankee Atomic
25 Electric Corporation. He has just completed an

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1 assignment with the IAEA in Vienna working on programs
2 for reactor development and assessment.

3 Dr. Schultz has authored and co-authored
4 over 20 publications in relevant nuclear engineering
5 and other scientific journals. Dr. Schultz holds an
6 M.S. in Nuclear Science and Engineering from
7 Rensselaer Polytechnic Institute and a doctorate in
8 Nuclear Engineering from the Massachusetts Institute
9 of Technology. He is a registered professional
10 engineer in North Carolina. Again, welcome.

11 Okay, the first item on the agenda is the
12 Turkey Point Units 3 and 4 extended power uprate and
13 Dr. Bill Shack will lead us through that.

14 MEMBER SHACK: We had a Subcommittee
15 meeting in December on this uprate. It's a 15 percent
16 increase in license core power that they're looking
17 at. That's a 13 percent power uprate and a 1.7
18 measurement uncertainty recapture. The license
19 amendment was prepared utilizing the review standard
20 for extended power uprates and addresses the issues
21 and provides the analyses generally identified in the
22 review standard.

23 I would point out they've made numerous
24 hardware modifications. They've installed the leading
25 edge flow measurement system which is for their

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1 measure uncertainty recapture, refurbished auxiliary
2 feedwater pumps, removed auxiliary feedwater control
3 valve travel stops. They have a new high-pressure
4 turbine, new turbine controls, new moisture separate
5 reheaters, and replaced the main condenser. They've
6 also done code changes to support the uprate. Several
7 code changes were made. Probably the most important
8 one is the switch to the ASTRUM large-break LOCA
9 methodology to give them some more margin there. But
10 all the codes that they're using have received prior
11 NRC approval. The applicant discussed issues like
12 steam generator tube vibration and boric acid
13 precipitation analysis that have arisen in other EPU
14 reviews.

15 We did have a number of open issues that
16 came from the Subcommittee. Probably the most
17 important and one we haven't seen before was the
18 effect on fuel thermal conductivity decrease with
19 burnup which was identified in Information Notice
20 2009-23. Subcommittee members also noted there was a
21 rather small margin to RCS pressure limits in the non-
22 LOCA overheating analysis. Staff had proposed a spent
23 fuel pool license condition concerning the mods that
24 are needed for operation at EPU and we had some
25 problems with the wording of that license condition.

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1 There were also questions about the reference
2 documents that were used to determine the
3 acceptability of the zone of influence for GSI-191 and
4 other impact analyses, although the EPU itself is
5 being treated independently of the GSI-191 resolution.

6 We'll hear about the status of these open
7 issues today. However, additional issues have been
8 identified by the staff since the Subcommittee meeting
9 that they will tell us about. Because we're still
10 looking at the resolution of these issues, we will not
11 be writing a letter on the EPU at this meeting. That
12 will probably occur in the March meeting. These
13 issues obviously have to be resolved and the
14 resolution has to be available for our review before
15 we can proceed with the letter and we're just not
16 there at the moment.

17 With that, I'll turn the presentation over
18 to the NRC staff.

19 MR. HOWE: Thank you, and good morning.
20 I'm Allen Howe, Deputy Director, Division of Operating
21 Reactor Licensing in the Office of Nuclear Reactor
22 Regulation.

23 We do appreciate the opportunity to brief
24 the ACRS today on the Turkey Point extended power
25 uprate application. We briefed the Subcommittee, as

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1 you mentioned, back in December on this topic. We are
2 going to provide an overview of the application. The
3 licensee will provide information on their
4 modifications and their analysis for the application.
5 The NRC staff will discuss our review and our
6 findings.

7 As was mentioned, there are some open
8 items. The staff will discuss the resolution of those
9 open items or the status of the resolution of those
10 open items as some of them are continuing to be worked
11 at this point in time.

12 We've worked diligently to address those
13 issues, however, as you'll hear during the
14 presentation we have encountered some unique
15 challenges as a part of this and we will need to come
16 back and rebrief the ACRS.

17 That being said, I am very pleased with
18 the thoroughness and the comprehensiveness of the
19 staff's review including the efforts to address the
20 thermal conductivity degradation and the other
21 emerging issues that you'll hear a little bit more
22 about. We've had frequent interactions with the
23 licensee during this period of time and during the
24 review. We've had multiple rounds of requests for
25 additional information. We've done audits of licensee

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1 and vendor analyses as a part of that. We think that
2 this interaction, this dialogue really helped us out
3 with our understanding and moving the staff's review
4 forward.

5 I'd like to, at this point, turn the
6 discussion over to Jason Paige who is the project
7 manager for this review. Thank you.

8 MR. PAIGE: Thank you, Allen. Good
9 morning. My name is Jason Paige. I'm the project
10 manager in the Office of NRR assigned to Turkey Point.
11 First, I'd like to take this opportunity to thank the
12 ACRS members for your effort in reviewing the proposed
13 EPU application and providing this opportunity for the
14 staff to present the results of its review to you.

15 I also want to express my thanks to the
16 NRR technical review staff for conducting a thorough
17 review of a very complex application and also for
18 providing support to these meetings. During today's
19 full Committee meeting, you will hear from both the
20 licensee and the NRC staff on the details of the EPU
21 application.

22 Our objective is to provide an overview of
23 the Turkey Point EPU application, present the results
24 of the staff's review, and provide a status of open
25 items generated during and after the ACRS Subcommittee

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1 meeting in December 2011.

2 Before I cover agenda items for today's
3 meeting, I would like to provide some background
4 information related to the proposed EPU. On October
5 21, 2010, the licensee submitted its license amendment
6 request for the Turkey Point Units 3 and 4 EPU. The
7 amendment would increase each unit's licensed thermal
8 power from 2,300 megawatt thermal to 2,644 megawatt
9 thermal. This represents a net increase of 15 percent
10 including a 13 percent extended power uprate and a 1.7
11 percent measurement uncertainty recapture.
12 This would also represent a 20 percent increase from
13 the original licensed thermal power level.

14 The staff's method of review was based on
15 Review Standard-001 which is NRC's review standard for
16 extended power uprates. This review standard provides
17 guidance to the NRC staff for their review of EPU
18 applications including acceptance criteria, a safety
19 evaluation template, and matrices that identify the
20 multiple technical areas the staff is to review.

21 There are no open licensing actions
22 associated with or linked to this EPU application.
23 The staff recently issued two associated amendments
24 the licensee needed before it could implement the EPU.
25 The staff approved an alternative source term

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1 amendment and a spent fuel pool criticality analysis
2 amendment in June and October 2011, respectively.

3 The licensee submitted approximately 45
4 supplements to the application in response to the
5 multiple staff requests for additional information
6 which supported the staff's completion of its safety
7 evaluation. In addition, the staff conducted several
8 audits to complete its review and resolve open items.

9 This slide provides the agenda topics that
10 will be covered during today's presentations. The
11 presentations will include five open items generated
12 from the Subcommittee meeting on December 14th and
13 additional issues that were recently identified by the
14 staff. The staff will provide details and the status
15 of these open items during their presentations.

16 The licensee will provide an overview of
17 the proposed EPU and related proposed plant
18 modifications. The NRC staff will then provide an
19 overview of its review and safety analysis, focus
20 presentations on the thermal conductivity degradation
21 issues, and the two mechanical and civil engineering
22 open items generated during the Subcommittee meeting.

23 During the Subcommittee meeting, the staff
24 presented an emerging issue regarding the thermal
25 conductivity degradation as an open item. At the

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1 conclusion of the meeting, the Subcommittee requested
2 that the staff forward any licensee supplements
3 related to this issue to the ACRS and address the
4 resolution of staff findings on the issue during
5 today's meeting. The licensee supplements dated
6 December 31, 2011 and January 16, 2012 were provided
7 to the ACRS and will be discussed by the licensee
8 during its presentation.

9 Although the staff and the licensee have
10 worked diligently to resolve this issue before today's
11 meeting, you will hear during our presentations that
12 this issue has presented unique challenges and remain
13 as an open item. The licensee and staff will provide
14 a status and additional details on this issue in our
15 proposal to disposition the issue during a subsequent
16 ACRS meeting.

17 Unless there are any questions, I'd like
18 to turn the presentation over now to Mr. Mike Kiley
19 for the licensee's presentation.

20 MEMBER SHACK: Let me ask a question. The
21 mechanical degradation, we've seen a number of large
22 EPUs for PWRs, Point Beach, Kewaunee. Why is this
23 issue being raised now and is it something that has to
24 go back and looked at in some of these other EPUs?

25 MR. HOWE: Tony, could you address that

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1 issue, please?

2 MR. ULSES: This is Tony Ulses. I'm the
3 Branch Chief of the Reactor Branch. The short answer
4 is yes, it needs to be dealt with and it has been
5 dealt with by licensees. In response to the
6 Information Notice, they all did an immediate
7 determination of operability and all concluded that
8 they had adequate margin in their analysis right now
9 to accommodate this. However, we are continuing to
10 address this issue generically and we are continuing
11 to follow it.

12 MEMBER SHACK: Was it addressed in the
13 EPUs, the large EPUs that we've looked at for the
14 PWRs?

15 MR. ULSES: Our first understanding of the
16 magnitude of this issue was identified to us in early
17 December of last year. So the short answer is we knew
18 about the issue, but we've never seen a quantification
19 of the magnitude of the issue until last year in
20 December. And so we acted very quickly and we got the
21 Information Notice out of the NRC within a matter of
22 a week in order to get the information out to
23 licensees for them to have the information to take the
24 appropriate actions as required by the rule.

25 MR. PAIGE: Unless there's any other

1 questions, I'll turn it over to Mr. Mike Kiley. He's
2 the Site Vice President at Turkey Point.

3 MEMBER BANERJEE: Bill, what did you imply
4 by your question? I'm trying to understand.

5 MEMBER SHACK: Oh, just the question of
6 whether this has to be reexamined for some of those
7 other large EPUs that we've looked at for PWRs. We're
8 here today -- you have to take some steps in your core
9 design to address it and the question is have the
10 other EPUs considered that and will it impact their
11 core design?

12 MEMBER BANERJEE: I think then the answer
13 is not all that clear because Tony, does that mean
14 that the other EPUs such as Point Beach and so on are
15 just addressing the issue independent of the EPU?
16 What's going on?

17 MR. ULSES: Let me try to speak a little
18 more about this in the context of what's required by
19 the rule. 50.46 has a process in it that allows for
20 the identification of errors or changes to the
21 evaluation models. In other words, it's expected that
22 if an error is out there, we will find errors in the
23 methodology. That rule requires that the licensee
24 make an assessment of the impact of the error. They
25 have to identify whether or not that error will cause

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1 any of the 50.46 acceptance criteria to not be met.
2 In other words, in this case, the 2200 value on PCT is
3 really the driver here. All the licensees have taken
4 the information that was provided in the information
5 notice and they have done that assessment. And they
6 have concluded that they have adequate margin in
7 either their ECCS evaluation model or how they operate
8 their plant.

9 In other words, the analysis is generally
10 done in extremely limiting conditions and the plant
11 doesn't operate at those conditions. And therefore,
12 they've concluded that they have adequate margin. But
13 as I said, we are continuing to follow this issue
14 generically and we will also follow it on a price-
15 specific basis as needed and as the information comes
16 to us.

17 CHAIR ARMIJO: I'd just like to ask a
18 question. Is that adequate margin based on the ECCS
19 analysis of record is margin because there's been some
20 modifications or conservatisms available to be put
21 into the analysis of record?

22 MR. ULSES: I think what you're asking is
23 is there margin to -- in how the plant is operated
24 versus how it was analyzed -- is that the question?

25 CHAIR ARMIJO: No. The analysis that's

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1 used to establish PCT --

2 MR. ULSES: Right.

3 CHAIR ARMIJO: Even with the thermal
4 conductivity degradation, do you still meet the PCT
5 limit without any changes in the analysis method?

6 MR. ULSES: The answer to the question is
7 that that's the assessment that the licensees have
8 concluded and that's their conclusion, that they have
9 again, they have -- one example, for example is these
10 analyses are generally done in extremely limiting
11 power distributions. But the plant doesn't generally
12 operate at those power distributions and that gives
13 them margin which is inherent in the -- and actually
14 the other plant is analyzed versus how it's operated
15 and that's one area that licensees have assessed and
16 they've concluded that they have adequate margin.

17 MEMBER POWERS: If they're relying for the
18 margin on quote "how they operate the plant," unquote,
19 is that operational mode now move into the tech specs
20 or something? I mean I can say yes, I've never
21 operated in this mode so I have margin and tomorrow I
22 change my operation mode.

23 How do you prevent them from changing the
24 way they operate the plant?

25 MR. ULSES: Well, right now again, the way

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1 this is controlled, this is a licensee process; 50.46
2 has very specific requirements that the licensees have
3 to follow. The NRC staff, as I said, is continuing to
4 follow this issue and we are continuing to look into
5 it, using the processes we have available to us. But
6 as it stands right now, the licensees have made this
7 assessment and they have concluded that they are
8 operating in accordance with 50.46b requirements.

9 MEMBER BROWN: Do you all agree?

10 MR. ULSES: We have taken a look at the
11 information that the -- we identified the plants that
12 have a PCT in excess of 2,000 degrees. We have looked
13 at those operability evaluations and right now the
14 information in front of us we agree with their
15 assessment.

16 MEMBER BANERJEE: With the EPUs that we
17 approved, Tony, are they going back and evaluating the
18 situation with regard to EPU conditions then?

19 MR. ULSES: They're evaluating the plant
20 as it's currently operating, so the answer is yes.
21 They're looking at the plant at EPU conditions based
22 on their current analysis of record which would be
23 done at EPU power. So, for example, the Point Beach
24 example that was analyzed and looked at at its current
25 operating power.

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1 MEMBER BROWN: If I could just make sure
2 I understand. They don't meet it on a design basis.
3 They're depending on the operational mode that they're
4 operating in in order to show that they've got margin,
5 yet in response to the other question we're not aware
6 of any particular operating tech spec or limits that
7 have been put in place to ensure that they don't ever
8 get into a condition outside of the operating mode
9 where they've done their analysis for margin.

10 Is that -- that's all I've heard from
11 talking to -- from listening to the conversation. Is
12 that right or wrong?

13 MR. ULSES: The information again is what
14 was done, was an immediate determination of
15 operability which again took into account how the
16 plant is operated versus how it's analyzed and that's
17 what the licensee did, that's what they provided to us
18 via resident inspectors at the sites. The staff at
19 headquarters took a look at it and we concluded that
20 we accept their immediate determination of
21 operability. But as I said, we are continuing to
22 follow this issue, using the processes available to
23 us.

24 MEMBER ABDEL-KHALIK: Do you expect any
25 tech spec changes to come out as a result of this?

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1 MR. ULSES: Well, it's hard to say. I
2 would say right now based on what we've seen I would
3 expect at a minimum or what a site may have to do
4 would have been taken and follow an approach similar
5 to what you're going to hear today from staff and FPL.
6 From what I understand, FPL has looked at their
7 operating power distributions and is making changes to
8 those as necessary. But that's one area that I think
9 licensees have looked at and that's one area where I
10 would expect to see if any changes I would expect to
11 see changes there.

12 MR. HALE: Yes, if I could -- Steve Hale,
13 Florida Power and Light speaking from the licensee's
14 perspective. When an error of this type, whether its
15 TCD or anything is identified, typically we have to do
16 an evaluation. If the evaluation identifies a greater
17 than 50 degree impact on PCT as a result of the error,
18 whatever it might be, we're required to file a 50.46
19 report which specifically identifies restrictions and
20 limitations that we have to impose and until we do a
21 reanalysis, consistent with an approved evaluation
22 methodology. So while there are interim positions
23 that are established and it would be included in a
24 50.46 report, this is not the first time that an error
25 has been identified that negatively impacts peak clad

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1 temperature.

2 MEMBER SIEBER: This analysis is performed
3 at every reload safety evaluation as part of your
4 reload analysis?

5 MR. HALE: No, not necessarily.
6 Typically, what we do is we establish limitations.

7 MEMBER SIEBER: You use the box method?

8 MR. HALE: You develop a box and you
9 ensure that you're within that box.

10 MEMBER SIEBER: Right.

11 MR. HALE: Now for our case, coming
12 forward with a new license and action, our box has
13 gotten a lot smaller as a result of the TCD issued.

14 MEMBER SIEBER: That's right. And for the
15 next reload for every unit that's affected by this,
16 that box will change.

17 MR. HALE: That is correct, until such
18 time as a reanalysis or a new evaluation methodology
19 is available to address it. I hope that helps.

20 MEMBER BROWN: No, I understand what you
21 needed to do. My issue and I'm just trying to frame
22 Dana's question about how does everybody know that
23 they're bracketed or bounded -- they've got boundary
24 conditions on their operations and it's known to the
25 operators where they can go and where they can't go,

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1 while the analysis is being completed.

2 I'm not questioning the ability to do
3 this. It's obvious you need to be able to do it. It
4 was just what do you put in place to make sure you
5 stay safe while all the i's are dotted and the t's are
6 crossed.

7 MR. HALE: Understood.

8 MEMBER BROWN: And it's known to the
9 people operating the plant. Thank you.

10 MEMBER SHACK: Mr. Hale, I think we can
11 move on.

12 MR. HALE: Okay.

13 (Laughter.)

14 MR. HALE: With that, Mike?

15 MR. KILEY: All right. As Jason said, my
16 name is Mike Kiley. I'm the Site Vice President for
17 the Turkey Point Nuclear Plant. Again, I'd like to
18 thank the ACRS for the opportunity to present the
19 Turkey Point EPU.

20 At this point, I'd like to introduce the
21 staff that we did bring this morning. So on my far
22 left Sam Shafer. Sam is a current licensed SRO at the
23 station with more than 25 years of operating
24 experience at Turkey Point. Steve Hale, he's the
25 Director of Licensing for the EPU. And to my

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1 immediate left is Carl O'Farrill. He's our Fuels
2 Engineering Manager. So I'm confident with the staff
3 we have here today, we can answer any questions that
4 are asked.

5 So Turkey Point, I'm just going to give
6 some brief introductions, Turkey Point is located
7 about 25 miles south of Miami. It sits on
8 approximately 11,000 acres and has 5 operating units
9 and that's the numbering sequence that puts the two
10 nuclear Units 3 and 4. So there's two fossil units
11 that came on line in '67 and '68. Those are Units 1
12 and 2; 3 and 4 came on -- the nuclear units came on
13 line in '72 and '73. And Unit 5 is a fairly new
14 combined-cycle unit, 1,100 megawatts that came on in
15 2007.

16 The two nuclear Units 3 and 4, they're 3-
17 loop Westinghouse PWRs with a Westinghouse secondary,
18 currently producing 795 megawatts electric gross.
19 That was the original AE, architect engineer for
20 construction and design.

21 As I mentioned, Units 3 and 4 did come on
22 line in '72 and '73. We did get the license renewal
23 approved in 2002 and that brings the license out to
24 2032 and 2033, respectively. Like many plants in the
25 industry, we have replaced our steam generators. The

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1 generators were replaced in the early '80s, '82 and
2 '83. We did install two additional diesels, so we
3 have four safety-related diesels at the station,
4 uniquely designed that one diesel can maintain both
5 units in safe shutdown condition. The heads, again
6 like most of the industry, we did replace the reactor
7 vessel heads in 2004 time frame.

8 So as Jason said, our original licensed
9 thermal limit was 2,200 megawatts thermal. We did go
10 through a 5 percent stretch power in 1996 to bring us
11 up to 23. What we're here to present today is the EPU
12 which would bring us up to 2,644.

13 So if there aren't any questions at this
14 point, I'd like to turn it over to Steve Hale.

15 MR. HALE: All right, thanks, Mike. As
16 Mike indicated, I'm Steve Hale. I'm the Licensing
17 Director for the EPU effort at Turkey Point. As Jason
18 summarized, we're doing a 15 percent total extended
19 power uprate. Includes 13 percent EPU, plus a 1.7
20 percent measurement uncertainty recapture, the total
21 being about 17 percent or 2,644 megawatts thermal.

22 Just some of the attributes of the Turkey
23 Point extended power uprate, we are able to meet NPSH
24 requirements for the ECCS pumps without any credit for
25 containment overpressure. We're not making any

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1 mechanical fuel design changes for the EPU. And as
2 Jason also mentioned, there were two other license
3 amendments, the alternate source term which was
4 approved in June, as well as the spent fuel
5 criticality, revised spent fuel criticality analysis.
6 And that amendment was issued in October of 2011.

7 We have completed all the grid stability
8 studies, not only for the Turkey Point uprate, but as
9 you'll be seeing some time in the future the St. Lucie
10 extended power uprates, since they're all part of the
11 same grid. And our current plan is to implement all
12 of our final modifications for the extended power
13 uprate for Unit 3 in the spring of 2012 and in the
14 fall of 2012 for Unit 4.

15 I've included a summary. I won't go
16 through these individually, but this just gives you a
17 perspective on the changes in various parameters from
18 the original through the stretch power uprate that was
19 implemented in 1996 and for the EPU change. As you
20 can see, we are -- we do have an increase in T av. We
21 are taking credit for some of the margin and thermal
22 design flow with reactor coolant pumps. You can see
23 some of the other parameters we've indicated there.

24 Next slide.

25 This is a summary of the modifications.

1 Again, we went through this in some detail with the
2 Subcommittee, so I won't get into specifics, just some
3 of the highlights. These are the safety-related
4 modifications we implemented. As Dr. Shack had
5 mentioned, we did implement refurbishment on the
6 auxiliary feedwater pumps. We are making some changes
7 to main steam safety valve and pressurizer safety
8 valve setpoints and we've implemented the leading edge
9 flow measurement system which supports our NUR.

10 Next slide.

11 Looking at the modifications on the
12 secondary side, we are implementing a new high-
13 pressure turbine and the electrohydraulic control
14 valves for the turbine. This is a major reliability
15 upgrade for the plant. We are going to digital
16 turbine controls. We'll be placing the MSRs in the
17 condensate and feedwater system. We're actually
18 replacing the main condenser and the condensate pumps
19 and motors. We're upgrading the feedwater pump
20 rotating assemblies and so on and so forth as you can
21 see in those mods.

22 Next slide, please.

23 Again, going forward, modifications to the
24 heater drains, a lot of this stuff is flow based, but
25 we are looking at improvements and reliability by

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1 upgrading some of the controls.

2 Next slide.

3 And then on the electrical side, we are
4 rewinding the electrical stator and we're also
5 replacing rotor. We're including a number of other
6 modifications associated with the generator
7 modifications. We have replaced the iso-phase duct
8 cooling system, upgraded it to provide additional
9 cooling, providing upgrade cooling. We did replace
10 the main transformers some time ago and we're
11 upgrading the cooling there to address additional
12 capacity. We're replacing the aux transformers and
13 we're implementing some other special measures.

14 Just an update. We had five open items
15 walking away from the Subcommittee. Three of the
16 items will be addressed by the staff today. This is
17 based on interface between ourselves and the staff.
18 As Dr. Shack mentioned, the spent fuel heat exchanger
19 license condition, talk a little bit about HELB and
20 our loss of load analysis, our conservatisms
21 associated with that.

22 MEMBER SKILLMAN: Steve, a question,
23 please? I'm Dick Skillman. For the spent fuel
24 license condition, does the approach that FPL is using
25 ensure that the modifications are completed before you

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1 go into the next cycle with the higher percentage
2 fuel?

3 MR. HALE: That is correct.

4 MEMBER SKILLMAN: Thank you.

5 MR. HALE: And then the two remaining open
6 items you'll hear -- Carl will be addressing the
7 thermal conductivity degradation and the amount of
8 work we've completed over the last few weeks. As you
9 can see with the documents we submitted, we've done
10 quite a bit in addressing this particular issue and
11 Carl will try to summarize where we stand with that.

12 And the other is the new fuel storage area
13 criticality analysis. We submitted to the staff what
14 they needed in December and that's still under review
15 and hopefully, we'll be closed here shortly.

16 I know that was fairly quick, but if there
17 are any additional questions, I'll turn it over to
18 Carl for the safety analysis portion.

19 MR. O'FARRILL: Good morning. My name is
20 Carl O'Farrill and I'm the Fuel Engineering Manager
21 for Florida Power and Light. Today, I'd like to
22 provide an overview of the safety analysis that was
23 performed in support of the Turkey Point extended
24 power uprate.

25 Some of the key changes that we made --

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1 Steve mentioned some of the modifications that were
2 made in order to accommodate the EPU which also were
3 factored into the safety analysis, but some of the
4 other changes that we have made, we have improved
5 methods. Dr. Shack mentioned that as well. Key to
6 that is that change from the CQD to the ASTRUM
7 methodology would be a large break LOCA analysis.

8 We also made reductions to the peak heat
9 factors, F_q , as well as $F \Delta H$ and reduction in the
10 actual offset operating limits for the plant site and
11 these are the boxes we were talking about when we
12 discussed the TCD. In fact, I'll get into that a
13 little later on. The diesel boxes had to be reduced
14 further in order to accommodate the impact of TCD in
15 the large break LOCA analysis.

16 We made conservative assumptions for the
17 physics parameters and assured ourselves that those
18 would bound our future EPU core designs. We also
19 included bounding, as typically done, bounding plant
20 parameters in the analysis of assumptions, as well as
21 conservative trip setpoints.

22 We maintain as per the Westinghouse
23 methodology a conservative analysis limit, a safety
24 analysis limit for the DNB requirement which provides
25 considerable margin to the design limit for departure

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1 from nuclear boiling.

2 Next slide.

3 What we did here in these next few slides
4 is look at the class of events and summarizing briefly
5 the results from the limiting events for those
6 particular class. And we'll just start to go through
7 it. For the loss of flow or reduction in flow we have
8 the loss of flow event as well as the locked rotor
9 event. You can see that we had margin to the limits
10 and those results.

11 With respect to overheating, the loss of
12 load is the most limiting event for us and the minimal
13 margin that Dr. Shack mentioned also that was
14 discussed at the ACRS Subcommittee, but there are
15 significant conservatisms in the analysis that lead to
16 that result in which we bound all the operating
17 parameters in a deterministic fashion. Everything is
18 in the worst direction, all at the same time.

19 MEMBER SKILLMAN: Carl, I would like to
20 ask a question about that, please. I see the
21 communication from Steve Hale to Jason at the end of
22 the year. And on the topic of conservatisms, we start
23 from those conservatisms to get, if you will, the most
24 accurate result with what I think you're communicating
25 are the worst case beginning conditions. I would like

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1 to ask this question. In the December 29th email you
2 sent to Jason, you said that you were going to use the
3 nominal pressurizer pressure minus the uncertainty and
4 the nominal pressurizer water level plus level
5 uncertainty.

6 My question is had you used your highest
7 pressurizer pressure and your highest pressurizer
8 level, would you have exceeded your 2748 criteria for
9 loss of load?

10 MR. O'FARRILL: I believe Ed Monohan with
11 Westinghouse who provided me that input could address
12 that specifically.

13 MR. MONAHAN: This is Ed Monahan from
14 Westinghouse. We did look at those cases for other
15 plants and for other analyses. And it turns out that
16 actually modeling minus uncertainties on the pressure
17 will give you a lower transient peak pressure once you
18 run the cases.

19 So if we did model plus uncertainty on the
20 initial pressure with a plus uncertainty on the level,
21 we would get a better answer than what we're
22 presenting here. I don't have that number with me
23 right now, but that's what we found.

24 MEMBER SKILLMAN: I would like to ask for
25 that, please, as part of the record. I would like to

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1 know that there isn't that case where you're entering
2 what is basically a secondary load reduction and
3 you're going in with your highest pressurizer pressure
4 and you then worked your way through that. My sense
5 is that you will end up with a higher reactor coolant
6 system pressure than your analysis presently predict
7 that you will.

8 MR. HALE: Yes, intuitively you would
9 think that, but the input we got from Westinghouse was
10 just the opposite. So we'll have them formalize that
11 for you.

12 MEMBER SKILLMAN: Thank you.

13 MEMBER ABDEL-KHALIK: Is this an artifact
14 of the reactor trip signal that actually shuts the
15 reactor down in this transient?

16 MR. MONAHAN: This is Ed Monahan. Yes, I
17 think it does have to do with the timing of when
18 reactor trip occurs. There's a tradeoff between
19 having a higher initial pressure. We tend to give you
20 a penalty, but at the same time it can delay the trip
21 which is on high pressurizer pressure. So there's a
22 tradeoff and it turns out that the reactor trip aspect
23 is actually a little more important and so the net
24 result is a little bit answer when you do that.

25 MEMBER STETKAR: Suppose you take the

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1 first trip though? Suppose you take it on turbine
2 trip rather than waiting for the pressure? Then what
3 happens?

4 MR. MONAHAN: Then you get a very good
5 answer. You get a very quick reactor trip and the
6 transient is gone. That's why we ignore that first
7 trip.

8 MEMBER SKILLMAN: Thank you.

9 MR. HALE: We'll take that action and get back
10 to you.

11 MEMBER SKILLMAN: Thank you. Yes, sir.

12 MEMBER STETKAR: Steve, I wasn't at the
13 Subcommittee meeting so this is the first time I've
14 seen these numbers. The ATWS is that all valves open,
15 the 3174? All safety, all relief valves?

16 MR. HALE: Yes.

17 MR. O'FARRILL: All right, next slide.

18 The over-cooling events and these are the
19 main steam line breaks that are the limiting events.
20 We did the hot full power as well as the hot zero
21 power main steam line break. Previously, we had not
22 had the hot full power main steam line break as part
23 of our design basis, but in light of the EPU we
24 included that as well. And we're showing margin to
25 the DNB limits as well as to the linear heat rate

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1 limits.

2 I must point out here that we updated the
3 slides for TCD, the analysis, and this slide did not
4 get updated. We now have a linear heat rate limit, a
5 power to melt limit, that is a function of burnup as
6 well. And we went by and what this does is we
7 verified that all the EPU designs are still satisfying
8 that limit. So we have confidence that we can design
9 under the new limit which is a function of burnup as
10 a result of the thermal conductivity degradation on
11 the fuel.

12 Next slide.

13 The reactivity addition and that's the rod
14 withdrawal of power and the rod ejection events are
15 the limiting events here. You see we still maintain
16 margin to the safety analysis limit to DNB, so there's
17 additional margins to the design limit in DNB as well.

18 For rod ejection, that was one of the
19 events that was more affected by TCD and the
20 reanalysis shows that we were still maintaining the
21 margin to the limits for the deposited energy. We did
22 see an increase in the amount of fuel melt as can be
23 expected when we're accommodating the effect of TCD,
24 but still within the limits.

25 MEMBER REMPE: How much of an increase did

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1 you see?

2 MEMBER POWERS: I have no idea what to do
3 with these numbers. I mean the criteria is wrong.
4 What do you do with that, Jack, live with it?

5 MEMBER SHACK: Same that we do all the
6 time, just grind my teeth.

7 MEMBER BANERJEE: We had this problem
8 before, Dana, I recall.

9 MEMBER POWERS: We always have this
10 problem. When are we going to get the regulations on
11 a scientific footing?

12 MEMBER BANERJEE: I guess Tony should
13 answer that.

14 (Laughter.)

15 MR. CLIFFORD: Paul Clifford, Division of
16 Safety Systems. We've had this discussion before.
17 I'd like to reiterate that the Westinghouse 200
18 calories per gram is that of the upper threshold for
19 coolability and our interim criteria in which we're
20 currently applying to the new reactors goes from 235
21 calories per gram and it decreases with burn up. So
22 with 200 calorie per gram upper limit on coolability,
23 that's not cladding failure threshold, that's
24 coolability, is actually conservative relative to all
25 the data we have.

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1 The other idea is they're using DNB as a
2 figure of merit to determine the amount of cladding
3 that fails for the dose calculations. And DNB has
4 been shown to be very conservative for estimating the
5 number of failed pans. Now there is another failure
6 mechanism which is PCMI which is not represented in
7 their analysis right now. And that's the value that
8 is generally cited as about 150 calories per gram are
9 changed in calories per gram in decreases with
10 cladding hydrogen content. That's not reflected in
11 their analysis right now.

12 MEMBER POWERS: So the question is why
13 isn't it?

14 MR. CLIFFORD: The staff is still
15 evaluating the data and we expect to go final with the
16 PCMI failure threshold in the next few months. Right
17 now, it's being applied to the new reactors only. We
18 expect to retrofit it to the existing fleet. I would
19 expect that we would have an update to the Standard
20 Review Plan within six months or a year.

21 MEMBER POWERS: So these poor guys are
22 going to go through another round of delay after that
23 new Reg. Guide comes out?

24 MR. CLIFFORD: I wouldn't expect that it
25 would -- the maximum total calories per gram they're

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1 predicting right there is 178. The change in calories
2 per gram is probably around 150. So would they fail
3 rods due to PCMI? Maybe. Would they fail more rods
4 than they currently predict which is their does
5 analysis is based on 10 percent? I doubt it because
6 it's a highly localized transient. In order to get a
7 high ejective rod you have to have a heavily-rodded
8 core and you eject a rod. And only a small portion of
9 the core itself experiences the power excursion.

10 So it's almost self limiting in a sense
11 that it's difficult to fail a large percentage of the
12 core because the remainder of the core remains in a
13 rodded configuration. It's only the one single rod
14 that ejects. So I wouldn't expect that the dose
15 calculation would be affected.

16 MEMBER REMPE: You indicated that there's
17 a change due to the thermal conductivity degradation
18 and how much of a change was there before the other
19 questions came up.

20 MR. O'FARRILL: Right, for the most
21 significant change was in the amount of melt that
22 we're seeing in the fuel.

23 MEMBER REMPE: And how much was that?

24 MR. O'FARRILL: And it went from around
25 three percent to this eight percent value.

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1 MEMBER REMPE: Okay.

2 MR. O'FARRILL: Next slide. We covered
3 the non-LOCA events and now we're going to get into
4 the loss-of-coolant accident events starting with the
5 small break and these are some of the changes that we
6 made to the assumptions, the changes to the plant to
7 accommodate the EPU.

8 As I mentioned before, we reduced the
9 power peaking, both in the hot channel enthalpy rise
10 factor, the F delta H, as well as the axial offset.
11 Steam generator tube plugging level was also reduced,
12 compared to our current analysis of record in order to
13 provide more margin, but one of the more --

14 MEMBER SHACK: That still has to be
15 decreased again, right, for thermal conductivity?

16 MR. O'FARRILL: Yes. But small-break LOCA
17 we did not have to do that, but for the large-break
18 LOCA we had to decrease that limit that we had from 10
19 percent to 5 percent for the large-break LOCA.

20 The high-head safety injection pumps, we
21 have a configuration where we share the four high-head
22 safety injection pumps. It is recognized in our tech
23 specs and so what happens is that we end up delivering
24 tube flow from at least two high-head safety injection
25 pumps to the affected unit that's experiencing the

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1 LOCA.

2 The next slide provides the results from
3 that analysis and shows that those changes were more
4 than sufficient to accommodate EPU and we see a
5 reduction from our current licensing basis, ECT, for
6 the small-break LOCA.

7 Next slide.

8 These values, as in the other slides, have
9 been updated for the TCD results. We're seeing a peak
10 clad temperature of 2152 when we incorporate the
11 effects of TCD and a maximum localized oxidation of
12 10.5. We're still showing considerable margin in the
13 statistical approach from the 9595 value to the best
14 estimate, if you will, 50th percentile of 1633 degrees
15 PCT.

16 MEMBER BANERJEE: The degraded
17 conductivity is not in there right now.

18 MR. O'FARRILL: Yes, it is.

19 MEMBER BANERJEE: The effect of the
20 degraded conductivity is to have what, more stored
21 heat?

22 MR. O'FARRILL: More stored energy in the
23 fuel rods.

24 MEMBER BANERJEE: And also it comes out a
25 little bit later, correct?

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1 MR. O'FARRILL: Right.

2 MEMBER BANERJEE: The time constant
3 changes. How much does it raise the value?

4 MR. O'FARRILL: What had changed from
5 before, what we had to do here was also have some
6 offsetting. So it's also factored in here.

7 MEMBER BANERJEE: So everything has been
8 --

9 MR. O'FARRILL: That's correct. So we
10 reanalyzed, we updated the analysis, factoring in the
11 offsetting effects. And the major one was the power
12 peaking that we did. We reduced from a 165 on the F
13 delta H to 160. The FQ when from a 2.4 to --

14 MEMBER BANERJEE: So this is just a
15 thought exercise. Let me ask, suppose you had not
16 adjusted anything, how much did the temperature
17 change?

18 MR. O'FARRILL: We'd be over --

19 MEMBER SIEBER: Yes, you'd be --

20 MR. O'FARRILL: We'd be over the criteria.

21 MEMBER BANERJEE: How much over would you
22 go?

23 MR. O'FARRILL: I don't have that number.
24 I don't know whether we --

25 CHAIR ARMIJO: We saw that number earlier.

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1 MEMBER BANERJEE: Oh, you saw it?

2 CHAIR ARMIJO: Yes. I don't know if it's
3 something, in one of your documents.

4 MEMBER BANERJEE: But significantly over.

5 MEMBER ABDEL-KHALIK: Does this analysis
6 have to be done iteratively? In other words you pick
7 whatever results you want for the peak-clad
8 temperature and you adjust your peaking factors
9 accordingly to give you that result?

10 MR. O'FARRILL: No, that's not what we
11 did. What we did was we looked at the peaking factors
12 that we could live with and successfully design for
13 for EPU. And so we lowered that, those peaking
14 factors.

15 MEMBER ABDEL-KHALIK: That's different
16 from what you said during the Subcommittee meeting, in
17 a sense that you said at the time that you would pick
18 whatever results you want and see what peaking factors
19 would give you that result and then you design the
20 core accordingly.

21 MR. HALE: This is Steve Hale. I just
22 want to say it was a combination of both, okay? We
23 certainly would not want to, as we indicated in the
24 Subcommittee, we wanted to target 2150 as being
25 acceptable or livable in terms of margin. But we also

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1 did not want to reduce peaking factors beyond the core
2 as we currently have designed for Unit 3 and Unit 4.

3 So as a result, we looked at about where
4 we wanted to be on peak clad temperature, but at the
5 same time we had to ensure that whatever we reduced
6 the peaking factors to, we could accommodate by the
7 existing design cores that we have.

8 So it was a combination of both, really,
9 but you know, we knew that the primary factor in
10 dealing with this issue was going to be reducing
11 peaking factors. And they kind of go hand in hand
12 when you do the analysis because the results are
13 directly tied to the power factors you assume and the
14 effective TCD is tied directly to the power factors
15 you assume. So you kind of have to do them in
16 conjunction together.

17 MEMBER ABDEL-KHALIK: So it's fortuitous
18 that you had already designed a core with a peaking
19 factor of 1.6?

20 MR. HALE: Well, we typically --

21 MR. O'FARRILL: No, it wasn't fortuitous.
22 We looked at the core designs that we did as a study
23 for the EPU and we looked at what we could bring down
24 and whether we could continue to bring it down even
25 further as part of the initial run. So we ended up

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1 doing a one-time reduction. And it turns out that
2 that's the results that we got from that. So we
3 didn't do a lot of iteration on the peaking factors.
4 We recognize that that was going to be beneficial.

5 We also made some changes to other input
6 parameters to try to give us as much margin as
7 possible so that we would be successful at that
8 peaking factor.

9 CHAIR ARMIJO: Were all these changes
10 basically core design, no changes in bundle design?

11 MR. HALE: No. It required no changes in
12 bundle design. It was all core design.

13 MEMBER BANERJEE: And what sort of burn
14 ups are we talking about?

15 MR. O'FARRILL: Well, when we did the
16 large break LOCA, they do a sampling over the first
17 burn for fuel rods. That's the approved methodology
18 and it typically goes from around zero, fresh fuel,
19 all the way to about 30,000 which is what you'd expect
20 to see on a rod in its first cycle of burn.

21 But in recognition that we had a
22 continuing degradation in fuel conductivity, we also
23 looked at the second cycle and did an assessment of
24 the second cycle burn and there, we have a burn down
25 and that's typically what you see in normal operation.

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1 In the second cycle, you'll see a
2 decreasing power peaking in those rods as the burn up
3 goes up. So we ended up crediting that as well and
4 demonstrated to ourselves that we saw a declining
5 trend that offset the effect of TCD in the second
6 cycle of burn so that we were assured that the first
7 cycle was going to give us the limiting results.

8 MEMBER SIEBER: Now you've had to struggle
9 with margin for the next core because you already
10 picked the core design before you knew what the
11 envelop looked like. If future designs, future
12 reloads, you'll have more latitude because you can
13 adjust the enrichment of fresh fuel, the number of
14 assemblies. And therefore, design into the reload
15 pattern a less peak --

16 MR. O'FARRILL: Flatter core basically
17 with less peaking.

18 MEMBER SIEBER: And so the situation that
19 you're in right now is sort of unique to the
20 circumstances under which the core design was done
21 under an old regime of codes and then when you change
22 codes, you find out you're missing some margin that
23 you had to gauge, in fact, by analysis.

24 MR. O'FARRILL: That is correct. We did
25 look at the current design that we already had in the

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1 books going into this --

2 MEMBER SIEBER: You already decided what
3 it's going to be, right?

4 MR. HALE: But I would like to point out
5 that these reduction in peaking factors are
6 significant and they will impact our fuel costs and
7 the number of fuel assemblies and things of this sort.
8 And when we started out with a box, like you said, up
9 here, we've crunched that box down that we're very
10 tight and it's limited our flexibility in terms of on-
11 going fuel cycles.

12 MEMBER SIEBER: Well, you save a few
13 dollars on enrichment costs, but you spend money on
14 fabrication costs and that lengthens your outage.

15 MR. O'FARRILL: Yes, the more fuel
16 assemblies you put into a core design, the less
17 efficient that core design is going to be, because
18 you're going to get less burn up on that fuel and
19 you'll be discharging it earlier.

20 MEMBER SIEBER: There's a lot of economic
21 disadvantages, but some things you have to do.

22 MR. HALE: The ultimate plan certainly is
23 for Westinghouse to update their codes to -- we're
24 treating this relatively conservatively now in the
25 interim until such time as Westinghouse updates their

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1 PAD code to take this into account.

2 CHAIR ARMIJO: Could you explain why the
3 9595 maximum local oxidation decreases from 11 to 10.5
4 at the same time that the peak cladding temperature
5 increases from 2040 to 2152? I would expect they
6 would both increase.

7 MR. O'FARRILL: I'm going to have to defer
8 to Cesare from -- my colleague from Westinghouse. If
9 you could introduce yourself and respond?

10 MR. FREPOLI: Cesare Frepoli,
11 Westinghouse. The reason you see the difference is
12 more attributed to the different methods that were
13 used. The 11 percent, pre-ASTRUM, was based on the
14 CQD method. It is a rather simplistic conservative
15 approach to maximum localized oxidation. With ASTRUM,
16 we have the more explicit calculation.

17 In other words, we look at every single
18 calculation from the sample, what maximum localized
19 oxidation is so it's -- you gain so much in there. So
20 that's why you may see a slightly lower value, even
21 though the power is high and the temperature is high.

22 MEMBER BANERJEE: You mean that
23 temperature and oxidation is not directly correlated?

24 MR. FREPOLI: We take a very conservative
25 approach, actually. As part of the ASTRUM we use non-

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1 parametric tolerance limit and we don't take any
2 assumption on how they are correlated. The
3 mathematical assumption is actually that they are
4 anti-correlated, therefore that's why we pick one out
5 of a sample, 1 out of 24. It's the maximum for PCT
6 maximal localized oxidation, correlated oxidation so
7 that simultaneously you have a joint probability to
8 bound a 95th quantile on the three attributes with 95
9 percent of ability.

10 MEMBER BANERJEE: So you found a way
11 around Arrhenius' law by sampling?

12 (Laughter.)

13 MR. FREPOLI: What's the question?

14 MEMBER BANERJEE: Did you find a way
15 around the Arrhenius equation by sampling, apparently,
16 that's what it looks like.

17 MR. O'FARRILL: Cesare, I think he's
18 asking is there a strong relationship between PCT and
19 localized oxidation.

20 MR. FREPOLI: Yes, when you've brought
21 them up there is indeed a strong correlation. I think
22 the point that I was making is that we don't take
23 credit of that correlation because if you will take
24 credit of that correlation you will be able to look at
25 lower of the statistics rather than the first one.

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1 You may look at the second or the third one, which
2 will give you more -- better results, I mean lower
3 results.

4 MEMBER BANERJEE: I'm still puzzled. It's
5 far enough away from the margin that I'm not too
6 concerned.

7 CHAIR ARMIJO: Yes, it kind of makes you
8 wonder about --

9 MEMBER SHACK: Well, they changed the law
10 to things in going from one analysis to the other.

11 CHAIR ARMIJO: I know, we're trying to
12 follow.

13 MEMBER BANERJEE: But you would expect the
14 temperature and oxidation are correlation?

15 MEMBER SIEBER: Yes.

16 MEMBER SHACK: I don't think he's denying
17 that.

18 (Laughter.)

19 MR. FREPOLI: No, I'm not denying that.
20 I guess if I go back to the question as it started,
21 the CQD as a simplistic was some sort of a recipe
22 where the goal was to show compliance. So if you were
23 able to get some very conservative bounding value,
24 that was reported to say okay, it's 11 percent, that's
25 70 percent and we're fine.

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1 If we ended up that the margin was not
2 there, there was like a recipe where they're trying to
3 sharpen the pencil and get the number better. So it
4 was more like an iterative process, but you know,
5 first year, second year, type of approach. With the
6 ASTRUM, it's a more direct measure of that value.

7 MEMBER ABDEL-KHALIK: Does the change in
8 peaking factors have an impact on rod worth?

9 MR. O'FARRILL: Well, core design has an
10 impact on rod worth, but that's also one of the design
11 parameters we go to to assure ourselves --

12 MEMBER ABDEL-KHALIK: Right, and the
13 question then is did that have an impact on the
14 results of your rod ejection accident?

15 MR. O'FARRILL: No, what we do in the
16 other events is typically pick a bounding set of
17 parameters including rod worth as part of that
18 analysis to assure ourselves we're going to bound
19 future core designs. So it would not affect that.

20 MEMBER ABDEL-KHALIK: So the timing of
21 when these analyses were performed, the fact that you
22 had already completed your rod ejection accident
23 analyses before doing the large-break LOCA and
24 changing the peaking factors doesn't have an impact on
25 the results?

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1 MR. O'FARRILL: I think you're touching on
2 a point that speaks to the conservatism of the overall
3 approach when we do these analyses. They're not
4 necessarily related in that if I reduce peaking
5 factors to offset some effect, to make sure that I get
6 acceptable results in one event, I still pick
7 conservative rod worth in this case for the rod
8 ejection that bounds. So I don't ever want that event
9 to have to be relooked at again when I do my core
10 designs going forward. So I have something that's
11 conservatively bounding, but yet still meets the
12 acceptance criteria.

13 So I can have something that's not
14 necessarily correlated and in fact, that is indeed the
15 case for the rod ejection. We have very bounding
16 parameters as to what we assume for the rod worth of
17 the ejected rod, as well as the post-ejection peaking
18 factors. And typically, what we have seen and when we
19 compare ourselves to the EPU designs that we've looked
20 at is we have considerable margin to those limits.

21 MEMBER ABDEL-KHALIK: Your peaking factor
22 prior to the reduction that you introduced that is a
23 result of the large-break LOCA was what, compared to
24 1.6?

25 MR. O'FARRILL: 1.65.

1 MEMBER ABDEL-KHALIK: 1.65.

2 MR. O'FARRILL: Roughly, four percent
3 drop.

4 MEMBER ABDEL-KHALIK: Four percent. So
5 your rod worth probably dropped by eight percent?

6 MR. O'FARRILL: It is also loading pattern
7 dependent as to where you put that fuel assembly that
8 has the peak hour relative to the control banks.

9 MEMBER ABDEL-KHALIK: Okay, thank you.

10 MEMBER STETKAR: Carl, I hate to do this
11 because we're getting a little short on time, could
12 you go back to Slide 20 and I have to apologize, like
13 I said. I didn't attend the Subcommittee meeting.

14 I'm not sure I understand the plant. If
15 I go to Turkey Point Units 3 and 4, there are -- I can
16 touch a total of four high-head safety injection pumps
17 between the two units. Is that correct?

18 MR. O'FARRILL: That is correct.

19 MEMBER STETKAR: With EPU, I've changed
20 essentially my success criteria from one high-head
21 safety injection pump to cope with a small LOCA to
22 two. Back on Slide 17, the loss of load transient
23 peak pressure, it's calculated as 2746 pounds. Does
24 that include credit for the pressurizer relief valves
25 opening or not?

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1 MR. O'FARRILL: Yes, the relief valves.

2 MEMBER STETKAR: Not safety.

3 MR. O'FARRILL: No, the safety -- you're
4 talking about the power operated -- no, it does not
5 credit that.

6 MEMBER STETKAR: It does not. So in the
7 real world they will open?

8 MR. O'FARRILL: Yes, that is correct.

9 MEMBER STETKAR: I'm thinking now about
10 how much -- and in the Subcommittee did you talk about
11 the effects of two units and shared systems? Because
12 in the current design if I have a loss of offsite
13 power, and I actually open the pressurizer relief
14 valves and one sticks open on each unit because losses
15 of offsite power will affect both of these units
16 simultaneously, I still have margin because I only
17 need one high-head safety injection pump on each unit
18 and I have a total of four.

19 Now I have no margin because I need two
20 and two. Did you look at all of that?

21 MR. O'FARRILL: Well, first of all, this
22 is not a design change. This is design we've had
23 originally on that --

24 MEMBER STETKAR: It's a success criteria
25 change though.

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1 MR. O'FARRILL: Crediting it in the safety
2 analysis is the only change that we're doing here.
3 There is no physical change to the plant.

4 MEMBER STETKAR: I understand that, but
5 you need to credit two pumps in the safety analysis
6 now and you didn't before.

7 MR. HALE: If I could, this is Steve Hale.
8 The original plant design included two out of four.
9 When we did the stretch power uprate including the
10 tech specs, the PRA, all of that reflected two out of
11 four. When we did the stretch power safety analysis
12 in the mid-'90s, we assumed one pump versus two --

13 MEMBER STETKAR: Two out of four, putting
14 the blinders on, assuming that this is a pipe break
15 LOCA that occurs only at one unit, not a transient-
16 inducted LOCA that could affect both units
17 simultaneously.

18 MR. HALE: We do assume loss of offsite
19 power on both units, but we do not take simultaneously
20 LOCAs. That is correct.

21 MEMBER STETKAR: Okay.

22 MR. HALE: That was the original plant
23 design. Now when we did the safety analysis for the
24 stretch power uprate for the potential of reducing the
25 reliance on the SI pumps, we assumed only one pump,

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1 but we did not implement any tech spec changes or make
2 any changes with regards to success criteria and that
3 sort of thing with the PRA. It's always been two out
4 of four.

5 MEMBER STETKAR: Assuming a single-unit
6 vent.

7 MR. HALE: Right, right. But that's the
8 fundamental design, licensing basis for the plant. We
9 do not assume simultaneous LOCAs. We do assume loss
10 of offsite power with a --

11 MEMBER STETKAR: But relief valves always
12 re-seat perfectly.

13 MR. HALE: I wouldn't say that.

14 MEMBER STETKAR: Okay. Anyway, I guess
15 we're getting short of time so we should probably
16 continue --

17 MR. HALE: I hope I answered your
18 questions.

19 MEMBER STETKAR: Not completely.

20 MR. O'FARRILL: Just to get clarity on
21 your question, you're asking for a dual unit event.
22 Not only the loss of offsite power, but that the PORV
23 is open, but they also --

24 MEMBER STETKAR: That's correct.

25 MR. O'FARRILL: Are struck open.

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1 MEMBER STETKAR: Yes.

2 MR. O'FARRILL: So we have a failure of
3 the PORVs in both units at the same time.

4 MEMBER STETKAR: I'm just trying to get a
5 feel for what -- how much we've eroded margin because
6 of the increased power level and increased injection
7 requirements at the site, not looking at design basis
8 analysis for a single unit in isolation.

9 MEMBER BANERJEE: So John, what's the
10 probability that something will stick open, the
11 valves. Is it fairly high?

12 MEMBER STETKAR: It's not, you know, I
13 don't have the data right at my fingertips, probably
14 once in a 100 to once in a 1,000 -- you know, they're
15 not going to definitely stick -- you're not really
16 even water through these things.

17 MR. HALE: Right.

18 MEMBER STETKAR: You're probably going to
19 open, how many PORVs do you have?

20 MR. HALE: Two on each unit.

21 MEMBER STETKAR: Two on each unit. So
22 they're both going to open under that transient.

23 MR. HALE: I would like to mention also
24 that the staff did come to the site and we did do
25 simulator runs on operator performance relative to

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1 stuck open PORVs and their response to those events.
2 So that was one of the things they looked at.

3 MS. ABBOTT: This is Liz Abbott from FPL.
4 In that scenario, the design basis is for a loss of
5 offsite power on both units in a single failure is
6 what's considered. So when we start postulating the
7 loss of offsite power on two units and then failure of
8 multiple PORVs to close, that's considered kind of
9 behind design basis.

10 MEMBER STETKAR: I'm sorry --

11 MS. ABBOTT: We do have the capability to
12 withstand it though because the operators are well
13 trained that if they observe a PORV open when it
14 should not be open, they would close the block valve.
15 So there is design capabilities to address that
16 circumstance.

17 And as Steve mentioned, that was one of
18 the things that actually we did perform an audit and
19 a demonstration on the simulator to show how quickly
20 the operators do recognize that event and then
21 mitigate that event by either manually closing the
22 PORV itself and if that doesn't work, then they would
23 immediately go to close the block valve. So it's a
24 very fast transient. And that would occur based on
25 our demonstrations in the simulator and the regular

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1 practice that the operators get, that would occur well
2 before you would see safety ejection occur. Those
3 trips basically occur before the safety injection
4 actuation of settings, based on our operator
5 performance and procedures.

6 MEMBER STETKAR: Turkey Point is fortunate
7 because you have countable numbers of events for
8 losses of offsite power. You don't need to be -- do
9 big analyses to estimate frequencies. What fraction
10 of the loss of offsite power events have affected both
11 units versus only a single unit?

12 MR. HALE: We've had several. Over the
13 last -- since 2000, I think this question came up at
14 Subcommittee, we may have had two or three --

15 MEMBER STETKAR: They had a fair number
16 before 2000.

17 MR. HALE: Before 2000, but we've been --
18 the grid has been pretty stable.

19 MEMBER STETKAR: Of those that you've had
20 two or three, what fraction of them have affected both
21 units versus only one unit?

22 MR. HALE: Typically, it would affect, if
23 it's a system-related problem, it would be both units
24 --

25 MEMBER STETKAR: I just wanted to get on

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1 the record the fact that arguments if you assume a
2 single unit loss of offsite power, the condition or
3 likelihood of getting both units loss of offsite power
4 is like one. If you have loss of offsite power, this
5 is not an isolated -- especially with all of the
6 shared systems on this.

7 MR. HALE: I believe Liz was talking about
8 the combination of loss of offsite power plus single
9 failures, plus another event is what she was speaking
10 to.

11 MS. ABBOTT: Yes.

12 MR. HALE: And the probabilities --
13 they're very small.

14 MEMBER STETKAR: Have you done a dual-unit
15 PRA?

16 MR. HALE: That question I can't answer.

17 MS. ABBOTT: I think -- this is Liz Abbott
18 from FPL again. I think we do consider a dual-unit
19 loss of offsite power. At the Subcommittee, we did
20 provide the information on frequency that occurs. And
21 actually we had two or three incidences and they were
22 not both dual-unit events. They involved unit-
23 specific equipment and not switchyard-related impacts.
24 There was one that was a switchyard-related impact and
25 we fully agree, if it's a switchyard-related impact,

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1 there's a higher likelihood that it would be a dual-
2 unit event. But that -- there are other equipment-
3 specific issues that could cause loss of offsite power
4 that only affect a single unit. So that is not always
5 the case.

6 And just to clarify, maybe I wasn't clear,
7 but the single-failure criteria doesn't preclude the
8 fact that our design basis is to consider the loss of
9 offsite power as a dual-unit event. So you would
10 consider a single failure and I think once again, we
11 do have the design capabilities. The operators can
12 manually close a PORV and they are trained to
13 recognize that extremely quickly. It was a matter of
14 seconds for them to recognize that when we
15 demonstrated that in an audit in December with the
16 staff.

17 And if the valve does not close based on
18 the manual signal, the switch actuation that they give
19 them, then the operators immediately go to close the
20 block valve. And those are what are considered prompt
21 operator actions that upon recognition and
22 confirmation from a senior reactor operator on shift
23 right there, they are able to perform that action
24 without even having to bring the procedure out on the
25 table and go through it.

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1 MEMBER STETKAR: Was that audit done with
2 a loss of offsite power in a single failure like a
3 diesel?

4 MS. ABBOTT: That was not the scenario
5 that was run. The scenario that was run was an
6 inadvertent opening of a PORV.

7 MEMBER STETKAR: I can recognize that
8 pretty quickly. I used to be an operator.

9 MEMBER SHACK: I think we're going to have
10 to --

11 MEMBER STETKAR: Anyway, I just wanted to
12 kind of pulse the dual unit effects because of -- and
13 margin at the site basically.

14 MS. ABBOTT: Understood.

15 MEMBER ABDEL-KHALIK: Just as a follow up
16 to this question, what signal gives you SI in this
17 event?

18 MR. HALE: Which event?

19 MEMBER ABDEL-KHALIK: This loss of load or
20 loss of feedwater?

21 MR. O'FARRILL: You wouldn't get SI.

22 MEMBER ABDEL-KHALIK: If you were to open
23 the safeties, would you get SI on high-containment
24 pressure?

25 MR. O'FARRILL: No, we would not, not for

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1 the --

2 MEMBER ABDEL-KHALIK: The PRT disc
3 wouldn't rupture?

4 MR. O'FARRILL: No, as soon as you
5 depressurize, the safeties would shut again and the
6 same thing -- as designed, the PORVs would also shut
7 again.

8 MEMBER STETKAR: As long as one doesn't
9 stick open, you shouldn't -- you blow down a little
10 bit and put PRT in it, it quenches.

11 MR. O'FARRILL: I think we were talking
12 more of a PRA.

13 MEMBER STETKAR: It is, multiple failure
14 is occurring.

15 MR. O'FARRILL: Slide 23. I think a lot
16 of these points were already covered in the discussion
17 either by the staff or during our discussion. The
18 first slide is just a history that I think the staff
19 covered pretty well through there that this is a new
20 recognition that the impact would have been greater
21 than previously thought.

22 CHAIR ARMIJO: Yes, I'd like to ask in
23 view of the fact that we're going to have more -- this
24 is not going to be the final meeting on this EPU and
25 I guess the question to Bill is are we going to have

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1 a subcommittee meeting on the -- for example, of
2 December 31 submittal? There are a lot of issues
3 there. A lot of it is proprietary. Or is it planning
4 to come back to the full Committee? Have you thought
5 through what you want to do?

6 MEMBER SHACK: I had sort of assumed we
7 would come back to the full Committee. Maybe after we
8 hear the staff's discussion we can decide whether we
9 need another Subcommittee meeting.

10 CHAIR ARMIJO: Yes, this is a pretty big
11 submittal and a lot of questions in it.

12 MR. O'FARRILL: Yes, I guess we can go to
13 Slide 25 and just go to that. And I think the purpose
14 behind the slide is -- I wanted to indicate that as
15 you saw from our submittal, we did a comprehensive
16 look at it and we wanted to make sure that we looked
17 at all the areas and plus on everything that could
18 have been impacted by TCD. And as you would expect,
19 we really just saw more of a localized effect from TCD
20 on the fuel rod performance during accident analysis
21 more than anything.

22 So many of these areas had either minimal
23 effect, accommodated well within the margins of the
24 analysis or no effect whatsoever. And that got us
25 down to the next slide, Slide 26, as to where we did

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1 have some of the more significant impacts from TCD and
2 it was in the fuel mechanical design rod performance
3 codes. We talked about the power to melt limits now
4 being burn up dependent. Rod internal pressure is
5 also affected when you have higher temperatures in the
6 fuel rod and the cladding strain and stress was also
7 impacted and from the safety analysis standpoint, the
8 non-LOCA one was the rod ejection and we did talk
9 about that, and as well the large-break LOCA.

10 The last slide just restates what has been
11 stated before as to where we are in this review
12 process. That concludes my presentation. Are there
13 any more questions?

14 MEMBER POWERS: When did Turkey Point do
15 its last integrated leak rate test?

16 MR. O'FARRILL: I don't -- Steve, do you
17 know the answer to that?

18 MR. HALE: We have someone here.

19 MR. TIEMEAN: This is Phillip Tiemean,
20 Florida Power and Light. We did those during the head
21 replacement outages in 2004 and '05.

22 MEMBER POWERS: So in a couple years from
23 now you'll have to do another one.

24 MR. HALE: Any other questions from the
25 Committee? All right, thank you.

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1 MEMBER SHACK: We move on to the staff's
2 presentation.

3 MR. PARKS: Good morning. My name is
4 Benjamin Parks. I work in the Reactor Systems Branch
5 in NRR. To my right here is Sam Miranda, also in the
6 Reactor Systems Branch. We're also joined by Paul
7 Clifford, Division of Safety Systems, and Len Ward in
8 the Nuclear Performance and Code Review Branch and
9 they are prepared to jump in if there are any
10 questions in their area. We were all contributors to
11 the safety review for the Turkey Point uprate.

12 And we're going to speak this morning
13 about the safety analysis.

14 Briefly, to recapitulate what we covered
15 during the Subcommittee, we had a couple of key focus
16 areas for our safety evaluation and these included the
17 main steam line break, the emergency core cooling
18 system evaluation and the safety-significant events
19 that were outside Turkey Point's licensing basis.
20 Having been licensed prior to our issuance of the
21 general design criteria and the more recent revision
22 of the Standard Review Plan, there are some events
23 that are not within their licensing basis that we
24 asked about. These included the feedwater line break,
25 the inadvertent opening of the primary relief valve,

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1 and the modes 4 and 5 boron dilution.

2 From those events which we covered in
3 detail in the Subcommittee meeting, we wish to kind of
4 reiterate the results from those and I think that
5 there are three significant results. For the lower
6 mode boron dilution events, the licensee ended up
7 increasing shutdown margin requirements in their tech
8 specs. The licensee was required to demonstrate
9 operator capability to mitigate the inadvertent PORV
10 event and the reason that that happened was because we
11 asked for an analysis of this event and typically it's
12 understood to be a DNV transient.

13 The initiating event causes a reactor
14 coolant system depressurization. And the plots that
15 we got showed there was a very strong surge into the
16 pressurizer right about the time that the DNV
17 transient was over. So we asked about that because we
18 didn't see the reactor coolant system effectively
19 stabilizing at the end of the event.

20 And what we found out was and through our
21 own thinking, the surge was caused by some hotleg
22 saturation or hotleg flashing that was occurring at
23 the end of the event. And we also began to put
24 together that because this unit has four high-head
25 safety injection pumps that would begin to align and

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1 inject at the onset of a depressurization event like
2 this, as the system depressurizes, you've got that
3 much safety injection. So we asked about the
4 pressurization aspects of this event, too.

5 What we found out was the pressurizer
6 would fill at Turkey Point in about five minutes.
7 However, we did go to the simulator and observed this
8 event and the operators, given an instrument failure
9 that causes the PORVs to open, the operators responded
10 in about nine seconds to close it. It was a fairly
11 immediate action.

12 So there was a lot of margin between the
13 operator response time and the required response time
14 as demonstrated by the safety analysis. Now having
15 pulled that forward from Turkey Point that's also an
16 issue that we'll be pursuing generically as well.
17 It's sort of a lessons learned from the Turkey Point
18 review that maybe there's some downstream effects from
19 the inadvertent PORV that aren't necessarily related
20 to the departure from the fleet boiling.

21 MEMBER POWERS: How do we extrapolate
22 timing from a simulator to an actual control room
23 operation?

24 MR. PARKS: We didn't extrapolate the
25 timing. We wanted to see the operators' capability,

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1 once we knew what the acceptance criterion was and
2 that was inferred from the safety analysis. And so
3 the safety analysis showed that the operator response
4 was required in five minutes under a set of conditions
5 designed to deliver a pessimistic result which was
6 fill the pressurizer as quickly as possible.

7 MEMBER POWERS: And you said that the
8 operator in the simulation responded within nine
9 seconds. And therefore, you assume that in the
10 control room you would have margin. And what I'm
11 asking is what was the basis, the technical basis for
12 making that extrapolation? In other words, how do you
13 know that the operator will respond in nine seconds in
14 the control room or some small multiple of nine
15 seconds and not in 309 seconds in the control room?

16 There must be some reason that you make
17 that extrapolation. I just want to know what it is.

18 MR. PARKS: Right, because certainly, it's
19 not exactly nine seconds and it's not going to be nine
20 seconds every time. The licensee explained to us that
21 this is not a procedure that they're required to look
22 up. They're required to acknowledge it and respond
23 immediately. So that's one bit of information that
24 says that they're responsible, be expeditious. That's
25 just not a quantifiable data point. We just know that

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1 it's going to be quick, based on that.

2 The licensee also assured us that they
3 train on this type of scenario often, so we know that
4 this is repeated in the simulator for all the
5 operators as a part of their normal training. So
6 that's another data point that says it's going to be
7 a small amount of time because it's well rehearsed.

8 Then we saw the demonstration and that was
9 nine seconds. And so that was confirmatory in the
10 sense that we know it's a pretty small amount of time
11 and then beyond that, had the event not gone as
12 planned in the simulator, there are a couple other
13 indications. They got an indication because the PORV
14 actually opened. I think it was a position switch.
15 But there are also tailpipe acoustic monitors and
16 pressurizer relief tank sensors that would also alarm
17 the operators. And if they failed to be successful at
18 closing the PORV itself, there's also block valves
19 that they could close. So there are a number of
20 different ways that they could respond differently,
21 but still, given the difference between nine seconds
22 and five minutes, we deem that to be adequate.

23 MEMBER POWERS: That, by the way, was an
24 excellent answer.

25 MR. PARKS: Thank you. And the final

1 review result was in the post-LOCA boron precipitation
2 analysis, the licensee provided some analytic
3 improvements. Dr. Ward did some of his own
4 calculations to calculate the onset of boric acid
5 precipitation and there was a difference in his
6 analysis relative to Westinghouse's and that was that
7 Westinghouse assumes basically pure water condensing
8 and containment returning to the sump and Len's
9 analysis assumes boric acid condensing in containment
10 and returning to the sump which is a bit unrealistic,
11 but it is conservative because you don't know how much
12 entrained boric acid is going to return to containment
13 and return to solution or be carried out through --
14 spilling liquid as opposed to vapor, etcetera. So
15 Len's analysis is conservative in that respect. And
16 the licensee improved its analysis and the results
17 were very similar.

18 Now to the open items for --

19 MEMBER BANERJEE: Is there some assumption
20 --

21 MR. PARKS: I'm sorry.

22 MEMBER BANERJEE: Is there some assumption
23 about the mixing in the lower plenum calculation?

24 MR. PARKS: There is. The licensee
25 assumes half of the lower plenum mixes.

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1 MEMBER BANERJEE: Right.

2 MR. PARKS: And in Len's analysis, he
3 doesn't assume that that happens until density
4 conditions in the vessel actually warrant mixing in
5 the lower plenum. So if you were to look at a trace
6 of Len's analysis compared to the licensee's you would
7 see that his has a spike and then it comes down,
8 whereas theirs is a smooth curve. But it doesn't make
9 a big difference in the overall result.

10 MEMBER BANERJEE: But the volume does,
11 right? I mean if you didn't take -- let's say the
12 licensee took a different fraction of the lower plenum
13 being next, how sensitive is that? Do we know?

14 MR. PARKS: It's sensitive directly
15 related a portion of the lower plenum volume to the
16 total, right?

17 MEMBER BANERJEE: Yes.

18 MR. PARKS: And so if you reduce it, it
19 will definitely affect your precipitation time and it
20 will precipitate earlier.

21 MEMBER BANERJEE: If it's a third or a
22 quarter or something rather than a half.

23 MR. PARKS: Absolutely, the results are
24 sensitive to that. I believe based on the staff's
25 review of experimental data, a half is a reasonable

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1 assumption right now. We don't have the best data
2 possible. And I know that there is some testing, both
3 with the Owners Group in concert with GSI-191 and
4 internationally that the NRC is involved with to sort
5 of refine those types of assumptions.

6 MEMBER BANERJEE: This should be for
7 Turkey Point, but this is an issue which has come up
8 repeatedly, the effect of scale on the volume that you
9 can assume.

10 I agree that if -- whether you have the
11 spike or not may not be a big deal, but the amount of
12 the volume of the mixing is important. So we need to
13 get a handle on that on a large scale probably.

14 Most of the experiments, I don't remember
15 what the scale was. Somebody should remind me about
16 the mixing. Maybe Len knows or somebody?

17 DR. WARD: Yes, Len Ward. The scale, I
18 guess what --

19 MEMBER BANERJEE: What fraction -- sorry?

20 DR. WARD: There aren't many tests, but
21 what the basis was that for was on some -- there was
22 some European tests in Finland and there were some
23 scaling issues. Some of the tests showed that the
24 entire lower plenum contributed and other tests
25 suggested that that wasn't true. And if you cut in

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1 half the lower plenum you would predict the data.

2 I mean as Ben mentioned, this is an issue
3 that the Owners Group is looking at, boric acid
4 precipitation methods, and one of the issues that
5 we're requesting them to address is you need to
6 identify how much mixing there is in the lower plenum
7 and it needs to be based on some test data so that we
8 can better understand how much actually contributes
9 and what that contribution is. So that's something
10 that's ongoing now.

11 MEMBER BANERJEE: What was the scale of
12 the Finnish tests?

13 DR. WARD: There was -- I think one of
14 them was -- I thought one of -- maybe I'll have to get
15 back to you on that. I seem to recall that -- one of
16 them was a full scale and the other one was a scaled
17 test. There were mixed results. There were scaling
18 issues and so that's why I said look, you can't take
19 credit for entire lower plenum mixing. We're only
20 going to let you go with half until you can do some
21 testing later on and then show that if it's any larger
22 than that, then you can take credit for it.

23 Right now, we allow them to credit half
24 the lower plenum in the mixing volume. And as you
25 said, it is very important. If you don't credit that,

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1 you can shift the precipitation time earlier by hours.
2 So it's very important. But it's also important --
3 I've always had an issue with the vendors. They'll
4 include that lower plenum mixing from time zero.
5 Well, it won't contribute until the density in the
6 core exceeds -- obviously. So you want to look at
7 that spike.

8 There are some plants -- there are power
9 levels and air boric acid concentration sources that
10 affect that. You want to make sure that initial
11 doesn't -- you don't precipitate because it can go
12 upwards of 20 percent before it starts to mix. So
13 it's important to be able to model it correctly so
14 that you don't violate precipitation very early.

15 MEMBER BANERJEE: Thanks.

16 MR. PARKS: Okay, so on to the open items
17 that we have within the Reactor Systems. The first is
18 thermal conductivity degradation and I would like to
19 clarify that there are two information notices about
20 this issue right now. One is the one that we wrote in
21 2009 when we knew that there was a discrepancy between
22 experimental data and the capability of the legacy
23 codes.

24 And once we had a quantifiable result in
25 the downstream safety analyses, particularly in the

1 best estimate LOCA analyses, we issued Information
2 Notice 2011-21, Realistic Emergency Core Cooling
3 System Evaluation Model Effects Resulting from Nuclear
4 Fuel Thermal Conductivity Degradation, and that was
5 during the Turkey Point EPU review.

6 And so at the same time about, I guess two
7 days before we issued this Information Notice, we also
8 asked Turkey Point about the effect this would have on
9 their LOCA analysis.

10 And the licensee in response has been
11 working to revise steady-state fuel performance
12 calculations and the ECCS evaluation to incorporate
13 the effects of this. I briefed you on that earlier.

14 We took an action to discuss conservative
15 analytic inputs in the reactor coolant system over
16 pressurization analyses. And I think the key message
17 there is that the over-pressurization analyses are
18 deterministic analyses. They use pretty pessimistic
19 inputs intended to deliver a bounding result,
20 conservative high heat pressure. And I think that
21 there's an interplay of the key phenomena.

22 Initial pressure, initial pressurization
23 level, so you're talking about the mass in the RCS,
24 how much liquid is there, how much enthalpy, and the
25 reactor trip signal.

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1 If you're responding to an anticipatory
2 trip that comes in quickly, then the RCS initial
3 conditions are very important. But if you look at a
4 symptom-based trip like the RCS or the pressurizer
5 pressure, then you're delaying that trip time until it
6 gets so bad. And when that happens you add energy.
7 And so the energy that you're adding to the RCS during
8 that time becomes important. So there's an interplay
9 between the two and that could cause the limiting set
10 of initial conditions to change.

11 We had an open item with the spent fuel
12 pool criticality analysis and this is a parenthetical
13 phrase in the text specs that relates to the new fuel
14 storage area and the staff is continuing its review of
15 that parenthetical statement.

16 Open item resolution. The licensee has
17 provided supplements describing the TCD analyses. I
18 know that some Committee members, if not all of you
19 have received those supplements, so you know what --
20 at a high level what's going on there. These
21 supplements do include steady-state fuel performance
22 calculations, transient accident analysis, impact
23 assessments. Some results are a little bit different,
24 and some changes to the realistic ECCS evaluation
25 model.

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1 In response to that, our review is
2 continuing as follows. We are doing some confirmatory
3 fuel performance calculations using FRAPCON. Paul
4 Clifford is helping us out there. We're assessing the
5 realistic ECCS evaluation model changes. We're
6 reviewing licensee evaluation of remaining accident in
7 transient analyses and we will issue a supplemental
8 safety evaluation once we're finished with this review
9 effort. And at a later meeting, we will brief the
10 ACRS on the results and conclusions of our review.

11 So in conclusion --

12 CHAIR ARMIJO: Ben, when do you think
13 you're going to be finished with that work?

14 MR. PARKS: My target to issue a
15 supplemental SE right now is next Friday. Before we
16 got the supplements, we also audited the licensee's
17 efforts. So we know generally what's contained in the
18 most recent supplemental although we haven't taken a
19 detailed look at it yet. And in terms of the ECCS
20 LOCA analyses, they had done in December a subset of
21 67 cases and we didn't think 67 cases of the realistic
22 evaluation was enough, especially because it completed
23 rescattered all the cases. The limiting PCT case
24 wasn't the limiting PCT case any more.

25 In fact, there was very little correlation

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1 between the original and updated set of 67 cases. So
2 in terms of the LOCA evaluation though those 67 were
3 generally the limiting cases. Now they've done the
4 additional 57 that are required to complete the set of
5 124, so the ECCS evaluation, we're not completely
6 starting from scratch based on this week's supplement.

7 MEMBER SCHULTZ: And are the FRAPCON
8 analyses already completed that are going to be used
9 to compare against the licensee's calculations?

10 MR. PARKS: Sure. I'll ask Paul to speak
11 to that. He's doing these calculations.

12 MR. CLIFFORD: Paul Clifford, DSS. I've
13 completed the confirmatory calculations for rod
14 internal pressure. But I'm still running cases to
15 confirm the calculation of approached centerline melt
16 and cladding strain during an AOO over-power event.

17 MEMBER SCHULTZ: When do you expect those
18 to be completed?

19 MR. CLIFFORD: He says by next Friday.

20 (Laughter.)

21 MEMBER REMPE: All of this work about
22 thermal-conductivity degradation is based on one test
23 at Haldon with a lot of different types of fuel in
24 that test. Could you comment about some of -- how
25 would you characterize the uncertainty and results

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1 from that test?

2 MR. CLIFFORD: Degradation thermal
3 conductivity is well established. It's not a single
4 test. There are dozens of fuel rods on different fuel
5 types.

6 MEMBER REMPE: At the Haldon facility,
7 right?

8 MR. CLIFFORD: Correct, all at Haldon.
9 Haldon has the unique capability of having centerline
10 thermal couples where they can measure fuel
11 temperature online.

12 MEMBER REMPE: But don't they use modified
13 fuel rods where they have shortened the gap between
14 the cladding and the fuel and --

15 MR. CLIFFORD: All that is taken into
16 account when they determine what the conductivity is
17 based upon, centerline temperature and operating power
18 history.

19 MEMBER REMPE: And so I mean they say five
20 to seven percent based on whatever, but what's the
21 uncertainty? Have they -- can you characterize what
22 it is? Are they ten percent off when you finally get
23 this five to seven percent?

24 MR. CLIFFORD: Just to clarify, you mean
25 the uncertainty in the Haldon data or the uncertainty

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1 to predict the Haldon data?

2 MR. FREPOLI: Uncertainty in the Haldon
3 results.

4 MR. CLIFFORD: Well, any time you measure
5 something, it's going to be some uncertainty to the
6 thermal couples.

7 MEMBER REMPE: Right.

8 MR. CLIFFORD: Absolutely. But the trends
9 are -- the trends are definitely there. I mean you
10 can't argue with the trend and the decrease in
11 conductivity as a function of burnup. Is there some
12 uncertainty in the measurements, yes, but that's why
13 you have a lot of data points. And you take that
14 uncertainty into account when you put it into your
15 design methodology.

16 MEMBER POWERS: Can we thoroughly expect
17 degradation in thermal conductivity just on
18 mechanistic grounds?

19 MEMBER REMPE: Yes, I just am kind of
20 wondering. I mean you did say there were a lot of
21 tests and I guess what I saw was that it was a lot of
22 different types of fuel in -- wasn't it just one test
23 or how many?

24 MR. CLIFFORD: No. I could provide you
25 with the extent --

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1 MEMBER REMPE: I've be interested in
2 seeing the actual Haldon reports if that would be
3 possible.

4 MR. CLIFFORD: Okay, no problem.

5 MR. PARKS: With that, that concludes the
6 Reactor Systems Branch formal presentation. If there
7 are any questions, we'd be happy to answer them.

8 MEMBER STETKAR: Ben, did -- I'm still
9 trying to do back-of-the-envelope calculations here
10 and things. Did you look at all at the dual unit
11 effects?

12 MR. PARKS: You're talking about size
13 systems?

14 MEMBER STETKAR: I don't want to focus on
15 one particular system. This is obviously a plant that
16 has some number of shared systems and we're reducing
17 margin. Now the confidence in the reduction of margin
18 if you look at an isolated single unit may be
19 different than the confidence in the reduction if you
20 look at events that affect both units. That's why I
21 picked the loss of offsite power with stuck open
22 relief valves. That's one. There could be others.
23 Have you thought much about that?

24 MR. PARKS: In terms of the safety
25 analysis, the units are typically treated as stand-

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1 alone units.

2 MEMBER STETKAR: I understand that.

3 MR. PARKS: Now one place where I did
4 specifically consider it was in the LOCA analysis
5 where the two out of four unit safety injection system
6 is used. And the consideration that I gave in my
7 review was Turkey Point has a unique tech spec
8 requirement for a safety injection. All four SI
9 subsystems must be operable and the only exception to
10 that is to allow one SI system to be down while one
11 unit is down so that they can remove it from service
12 to do testing.

13 And so from our standpoint that means
14 effectively there might at any given time be three SI
15 units available. And so in order to comply with GDC-
16 35, one of those would have to fail and so that leaves
17 two available for our consideration in the safety
18 analysis. So that's the way that we considered it
19 there.

20 MEMBER STETKAR: And you said one unit has
21 to be down?

22 MR. PARKS: Right, it's my belief that
23 that tech spec, it's a limiting condition for
24 operation and it applies so that the unit can be -- or
25 the safety injection system can be tested.

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1 Thank you very much for your time.

2 DR. BASAVARAJU: My name is Chakrapani
3 Basvaraju. Technical Reviewer in the Mechanical and
4 Civil Engineering Branch.

5 This branch is responsible for reviewing
6 the structural integrity of the mechanical systems and
7 components and to establish they are structurally
8 adequate for the extended power uprate conditions.

9 There were two open items from the
10 Subcommittee meeting regarding these mechanical
11 components. One is the license condition welding for
12 the SFP, supplemental heat exchanger. And the other
13 one is the high-energy line break for the 6th
14 feedwater heater nozzle zone of influence.

15 I will briefly touch on those open items.
16 To maintain the design limits at EPU conditions, a
17 supplemental heat exchanger will be added to the
18 cooling loop of the spent fuel pool for each unit of
19 the Turkey Point plant. During the review of the
20 staff, I identified the design analysis of the
21 modification of the spent fuel pool heat exchangers
22 were not completed. Therefore, the staff decided to
23 impose the following license conditions. The SER
24 members wanted some clarification on license condition
25 so we had discussions with the licensee and we

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1 modified the license condition welding to clarify that
2 the -- all the modifications and installation
3 associated with this key supplemental heat exchanger
4 are completed prior to entering the EPU conditions.
5 So that is the clarification we added here.

6 And then we required the licensee to
7 provide the staff a summary of the structural
8 integrity evaluations and margins associated with this
9 modification. That's the evaluation for that open
10 item.

11 The second one was related to the terminal
12 end break of the nozzle of the 6 feedwater heater.
13 The nozzle size has changed and there was some
14 questions raised about the zone of influence and then
15 we had further discussions on this with the licensee
16 and some interactions and based on that, the licensee,
17 based on the licensee's input, the licensee actually
18 took a different approach than used the zone of
19 influence methodology for EPU.

20 They took a very conservative approach and
21 they decided to install a jet shield to complete
22 divert the jet from the safety-related components.
23 And the staff's review accepts the conservative
24 position, so there is no zone of influence what it's
25 usually called in the EPU of this terminal end break.

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1 Next slide, please.

2 And the only one that's effective is this
3 outside containment is this 6 feedwater nozzle the
4 diameter had changed from 18 inches to 24 inches
5 diameter.

6 Next slide, please.

7 The licensee performed walkdowns and they
8 identified equipment important to safety and they
9 protected all the safety-related equipment with a jet
10 shield to divert the jet away from those components.
11 The staff finds that the licensee has adequately
12 addressed and evaluated this terminal end break at the
13 outlet nozzle of 6th feedwater heater.

14 So that's in summary the resolution for
15 the two open items of the Subcommittee meeting. Based
16 on the review of the license's evaluation, the staff
17 concludes that there is reasonable assurance that the
18 plant's systems, structures, and component related to
19 safety structurally adequate to perform their intended
20 design functions for the EPU conditions.

21 That concludes my presentation.

22 MEMBER SHACK: Are there any additional
23 questions for the staff? Okay, thank you very much.
24 I guess the remaining open item for us is decide
25 whether we're going to need a Subcommittee meeting to

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1 review this thermal degradation analysis.

2 CHAIR ARMIJO: Yes. It's a very complex
3 submittal. There's a lot of material there. Maybe
4 both the Fuels Subcommittee and Turkey Point --

5 MEMBER RAY: Bill, I was trading a note
6 here with John, maybe I'm off base, but it seemed to
7 me like this issue of shared systems that are both
8 affected by a common cause event affecting both units
9 is one I'm still wrestling with. And as to whether or
10 not we've changed as a result of the EPU from a state
11 in which operator action wasn't required as it is
12 potentially after the EPU is the thing I'm -- I didn't
13 go to the Subcommittee meeting, as you know, and I'm
14 just hearing this for the first time and trying to
15 react to it. But I would like to understand that
16 better, I guess, somehow. Maybe I just offline get
17 educated here. It's something I'm at least focused
18 on, if I understood correctly.

19 There's a credible common cause affecting
20 both units, loss of offsite power. And without the
21 EPU circumstances would be one way and with it it
22 would be significantly different. Now there's a level
23 of confidence, response required under this
24 hypothetical would be reliable, proven to be something
25 we could count on, but still it's a delta that I'm not

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1 yet sure I understand why it's okay.

2 MEMBER SHACK: Okay, now is this in a PRA
3 sense beyond design basis or on a safety analysis
4 design basis sense?

5 MEMBER RAY: I think the latter. Just
6 take for example one of the issues, not the exclusive
7 issue, but one of the issues with CAV in my mind
8 anyway is the dependence on operator action that is
9 introduced in some cases, not in all. I understand
10 the big difference between these things. But
11 nevertheless, the greater dependence, I guess, on
12 operator action would be a fair way to characterize
13 CAV to maintain NPSH. And so that's one source of
14 concern. There are others. But it's something that
15 is similar in this instance in that the EPU triggers
16 a need for operator action and I'm just wanting to be
17 satisfied that that isn't something we've overlooked,
18 that it's consistent with how we treat similar issues
19 anywhere.

20 MS. ABBOTT: This is Liz Abbott from FPL.
21 In our application, we address really two specific
22 areas. One, the application addresses our licensing
23 basis in a deterministic fashion and we summarized,
24 and the staff reviewed the accident analysis portions
25 of those. And those were done consistent with our

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1 licensing basis. And in a number of areas, we
2 actually added additional evaluations and analyses
3 that went beyond our licensing basis to expand the
4 licensing of the plant.

5 In addition, in Section 2.13 of the
6 application, we also assess the impact of the EPU from
7 what I call a beyond design basis perspective or a PRA
8 perspective. And there were a couple of questions
9 earlier that perhaps maybe I could try to address.
10 Our PRA is done for both units. It does reflect both
11 units and in the case of the loss of offsite power it
12 is reflective as a dual-unit event.

13 Turkey Point's PRA, because of some of
14 these shared systems, we have an unusually low overall
15 core damage frequency result from our PRA. We're
16 about a decade lower than the average PWR plant and in
17 Section 2.13 of our application, we did assess the
18 impacts of the EPU from a PRA perspective as well.
19 Those show that the CDF increase was on the order of
20 5 times 10^{-8} per year. It's an insignificant impact.
21 Our baseline is on the order of 10^{-7} . And our LERF
22 increase was on the order of 4 times 10^{-9} per year, so
23 also what's considered an insignificant increase in
24 risk.

25 Our numbers are particularly low in large

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1 part due to some of the common systems that we have
2 and capabilities that we have. I think you may have
3 heard earlier in the presentation the diesel
4 generators, as an example. We have four installed
5 diesel generators. On an event requiring a diesel to
6 start, one diesel generator can actually carry the
7 load of both units for our design basis events. So it
8 really provides us a substantial improvement when you
9 look at things from a risk perspective.

10 The safety-injection system that was
11 mentioned earlier, where we have four pumps and in
12 most accident scenarios one pump is all that's needed
13 for success. Only the small-break LOCA is the one
14 where we now rely on two pumps. That has been
15 factored into these PRA results that were presented in
16 Section 2.13 of the application. And we still show
17 basically a very low risk profile for this plant. And
18 those systems really help us out. Aux feedwater is
19 another one that provides a particular benefit to this
20 plant, that really puts us below the normal types of
21 numbers that you see for overall risk on a unit.

22 MEMBER RAY: I've got to go to something
23 here, but I'm not talking about risk base.

24 MEMBER STETKAR: Those dual-unit studies
25 though, I still didn't hear -- they still focus on a

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1 single unit, presuming that the other unit is
2 perfectly okay. Is that correct?

3 MS. ABBOTT: That's not true for loss of
4 offsite power event. It is reflected that it's a
5 dual-unit event and each unit is analyzed in PRA
6 space, based on the capability and availability of the
7 equipment that's present.

8 MEMBER STETKAR: Did you look at loss of
9 offsite power which a stuck open PORV on each unit,
10 yes or no?

11 MS. ABBOTT: From a Chapter 15 analysis --

12 MEMBER STETKAR: No, no, you said PRA.
13 We're talking PRA now.

14 MS. ABBOTT: In PRA space, the failure
15 probability of those valves would have been modeled
16 and if that showed up as a cut set, it would have been
17 reflected in the PRA.

18 MEMBER STETKAR: On both units?

19 MS. ABBOTT: I don't have the specifics of
20 whether it shows up in the top 200 cut sets or so from
21 a risk perspective. I do know the failure
22 probability, you know, of our relief valves was on the
23 order of 10^{-3} . They are very highly reliable. An
24 opening of a PORV due to valve failure is not a
25 Category 2 event. It is less frequent than that.

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1 Typically, you're talking on the order of 10^{-2} for a
2 Category 2 event. So it's a very low probability
3 event. So you're talking just the dual opening or
4 failure of two PORVs is on the order of 10^{-6} times per
5 reactor year on event frequency.

6 MEMBER STETKAR: I'm not -- here's the
7 scenario. Loss of offsite power requires pressure to
8 increase in the pressurizer. PORV is open. One PORV
9 sticks open on each unit and you have two diesel
10 failures. Now they have to be the right diesels and
11 they might be diesels -- I'm assuming you got motor
12 operated block valves, not air operated or fail closed
13 block valves.

14 The motor operator block valves, the
15 diesel failures, if they're the right diesels prevent
16 you from isolating the PORVs that are stuck open and
17 if you have two diesel failures you don't have enough
18 injection to have injection for the small LOCA on
19 either unit. It's not a good day at the power plant.
20 That's a two-unit event. You can't isolate it by
21 looking at a single unit with single unit assumptions
22 and it has nothing to do with PORVs failing to open on
23 demand.

24 I'm curious whether this PRA, you might
25 recognize this is not a risk-informed EPU. I'm simply

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1 trying to think about margins and one way of
2 evaluating margins is to look at these kind of
3 numbers. It's not a risk-informed EPU and I
4 absolutely agree with you that in design basis single
5 unit deterministic space you don't have a problem.
6 I'm trying to understand kind of the broader picture
7 at the site level.

8 And some of the numbers you were throwing
9 around, I can't come up with just doing back-of-the-
10 envelope calculations here on just simple --

11 MR. HALE: If I can just clarify something
12 for the loss of offsite power dual unit? For Category
13 2 events, we're not allowed to fill the pressurizer.
14 That's our limit. So by design, you will not open the
15 PORVs on a dual unit loss of offsite power event. It
16 would have to be a spurious opening of the PORV in
17 order to do that.

18 MEMBER STETKAR: What's giving you the
19 high pressurizer pressure then on your loss of load
20 events?

21 MR. HALE: What's giving you the high
22 pressurizer pressure? Reactor trip? I don't
23 understand. Run that by me again.

24 MEMBER STETKAR: You have a loss of load
25 on your Slide 17. Showed a peak reactor coolant

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1 system pressure of 2700 and some odd pounds.

2 MEMBER SHACK: Two psi margin.

3 MEMBER STETKAR: Yes, 2 psi margin. But
4 it's 2700 pounds which is well above the PORV opening
5 setpoint and you said well, you didn't take credit for
6 the PRVs. What is the event that triggers that
7 pressure increase?

8 MR. HALE: We're mixing apples and
9 oranges. The loss of load event specifically does not
10 allow you to credit turbine trip on a reactor or the
11 first safety related reactor trip. That's a loss of
12 load analysis specifically focused on sizing safety
13 valves.

14 MEMBER STETKAR: Okay.

15 MR. HALE: Okay? I believe we were
16 talking about a loss of offsite power event.

17 MEMBER STETKAR: Yes.

18 MR. HALE: Okay. Loss of offsite power
19 event is analyzed as a Category 2 event.

20 MEMBER STETKAR: Right. I see what you're
21 saying.

22 MR. HALE: All right, and for our
23 acceptance criteria are very limited. You don't carry
24 the event to the point that you're trying to challenge
25 your safety valves. And just another clarification,

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1 there is no -- to the point Dr. Ray, I believe, we are
2 not triggering any additional operator actions --

3 MEMBER STETKAR: Yes, I'm sorry, you had
4 to leave, but I actually agree with you there. There
5 is no new operator action as far as I can tell. That
6 same operator action would apply regardless of EPU or
7 not. It's a way to mitigate a stuck open valve.

8 MR. HALE: Exactly.

9 MEMBER STETKAR: I'm just worried about
10 the increase in success criterias for a small LOCA,
11 trying to think about transient-induced small LOCAs.

12 MR. HALE: I understand. I just wanted to
13 explain that the loss of offsite power is different
14 than this loss of load analysis that you were talking
15 about.

16 MEMBER STETKAR: Okay. I'll have to think
17 about that. Thank you. That helps.

18 MEMBER ABDEL-KHALIK: Mr. Chairman, Bill
19 had to leave so at this time in the agenda we're
20 supposed to ask if there are any public comments. Is
21 there anybody in the room, a member of the public, who
22 would like to make a statement?

23 Is there anyone on the phone who would
24 like to ask a question or make a statement? Please,
25 if there is anyone on the phone, please say something

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1 so that we know that the phone lines are open.

2 PARTICIPANT: No questions. Thank you.

3 MEMBER ABDEL-KHALIK: Okay. So if there
4 are no questions at this time I guess we need to ask
5 about Committee comments. I guess we discussed whether
6 or not we need to hold a Subcommittee meeting before
7 the next full Committee presentation which would
8 likely be at the March meeting that we can probably
9 discuss that at P&P and decide on that. At this time,
10 we are at the end of the agenda and I would turn it
11 back to you, Mr. Chairman.

12 CHAIR ARMIJO: Okay, very efficient, right
13 on time. What we'll do is we'll recess and reconvene
14 at 10:45.

15 (Whereupon, the proceedings in the
16 foregoing matter went off the record at
17 10:31 a.m. and went back on the record at
18 10:47 a.m.)

19 CHAIR ARMIJO: Okay. We're back on the
20 agenda. The next item is a briefing on the background
21 of 10 CFR 50.46(c), the proposed rule and related
22 activities.

23 So since I was Subcommittee chairman, I
24 guess I can't turn this over to anybody.

25 (Laughter.)

1 So I'm stuck. We had I believe a very
2 good Subcommittee meeting in December, covered not
3 only the proposed rule but, at least at an overview
4 level, the supporting draft reg guides to the proposed
5 rule, and also an assessment of the ability of the
6 U.S. fleet to comply with the acceptance criteria of
7 the proposed rule. That required a voluntary effort
8 and good cooperation between the staff and the
9 industry.

10 Today I think, you know, we don't have
11 enough time to cover all of that stuff. So Paul I
12 think is going to concentrate, I hope, on the proposed
13 rule and the assessment. But you are free to do
14 whatever you want.

15 (Laughter.)

16 We did have issues that came up in
17 discussion. I would like to compliment our staff for
18 putting out a good set of minutes that I urge the
19 members to take a look at, if they haven't already.

20 And with that, I would like to turn it
21 over to staff. And I think, Bill, you wanted to take
22 the lead on that?

23 MR. RULAND: Yes, thank you, Mr. Chairman.
24 Good morning, everyone. The purpose of this briefing
25 of course is to brief the full Committee on the

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1 proposed rule to 50.46(c). This proposed rule will
2 eventually replace existing ECCS requirements. It is
3 not an alternative to the existing requirement, nor
4 will it be an optional regulation.

5 The main objectives of this rulemaking are
6 to capture the research findings which identify new
7 cladding embrittlement mechanisms and to respond to a
8 Commission directive to develop a more performance-
9 based ECCS rule. This rulemaking also responds to two
10 petitions for rulemaking.

11 Both the ACRS Subcommittee and full
12 Committee have been previously briefed on the LOCA
13 research which comprises the technical bases for this
14 rulemaking. In a letter to the Commission, the ACRS
15 stated that this technical basis was sufficient and
16 the rulemaking should proceed. Today's briefing
17 focuses on the proposed rule language and the strategy
18 for implementation.

19 To support the performance-based aspects
20 of this proposed rule, the staff developed three new
21 draft reg guides, which has also been briefed to the
22 Committee. Upon the receipt of the LOCA research
23 findings in 2008, NRR completed an initial safety
24 assessment to determine the regulatory path forward.

25 When new information becomes available

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1 which shows that existing regulations may not achieve
2 their intended safety purpose, the staff must decide
3 the speed at which the new requirements are imposed
4 upon the industry. In 2008, the staff determined that
5 no imminent safety issues existed for this proposed
6 rule, and that the rulemaking process should proceed
7 normally.

8 Recognizing that finalization and
9 implementation of the new ECCS requirements would take
10 several years, the staff decided that a more detailed
11 safety assessment was necessary. So today's briefing
12 also includes presentations by an industry
13 representative about that safety assessment.

14 And, finally, I would just like to
15 emphasize again that this is a proposed rule.
16 Typically, it's slightly unusual of course for the
17 Committee to have meetings on a proposed rule. And
18 whatever comments the Committee chooses to make on
19 this rule, which of course is up to you, would be --
20 stating the obvious --

21 (Laughter.)

22 -- is something -- you know, we are
23 getting ready for the proposed rule stage, so we are
24 going to be taking comments from the public. So,
25 clearly, ACRS is part of that public. So if you do

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1 have comments, we sure would appreciate it. And if
2 you don't, we have gotten lots of comments from you
3 already.

4 (Laughter.)

5 With that, my opening remarks are
6 completed, Mr. Chairman.

7 CHAIR ARMIJO: Thank you, Bill.

8 MS. INVERSO: Good morning. My name is
9 Tara Inverso. I'm the Rulemaking Project Manager for
10 the 50.46(c) proposed rule.

11 As Bill mentioned, the purpose of today's
12 meeting is to present the 50.46(c) proposed rule to
13 the ACRS full Committee. And then, Gordon Clefton is
14 here from the Nuclear Energy Institute to review
15 information contained in the pressurized water reactor
16 and boiling water reactor owners groups reports, and
17 that information was provided as a voluntary
18 initiative as an alternative to a Generic Letter. And
19 then, Paul will discuss the NRC's audit of that
20 information and wrap up with an implementation
21 schedule discussion.

22 The meeting will begin with this
23 background presentation. Then, Paul will walk through
24 the rule language paragraph by paragraph, and we will
25 wrap up with Gordon and Paul's discussion of the

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1 safety assessment.

2 This rulemaking has many purposes. The
3 first is to incorporate research findings. This
4 research program focused on high-exposed fuel rods
5 under accident conditions. It identified previously
6 unknown embrittlement mechanisms and also expanded the
7 NRC's knowledge of existing mechanisms.

8 And the biggest finding was that
9 zirconium-based alloy claddings may embrittle at a
10 lower combination of post-quench ductility and oxygen
11 absorption than previously considered. As such, post-
12 quench ductility might not be guaranteed following a
13 LOCA under the current regulations.

14 It is because of that that the staff has
15 concluded that this is an adequate protection
16 rulemaking to restore that level of protection which
17 the NRC thought was provided for in the current
18 regulation.

19 We have Commission direction to do this
20 rulemaking through SRM SECY-02-0057. The Commission
21 told the staff to replace the prescriptive analytical
22 limits with performance-based requirements, and also
23 to expand the applicability of the current regulation.
24 The current regulation is written to apply just to
25 zircalloy and ZIRLO alloys.

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1 There are two petitions for rulemaking
2 that will be resolved with this rulemaking. The first
3 is PRM-50-71, which was submitted by David Modeen of
4 NEI back in March of 2000. And NEI requested in that
5 petition to expand the applicability, much like the
6 Commission direction.

7 And then, a second PRM was from March of
8 2007. It was submitted by Mr. Mark Lasey and
9 requested rulemaking in a few areas, one of which was
10 the consideration of thermal resistance of crud in the
11 LOCA analyses.

12 We have had extensive public interaction
13 throughout this rulemaking. It starts with the
14 technical basis. The technical basis for this rule is
15 in NUREG/CR-6967. And Research Information Letter
16 0801 points to and references NUREG/CR-6967.

17 We published those documents in July of
18 2008 for public comment. There was a public meeting
19 in September of 2008 to discuss those comments on the
20 technical basis. From there, an advanced notice of
21 proposed rulemaking, or ANPR, was published on
22 August 13, 2009. That ANPR had 12 specific requests
23 for comment.

24 Nineteen entities submitted comment
25 submissions. It was based on a variety of industry

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1 input, international community, and also public
2 citizens.

3 There was a workshop on April 28th through
4 the 29th of 2010. April 28th focused on the public
5 comments received on the ANPR and the NRC's response
6 to those comments. And the portion of the public
7 workshop on April 29th was to focus on what the staff
8 was calling at that point a prospective Generic Letter
9 on the potential embrittlement of fuel rods.

10 And that is when the industry suggested
11 that there may be another way to provide that same
12 information that might be a quicker and smoother
13 process, which eventually evolved into the owners
14 groups reports that Gordon will talk about.

15 But three additional public meetings
16 listed as August 12th and December 2, 2010, and
17 March 3, 2011, were held to coordinate work on that
18 report and to ensure that the requested information
19 that might be in a Generic Letter was incorporated
20 into those owners group reports.

21 We have been to the Advisory Committee for
22 Reactor Safeguards multiple times this past year. And
23 also, again in 2008, as Bill mentioned, we briefed the
24 technical basis for the rule. Last year, in May and
25 June of 2011, Michelle Flanagan from the Office of

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1 Regulatory Research presented three draft regulatory
2 guides.

3 Those draft regulatory guides are on
4 conducting periodic testing for breakaway oxidation,
5 testing for post-quench ductility, and establishing
6 analytical limits for zirconium-based alloys. And
7 those three draft regulatory guides will be published
8 concurrent with the proposed rule, so that the
9 industry and public stakeholders can comment on both
10 the requirements and the regulatory guidance at the
11 same time.

12 And the working group presented the
13 proposed rule to the Subcommittee of the ACRS last
14 December.

15 Back in the May and June timeframe, the
16 staff had mentioned in its briefings to ACRS that we
17 were considering possibly a new phenomena -- fuel
18 fragmentation, relocation, and dispersal. The staff
19 has concluded since then that further research is
20 needed in this topic, but is recommending to the
21 Commission that we proceed with this proposed rule,
22 because it meets all of the objectives and is complete
23 and should go forward to address the known
24 embrittlement phenomenon.

25 The rulemaking schedule -- the rule is due

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1 to the Executive Director for Operations on
2 February 29, 2012, and from there it will proceed to
3 Commission review, and then, if voted on, public
4 comment period.

5 Are there any questions?

6 MEMBER POWERS: Yes. What happens if you
7 don't meet the February 29th date? Paul gets drawn
8 and quartered or --

9 (Laughter.)

10 MR. CLIFFORD: Again?

11 (Laughter.)

12 MS. INVERSO: We are planning to meet it,
13 so hopefully we won't find out if we're publicly
14 hanged or anything.

15 CHAIR ARMIJO: Okay. Any questions?

16 (No response.)

17 All right. Let's move right along. Mr.
18 Clifford.

19 MEMBER POWERS: I have one question.
20 There is further research needed on fuel dispersal.
21 Can you clarify what that further research -- I mean,
22 what is the issue that you want to explore in that
23 further research?

24 MR. CLIFFORD: Sure. There is significant
25 data that has been compiled on fuel fragmentation.

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1 Both in pile and out of pile integral LOCA tests have
2 shown that fuel fragments potentially relocates within
3 the enlarged blown region and potentially disperses
4 out of the fuel rod.

5 But we don't have a sufficient
6 understanding of the sensitivity of the fragmentation
7 size to, say burnup, to really draw a line in the sand
8 to say, "This is a limitation" or "this is how we
9 would develop a regulatory requirement on how to deal
10 with fragmentation."

11 MEMBER POWERS: Well, there -- I mean, in
12 the issue of where things go, do you get an
13 accumulation of particles in the balloon region? Do
14 you throw things out the hole you have created? Those
15 are very difficult.

16 As far as the size distribution of the
17 fragments as a function of burnup, it seems to me that
18 there have been some fairly sophisticated modeling
19 that has evolved. Now, I have to admit nothing comes
20 to mind of people doing detailed comparisons of size
21 distributions versus what the models will predict.

22 MR. CLIFFORD: Right.

23 MEMBER POWERS: Is it that data comparison
24 that you are looking for, or is it a phenomenological
25 understanding?

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1 MR. CLIFFORD: Well, the size distribution
2 is the first thing that comes to mind, but you're
3 right, it's -- there's many issues. Certainly, the
4 uncertainty in predicting the transport of -- and the
5 deposition of fuel particles throughout the RCS is a
6 significant challenge.

7 MEMBER POWERS: But the transport issue --
8 I mean, the particles tend to be very, very large. So
9 the only real issue is what the drag coefficient is.

10 MR. CLIFFORD: Well, I don't know how you
11 define "large," but some of our tests the fuel
12 particles look like gun powder.

13 MEMBER POWERS: Gun powder is very, very
14 coarse.

15 (Laughter.)

16 I mean, Newtonian physics, I mean, you are
17 not dealing with the problem of aerosols. You're
18 dealing with the problem of rocks.

19 MR. CLIFFORD: Right.

20 MEMBER POWERS: Okay? And so the only
21 question is what the drag coefficient is on the thing.
22 And I would suspect you could use literature data to
23 get drag coefficients close enough on that.

24 Now, whether it gets out into the channel
25 at all to flow is one I -- I'm not familiar with

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1 anybody that has discussed that issue.

2 MR. CLIFFORD: Right.

3 MEMBER POWERS: And like I say, the
4 modeling of the fragmentation -- I think there are
5 some fairly sophisticated -- I mean, the problem is,
6 you start fragmenting the first time you heat this
7 fuel, take it up in power. And then, you start
8 fragmenting it more every time you run a cycle --

9 MR. CLIFFORD: Absolutely.

10 MEMBER POWERS: -- on the thing. But the
11 -- it's a decreasing return. I mean, it's not a
12 linear function of burnup. And some of that has
13 gotten very sophisticated in the modeling.

14 If what your concern is -- that had people
15 taken those models and then actually looked at the
16 fragments in fuel and compared the two in some
17 profoundly strong statistical method, I'm not familiar
18 with anybody doing that.

19 MR. CLIFFORD: Right.

20 MEMBER POWERS: And if that's what is
21 missing, fair enough. Is that a hot -- hard job?
22 And, yes, you need a real serious hot cell, which are
23 becoming scarce as hen's teeth around this country.

24 CHAIR ARMIJO: Well, you know, I think the
25 staff wisely decided to put that side for now.

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1 MEMBER POWERS: Yes.

2 CHAIR ARMIJO: And I'm -- just my own
3 opinion is I really don't see the down side
4 consequences of some fragmented fuel coming out of the
5 ballooned region, other than plant contamination. So,
6 you know, possibly plugging up the strainers? I doubt
7 that.

8 But, you know, I was just wondering what
9 the staff is -- you know, I could ask the question:
10 so what? You had a LOCA and you had a ballooned
11 region, some fuel coming out of the ballooned region.
12 What is the concern?

13 MR. CLIFFORD: Well, there are several
14 concerns. The first is, how much additional fuel
15 could be lodged within the enlarged balloon area, thus
16 increasing the heat load?

17 MEMBER POWERS: Yes, that's an issue.

18 MR. CLIFFORD: One. And that would be if
19 you had a very small rupture opening, so the fuel
20 couldn't escape. If the fuel does escape, then you
21 could have potential issues with energy addition to
22 the system. I know you obviously already have a break
23 in the system, so you don't have to worry about
24 breaching your RCS pressure boundary.

25 But you are still adding a significant

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1 amount of energy at a particular time during the
2 transient. Could that affect the reflood, timing of
3 reflood? And then, there's the deposition of the
4 particles.

5 MR. RULAND: Paul, don't we ask a question
6 about this topic in the proposed rule package? I
7 mean, not specifically the technical part, but don't
8 we ask a general question about proceeding with the
9 rulemaking? I'm trying to remember.

10 MR. CLIFFORD: No, we removed that
11 question.

12 MR. RULAND: Okay. Then, secondly, you
13 know, if we need to have a separate meeting someplace
14 down the road on this topic, since it is outside the
15 current rulemaking we would be happy to do that.

16 CHAIR ARMIJO: Yes, yes. We will when you
17 are ready with -- to talk to us about that. But for
18 now let's just stick with what we've got.

19 MR. CLIFFORD: Okay. The purpose of this
20 presentation is to describe the scope, structure, and
21 basis of the proposed 50.46(c) rule package. Just as
22 a reminder, the design function of the emergency core
23 cooling system is to mitigate the consequences of a
24 loss of coolant accident. Specifically, the
25 performance objectives of the systems, structures, or

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1 components is to replenish the liquid inventory in
2 order to maintain core temperature at an acceptable
3 level.

4 The existing 50.46 rule dictates
5 prescriptive analytical limits with no defined
6 performance objective. To achieve the Commission's
7 directive of a performance-based regulation, the
8 working group started with a blank sheet of paper. As
9 a result, 50.46(c) represents a major restructuring of
10 the rule.

11 This slide shows an outline of the
12 proposed rule. The existing rule is limited in
13 applicability to lightwater reactors with uranium
14 oxide pellets within cylindrical zircalloy or ZIRLO
15 cladding. Hence, there is no ECCS regulatory
16 requirements for a licensees opting for an advanced
17 zirconium alloy such as M5 or optimized ZIRLO, nor are
18 there any regulations governing the performance of new
19 cladding materials during a LOCA.

20 The first step in the development of
21 50.46(c) was to define an expanded applicability. The
22 rule is meant to be universally applicable to all
23 LWRs, independent of ECCS design and independent of
24 fuel design.

25 The second step in the development was to

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1 define principle ECCS performance objectives.
2 However, since the performance of the ECCS will be
3 judged on how well the fuel holds up under LOCA
4 conditions, specific fuel design dependent performance
5 requirements must also be defined.

6 For example, you would expect that the
7 specific performance requirements for a ceramic UO2
8 pellet within a zirconium metal cladding would differ
9 from the performance requirements of a metallic
10 thorium-plutonium pellet within a ceramic cladding
11 material. Therefore, the capabilities and capacities
12 of the ECCS may differ based on the type of fuel for
13 which it is trying to cool. However, the principle
14 requirements are universal.

15 The third step in the development of this
16 rule package was to define specific requirements for
17 the current generation of fuel. Regulatory
18 requirements of the ECCS consist of principal
19 performance objectives, which are to maintain
20 acceptable core temperature during a LOCA and to
21 remove decay heat following a LOCA, and principal
22 analytical requirements.

23 In other words, each LWR must be equipped
24 with an ECCS capable of satisfying these principal
25 performance objectives, and each licensee must provide

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1 a demonstration showing compliance.

2 For each fuel design, the rule must define
3 specific performance requirements and analytical
4 requirements which form the basis of the acceptable
5 core temperature, which is the principal performance
6 requirements. And that should be based upon all
7 established degradation mechanisms and any unique
8 features of the fuel in the core.

9 In addition, the applicant would need to
10 define specific analytical requirements which could
11 impact the predicted performance during a LOCA.

12 For current fuel designs consisting of
13 uranium oxide or mixed uranium-plutonium oxide pellets
14 within zirconium alloy cladding, 50.46(c) defines
15 these specific performance requirements and analytical
16 requirements based upon an extensive empirical
17 database, including the recent results from the LOCA
18 high burnup research program.

19 For new fuel designs, additional
20 requirements may be necessary -- and additional
21 research -- I'm sorry, additional research would be
22 necessary to define all of the degradation mechanisms
23 and any unique features of that specific new fuel
24 design under LOCA conditions.

25 And then, new performance objectives,

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1 analytical limits, and analytical requirements would
2 need to be established based upon that research. As
3 indicated in the previous slide, we have maintained
4 several vacant paragraphs to accommodate future fuel
5 design.

6 In this section, I'll walk through the
7 language and discuss the regulatory and technical
8 basis for each of the paragraphs.

9 Paragraph A, applicability. The revised
10 text achieves the rulemaking objective to expand the
11 applicability beyond zircalloy or ZIRLO and expands to
12 encompass all LWRs. This eliminates the need for
13 specific exemption requests for new zirconium alloys,
14 which we have been granting for M5 and optimized
15 ZIRLO.

16 Paragraph B, definitions. We added a
17 definition for the new cladding embrittlement
18 mechanism breakaway oxidation. I'm going to be moving
19 pretty fast here, because we don't have a lot of time.

20 Paragraph C, relation to other
21 regulations. The first thing you should notice when
22 I show the text at the top of each slide is there is
23 a gray text and there's a black text. The gray text
24 is unchanged from the existing rule, so you can easily
25 identify what has been changed. Here we just add

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1 clarification that the evaluation model needs to be
2 approved.

3 Paragraph D, ECCS system design.
4 Section 1 of this paragraph defines principal
5 performance objectives and requires all LWRs to have
6 an ECCS design to satisfy these performance
7 requirements. And those are that core temperatures
8 must remain below fuel-specific analytical limits and
9 sufficient capability for long-term cooling.

10 The second part requires ECCS performance
11 demonstration by use of the licensees. As with the
12 current regulation, licensees may opt to either use an
13 Appendix K model or a realistic evaluation model.

14 Item 3, this paragraph requires factors
15 which impact predicted core geometry and coolant flow
16 be included in the evaluation model. Fuel-specific
17 factors would be defined in subsequent sections.

18 Item 4, this paragraph provides analytical
19 requirements related to identifying the most limiting
20 combination of break size and location. This is
21 unchanged from the current regulation. New text has
22 been added to clarify existing requirements, but the
23 demonstration must cover the entire duration of the
24 transient. Not a new requirement, just a
25 clarification.

1 CHAIR ARMIJO: On that one, you know, the
2 most severe loss of coolant accidents, does the issue
3 of the transition break size being smaller than the
4 largest pipe diameter impact this, or is it addressed
5 in some way?

6 MR. CLIFFORD: Right. What we work on in
7 50.46(a)?

8 CHAIR ARMIJO: Yes.

9 MR. CLIFFORD: That is the optional or the
10 alternative rule, which allows for risk-informed break
11 size determination. That would replace this, so, yes,
12 they would have different criteria for evaluating
13 below the transition break size than they would above
14 -- not different criteria, but different requirements
15 for below the transition break size and above the
16 transition break size.

17 CHAIR ARMIJO: So would this apply or not
18 apply?

19 MR. CLIFFORD: Well, 50.46(a) is an
20 alternative, so --

21 CHAIR ARMIJO: But if those chose that
22 alternative, this is still mandatory or is it one or
23 the other?

24 MR. LANDRY: Ralph Landry from the Office
25 of New Reactors, which mind sound in congruence with

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1 what you are asking about. But I was on the working
2 group that wrote 50.46(a) also in addition to
3 50.46(c).

4 The intent that we had when we wrote
5 50.46(a) was, if adopted, and then the acceptance
6 criteria delineated in 50.46 were changed, as we are
7 talking about with 50.46(c), the intent was to make
8 50.46(a) conform with 50.46 what is now (c) in the
9 acceptance criteria for the break sizes below the
10 transition break size.

11 Our intent was always to make the
12 acceptance criteria in 50.46(a) below the transition
13 break size identical to 50.46. The acceptance
14 criteria above the transition break size would be
15 relaxed. So we haven't gone back now and looked at
16 50.46(a) and made any conforming changes at this
17 point.

18 CHAIR ARMIJO: Okay.

19 MR. LANDRY: But the intent was to make
20 conforming changes should both rules be adopted.

21 CHAIR ARMIJO: Okay.

22 MR. LANDRY: Does that answer your
23 question?

24 CHAIR ARMIJO: Yes, it does.

25 MR. RULAND: 50.46(a) has now been with

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1 the Commission for over a year, and no action and no
2 votes have been taken.

3 CHAIR ARMIJO: Yes. Well, some day they
4 will address it. But I just wanted to know how it
5 would fit with this rule.

6 Okay. Thanks, Paul.

7 MR. CLIFFORD: Okay. Item 5 simply
8 provides a pointer to the analytical requirements
9 which were -- which will be provided in subsequent
10 paragraphs.

11 Section 3 of this paragraph defines
12 required documentation. This section remains
13 unchanged from Appendix K. It has just been moved up
14 into the main body of the rule, so that it would be
15 directly applicable to both Appendix K and to
16 realistic models, which are outside of Appendix K.

17 Okay. Paragraph G specifies performance
18 requirements and analytical limits used to judge the
19 ECCS performance for the current generation of fuel.
20 Peak cladding temperature is the first of five fuel
21 temperature analytical limits associated with the
22 principal ECCS performance objective to maintain an
23 acceptable core temperature.

24 Research has confirmed the continued
25 applicability of the 2,200-degree Fahrenheit limit on

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1 peak cladding temperature. It should be noted that
2 PCT limit also prevents runaway oxidation and high
3 temperature failure but is governed in this case by
4 cladding embrittlement performance requirements.

5 MEMBER CORRADINI: Can you repeat that?
6 I think I know it, but just say it again, please.

7 MR. CLIFFORD: PCT -- a limit on peak
8 cladding temperature also prevents runaway oxidation
9 and high temperature failure modes. But it is limited
10 to 2,200 because of embrittlement concerns.

11 Paragraph G2, cladding embrittlement.
12 This paragraph defines the preservation of cladding
13 ductility as the performance objective. This is
14 consistent with the basis of the current regulation.
15 The rule and the associated reg guide capture the
16 research finding, which is the new embrittlement
17 mechanism we refer to as hydrogen-enhanced beta-layer
18 embrittlement.

19 The paragraph requires the use of an
20 approved analytical limit for PCT and integral time
21 and temperature based upon an approved experimental
22 technique. The staff has developed draft reg guides
23 which provide acceptable analytical limits for
24 licensees who do not want to perform additional
25 testing. If a licensee opts to perform additional

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1 testing, the staff is also provided a reg guide which
2 provides an experimental -- an acceptable experimental
3 technique for conducting those tests.

4 CHAIR ARMIJO: Paul, just to make sure
5 it's clear to everybody. If someone comes in with a
6 zirconium-based alloy that is neither ZIRLO nor M5 nor
7 zircalloy-2 or 4, but it's a dilute alloy --

8 MR. CLIFFORD: Right.

9 CHAIR ARMIJO: -- zirconium, it has not
10 been tested in your test program, will they be
11 obligated to do additional testing, or will they be
12 allowed to use the same limits that you have
13 prescribed?

14 MR. CLIFFORD: The reg guides provide
15 specific guidance on that -- on that circumstance. It
16 says that if you -- do you want to talk?

17 MS. FLANAGAN: You can go ahead.

18 (Laughter.)

19 MR. CLIFFORD: Okay.

20 CHAIR ARMIJO: If you need to caucus
21 before you answer, it's okay.

22 MR. CLIFFORD: Okay. The reg guide
23 provides specific guidance on that application.
24 Essentially, they would have to perform a subset of
25 tests to show that their alloy behaved in a similar

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1 manner to the larger empirical database, which is
2 developed at Argonne. And if they could show that,
3 then they would use the complete data set to develop
4 analytical limits or they could use -- they could use
5 our acceptable limits.

6 CHAIR ARMIJO: And because of the
7 consistent performance among various alloys of very
8 different -- you know, niobium versus iron chrome, and
9 all of that, your expectation would be that they
10 actually perform the same way.

11 MR. CLIFFORD: Correct. Our expectation
12 would be to perform the same. However --

13 CHAIR ARMIJO: But they still would have
14 to do a certain amount of testing to confirm that that
15 is true.

16 MR. CLIFFORD: Correct.

17 CHAIR ARMIJO: Okay.

18 MR. CLIFFORD: The next item, paragraph
19 G3, is breakaway oxidation. This paragraph is very
20 similar in structure to the previous paragraph and
21 captures the new embrittlement mechanism identified by
22 the NRC high burnup LOCA research program.

23 It requires the use of an approved
24 analytical limit on breakaway oxidation based upon an
25 approved experimental technique which has developed

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1 and a draft reg guide which provides an acceptable
2 experimental technique for measuring the onset of
3 breakaway oxidation.

4 MEMBER SKILLMAN: Are there facilities
5 available to validate a technique? In other words, if
6 you publish this, have you not put the industry in a
7 box where it can't comply because it doesn't have the
8 access to the facilities that it needs access to in
9 order to do the tests?

10 MR. CLIFFORD: This type of testing has
11 already been completed at several independent labs,
12 and we expect -- the reg guides are going out for
13 public comment, and we expect we will get comments
14 from the industry on their success at performing these
15 tests. So they will hopefully scrutinize the level of
16 detail we have in our experimental techniques and
17 protocols for --

18 CHAIR ARMIJO: The staff, working with the
19 industry, have created a round robin program among the
20 different vendors and their laboratories to be sure
21 that this testing works, that the different labs get
22 the same kind of results as Argonne National Lab got
23 when they did the testing.

24 So, yes, it is being addressed. We don't
25 have the results yet, at least the staff -- ACRS

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1 hasn't seen the results of that round robin.

2 MEMBER SKILLMAN: Thank you.

3 MR. CLEFTON: This is Gordon Clefton from
4 NEI. I can support that we do have the round robin in
5 place. We have seven to nine invitations out. Many
6 of the labs have come back and already started it.
7 Our interest was to have the same testing criteria
8 going into each lab but have different laboratory
9 results.

10 In one of the ACRS meetings we talked
11 about bringing the government's labs back into the
12 round robin, and I think we agreed that it would be
13 best to use that laboratory as a collection point of
14 the results of the laboratory and do a comparison if
15 there is a delta what existed previously rather than
16 having a participation aspect.

17 We brought the thought to the table that
18 the government lab would be an oversight of the other
19 round robin results and those are in progress now. We
20 have varying dates based on availability of the labs
21 and cost resources available and such as that. So we
22 don't have a firm schedule, because we haven't gotten
23 response back from all of the labs. But it is in
24 progress right now.

25 MEMBER SKILLMAN: Thank you.

1 MEMBER POWERS: The testing that you do
2 here is on fresh clad, is it not?

3 MR. CLIFFORD: On breakaway oxidation,
4 that is correct. And for post-quench ductility, it
5 would be done either on fresh cladding, on fresh
6 cladding that has been pre-hydrided, or on irradiated
7 cladding.

8 MEMBER POWERS: Do you ever test cladding
9 that has crud or absorbed boric acid in the oxide
10 layer?

11 MR. CLIFFORD: Well, the testing that was
12 done at Argonne included irradiated test -- irradiated
13 samples. So they would have been --

14 MEMBER POWERS: Irradiated is not my
15 question. It is kind of hard to understand how
16 radiation affects things, because the interesting part
17 of the oxidation, you probably annealed any radiation
18 damage away.

19 The question is: suppose you absorb into
20 the oxide layer these extraneous materials -- boric
21 acid, cobalt, manganese, things like that. Does that
22 create something unusual in the temperature ranges of
23 interest? Or is the material kind of -- it neglects
24 that? I mean, it is --

25 MR. CLIFFORD: With respect to the timing

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1 of breakaway oxidation?

2 MEMBER POWERS: That's right, yes, I mean
3 timing of breakaway or the details of the kinetics and
4 things like that.

5 MR. CLIFFORD: I'd ask Research to step
6 in.

7 MS. FLANAGAN: So the question was whether
8 or not there is -- oh, Michelle Flanagan from the
9 Office of Research. And, Dana, your question was
10 regarding the effect of different things that evolve
11 over operating life, whether they have an influence on
12 breakaway oxidation behavior?

13 MEMBER POWERS: Exactly.

14 MS. FLANAGAN: You know, I really don't --
15 I can't answer that question with what I know right
16 now and the experience I have had with -- and the
17 knowledge of the testing program. We have only done
18 the testing on fresh cladding material. So there
19 is --

20 CHAIR ARMIJO: And irradiated cladding,
21 but under -- but in -- not under real conditions, you
22 know, where there is boron floating around in the
23 water and in BWRs.

24 MEMBER SHACK: That would be the ductility
25 tests were done on fuel with service, so that --

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1 MS. FLANAGAN: Yes.

2 MEMBER SHACK: -- but not in the breakaway
3 oxidation.

4 CHAIR ARMIJO: But not fuel that had gone
5 through a LOCA transient, a LOCA transient where
6 you've got boron floating around. No, see, the issue
7 is it would get heated up and go through that process
8 during a LOCA, and did the boron get into the oxide
9 and affect the properties. I think that is kind of
10 what Dana is getting at.

11 MEMBER POWERS: Well, I mean, when you
12 think about things like breakaway, you're thinking
13 about things where the crystal structure might have
14 changed and you create stress points that will cause
15 rupture. And what kinds of things will do this?

16 Well, you say, gee, zirconium dioxide is
17 an FCC lattice. So if I react it with manganese to
18 create a porosite structure that is going to have a
19 different crystal structure, and maybe it ruptures
20 easier, or something like that. I mean, that's the
21 kind of thinking you go through when you say, gee,
22 what about crud, what about boric acid?

23 Boric acid creates an extended lattice,
24 covalent bonding in the material, so you might think
25 that has a different structure. And typically these

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1 are going to be more voluminous structures than an FCC
2 lattice. And so you are going to create stresses in
3 the oxide and maybe you get to breakaway easier or
4 something like that.

5 Unfortunately, you know, if you were 500
6 degrees hotter, I would say, "Oh, absolutely, you've
7 got to do this." If you were 500 degrees colder, I
8 would say, "Absolutely, you don't need to worry about
9 this." You are just right in my ignorance range, and
10 I don't know whether you can get reactions at these
11 kinds of temperatures.

12 MR. CLIFFORD: Well, during the Argonne
13 program we did investigate the effects of surface
14 roughness and pre-existing scratches in the cladding
15 of various depths.

16 MEMBER POWERS: Yes, those all --

17 MR. CLIFFORD: We did not investigate
18 impurities.

19 MEMBER POWERS: Those or --

20 MS. FLANAGAN: There is one element that
21 was investigated that kind of speaks to what you are
22 talking about, and that is some of the cleaning
23 materials that were used on the surface, such as
24 hydrogen chloride. We saw that that did have a big
25 impact on the breakaway oxidation behavior. So we do

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1 know that there is a possibility to have an
2 external --

3 MEMBER POWERS: Yes, the effect of
4 chlorides on oxidation has just been known like since
5 from the dawn of time.

6 MS. FLANAGAN: Yes, so we have seen the
7 external surfaces have an influence. But the main
8 effect on the breakaway testing was to distinguish --

9 MEMBER POWERS: I just would not make a
10 leap that says that chloride -- because chloride has
11 an effect, ipso facto then other things will have an
12 effect. Chloride is such a nasty little bugger, and
13 people have been so aware of it that -- to avoid it
14 like the plague. It is not clear to me these other
15 things have an effect. I just wondered if you had
16 looked at it, and apparently not.

17 Okay. Fair enough. Put that on the to do
18 list. Let's go on.

19 CHAIR ARMIJO: It's amenable to laboratory
20 kind of testing, but it isn't easy to -- you have to
21 --

22 MEMBER POWERS: It's one of those things
23 that I would have to really think about how you
24 actually do it. I suppose that if you were doing an
25 autoclaving to create your oxide structure that you

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1 could do the autoclaving with a solution, and either
2 a suspension or a solution to get it in -- it's not
3 one of those things where you can just paint it on the
4 outside and then heat it up. It's -- you've got to
5 think carefully about how it gets where it's going.

6 CHAIR ARMIJO: And the kinetics have to be
7 pretty quick, because you are talking a couple
8 thousand seconds and everything is over.

9 MEMBER POWERS: Yes. I mean, it will
10 either react or it won't. That's --

11 MEMBER ABDEL-KHALIK: So you're talking
12 about building up a crud layer on the outside of the
13 cladding, having that crud layer loaded with lithium
14 metaborate to simulate conditions that may happen in
15 a PWR?

16 MEMBER POWERS: I would be more concerned
17 about things that could get into the pore structure of
18 the external oxide over the course of 17 months of
19 operation. And then, when I go through the transient,
20 I get reactions that give me a volume change that
21 create stresses in the oxide and have it exfoliate on
22 me. It's the outside layer. The outside is the
23 outside. It is already exfoliated out there. It has
24 to be down into the pore structure of the oxide.

25 MEMBER ABDEL-KHALIK: And how thick would

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1 that oxide layer be for you to be concerned?

2 MEMBER POWERS: Well, I mean, these oxide
3 layers form during normal operation for -- it depends
4 on your alloy. For zircalloy, at the end of life fuel
5 might run 80-micron thick oxide layer; for M5, what,
6 20-, 30-micron layer, something like that?

7 MR. CLIFFORD: That's correct.

8 MEMBER POWERS: And what not. I'm not
9 sure the thickness of the oxide matters. It is
10 whether you can get a stress riser due to a volume
11 change of reaction from something in the pore
12 structure.

13 CHAIR ARMIJO: Well, we did see that
14 happen in -- due to crud with copper infiltrating the
15 zirconium

16 MEMBER POWERS: Oh, yes, copper.

17 CHAIR ARMIJO: -- oxide that -- crud-
18 induced localized corrosion effect during normal
19 operation. And that really damaged the zirc oxide,
20 and I would not want to have a LOCA with --

21 (Laughter.)

22 But, fortunately, that problem has been
23 solved in the BWRs, and so that has been put to bed.
24 But the basic question I think is a valid question.

25 My guess is it's -- you know, we haven't

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1 seen, other than that, infiltration or doping of the
2 zirc oxide due to normal operation that is -- you
3 know, from a post-PIE of fuel it would be -- and there
4 has been a lot of fuel looked at, but maybe not as
5 detailed as --

6 MEMBER POWERS: Yes, and the question is
7 we look for the right thing. And I don't know the
8 answer to this -- I do know that there is a lot of
9 work now going on with people modifying FCC lattices
10 with these -- in ADAMS to get these multi-phasic
11 structures. And they are looking at it for ion
12 exchange purposes. Here we would be interested more
13 in how it affects the oxidation kinetics.

14 CHAIR ARMIJO: Okay.

15 MR. CLIFFORD: Okay. Item 4, maximum
16 hydrogen generation. This paragraph limits the
17 generation of combustible gas, which is hydrogen, and
18 remains unchanged from the current regulations.

19 CHAIR ARMIJO: Paul, I've just got to go
20 back to the breakaway oxidation, just to make sure
21 that the people who were not at the Subcommittee hear
22 the arguments on -- related to the testing and
23 retesting requirement. Are you going to get to that
24 in another paragraph on --

25 MR. CLIFFORD: There's a paragraph on

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1 reporting.

2 CHAIR ARMIJO: Okay. Yes, because I've
3 got a number of issues there. We elaborated on those
4 issues in the ACRS minutes of the Subcommittee
5 meeting, and -- but, you know, very few members were
6 actually at the Subcommittee meeting. So I'd like to
7 at least raise those issues at the right time.

8 MR. CLIFFORD: Okay.

9 MEMBER POWERS: You have chosen one
10 percent again for -- you have changed -- it looks like
11 you have changed the basis for the one percent, but it
12 is one percent nevertheless. Why is one percent
13 taken?

14 MR. CLIFFORD: Right. Well, it hasn't
15 changed from the current requirement. You are
16 wondering what the basis of the current requirement
17 is?

18 MEMBER POWERS: Yes. I've always kind of
19 wondered.

20 (Laughter.)

21 I believe that in the end the one percent
22 was chosen to force a limit to the time that you could
23 remain at the peak temperature. Okay? But I don't
24 know that for a fact. I mean, it is my inference that
25 one percent was chosen to constrain you from sitting

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1 at the peak temperature for a long period of time.

2 MR. CLIFFORD: I don't believe that's --
3 Ralph?

4 MR. LANDRY: Ralph Landry from the Office
5 of New Reactors. Back in '72 and '73, when the
6 hearings were underway developing 50.46, the belief
7 was that if you could control the amount of cladding
8 that would be reacted to, less than one percent of the
9 total cladding material in the active fuel region, you
10 would produce a quantity of hydrogen that would remain
11 below the combustible limit in the containment
12 atmosphere. So this --

13 MEMBER POWERS: No kidding. One percent
14 would keep you well below combustion limits and --

15 MR. LANDRY: The purpose of the one
16 percent is not a determination of oxidation of the
17 cladding. The one percent is the equivalent amount of
18 hydrogen produced, and the idea was to keep the amount
19 of hydrogen produced, and a sufficient level of that
20 combustion was not a major problem.

21 MEMBER POWERS: Yes, one percent certainly
22 is going to keep you below combustion limits in just
23 about any containment I can think of.

24 CHAIR ARMIJO: So, Paul, in your format
25 this should be light gray.

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1 MR. CLIFFORD: It should be gray. It
2 should be gray.

3 CHAIR ARMIJO: Okay. Because that didn't
4 change. Okay.

5 MEMBER POWERS: Well, I wonder -- I mean,
6 in your spirit of generality, why don't you change
7 this requirement to say, "Thou shalt not produce
8 enough hydrogen to -- if I transfer it to containment
9 that I would be over the lower flammability limit."

10 MEMBER CORRADINI: Wouldn't you have a
11 problem, Dana, about concentrating and then showing
12 how you distribute it and mix it? I mean, this one
13 tells you that it is not going to be controlling.

14 MEMBER POWERS: I will always have the
15 problem that if I take one percent and look at the
16 break, it will be above the lower combustion limit.
17 I will always have that problem.

18 MEMBER CORRADINI: But, I mean, another
19 way of looking at it is this doesn't control anything.
20 This doesn't affect anything. It is a -- I mean, the
21 other question is: why even keep this at all?

22 MEMBER POWERS: No, no, I understand why
23 they want to keep it. But I'm wondering, if you're
24 trying to make this more general, and I look to issues
25 like small modular reactors, you may be imposing on

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1 them in a way that you don't really want to do. I
2 mean, from a safety concern, you are being way too
3 conservative.

4 If you cast this requirement into one of
5 thou shalt not get above the lower flammability limit
6 in your containment, then it becomes more general.

7 MEMBER CORRADINI: More performance-based.

8 MR. LANDRY: But, Dana, this has not been
9 a problem. This limit, going back through 35, 40
10 years of looking at LOCA analyses, we have never seen
11 a LOCA analysis that even approaches a one percent
12 core-wide oxidation level. So this --

13 MEMBER POWERS: I understand.

14 MR. LANDRY: -- this has never received a
15 comment from anybody, because it is so low-ended the
16 calculations don't even approach it. So it is really
17 not a concern.

18 MEMBER POWERS: I understand. I'm saying
19 you have not seen a LOCA analysis for the reactor that
20 will be proposed to you in 2025.

21 CHAIR ARMIJO: Well, you know, that opens
22 the other issue of mandatory --

23 MEMBER POWERS: You want it to be a
24 performance-based requirement.

25 CHAIR ARMIJO: You could write it that

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1 way, definitely.

2 MR. CLIFFORD: I understand. If they
3 wanted it to be purely performance-based, then you
4 would write what the performance objective was. And
5 if it's to protect against a concentration that would
6 ignite, then that would be the performance metric.

7 MEMBER POWERS: Yes. Some feedback to
8 you, and take it for what it's worth.

9 CHAIR ARMIJO: That just reminded me of a
10 question that came up in the Subcommittee meeting.
11 This applies to all reactors, all LWRs. And we just
12 are close to certifying the ESBWR design --

13 MR. CLIFFORD: Correct.

14 CHAIR ARMIJO: -- which never uncovers the
15 core in these events. And then, so would the people
16 who -- licensees of a -- operators of an ESBWR face a
17 problem of everything, you know, related to cladding
18 embrittlement, breakaway oxidation doesn't apply to
19 them.

20 MR. CLIFFORD: I think their performance
21 demonstration would just be that much simpler, because
22 it wouldn't be challenged. But they would still need
23 to provide a demonstration that it could meet the
24 requirements.

25 CHAIR ARMIJO: Like what -- it is going to

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1 be an analysis. Hasn't that already been demonstrated
2 in the certification process that these things are --

3 MR. CLIFFORD: Certainly.

4 CHAIR ARMIJO: -- you never uncover the
5 core?

6 MR. LANDRY: Okay. I will put on the
7 other hat. This is Ralph Landry from the Office of
8 New Reactors. That very question came up during the
9 review of the ESBWR because the plant never uncovers
10 the core, and the criteria -- all five criteria at
11 that time were looked at. We said there has to -- you
12 obviously meet the criteria. Can we weigh something
13 else? And at that point we said, "Well, you can show
14 that you never drop below a certain level above the
15 core. Therefore, that's an acceptance criterion for
16 this design." So --

17 CHAIR ARMIJO: Okay. So, you know --

18 MR. LANDRY: -- you never uncover the
19 core. These criteria don't mean anything.

20 CHAIR ARMIJO: Right. So the -- but this
21 was a rule in the requirement for breakaway oxidation
22 testing, qualification of the cladding material, new
23 cladding material, embrittlement, all of that sort of
24 stuff. Does it really apply? I would say no, but --

25 MEMBER CORRADINI: Well, Sam, isn't

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1 another way of saying it is that they meet it easily
2 by --

3 MEMBER SHACK: No, it comes back to this
4 issue of testing. This -- that question came up at
5 the Subcommittee. Bert Dunn wrote it up that -- for
6 a guy that never uncovers his core, are you going to
7 make him do a breakaway oxidation test?

8 MR. CLIFFORD: But they could set their
9 time above 800 C to an enormous number. I'm sorry --
10 a very small number, so they could show that they are
11 never going to challenge it.

12 CHAIR ARMIJO: I'm just saying, is there
13 a way to --

14 MEMBER SHACK: But they still have to do
15 the test to determine it. They can meet the criteria,
16 whatever the criteria would be. The question is: do
17 they have to keep doing the testing?

18 MR. CLIFFORD: Right now they would.

19 MEMBER SHACK: They would.

20 CHAIR ARMIJO: They would. You have to be
21 reporting. They'd have to be reporting that they
22 are --

23 MR. LANDRY: They still have the
24 requirement of an approved fuel.

25 CHAIR ARMIJO: Yes, but they are --

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1 MR. LANDRY: And the fuel designs for the
2 new reactors are not using materials that are
3 different from the fuels in the operating fleet. If
4 a fuel vendor is going to make fuel for the operating
5 fleet and for the new fleet, and it's the same fuel,
6 they are going to be doing the testing.

7 CHAIR ARMIJO: It's not the testing, it's
8 not the material. It's just the regulatory burden of
9 a guy who -- it really isn't the same kind of reactor
10 -- having to do stuff that is just a waste of time.

11 MR. CLIFFORD: Well, they could always
12 seek an exemption to that reporting requirement, you
13 know, as part of their DCD, one-time exemption for
14 that type of reactor.

15 CHAIR ARMIJO: That's fair. They'd give
16 you all of the arguments, and then you'd give them a
17 one-time exemption and that's one of the benefits of
18 that particular design.

19 MR. CLIFFORD: Right.

20 CHAIR ARMIJO: Okay. I understand.

21 MR. CLIFFORD: Okay. We have identified
22 four previous temperature-related performance
23 requirements for the current generation of fuel. The
24 last one involves long-term cooling. The current
25 50.46(b)(5) states that, "After any calculated

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1 successful initial operation of the ECCS, the
2 calculated core temperature shall be maintained at an
3 acceptably low value, and decay heat shall be removed
4 for the extended period of time required by the long-
5 lived radioactivity remaining in the core." That's a
6 quote.

7 However, no performance requirements or
8 analytical limits are defined within the rule. So
9 acceptably low temperature is somewhat arbitrary.

10 For 50.46(c), the working group decided to
11 use the preservation of cladding ductility as a
12 performance metric, the same as -- the same
13 performance metric that is used during the initial
14 stages of the LOCA.

15 The Federal Register notice includes
16 specific requests for comment from the public and the
17 industry on alternate ways to meet or define the
18 performance metric for long-term cooling.

19 CHAIR ARMIJO: And the question came up,
20 you know, how many days is long-term cooling? Or
21 would that vary from plant to plant? You know, I saw
22 some information that came back from the staff that
23 said somewhere around 30 days, but maybe -- so is that
24 what you are looking at as a metric, that they have to
25 say you've got to maintain long-term cooling or

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1 cladding ductility for 30 days after the LOCA, or --

2 MR. CLIFFORD: Right. The 30 days isn't
3 specified in the regulation. However, past practice
4 shows that it consistently used 30 days in previous
5 licensing actions. I think some of this was presented
6 in the email we provided.

7 MEMBER CORRADINI: Thirty days is what was
8 used in the certifications.

9 CHAIR ARMIJO: Yes, I think that -- so
10 maybe that's -- but you are not -- you don't really
11 specify that in the rule.

12 MR. CLIFFORD: It's a reasonable comment.
13 Maybe we should.

14 MEMBER CORRADINI: Or at least put a
15 pointer to where it is defined.

16 CHAIR ARMIJO: If somebody could come in
17 and say, "Based on our analysis, 15 days is
18 sufficient." The way this rule is written, you would
19 have to evaluate that and decide whether that was okay
20 or --

21 MR. CLIFFORD: Well, right now, they would
22 have to define how they demonstrate that they maintain
23 ductility through the 30 days. So they would -- I'm
24 assuming they would run tests, and then show that --
25 define upper level on temperature and show that they

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1 stay below that temperature based upon the results of
2 their experiments.

3 CHAIR ARMIJO: Okay. For the cladding
4 alloys that you have tested to date, do you have
5 enough information to say that that long-term cooling
6 requirement is met for the materials in use today?

7 MR. CLIFFORD: The LOCA research program
8 did not focus on long-term cooling. It focused on
9 really post-quench ductility and breakaway oxidation.
10 So there were no long-term tests run. So we have no
11 new results from that test program.

12 CHAIR ARMIJO: So what would someone that
13 is using conventional zircalloy-2 that has gone --
14 satisfy this requirement in the rule?

15 MR. CLIFFORD: Currently?

16 CHAIR ARMIJO: Yes.

17 MR. CLIFFORD: Okay. You would expect
18 that they would provide you with the simulation of the
19 transient out to a period of time, and you would show
20 that the long-term ECCS delivery flow rate matched or
21 exceeded the boil-off rate and that temperatures were
22 continuing to decrease over a long period of time.

23 CHAIR ARMIJO: Or stay stable or decrease
24 or --

25 MR. CLIFFORD: Right. Okay. No, a

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1 second --

2 CHAIR ARMIJO: Okay. So it's an analysis,
3 no testing required.

4 CHAIR ARMIJO: Right now, it is -- as I
5 mentioned, it is kind of --

6 MEMBER SHACK: Did you have tests to
7 accept the owners group proposed temperature that they
8 -- limit that they had?

9 MR. CLIFFORD: That was -- in response to
10 GSI-191?

11 MEMBER SHACK: Right.

12 MR. CLIFFORD: Right. There were
13 proprietary tests.

14 MEMBER SHACK: Right. So, I mean, there
15 is --

16 MR. CLIFFORD: Supplied by a vendor to --
17 and they specified a given temperature. It hasn't
18 been adopted yet, but it is actually included in the
19 question that's going out in the Federal Register.
20 Should we adopt a limit such as that proposed? And
21 what -- and could the test data be made publicly
22 available?

23 CHAIR ARMIJO: Okay. Thanks, Paul.

24 MR. CLIFFORD: Okay. Paragraph G2 defines
25 fuel-specific analytical requirements. The first item

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1 captures the research finding that oxygen ingress from
2 the cladding ID surface promotes cladding
3 embrittlement and reduces the allowable time and
4 temperature to no ductility.

5 The second analytical requirement for
6 current zirconium is that the effects of crud
7 deposition in oxide layer must be considered in the
8 evaluation model. This additional analytical
9 requirement achieves the rulemaking objective to
10 address the petition for rulemaking.

11 Appendix K -- moving right along -- use of
12 NRC-approved fuel in a reactor. This paragraph
13 clarifies the requirement of the use of NRC-approved
14 fuel designs for which specific ECCS performance
15 requirements have been established. It also
16 recognizes the importance of leak test assemblies for
17 collecting irradiated data to approve new fuel
18 designs.

19 CHAIR ARMIJO: Which means that you could
20 put in different materials without having to satisfy
21 all of these requirements, because there is just, you
22 know, a few assemblies and --

23 MR. CLIFFORD: Correct.

24 CHAIR ARMIJO: Okay.

25 MR. CLIFFORD: Within the bounds of the

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1 plant tech specs.

2 CHAIR ARMIJO: Okay.

3 MR. CLIFFORD: Paragraph L, the authority
4 to impose restrictions on operation. This is not a
5 new authority for regulatory action. This paragraph
6 just separates the authority between NRR and NRO,
7 between Part 50 and Part 52 plants.

8 Paragraph M, reporting. The language in
9 paragraph M has been significantly upgraded from the
10 existing regulation in an attempt to clarify the
11 existing reporting requirements. No new reporting
12 requirements in paragraph M1 have been added, but the
13 text looks significantly different, because we have
14 clarified the various options for reporting with
15 respect to an error.

16 CHAIR ARMIJO: I have a problem with this
17 reporting requirement for errors or changes that don't
18 result in any response that exceeds the acceptance
19 criteria, and the error or change in itself is not
20 significant. And then, there is a reporting
21 requirement within 12 months, and there has to be
22 apparently some sort of description of the change or
23 the operation of the error.

24 Now, it is not significant in itself. It
25 hasn't resulted in any exceedance of a limit. And the

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1 question I have is: it's not clear why an error that
2 is so insignificant it doesn't need to be reported for
3 12 months needs to be reported at all.

4 MR. CLIFFORD: The reason for that is
5 really bookkeeping and keeping a track on the
6 evolution of an approved model. That they need to
7 provide us with very rigorous validation of their ECCS
8 models and we approve those. If they find a minor
9 error and make a change to the model algorithms, then
10 even though the result is insignificant being 50 --
11 change of 50 degrees, we want to be made aware of it
12 and have the opportunity to challenge that.

13 CHAIR ARMIJO: But shouldn't that
14 requirement be in the approval of that particular
15 model and say, "This is the things we expect you to do
16 as maintenance of the model," but not necessarily here
17 in the --

18 MR. CLIFFORD: Well, without this
19 reporting requirement, you would basically say that
20 they would have to resubmit the entire model for NRC
21 approval, and that takes a long time. So you would --

22 CHAIR ARMIJO: No, it's not for approval.
23 You are just saying you want information, just to be
24 kept up to date.

25 MR. CLIFFORD: Right. But if we didn't

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1 have that reporting requirement, we would say you can
2 only use an approved model with no changes. And if
3 they had to make a correction, then they have to
4 submit the whole model.

5 MEMBER CORRADINI: This makes sense, then,
6 I think.

7 CHAIR ARMIJO: It's okay, but to me that
8 is model maintenance. Why isn't that a requirement in
9 -- when they approve a model? That's -- just keep us
10 informed as that's part of your obligation in the
11 approval of the model.

12 Why is it here in the law, the law of the
13 land, reporting requirement with all of the bells and
14 whistles related to it? And if something doesn't
15 happen, there is violations and all sorts of stuff.
16 It just seems to me like it's --

17 MR. LANDRY: Paul, if I may --

18 MR. CLIFFORD: Okay.

19 MR. LANDRY: -- Ralph Landry. The models
20 that are reviewed and approved, a large part of that
21 approval is based on the demonstration that the model
22 submitted meets certain criteria and performs in a
23 certain manner versus experimental data.

24 Now, if you make a change in that model,
25 you either have to resubmit the model completely for

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1 the reviewed -- because you no longer have a
2 demonstration of performance versus data that is
3 valid, or we have to have some sort of mechanism to
4 allow changes to occur without resubmittal.

5 And that is what we are doing with the
6 reporting requirement. We are saying that if you make
7 -- you are allowed to make changes up to a certain
8 amount, and you have to tell us in 30 days. If you
9 make changes that don't meet that trigger, then you
10 tell us annually. But you have to tell us that you
11 have made changes in something that we have reviewed
12 and approved.

13 The alternative to a reporting requirement
14 such as this would be, if you make a change, any
15 change at all, you no longer have an approved model.
16 You must now submit the model and the supporting proof
17 of its validity for us to review and approve it.
18 Review and approval of a LOCA model takes about two
19 years or more. I don't think too many people would
20 like to do that on a regular basis.

21 So the basis for the reviewing -- for the
22 reporting requirement is it allows us to have changes
23 made, corrections made, improvements made, without the
24 entire material being reviewed again.

25 CHAIR ARMIJO: Okay. But, you know, my

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1 issue is with things that are in -- not significant.
2 And it is detracting from things that are significant,
3 and you have different reporting requirements for
4 significant changes that still don't violate the
5 limits that are more than a certain temperature
6 increase or ECR increase.

7 Then, you have reporting requirements and
8 actions for changes that are significant and exceed
9 the acceptance criteria and those are even more
10 restrictive. To me, those seem pretty reasonably. It
11 just seems like reporting of insignificant stuff is
12 just make-work and a burden.

13 But you're telling me that, well, if we
14 don't put it here, our regulatory process would result
15 in something that is even more onerous than what this
16 is. That's what I'm hearing.

17 MR. CLIFFORD: Correct. And also, it is
18 really documentation. You wouldn't want them stepping
19 49 degrees every year, you know.

20 VICE CHAIR STETKAR: The cumulative effect
21 of insignificant changes --

22 MR. CLIFFORD: Right.

23 VICE CHAIR STETKAR: -- at some point
24 becomes interesting.

25 MR. CLIFFORD: We want to capture what the

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1 new analysis of record is. If it changes by 40
2 degrees, you still want to know what that is.

3 MR. RULAND: Right. This rulemaking --
4 this reporting requirement cannot be viewed in
5 isolation. It is really in concert with our reviewing
6 and approving the methods. It essentially is a
7 permissive reporting requirement, and it maintains our
8 integrity of the review and approval of the methods
9 that we have done.

10 CHAIR ARMIJO: Okay. I have heard you,
11 and I am not going to take any more of your time on
12 that. And I also had an issue on your significance
13 levels, although they have not changed from the -- at
14 least the peak cladding temperature significance
15 definitions. You have added the ECR significance
16 definition --

17 MR. CLIFFORD: Right.

18 CHAIR ARMIJO: -- and I wanted to talk
19 about that a little bit.

20 MR. CLIFFORD: Right. Paragraph M2, as
21 you mentioned, we have maintained the 50 degrees as
22 the threshold for significant, but we have also added
23 a 0.4 percent ECR as a threshold for significant. And
24 the purpose of this is you can imagine there is many
25 changes you can make in a model that could affect the

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1 duration of the transient more than it does the peak
2 in the first 50 or 60 seconds.

3 So this would capture both a change that
4 affects the initial spike and a change that would
5 affect the duration of a transient.

6 CHAIR ARMIJO: Now, I know it hasn't
7 changed, but your -- the way you define the 50 degrees
8 Fahrenheit change or error, it is a sum -- especially
9 if it's an accumulation, it is a sum of the absolute
10 magnitude of the respective temperature changes.

11 So if someone finds an error that resulted
12 in a decrease in peak clad temperature of 25 degrees,
13 and then made a change that increased the peak clad
14 temperature by 25 degrees, is that a 50-degree -- a
15 significant change?

16 MR. CLIFFORD: Right.

17 CHAIR ARMIJO: In other words, as far as
18 margin to the limit, nothing has changed. But you --
19 everything is arbitrarily made non-conservative, even
20 if in reality it is -- it is -- you are increasing or
21 not changing margin.

22 MR. CLIFFORD: Right. Well, there is two
23 reasons. The first reason is they find an error and
24 it's 400 degrees. And then they say, "Well, I think
25 there is some conservatism in this part of the model,

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1 so I'm going to take credit for that," and that
2 compensates for it.

3 We want to be aware what sort of horse
4 trading is going on, and how they are justifying that
5 it may not be an immediate safety concern, because
6 they are going to be going into the model and finding
7 various levels of the --

8 CHAIR ARMIJO: Well, we've seen that
9 earlier today. We've seen that earlier today at
10 Turkey Point. That's why I wanted to get into this.
11 And the question is --

12 MR. CLIFFORD: So if they say it's 300
13 degrees in a non-conservative direction, but then we
14 have another 400 degrees of margin somewhere else, or
15 so it turns out to be less than 50, whatever the delta
16 is, we want to know how they are getting there. So
17 you put the -- you know, the accumulation of the
18 absolute value, so you know exactly how they are
19 divvying up various conservatisms and how they are
20 getting to the end point.

21 And as far as the change in either
22 direction, that is just as important as a change in --
23 you know, going from 2,000 to 2,100. That's in the
24 bad direction, but going from 2,000 to 1,900, and then
25 increasing their tech spec peaking factors to allow

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1 them to go back to 2,000 is also in a non-conservative
2 direction from a real work perspective.

3 CHAIR ARMIJO: Okay.

4 MR. CLIFFORD: So it's --

5 CHAIR ARMIJO: Paul, I don't -- if you are
6 at 2,150, I can see where that 50 degrees, defined
7 very conservatively, kind of makes a lot of sense. If
8 you are at -- your peak clad temperature is at 1,600,
9 you know, that 50 degrees F seems to be, at least to
10 me, not important. And there is no flexibility there.

11 MR. CLIFFORD: Right.

12 CHAIR ARMIJO: It doesn't matter what your
13 peak clad temperature is. You still have to do that
14 and --

15 MR. CLIFFORD: Originally, we thought
16 about a sliding scale. As you approach the limit, you
17 would have more stricter reporting requirements.

18 CHAIR ARMIJO: And the same for --

19 MR. CLIFFORD: Far away, but it got very
20 convoluted and very --

21 CHAIR ARMIJO: And the same for the ECR.
22 There is -- you know, .4 percent ECR for some alloys
23 is not much of an issue, but for others could be.

24 MR. CLIFFORD: Correct.

25 CHAIR ARMIJO: So -- okay. Well, look,

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1 we'll move on. You have answered my questions.

2 MR. CLIFFORD: Okay. Item 3 -- and this
3 will spark some debate also.

4 (Laughter.)

5 This is the new reporting requirement on
6 measured breakaway oxidation.

7 CHAIR ARMIJO: Ah, that's the one. I knew
8 you'd save the best for last.

9 MR. CLIFFORD: This cycle-specific
10 reporting requirement is necessary to ensure that
11 cladding alloy susceptibility to breakaway oxidation
12 has not been inadvertently affected due to either
13 planned or unplanned changes in fuel fabrication.

14 Wait for questions.

15 CHAIR ARMIJO: Well, you know, I think
16 before I argue with you on that, I think I would like
17 you to get through your what we call the performance
18 safety assessment. I think that's very important, and
19 it bears on this issue.

20 MR. CLIFFORD: Okay. That was the last --
21 we will be talking implementation maybe later. So
22 next slide, next package.

23 Gordon is next.

24 CHAIR ARMIJO: Okay. Well, that's good.
25 You know, this is a very important issue, and as far

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1 as the rest of this Committee's agenda this afternoon,
2 it is our internal activities. And we are going to
3 keep going until you are finished. If people choose
4 to leave, shame on them, but -- they are free to do
5 that, but I would ask you to stay, because I think
6 this is -- a really good job has been done here, and
7 I think we should focus on it.

8 All right. Gordon?

9 MR. CLEFTON: Yes, I'm Gordon Clefton from
10 NEI. The slides I brought today are pretty much to
11 support our conclusion from the industry that the
12 safety assessment done early on was correct. What we
13 found in the processing, working with management at
14 NRC and with the industry, was there was going to be
15 a significant impact on resources and expenses to do
16 a response to a Generic Letter.

17 It was going to take a significant amount
18 of time, and that didn't support the interests that
19 Paul had with moving forward with this rulemaking or
20 with what we had in the industry.

21 So when we heard that the NRC was
22 proposing a Generic Letter to acquire a certain amount
23 of information to support their safety assessment, I
24 offered an alternative that I could coordinate the
25 industry and the three fuel vendors to provide reports

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1 which would address and come up with the same
2 information as would have been requested in a Generic
3 Letter to support the safety assessment, that this is
4 not a major safety issue and it can be implemented in
5 a smooth and logical format.

6 So I coordinated the two owners groups,
7 and I brought in all three fuel vendor suppliers. We
8 had a multiple number of industry meetings, got
9 authorization through the management of the owners
10 groups, set an agenda, that matched what Bill Ruland
11 and I agreed was acceptable, which gave us months of
12 advanced information transfer over what a Generic
13 Letter process would have taken, and we met our
14 schedule, stayed on time, and provided the information
15 in two separate reports, one from the boilers, one
16 from the pressurized reactor owners groups.

17 Paul took those with the staff of the NRC
18 and did an audit of the two reports, with cooperation
19 of the three vendors. We did requests for additional
20 information back and forth and satisfied the teams
21 that did the audits on the two reports.

22 Our conclusions, if you go through here --
23 I don't need to talk about the history that we already
24 mentioned with Bill and with Tara, but these are some
25 of the references that you will have that showed the

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1 conservativisms we used, the grouping that we used.

2 In order to preserve the identity of each
3 of the powerplants, we grouped to see which common
4 factors might have influenced the margin that we had
5 to peak centerline temperature. What we came up with
6 was that there was basically no adjustment needed for
7 the embrittlement breakaway oxidation on a number of
8 the plants.

9 The remaining plants, which is a fairly
10 small number here when you look at the numbers, took
11 credit for various conservations. That's what Paul
12 was talking about on the adjustments to margin for
13 peak centerline temperature. These shared among the
14 three vendors as much as we could with proprietary
15 information, and then very specifics with the audit
16 team that came from the NRC.

17 But we were comfortable that with our
18 conclusion that all of the operating plants will show
19 a margin now with respect to the new research findings
20 concerning the hydrogen concentration in the cladding
21 materials, and that we feel confident that the
22 operating fleet can meet the proposed change in the
23 local oxidation acceptance criteria.

24 Now, we have had a significant amount of
25 interface 10, 11 years now. We started this in 2000.

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1 We would like to continue that interface with public
2 meetings, stakeholder involvement. And when Tara gets
3 into the implementation schedule, you will see a need
4 for windows where we have stakeholder input into the
5 wording on the proposed rule and the three reg guides
6 that are associated with it.

7 If there are any questions, I would be
8 happy to answer. We've got the detailed reports right
9 now and -- each of the three vendors to remove all of
10 the proprietary information in it, so it can go into
11 the public docket. We don't see any problems there.
12 We had some medical histories. That slowed things
13 down, the holidays slowed us down. There doesn't seem
14 to be a rush, particularly on getting it back other
15 than for the -- closing the loop of the process,
16 but --

17 CHAIR ARMIJO: All the members have access
18 to the --

19 MR. CLEFTON: That's correct.

20 CHAIR ARMIJO: -- version, so we
21 appreciate that. And the other thing I wanted to make
22 sure that the members knew, that in this assessment
23 you -- all the research findings related to the
24 influence of hydrogen related to the issue of fuel
25 clad bonding. All of those things were incorporated

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1 into this assessment. So there was nothing left out.
2 It was a pretty select -- gave you something to --
3 that you could count on, at least we're counting on
4 it.

5 MR. CLEFTON: It was a rather unique
6 project, if you will. And the fact that we had the
7 cooperation of both owners groups, management
8 associated --

9 CHAIR ARMIJO: And it saved a lot of time.

10 MR. CLEFTON: -- we estimate we probably
11 saved \$1.2 million at each of the utilities cross-
12 country, so we are talking a net gain of probably
13 \$100 million or more by taking this alternate path.

14 CHAIR ARMIJO: Yes.

15 MR. CLEFTON: It worked well this time.
16 The NRC did a parallel effort and did their generic
17 letter preparations in case it was not -- our project
18 was not as successful as it turned out to be. So that
19 there was an opportunity not to have a time delay, the
20 Generic Letter would have gone out.

21 We had conclusions that the alternate path
22 worked very well. We hope to use this in the future
23 if it's an opportunity.

24 CHAIR ARMIJO: Okay. Paul, you're on.

25 MR. CLIFFORD: Thanks. I'll be going into

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1 more detail of the safety assessment conducted by the
2 staff and the information provided by the industry.

3 Okay. In this presentation, we will be
4 briefly summarizing the research findings so everybody
5 is on the same page, talking about the initial staff
6 assessment that was done when the research became
7 available and the more thorough plant-by-plant safety
8 assessment which has recently been completed.

9 The Argonne research program identified
10 three new embrittlement mechanisms. I'm not going to
11 dwell on this, but this plot shows that the measured
12 offset strain decreases significantly in high burnup
13 zirc-4 versus fresh zirc-4. And it was determined
14 that this was due to hydrogen, which is absorbed in
15 the cladding material during normal operation.

16 This plot here shows measured -- this is
17 the allowable oxidation limit to preserve a minimum
18 amount of ductility as a function of hydrogen, and it
19 shows the extent of the empirical database.

20 CHAIR ARMIJO: As compared to a straight
21 line at 17 --

22 MR. CLIFFORD: Right.

23 CHAIR ARMIJO: -- 17 percent --

24 MR. CLIFFORD: Exactly.

25 CHAIR ARMIJO: -- across the board?

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1 MR. CLIFFORD: The current regulations,
2 it's 17 percent. So you can see even with small
3 amounts of hydrogen it invalidates the existing
4 regulatory limit.

5 Second embrittlement mechanism was that
6 oxygen, which may be present in the fuel clad bond
7 layer on the cladding ID, may diffuse into the base
8 metal, reducing the allowable time and temperature to
9 no ductility.

10 Third embrittlement mechanism was the
11 degradation of the protective oxide layer, which is
12 referred to as breakaway oxidation. As the oxide
13 layer degrades, hydrogen is absorbed and it results in
14 gross oxygen embrittlement.

15 CHAIR ARMIJO: I've been meaning to ask a
16 question on that picture, because it is used all the
17 time but as -- for a lot of reasons. But if you do
18 breakaway oxidation on a test, let's say zircalloy-2,
19 and it goes out for 5,000 seconds, and then it gets
20 into breakaway oxidation, does it look the same as
21 this picture?

22 MR. CLIFFORD: No. Would it look if we
23 ran it even longer?

24 CHAIR ARMIJO: Well, eventually. Yes,
25 sure.

1 MR. CLIFFORD: It may, yes, eventually.

2 CHAIR ARMIJO: But it generally doesn't.

3 MR. CLIFFORD: We would stop the test when
4 we saw first signs of the degradation in the --

5 CHAIR ARMIJO: So this is breakaway
6 oxidation, but it's a pretty gross thing. And this
7 happened in --

8 MR. CLIFFORD: This is the old Russian
9 alloy E-110.

10 MEMBER POWERS: This is E-110. This is
11 the fluoride-contaminated or something like that.

12 CHAIR ARMIJO: The fluoride-contaminated,
13 and that is why I want to get at the issue of the
14 retesting, because I think it is driven by this
15 observation and some other stuff that, you know, if
16 you can scratch some stuff locally you can get
17 breakaway there. But, you know, this is not typical
18 or common or anything, but it just drives this
19 requirement.

20 And that's where I have a problem,
21 particularly where the times for breakaway oxidation
22 shown here are 3,000 seconds, 5,000 seconds, greater
23 than 5,000 seconds. And these are the alloys in use
24 today.

25 MR. CLIFFORD: Correct.

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1 CHAIR ARMIJO: And the durations of the
2 LOCAs are 2,000 seconds, more or less. So you've got
3 tons of margin, and the only way you can -- you can
4 change that is by postulating that the alloy is so
5 close to a cliff that slight changes in manufacturing
6 procedures or processes or something like that, or
7 alloys, will trigger breakaway oxidation.

8 And I'm telling you that doesn't make any
9 sense. It's just not -- and so, you know, the problem
10 here is you are requiring a lot of testing and
11 retesting and reporting for something that is not
12 likely to happen when you take into account the fact
13 that the industry already does tons of testing to
14 prevent these kinds of off-normal events in their
15 factories -- you know, surface contamination, damage,
16 and all of that.

17 And if you took a normal zirconium alloy,
18 zircalloy-2, 4, whatever, contaminated it with
19 fluoride, put it in a conventional water test or steam
20 test used in -- to assure good corrosion during normal
21 operation, which is a top priority requirement for
22 fuel people, it would also be crummy. Okay?

23 So it's -- so the things that are causing
24 breakaway oxidation also cause a great deal of damage
25 to -- during normal operations.

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1 MR. CLIFFORD: But E-110 had exceptional
2 corrosion performance during normal operation. It was
3 just when you got up to this temperature range of
4 800 C that it behaved like this in just a couple
5 hundred seconds.

6 So without a requirement, how could we be
7 -- how could we ensure ourselves that E-110 -- how do
8 we know that it not going to creep into the --

9 CHAIR ARMIJO: E-110 fluoride-
10 contaminated, in normal operating water, would be just
11 as bad as the zircalloy-2 fluoride-contaminated normal
12 operating water. These alloys aren't that different.

13 And, you know, the reality is that if this
14 becomes a rule -- and it will, the breakaway oxidation
15 is real -- fuel manufacturers will just add one more
16 test to their standard set of tests that they do to
17 assure a good corrosion resistance during normal
18 operation, and that test will be the one that we use
19 for breakaway oxidation.

20 MR. CLIFFORD: Right.

21 CHAIR ARMIJO: But -- and that will be a
22 routine thing. Okay?

23 So now you are requiring a licensee to
24 test each batch, and then report every time a new
25 batch comes in for something that has tons of margin.

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1 The phenomena is well understood, well under control,
2 and will be tested anyway during -- in fuel factories
3 in fabrication.

4 MR. CLIFFORD: I don't think --

5 CHAIR ARMIJO: And I think a national
6 laboratory observation of a grossly contaminated
7 sample shouldn't drive this regulation.

8 MR. CLIFFORD: I don't think --

9 CHAIR ARMIJO: That's really my argument.

10 MR. CLIFFORD: I don't think the staff
11 position is that it is that well understood. And I
12 don't believe the staff position is that it is only
13 limited to the use of fluoride. So I don't believe
14 that is our position. Our position is that there are
15 potentially many suspect materials that could be
16 introduced into the fabrication process that could
17 promote early breakaway oxidation.

18 And we haven't performed enough of a
19 sensitivity study to capture all of the potential
20 alloying elements that could cause this. And because
21 of that -- there is two ways of doing it, right? You
22 could have a very, very, very extensive research
23 program and test every potential alloying element and
24 composition and show that it doesn't occur, or you
25 could just say, "Run the test each time you

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1 manufacture a batch."

2 CHAIR ARMIJO: Well, the other thing you
3 could say, "Look, you guys are going to be testing for
4 it anyway in your fuel factories. Tell licensees to
5 make that a requirement in their purchase
6 specifications." And that will be that they buy
7 material that meets the breakaway oxidation criteria.

8 And believe me, you get a lot more testing
9 on a routine basis out of a factory than just one or
10 two or three tests of a batch. A batch is a sample,
11 doesn't tell you anything about how the process is
12 changing. It is just really a poor way of getting
13 information, and it flies in the face of a lot of
14 experience in fabricating and testing zirconium
15 alloys.

16 And I don't -- you know, I don't know what
17 the fuel manufacturers or NEI's position on that is,
18 but it seems to me like it is totally unnecessary.

19 MR. CLIFFORD: But, I mean, I will say one
20 thing. It is -- the industry has been aware of these
21 test results for many, many, many years. And to the
22 best of my knowledge, they haven't updated their
23 fabrication quality control procedures, to include
24 this test, for any changes they make.

25 So they haven't taken the initiative

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1 themselves, so it's almost as if they are waiting for
2 the regulation to come.

3 CHAIR ARMIJO: Well, you know, I think
4 they will. You know, the regulation -- they are going
5 to do what they normally do.

6 MEMBER SHACK: If the regulation comes,
7 they will.

8 CHAIR ARMIJO: But if there is no
9 regulation -- but the regulation doesn't have to say
10 "and it has got to be reported by the licensee," and
11 all of that sort of stuff. It is just a matter of
12 getting the licensee to make that a requirement, the
13 breakaway oxidation resistance demonstration as a
14 requirement for all fuel that they purchase, period.

15 MR. CLIFFORD: I think the industry also
16 opposes, you know, the frequency of these tests, which
17 would be for every batch. So I think when we go out
18 for public comment we will be receiving a lot of
19 comment from the industry, and they are free to
20 propose an alternative, and we will weigh it based
21 upon its merits.

22 MEMBER SHACK: That was my question. I
23 mean, literally, every batch? I mean, couldn't you
24 have, you know, every production run of tubing -- or
25 you really want this done at the final stage after it

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1 has been through all of the --

2 MR. CLIFFORD: Well, we thought about, you
3 know, whether it's an ingot or heat or whatever it is.
4 But the -- it is only the licensee that the
5 regulations apply to.

6 MEMBER SHACK: Right.

7 MR. CLIFFORD: So --

8 MEMBER SHACK: And he is going to stuff it
9 back.

10 MR. CLIFFORD: -- if it crossed -- if he
11 had an ingot that crossed -- you know, crossed
12 licensees -- in other words, they generated so many
13 for Palo Verde, so many for SONGS, I mean, how would
14 you deal -- how would you deal with that? So it is
15 really -- the regulations apply to the licensees, not
16 the vendors. So we had to make it in some metric that
17 is associated with the licensee.

18 MEMBER SHACK: No. But, I mean, will it
19 be acceptable if the licensee goes back to the vendor
20 and says all of this tubing came from this heat, you
21 know, or this run, and it was all made the same way,
22 whether it was for SONGS -- you know, so SONGS would
23 go there, you know, Point Beach would go there, and
24 they would just get a little certificate from the
25 fabrication vendor. Would that be good? Or do they

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1 literally have to run their own tests?

2 MR. CLIFFORD: No, that would be fine.

3 CHAIR ARMIJO: Well, I tell you, I think
4 there is a big misunderstanding of how fuel factories
5 work. They work under a process control. Okay? And
6 they process qualification, change control, and
7 backing all of that up is a quality assurance program
8 that -- looking at if things are changing, even though
9 they are not supposed to be changing, something
10 happened that was off-normal, nobody spotted it, the
11 QA testing would spot it. And they do frequent
12 testing, okay? Probably more frequent than if you
13 just say, "Send me a breakaway oxidation test for that
14 batch." Okay? And so you would actually get a better
15 control.

16 But it seems that this is a normal
17 fabrication kind of activity, and the process control
18 is what you are counting on, because you can only
19 sample. And if -- and as far as allow variability,
20 you have already proven that alloy variability has no
21 effect on breakaway oxidation, as demonstrated by
22 these various alloys, very different alloys. And they
23 all have long breakaway oxidation times beyond your
24 LOCA duration.

25 So it really comes down to off-normal

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1 factory problems -- contamination with fluoride,
2 contamination with something else, oil. And all of
3 that has been known for, as Dana said, for eons, and
4 it is tested for.

5 All you're saying is, "Hey, we would like
6 to see a test at above 800 C under the conditions
7 defined in the reg guide." Fine. I think they do
8 that anyway. It is -- to me, the way that you've got
9 it, it is, one, ineffective; two, unnecessary. And it
10 is -- and, you know, that's my point.

11 So anyway, I will stop.

12 MEMBER ABDEL-KHALIK: We already said that
13 NRC would find acceptable the tests performed by those
14 manufacturers who would provide a certificate to the
15 licensee saying that such-and-such test was performed.

16 MR. CLIFFORD: Absolutely.

17 MEMBER ABDEL-KHALIK: So I don't know
18 where your objection comes from.

19 CHAIR ARMIJO: It's a process
20 qualification. You know, if the fuel manufacturer
21 supplies to the licensee, this is the fuel you bought,
22 it conforms to the following requirements in your
23 purchase order, blah, blah, blah, blah, which includes
24 a breakaway oxidation test. That's it. It is process
25 control.

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1 And that thing is sufficient, rather than
2 a batch-by-batch test and tracking each batch. You
3 are implying that these products are so variable and
4 so sensitive that you've got to be watching them on a
5 batch-by-batch basis. It's just like --

6 MEMBER SHACK: Well, I think the answer I
7 sort of got from Paul was that the licensee obviously
8 has to do it on a batch basis, because that is how he
9 gets his stuff.

10 CHAIR ARMIJO: No.

11 MEMBER SHACK: The vendor --

12 CHAIR ARMIJO: He buys a batch. A
13 manufacturer makes tons of cladding.

14 MEMBER SHACK: Right, right.

15 CHAIR ARMIJO: Some of it goes to this
16 guy, some of it goes to that guy, some of it goes to
17 that guy. But then, the certificate goes to
18 different --

19 MEMBER SHACK: Goes to every guy.

20 CHAIR ARMIJO: But the manufacturer has
21 qualified his process, and he is providing a qualified
22 product to the licensee. So the acceptance of the
23 manufacturer's qualification process by the licensee
24 should be sufficient for the NRC.

25 MEMBER SHACK: But we don't regulate their

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1 fabrication quality assurance program.

2 CHAIR ARMIJO: You do monitor the --
3 somebody monitors the fuel factories, and you get
4 updates and all of that. And I don't know what they
5 report to you and what they don't report to you, but
6 you don't get -- you don't require batch-by-batch
7 reports on space or hydrogen pickup. You don't
8 provide batch-by-batch requirements on Inconel stress
9 relaxation properties.

10 All of these things -- there's tons of
11 things that are measured and provided in a fuel bundle
12 that are important, very important, and can cause
13 problems that are not regulated. And I don't see this
14 as any different. In fact, less --

15 MEMBER SHACK: Well, this is only a
16 proposed rule, Sam. We are going to get lots of
17 comment, as I said, from --

18 CHAIR ARMIJO: Well, you are getting some.

19 MEMBER SHACK: -- the real world.

20 (Laughter.)

21 CHAIR ARMIJO: You are getting one now.
22 Okay. Well, then, I just -- I've made my speech.
23 Thank you for listening.

24 Okay, Paul.

25 MR. CLIFFORD: Okay. Reaction to new

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1 research findings. The response to the staff to new
2 information depends on how you answer four basic
3 questions. Are the research findings credible? Is
4 the research complete? Are current regulations
5 adequate? And is there an imminent risk to public
6 health and safety?

7 When RIL 0801 was published, NRR completed
8 an initial safety assessment. This was in July of
9 2008. And we concluded that due to measured
10 performance, realistic rod power histories, and
11 current analytical conservatisms, there is --
12 sufficient margin exists for the operating fleet.

13 And so we concluded that there was no
14 imminent safety risk, that we should proceed with the
15 rulemaking process, and we also identified some
16 additional research needs.

17 So if we go back to the previous slide,
18 was the research findings credible? Yes. Is it
19 complete? It was complete. Are current regulations
20 adequate? We determined they weren't, because the
21 allowable ECR dropped below 17 percent, a relatively
22 low hydrogen pickup. And is there an imminent risk to
23 public health and safety? We concluded there wasn't.

24 However, recognizing that this rulemaking
25 process takes many years and the implementation

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1 throughout each and every reactor would take many more
2 years, we decided that a more robust safety assessment
3 was needed. To support that, we developed some basic
4 ground rules. The first is that we would develop an
5 alloy-specific post-quench ductility analytical limit.

6 As you remember, the empirical data shows
7 that there was not a strong alloy dependence on the
8 allowable ECR as a function of hydrogen. But there is
9 a strong alloy dependence on the rate at which
10 hydrogen is absorbed by each of the alloys.

11 So this plot would show how even a
12 straight line would turn it into a family of curves
13 based upon the hydrogen pickup fraction of each of the
14 alloys. In addition, one of our ground rules was that
15 the cladding out of the oxidation would need to be
16 considered above 45 gigawatt days, and that the alloy-
17 specific breakaway oxidation would be judged against
18 time above 800 degrees C.

19 Looking just at what the analyses of
20 record in the plant FSARs are, we notice that there is
21 at least 40 plants that are calculating less than
22 three percent ECR. There's about 25 plants between
23 three and six percent ECR, and then the remainder of
24 the fleet is between nine and -- really, it's between
25 nine and 17 percent ECR.

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1 This gives you an idea of the magnitude of
2 the change in ECR relative to the entire fleet.

3 If you look at breakaway, the calculated
4 time above 800 C, over 60 plants only remain above
5 800 C for less than 500 seconds. There is about 30
6 plants that are between 500 and 1,000 seconds, roughly
7 10 plants that are between 1,000 and 2,000 seconds,
8 and there is only one plant that remains above 800 C
9 for more than 2,000 seconds.

10 CHAIR ARMIJO: And that is one little BWR-
11 2.

12 MR. CLIFFORD: Right. Okay. I think
13 Gordon touched upon some of these numbers. The
14 revised post-quench ductility analytical limits -- 65
15 of the 104 plants met the required -- required the new
16 limits based on the alloys that they have in their
17 reactor, with no adjustments or new calculations
18 needed. That represents 77 percent of the BWR fleet
19 and 55 percent of the PWR fleet.

20 It is worth saying that all of the plants
21 continue to satisfy the 2,200 degrees Fahrenheit, and
22 realistically you could say that most plants are PCT
23 limited and not ECR limited.

24 Eight of the BWRs performed new LOCA
25 calculations, which credit existing tech spec thermal

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1 mechanical operating limits, which is essentially, as
2 this plot shows, it is a limitation on allowable
3 linear heat generation rate as a function of exposure.
4 So crediting existing tech spec, they reran their LOCA
5 analysis and they show that they met the current -- or
6 they met the research data.

7 So no conservatisms, no analytical
8 credits, they just said, "How can my plants possibly
9 operate? It is limited by tech specs. If I take
10 credit for the existing tech specs, I meet the
11 requirements."

12 CHAIR ARMIJO: So they'd get into trouble
13 -- if they were operating at higher powers somewhere
14 out there there would be issues above this that would
15 --

16 MR. CLIFFORD: Right. This tech spec
17 would be governed by thermal mechanical, probably rod
18 internal pressure. So if they exceeded -- if they
19 exceeded at high burnup, exceeded this rod power, then
20 they would potentially burst rods due to rod internal
21 pressure.

22 CHAIR ARMIJO: Okay.

23 MR. CLIFFORD: The PWR side, 31 of the
24 PWRs either performed new calculations or identified
25 some credits within the current approved methods.

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1 Nine PWRs -- and there is a breakdown. Nine of them
2 performed new calculations which credit rod power
3 history, similar to what the BWRs did. Eleven of them
4 credit a transition to an approved -- improved
5 evaluation model, but it is also an approved
6 evaluation model, just not applied to this specific
7 plant.

8 MEMBER POWERS: It's an improved and
9 approved --

10 (Laughter.)

11 MR. CLIFFORD: Four of the PWRs credit
12 improved statistics within the Astram methodology, and
13 seven PWRs had to rely on multiple credits. All of
14 the calculations were performed and documented in
15 accordance with the vendor's Appendix B QA program.

16 MEMBER ABDEL-KHALIK: Do these
17 calculations take into account the change in thermal
18 conductivity that was discussed this morning?

19 MR. CLIFFORD: Not all of them.

20 MEMBER ABDEL-KHALIK: So how would that
21 affect your assessment of where we are?

22 MR. CLIFFORD: I will get to that.

23 MEMBER ABDEL-KHALIK: All right, good.

24 MR. CLIFFORD: With respect to breakaway
25 oxidation, as I mentioned, only one plant exceeded

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1 2,000 seconds. So the remaining 103 plants would
2 easily show that they were below the measured
3 breakaway time. but the last plant was -- while it
4 was a little closer to the breakaway time, remained
5 below.

6 The staff conducted an audit of all of the
7 supporting fuel vendor calculations, to confirm that
8 the revised analytical limits were in accordance with
9 the research findings, and that alloy-specific
10 corrosion models and hydrogen uptake models were used
11 and that were accurate and supported by data.

12 We evaluated the quantification,
13 justification, and application of the analytical
14 credits, reviewed a sampling of the new LOCA
15 calculations, and identified any changes to the
16 existing approved methods and models. And as a result
17 of the audits, we compiled plant-specific data and
18 evaluated each individual's plant with respect to the
19 revised limit. And we generated a -- what we call an
20 ECCS margin database, which provides the specific data
21 for each and every plant.

22 There it is -- ECCS margin database. I
23 believe this was made available to the Subcommittee.
24 I'm not sure any members of the full Committee have
25 seen it.

1 MEMBER SHACK: I didn't realize that was
2 put together by you rather than industry, but --

3 MR. CLIFFORD: It was put together by me,
4 yes.

5 MR. CLEFTON: We had trouble putting all
6 of the industry into one piece of paper because of the
7 proprietary information. Paul is a central point of
8 the separation between General Electric/Westinghouse.
9 We had cooperation, certainly, with each of their
10 representatives, but there was some information that
11 Paul saw uniquely with all three that individually
12 didn't show.

13 CHAIR ARMIJO: We've been treating that as
14 proprietary, but at some point it is non-proprietary.

15 MR. CLEFTON: We are working right now to
16 clarify a document that will have all of the
17 proprietary information removed, but --

18 MR. CLIFFORD: I would imagine we would
19 maintain two databases, one non-prop, one prop.

20 CHAIR ARMIJO: Yes, okay.

21 MR. CLEFTON: It turns out there is very
22 few words in there that are of concern. One was a
23 table that was directly copied, and it had a
24 proprietary statement on the bottom. That is back to
25 the lawyers, one of the vendors right now. And when

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1 they process it and give us the paperwork, then we
2 will be able to coordinate and get a fresh, sanitized
3 issue that can go out.

4 MR. CLIFFORD: Okay. For the existing
5 commercial fleet, the performance safety assessment
6 confirms and documents on a plant-specific basis that
7 each and every plant continues to operate in a safe
8 manner.

9 We also evaluated the future operation of
10 Watts Bar Unit 2 and Bellefonte's Units 1 and 2 with
11 respect to the research data and found that they would
12 have margin. In addition, the newer plants are also
13 using newer alloys, which are less susceptible to
14 hydrogen uptake.

15 But, yes, in general, the direction of the
16 fleet is in a beneficial direction, because the older
17 alloys are being retired, being replaced with new,
18 modern alloys, which absorb less hydrogen. Like, for
19 instance, I believe there is only four plants that are
20 currently being loaded with zirc-4, and it's my
21 understanding that they all have expectations to
22 migrate to advanced cladding.

23 For the certified reactor designs, the
24 advanced reactor designs include enhanced ECCS
25 performance characteristics. As we described earlier,

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1 the ESBWR, because of the system design, has no core
2 uncoverly. The remaining certified designs have
3 significant margin.

4 MEMBER ABDEL-KHALIK: I guess I didn't
5 hear, you know, your promise response as far as this
6 ECCS margin database as to the effective --

7 MR. CLIFFORD: That's on the next slide.

8 MEMBER ABDEL-KHALIK: Okay.

9 MR. CLIFFORD: I think. I deleted a bunch
10 of slides. Let me just --

11 CHAIR ARMIJO: Well, you must have,
12 because it's not on the next slide.

13 MR. CLIFFORD: Okay. Yes, I deleted some
14 slides from the -- but I will talk to it.

15 Right. The thermal conductivity
16 degradation would impact the stored energy, which
17 would impact the calculated PCT and ECR. Obviously,
18 the PCT hasn't changed. They are still meeting the
19 2,000. The question is: does the evaluation that
20 includes the effects of thermal conductivity affect
21 the margin that is generated in the database?

22 As the slide that I deleted,
23 unfortunately, talks about how we are going to
24 maintain the database, and that it will be updated on
25 an annual basis, as new license amendment requests

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1 come in, we will be asking them to confirm any changes
2 on -- like if they do a power uprate. How does a
3 power uprate affect the documented margin in the
4 database?

5 So we are going to be maintaining that
6 margin. I was at an audit last week for a fuel
7 transition, and we brought up that point and they
8 provided us with the data showing that, well, ECR
9 increased slightly with the fuel transition. It is
10 still such that they needed no credits. So they still
11 were in the same category they were before. They
12 needed no credits to meet the revised -- the expected
13 ECR based on the research data.

14 MEMBER SHACK: But you don't have enough
15 results to go off and apply an adjustment the way that
16 they used an adjustment, you know, to take credit for
17 some things.

18 MR. CLIFFORD: No.

19 MEMBER SHACK: I mean, this would be a
20 negative adjustment.

21 MR. CLIFFORD: Correct. Right now they
22 are doing plant-specific assessments. So as soon as
23 they make the assessment they will issue a 30-day
24 notice under existing 50.46 reporting requirements.
25 And when we receive those, we will then go back to

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1 each of the vendors -- each of the licensees -- sorry
2 -- and ask them, how does this affect the margin that
3 we are currently crediting to show that you are safe
4 in the interim until we implement the new rule?

5 So we will be actively going to each of
6 the licensees when they submit that 30-day report and
7 following up on how the changes impact the database.
8 And we're already doing that. We're doing it with
9 Turkey Point now. We're doing it with Dominion in
10 their fuel transition. So we are already doing it.

11 CHAIR ARMIJO: Okay, Paul.

12 MR. CLIFFORD: Okay. So the research
13 findings necessitate new ECCS requirements. The
14 majority of plants needed no new calculations or
15 adjustments to show positive margin. The database
16 will be maintained and confirmed until such a point as
17 the new requirements are implemented.

18 CHAIR ARMIJO: Okay. Thank you.

19 Implementation.

20 MR. CLIFFORD: This is very short, so --
21 okay. Here is the agenda. There is a tremendous
22 amount of work scope that is necessary to implement
23 the new requirements. This slide tries to capture, at
24 least in general terms, what the major tasks are,
25 milestones are, in order to implement.

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1 In blue I have highlighted what I feel is
2 the most labor intensive part, and that would be to
3 perform plant-specific LOCA analyses, to prepare
4 license amendment requests, and for the staff to
5 review 80-plus license amendment requests. I say 80
6 because some of the plants are multiple sites, so it
7 is not 104. It is generally somewhere less; it is
8 around 80.

9 Based upon the ANPR comments, we
10 identified workforce limitations to complete parallel
11 analysis. A staged implementation plan would be the
12 most effective and efficient way to implement the new
13 requirements of 50.46(c).

14 Our original attack -- or our original
15 approach to this strategy was that plants with the
16 least amount of safety margin would be required to be
17 in compliance at the earliest time. It's illustrated
18 here.

19 However, recognizing that plants with the
20 least amount of margin are likely to require the most
21 effort and the most calendar time to document
22 compliance, in that there is a substantial number of
23 plants that do not require new LOCA models, methods,
24 or analyses, we revised our staged implementation
25 strategy to move the 60-plus plants that are in track

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1 three up to the beginning of the calendar in parallel.

2 CHAIR ARMIJO: They are actually going on
3 in parallel, wouldn't they?

4 MR. CLIFFORD: Hmm?

5 CHAIR ARMIJO: These activities with track
6 one and two and three, wouldn't they basically be
7 going on in parallel?

8 MR. CLIFFORD: No.

9 VICE CHAIR STETKAR: In the industry, but
10 not --

11 CHAIR ARMIJO: In industry. The industry
12 guys would be preparing this up in parallel, but the
13 staff can't do it all at --

14 VICE CHAIR STETKAR: Correct.

15 MR. CLIFFORD: And the industry can't do
16 it all at the same time either. I'm sure Gordon can
17 attest that you just can't run 80 LOCA analyses at the
18 same time.

19 MR. CLEFTON: We get a choke point with
20 resources, no question about that. The benefit of
21 this -- bringing the majority in that have minimum
22 credits to apply is the fact that lessons learned of
23 doing the applications and submitting it will be
24 shared among the vendors and hopefully through NEI to
25 make those with least margin aware of some of the

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1 choices and options that are available for them.

2 So the lessons learned of the majority
3 going through first will help the folks that are, as
4 you identified, the most intense in response to the
5 new rule.

6 CHAIR ARMIJO: Okay.

7 MR. CLEFTON: So we are supportive of
8 getting a majority of minimum action people through
9 the process.

10 MEMBER ABDEL-KHALIK: "Help them" in what
11 sense? Sharpen their pencils or --

12 MR. CLEFTON: Well, look at the different
13 credits that are available. The plants that have --
14 we have all maintained the peak centerline temperature
15 values. We haven't looked at margin as such as a
16 regulatory requirement. We have a limit that we may
17 not exceed. So we have adjusted with variables and
18 credits associated with attaining the expected
19 performance at each plant.

20 And some of the plants have never touched
21 that or changed it since their original licensing.
22 And now with the -- a new regulation they may be
23 challenged to come up with a wider margin or a
24 different margin. So by sharing what other vendors
25 and other plants are using for credits, if you will,

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1 to make adjustments to their margin assessment
2 calculations, those with a small amount may be able to
3 get more accurate calculations on their own site.

4 MEMBER SHACK: Well, I guess, I mean,
5 also, it's not clear -- when we say "margin" here, we
6 are talking about sort of computational margin, aren't
7 we?

8 MR. CLEFTON: That's correct.

9 MEMBER SHACK: The guy with the -- nothing
10 but Appendix K calcs looks bad, but in fact he is
11 going to -- he has probably got the biggest real
12 margin in the world. He just doesn't know it.

13 MR. CLIFFORD: Right. And we took that
14 into account when developing --

15 MEMBER SHACK: Did you try to do that?

16 MR. CLIFFORD: We did.

17 MEMBER SHACK: Because that's --

18 MR. CLIFFORD: And I'll explain that.

19 MEMBER SHACK: So you really think this is
20 true -- or this is your best estimate of true margin.

21 MR. CLIFFORD: I mean, we feel that the
22 plants with the least available margin are the ones
23 that are already using an Astram or a realistic
24 model --

25 MEMBER SHACK: Okay.

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1 MR. CLIFFORD: -- but still needed to take
2 some credits to meet the data, whereas if we move the
3 Appendix K plants down to track -- well, they are
4 actually track two now in this spot. We moved them
5 behind it because they have inherent margin in their
6 calculational methodology. So we took that into
7 account.

8 Okay. The implementation plan was
9 designed to achieve the following objective: to
10 expedite the implementation to as many plants as soon
11 as possible, to prioritize implementation on plants
12 with less inherent safety margin, and to balance the
13 workload.

14 This table kind of explains the logic.
15 Track one, which would be -- required to be in
16 demonstration within 24 months of the effective date
17 of the rule would be the plants -- let's see, this is
18 -- a lot of BWRs and PWRs here, which do not require
19 new analyses or new -- or model revisions.

20 The next grouping of plants which we
21 required are the plants with really the least amount
22 of margin, and those are the realistic LOCA models
23 that require new analyses. And there is 16 plants
24 there.

25 The third are the plants using -- oh, I'm

1 sorry, Item 2 is also the BWR-2s, which have less
2 inherent margin relative to the rest of the BWRs.

3 CHAIR ARMIJO: So that's two of those
4 guys.

5 MR. CLIFFORD: Two of those.

6 CHAIR ARMIJO: Okay.

7 MR. CLIFFORD: And the third track would
8 be the PWRs using Appendix K and requiring new
9 methods. And they may require the most amount of
10 work, because most of those plants currently don't
11 have a realistic model. Most of the -- I don't
12 believe there is a realistic model of proof of the CE
13 fleet, so -- as an example.

14 And we grouped the BWR-3s in this
15 category, really to balance the workload. And even
16 though you see 16 plants in two and 23 plants in
17 three, it turns out to be the exact same number of
18 analyses of record due to multiple unit sites.

19 In the rule, there is a listing of plants
20 that you can -- you all have the rule language.

21 CHAIR ARMIJO: Yes.

22 MR. CLIFFORD: So if you look at the rule
23 language, there is a table that shows where the plants
24 fall, and in here it's Table 1. So if you wanted to
25 see how they fall here.

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1 Paragraph O, which is the implementation,
2 which is the rule language which dictates -- I'm not
3 going to go into each of the paragraphs, but
4 essentially this paragraph required many subparagraphs
5 because there is a lot of perturbations on where
6 plants were licensed, when they were licensed, and
7 where the rule falls.

8 In other words, if you are an existing
9 Part 50 plant, there has to be the legal definition of
10 when you have to be in compliance. If you are a
11 Part 50 construction permit, or you're a Part 52
12 certified design, or if you're a Part 52 COL, there's
13 a lot of different types of plants and types of
14 circumstances which needed to be put into the rule.

15 MEMBER ABDEL-KHALIK: If you go back to
16 the previous slide, the difference between 24 months
17 and 48 months, that increment between each group is
18 dictated by what?

19 MR. CLIFFORD: It's informed by the amount
20 of time it takes to do the analysis.

21 MEMBER ABDEL-KHALIK: Not the amount of
22 time it will take you to do the reviews.

23 MR. CLIFFORD: No. This is the date that
24 they would have to submit the analysis to the NRC, not
25 the date that the NRC would have to find it

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1 acceptable, because that would put a tremendous burden
2 on us to maintain the schedule.

3 MEMBER ABDEL-KHALIK: And that's bad.

4 (Laughter.)

5 MR. CLIFFORD: Well, it would put a burden
6 on the licensee, because it would be on their -- it
7 would be beyond their control. They would submit it.
8 And if it took us longer, they are in violation of the
9 rule, because we didn't get it done. That doesn't
10 make -- to me, that doesn't make sense.

11 MEMBER ABDEL-KHALIK: But if you look at
12 the first grouping, for example, what would be
13 involved on your part to do these reviews?

14 MR. CLIFFORD: Well, I'm glad you brought
15 that up, because I forgot to mention it. What we are
16 trying to do in grouping one is to define a regulatory
17 process whereby the plants would update their FSAR.
18 These are for plants that don't need to redo their
19 analysis.

20 So basically they would update their FSAR
21 saying, "I am now in compliance with 50.46(c)," and
22 then they would send us a report. They would send us
23 the annual report saying, "I am now in compliance.
24 Here is my analysis of record. I meet the new
25 requirements. Done." And we wouldn't review each of

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1 those license amendment requests.

2 CHAIR ARMIJO: Do those people have to do
3 anything else internally? Changing tech specs or
4 internal documentation or anything other than send me
5 this letter saying, "We have updated the FSAR and we
6 are in compliance"?

7 MR. CLIFFORD: There is a potential,
8 because they -- each of the vendors is probably going
9 to need to submit a topical report before this process
10 really begins, and identify their hydrogen uptake
11 model for each of their alloys, and then they would
12 define using the reg guide allowable ECR versus
13 hydrogen, they would convert that to probably
14 allowable ECR versus burnup for their given alloy.

15 And so that would be an approved topical
16 report. The question is: does that topical report
17 then have to be put into the tech specs of each plant?
18 And if that was required, then each plant would have
19 to submit a license amendment request.

20 So we are trying to avoid that, because we
21 want to get these 65 plants into compliance as soon as
22 we can.

23 MEMBER BROWN: How does the numbers of
24 these plants relate to this LOCA record thing, where
25 you've got a number, those four bars and -- the first

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1 bar is in implementation track one? That is 512.

2 MR. CLIFFORD: That's a different job.

3 MEMBER BROWN: It's a performance safety
4 assessment.

5 MR. CLIFFORD: It's not directly related,
6 because, for instance, if they were using M5, they
7 would be allowed 17 percent ECR, because M5 doesn't
8 absorb hydrogen. So even if they were calculating 16
9 percent, they would still be in conformance. So even
10 though they're on the far right side of that plot,
11 they still would needn't a reanalysis. they wouldn't
12 need to do anything.

13 MEMBER BROWN: Because they have a longer
14 time is irrelevant, or they've got better performance
15 requirement -- the 17 percent.

16 MEMBER SHACK: It's really -- the one that
17 controls is the previous bar graph, you know, this bar
18 graph.

19 MEMBER BROWN: Okay.

20 MR. CLIFFORD: Is that the ECR one?

21 MEMBER BROWN: Yes.

22 MR. CLIFFORD: Okay.

23 MEMBER BROWN: All right. I was just
24 trying to connect the dots between them.

25 MEMBER SHACK: For most of the guys, the

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1 breakaway is not going to be a problem for them.

2 MR. CLIFFORD: Right. There is only one
3 plant that that is even --

4 MEMBER SHACK: Right.

5 MEMBER BROWN: But your other slides show
6 that the fuel -- I'm not a fuel guy, so that's why I'm
7 asking. So all of them are 3,500 seconds and greater.
8 You had another slide where you went through all of
9 the four fuel types.

10 MR. CLIFFORD: Right.

11 MEMBER BROWN: Wherever that one is. So
12 that it seems like all of these fell well within --

13 MR. CLIFFORD: Except for that one plant,
14 that's correct.

15 MEMBER BROWN: Well, that's just greater
16 than 3,500 or -- is it greater than 5,000? Is it
17 cleanup?

18 MR. CLIFFORD: That is documented in the
19 margins, the proprietary margins.

20 MEMBER BROWN: Okay. All right.

21 MR. CLIFFORD: You can look at that plant
22 and you will see how much margin they have. It's a
23 good point, though, because we're talking that maybe
24 these tests aren't necessary. But that plant is
25 within a couple hundred seconds of its breakaway, so

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1 maybe there is a small manufacturing change that
2 causes it to go from 5,000 to 4,500, and now it is no
3 longer acceptable.

4 CHAIR ARMIJO: Well, that guy has got a
5 problem. But you don't punish the whole class because
6 one kid misbehaves, so --

7 (Laughter.)

8 MR. CLIFFORD: Well, during the
9 Subcommittee we talked about this implementation
10 flowchart. I don't know if -- it is tough to read
11 now, and I --

12 (Laughter.)

13 CHAIR ARMIJO: Yes, we looked at it, and
14 we were going to spend a lot of time --

15 MEMBER SHACK: At the Subcommittee we had
16 a big page.

17 VICE CHAIR STETKAR: This is a big page.

18 MEMBER SHACK: It was even bigger.

19 MR. CLIFFORD: The purpose is just to
20 understand the calendar time it takes to implement it.
21 And while there are some things in parallel, there are
22 also other activities that will be in series, and just
23 to illustrate, really, the timeframe.

24 CHAIR ARMIJO: Okay. Yes, I don't think
25 we need to go into the details of this, how you are

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1 going to pull it off. So we can -- unless you have
2 something else --

3 MR. CLIFFORD: That's all I have.

4 CHAIR ARMIJO: You're done?

5 MR. CLIFFORD: I'm done.

6 CHAIR ARMIJO: All right. Well, I would
7 like to get some feedback from the members, and I'll
8 start with Jack.

9 MEMBER SIEBER: I have no additional
10 comment.

11 CHAIR ARMIJO: Dr. Banerjee, nothing?

12 MEMBER BANERJEE: No.

13 CHAIR ARMIJO: Steve?

14 MEMBER SCHULTZ: I would be interested in
15 NEI's comments related to the obligations of the
16 licensee with regard to what is in the now-current
17 rule, proposed rule, regarding the testing.

18 MR. CLEFTON: We're in a situation that we
19 saw the statement of considerations about, what, a
20 week and a half ago for the first time. And it has
21 been distributed to our focus group but not to the
22 mass distribution of the entire fleet of plants.

23 So what we are looking forward to now is
24 a release of the official document, because this one,
25 as you can tell, has "draft" written all over it, and

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1 we may have some modifications that go out. Our
2 feeling is with stakeholder meetings, public
3 workshops, and stuff, we will refine our comments, so
4 we don't really have any right now other than
5 premature and what we have looked at through the APN
6 process -- ANPR process and this draft that we have.

7 So we will have a number of comments.
8 There is a lot of coffee cup conversations about the
9 duration of the review period, about the
10 implementation schedule, why we are selecting some or
11 just make it one date for the whole fleet. So those
12 types of comments will come out later on, but I think
13 it is premature right now to get a consensus statement
14 from the industry.

15 So I will have to buy off that we will get
16 that to you with the comment period -- or get to the
17 staff with the comment period that will follow within,
18 what, a month or two after the EDO finishes with.

19 We have Commission vote time, too, so we
20 may not even get a comment period that isn't until
21 later in 2012. I'm not sure that answers your
22 question, but we have some interest in that,
23 certainly.

24 (Laughter.)

25 MEMBER SCHULTZ: And my other concern

1 would be, as I think has been discussed quite
2 thoroughly, the issues that Sam brought up with regard
3 to the testing requirements. If anything is going to
4 be implemented, more direct guidance ought to be
5 provided, and it ought to be informed by examining the
6 fabrication process and the relationship between the
7 licensee and the fuel vendor, and all of the testing
8 and programmatic requirements that are already in
9 place.

10 CHAIR ARMIJO: Okay. Steve, is that it?

11 MEMBER SCHULTZ: Yes.

12 CHAIR ARMIJO: Dick?

13 MEMBER SKILLMAN: Yes, two issues. For
14 the three different implementation tracks, is it
15 accurate that the starting time for the licensees will
16 be the same point in time?

17 MR. CLIFFORD: I don't believe that is
18 possible, just due to the limitations in the qualified
19 technical staff at the fuel vendors. There's three
20 vendors. There are a limited amount of people that
21 can run these LOCA analyses. So there is no way they
22 could run them all in parallel.

23 MEMBER SKILLMAN: So the requests to the
24 utilities will be at different times or at the same
25 time?

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1 MR. CLIFFORD: No, no. When the rule is
2 issued --

3 VICE CHAIR STETKAR: That starts the time
4 clock.

5 MEMBER SKILLMAN: I believe that was the
6 answer. That's what I was looking for.

7 MR. CLIFFORD: Okay.

8 MEMBER SKILLMAN: Second question, to what
9 extent -- you mentioned that you have met with the
10 fuel vendors. To what extent will this request be a
11 surprise to the licensees? Do they know this is
12 coming?

13 MR. CLIFFORD: We have had, I would say,
14 more than the usual amount of public interaction on
15 this.

16 MR. CLEFTON: This is Gordon Clefton from
17 NEI. With the ANPR process, the draft proposed rule
18 with the 12 parts all provided to the industry, we had
19 workshops that had 75, 80, 90 people into rooms.

20 So the utilities were invited, and many
21 participated heavily. With the three vendors, we had
22 their participation as a supplement, because there was
23 significant interest from the utilities and the
24 different sites, so we have had good involvement.
25 They recognize that we have hit a plateau in

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1 development here since, what was that, 2009 when we
2 had most of those workshops? And they are waiting for
3 a comment period that will come out.

4 MR. CLIFFORD: And we have presented
5 material at an ANS conference --

6 MEMBER SKILLMAN: Okay.

7 MR. CLIFFORD: -- discussing the
8 probability of a new rule coming.

9 MR. CLEFTON: And at the RIC, too, right?

10 MR. CLIFFORD: And at the RIC.

11 MR. CLEFTON: So we had the RIC
12 presentation not this year but the year before and had
13 good participation there. So it has not been shaded
14 from the utilities at all. We have had good
15 participation.

16 MEMBER SKILLMAN: Thank you.

17 MR. CLEFTON: It should be no surprise.

18 MEMBER SKILLMAN: Thank you.

19 CHAIR ARMIJO: Dr. Powers.

20 MEMBER POWERS: Well, I would certainly be
21 interested in seeing what the public comments are on
22 this batch testing. E-110 scared the hell out of us
23 because of the sensitivity. On the other hand, this
24 is the sort of thing that gets scrubbed out when you
25 do a design of a process facility. And so it may be

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1 a concern that we need to revisit in drafting the
2 final rule language.

3 It is apparent to me -- I mean, I am
4 delighted that we are finally getting this research
5 finding out into the rule language, and trying to get
6 the rules so that they are less alloy-dependent,
7 because I think there are new alloys coming down.

8 One of the things that I guess I am
9 concerned about is, as we develop new alloys, we are
10 going to start wringing out more and more benefit, and
11 other things that have not been a concern to us in the
12 past are going to come up and surprise us. And one of
13 the areas that I am particularly interested in is
14 absorption of ions and species onto cladding that in
15 the past has not been important, but as we refine
16 these alloys may suddenly emerge as important.

17 So I think there is going to be room for
18 continued clad research in the future in this area.

19 Those are the only comments that I want to
20 make.

21 CHAIR ARMIJO: Okay. Thank you, Dana.
22 Harold?

23 MEMBER RAY: Nothing, thank you.

24 CHAIR ARMIJO: Okay. John.

25 VICE CHAIR STETKAR: Nothing. Thanks.

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1 MEMBER RYAN: No additional comments.

2 Thank you.

3 CHAIR ARMIJO: Mike.

4 MEMBER CORRADINI: No additional comments.

5 CHAIR ARMIJO: Dr. Shack.

6 MEMBER SHACK: No.

7 MEMBER BROWN: Just a question. 50.46(a)

8 doesn't get better voted on? Are these two things

9 interrelated, or can they be done separately?

10 CHAIR ARMIJO: Well, they're separate, but

11 they --

12 MEMBER BROWN: Well, they talked about you

13 needed conforming or something before --

14 CHAIR ARMIJO: Well, if 50.46(a) never

15 gets voted on, this still applies to everybody. And

16 it's just --

17 MEMBER BROWN: It's seems like it would.

18 I'm just asking --

19 CHAIR ARMIJO: It's just a benefit that

20 the AWR guys would never be able to take advantage of.

21 That's --

22 MR. LANDRY: This is Ralph Landry. If

23 50.46(a) was never voted out by the Commission, then

24 there is nothing to conform it. We would just -- it

25 won't affect this rule. The only rule that would be

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1 affected would be if 50.46(a) was voted out and
2 approved, then there would be some action taken to
3 require 50.46(c), but that was voted out in --

4 CHAIR ARMIJO: Yes.

5 MR. LANDRY: -- 46(a) would not affect
6 46(c).

7 CHAIR ARMIJO: Right. Well, it gets back
8 to me. I have said a lot of things, but what I
9 haven't said is the fact that this has been a really
10 superb piece of research and analysis and planning and
11 excellent cooperation between industry and the staff.

12 And I think it is moving forward. I think
13 this rule has the potential to really be a landmark
14 improvement where science, physics, chemistry,
15 reality, is in the regulations. And, you know, I
16 think you are going to get a lot of comments. You are
17 certainly going to get some from me, but -- and you
18 have already gotten them.

19 But I think the additional goal I would
20 kind of urge the staff to think about is not only is
21 it a good rule from a technical and safety point of
22 which, is sort of top priority, but also should be
23 viewed from a standpoint of practicality,
24 reasonableness, a burden on the staff, and on
25 licensees to minimize anything that isn't really --

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1 directly affects safety.

2 But with that, I would like to, again,
3 thank the presenters, a terrific presentation. Took
4 longer than we expected, but I --

5 MEMBER SHACK: You had an indulgent
6 chairman.

7 (Laughter.)

8 CHAIR ARMIJO: You had an indulgent
9 chairman, and our members have been very patient for
10 lunch.

11 And so with that, thank you very much.
12 And it is 1:00. I think we are going to -- we have
13 one letter to write this next day and a half, so I
14 think we can just reconvene at -- we'll take an hour
15 for lunch -- 2:00.

16 (Whereupon, at 1:00 p.m., the proceedings
17 in the foregoing matter went off the
18 record.)

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UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

590th Meeting of the Advisory Committee on Reactor Safeguards

Turkey Point Units 3 and 4 Extended Power Uprate

January 19, 2012

Introduction

Allen G. Howe

Deputy Division Director

Division of Operating Reactor Licensing

Office of Nuclear Reactor Regulation

Jason C. Paige

Project Manager

Division of Operating Reactor Licensing

Office of Nuclear Reactor Regulation

EPU Overview

- Background
 - ❖ TP EPU Application – October 21, 2010
 - ❖ 2300 to 2644 MWt, 15 % increase (344 MWt)
 - Includes a 13 % power uprate and a 1.7 % MUR
 - 20 % increase above original licensed thermal power
- EPU Review Schedule
 - ❖ Followed RS-001
 - ❖ Linked licensing actions
 - AST – approved June 23, 2011
 - SFP Criticality analysis – approved October 31, 2011
 - ❖ Supplemental responses to NRC staff RAIs and Audits

Agenda

- EPU Overview
- Plant Modifications
- Safety Analysis Overview
- Mechanical and Civil Engineering



Turkey Point Units 3 and 4 Extended Power Uprate

Safety Analysis

Benjamin Parks
Reactor Systems Branch

Subcommittee Recapitulation

- Review Focus Areas
 - ❖ Main Steam Line Break
 - ❖ Emergency Core Cooling System Evaluation
 - ❖ Safety-significant events outside TP licensing basis:
 - Feedwater Line Break
 - Inadvertent Opening of Primary Relief Valve
 - Modes 4/5 Boron Dilution

Subcommittee Recap, continued

- Significant review results:
 - ❖ Licensee increased shutdown margin requirements for boron dilution events
 - ❖ Licensee demonstrated operator capability to mitigate inadvertent PORV event
 - ❖ Licensee provided analytic improvements to post-LOCA boron precipitation analysis

Subcommittee Open Items

- Thermal-Conductivity Degradation (TCD)
 - ❖ NRC published IN 2011-21, “Realistic Emergency Core Cooling System Evaluation Model Effects Resulting from Nuclear Fuel Thermal Conductivity Degradation,” during staff review of EPU
 - ❖ Licensee is revising steady-state fuel performance calculations and realistic ECCS evaluation to incorporate TCD effects

S/C Open Items

- RCS Overpressurization
 - ❖ Conservative analysis input assumptions deliver a conservatively high peak pressure
- SFP Criticality Analysis
 - ❖ Staff review of a new, parenthetical statement in TS is ongoing

Open Item Resolution

- Licensee has provided supplements describing TCD analyses
 - ❖ Steady-state fuel performance calculations
 - ❖ Transient/Accident analysis impacts
 - ❖ Realistic ECCS evaluation model changes

Staff Review of Open Items

- Perform confirmatory fuel performance calculations using FRAPCON
- Assess realistic ECCS evaluation model changes
- Review licensee evaluation of remaining accident/transient analyses
- Issue supplemental safety evaluation
- Brief ACRS on results at later meeting

Conclusion

- Staff finds EPU safety analysis generally acceptable
- Staff continuing review of TCD assessment



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UNITED STATES NUCLEAR REGULATORY COMMISSION

Protecting People and the Environment

**Turkey Point Units 3 and 4
Extended Power Uprate
ACRS Full committee Meeting**

Mechanical & Civil Engineering Review

Chakrapani Basavaraju, Ph.D.

Martin Murphy (EMCB Chief)

Mechanical & Civil Engineering Branch

Division of Engineering

Office of Nuclear Reactor Regulation

Review Scope

- NRC staff reviewed the impact of the EPU on the structural integrity of the SSCs
- Piping systems that are mainly affected by the EPU include the following:
 - ❖ Main Steam, Condensate, Feedwater, Extraction Steam and Heater Drains.
 - ❖ These systems required piping and pipe support modifications and/or equipment replacement /modification/addition to accommodate EPU conditions.
- Structural evaluations of SSCs (including proposed modifications) at EPU conditions employed current plant design basis methodology and acceptance criteria
- Structural evaluations met design basis code allowable values

OPEN ITEMS from ACRS Subcommittee Meeting

- SFP supplemental heat exchanger license condition wording
- 6th Feed water Heater Discharge Nozzle Terminal End Break (TEB) Zone of Influence

License Condition related to SFP Supplemental Heat Exchanger

- To maintain current design limits at EPU conditions, a supplemental Heat exchanger will be added to the cooling loop of spent fuel pool for each unit
- The NRC staff's review of the EPU LAR identified that the structural design and analysis of spent fuel pool supplemental heat exchanger (SFP suppl HX) associated modifications at EPU conditions had not been completed
- Therefore, the staff has imposed the following license condition

SFP Suppl. HX License Condition

- **License Condition**

Prior to completion of the Cycle 26 refueling outage for Unit 3 and cycle 27 refueling outage for Unit 4, the licensee shall confirm to the NRC staff that the design, structural integrity evaluations, and installation associated with the modifications related to the SFP suppl. HXs are complete, and that the results demonstrate compliance with appropriate FSAR and code requirements. As part of the confirmation, the licensee shall provide a summary of the structural qualification results of the piping, pipe supports, supplemental heat exchanger supports, and the inter-tie connection with the existing heat exchanger for the appropriate load combinations along with the margins.

HELB Methodology Overview

- Current Turkey Point licensing basis requirements related to HELB are based on the Giambusso AEC Letter criteria (1972) for systems outside Containment & remain the same for EPU.
- The licensee is continuing the same HELB methodology for EPU that was previously used by the licensee for the CLB prior to EPU, as well as for license renewal.
- Acceptance criteria based on compliance with Turkey Point General Design Criterion (GDC) 40.

Replacement of Sixth FW Heater & Nozzle Modification in support of the EPU

- **Only HELB analysis outside containment affected by EPU is the main feedwater system because the number 6 feedwater heater discharge nozzle size increased from 18 inches to 24 inches nominal diameter**
- **In accordance with the HELB criteria, the licensee postulated terminal end breaks at the discharge nozzles of the replaced sixth FW heaters**

Replacement of Sixth FW Heater & Nozzle Modification in support of the EPU (cont'd)

- The licensee performed walkdowns and identified equipment important to safety
- **The licensee made a conservative decision to install deflector shields on the discharge nozzles and not to use any zone of influence criteria for EPU HELB analysis.**
- These shields are designed to redirect jet forces and guide streams in a direction away from the safety-related equipment
- The staff finds that the licensee has adequately addressed and evaluated the terminal end break at the outlet nozzle of 6th FW Heater

Conclusions

Based on the review of the licensee's evaluations, the staff concluded that reasonable assurance has been provided to ensure that plant systems, structures, and components important to safety are structurally adequate to perform their intended design functions under EPU conditions.

QUESTIONS

Public Comments

Committee Guidance Comments

Adjourn



FPL[®]

**Turkey Point
Extended Power Uprate (EPU)
ACRS Full Committee**

January 19, 2012

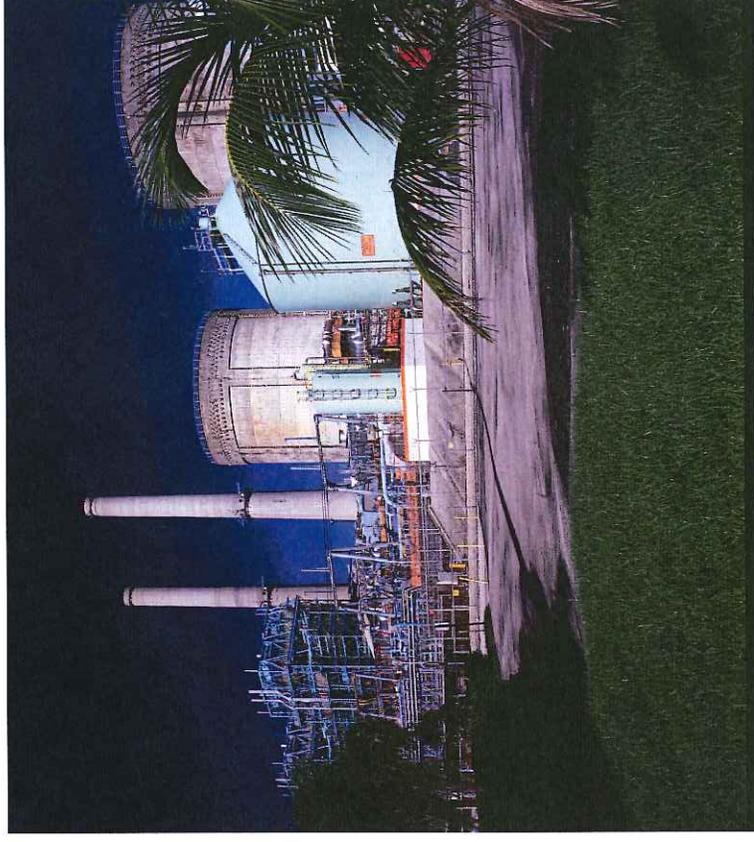
Agenda

- ➔ **Introduction** **Mike Kiley**
- **EPU Overview and Plant Modifications**..... **Steve Hale**
- **Safety Analysis Overview**..... **Carl O’Farrill**
- **Acronyms**



Turkey Point

- **Located 25 miles south of Miami, Florida**
- **Pressurized Water Reactor (PWR)**
- **Westinghouse 3 Loop Nuclear Steam Supply System (NSSS)**
- **Westinghouse Turbine Generator**
- **Architect Engineer – Bechtel Power, Inc.**
- **Each Unit output 795 MWe gross**



Turkey Point



- **Original operating licenses issued in 1972 for Unit 3 and 1973 for Unit 4**
- **Steam Generators (SGs) replaced in 1982 and 1983**
- **Two additional safety grade Emergency Diesel Generators installed in 1991**
- **Renewed Operating Licenses issued in 2002**
- **Reactor Vessel Heads replaced in 2004 and 2005**

Turkey Point



- **Thermal Power**
 - Original Licensed Thermal Power 2200 MWt
 - Current Licensed Thermal Power 2300 MWt
 - Stretch Uprate 104.5% (1996)
 - EPU Thermal Power 2644 MWt
 - Implement 2012 - 2013

Agenda

- Introduction Mike Kiley
- **➔ EPU Overview and Plant Modifications..... Steve Hale**
- Safety Analysis Overview..... Carl O’Farrill
- Acronyms

FPL is requesting approval for a 15% power level increase for the Turkey Point units

- **15% increase in licensed core power level (2644 MWt)**
 - 13% Power Uprate
 - 1.7% Measurement Uncertainty Recapture
 - $(2300 \times 1.13) \times 1.017 \sim 2644$ MWt
- **Attributes of the Turkey Point EPU**
 - Classic NPSH requirements for ECCS pumps are met without credit for containment overpressure
 - No fuel design changes for EPU
 - License Amendment Request 196: Alternative Source Term (AST)
 - Radiological accident analyses performed at EPU conditions
 - License amendment issued in June 2011
 - License Amendment Request 207: Spent Fuel Pool Criticality
 - Analyses included EPU fuel conditions
 - License amendment issued in October 2011

FPL is requesting approval for a 15% power level increase for the Turkey Point units

- **Grid stability studies have been completed and approved for the EPU full power output**
- **Final required modifications to support EPU operation will be implemented in 2012 - 2013**
 - Spring 2012 outage for Unit 3
 - Fall 2012 outage for Unit 4

Analyses were performed to evaluate the changes in design parameters

Parameter	Original	1996 Uprate	EPU	EPU Change
Core Power (MWt)	2200	2300	2644	+344
RCS Pressure (psia)	2250	2250	2250	0
Taverage (°F)	574.2	571.2 ⁽¹⁾ – 577.2	570.0 – 581.5	-1.2 / +4.3
Vessel Inlet (°F)	546.2	540.4 – 546.6	535.5 – 549.2	-4.9 / +2.6
Vessel Outlet (°F)	602.3	602.0 – 607.8	604.5 – 616.8	+2.5 / +9.0
Delta T (°F)	56.1	61.6 – 61.2	69.0 – 67.6	+8.4 / +6.4
Thermal Design Flow (gpm/loop)	89,500	85,000	86,900	+1,900
Core Bypass (%)	4.5	6.0	6.3	+0.3
Steam Pressure (psia)	785	701 - 832	701 - 822	0 / -10
Moisture Carryover (maximum, %)	0.25	0.25	0.25	0
Steam Mass Flow(10 ⁶ lb/hr)	9.60	10.13 – 10.17	11.59 – 11.64	+1.46 / +1.47

(1) Some analyses consider T_{avg} of 566.2°F for an end of cycle coastdown



Modifications will be made in support of the Safety Analysis

- **Nuclear Steam Supply System (NSSS) setpoints**
- **Pressurizer Level Program and Safety Valve Lift Settings**
- **Hot Leg Injection Flow Path**
- **Emergency Containment Coolers Auto Start Logic**
- **Main Steam Safety Valve Setpoint Changes**
- **Main Steam Isolation Valve (MSIV) and Main Steam Check Valve (MSCV) Upgrades**
- **Modify / Install Feedwater Isolation Valves**
- **Install Leading Edge Flow Measurement (LEFM) System**
- **Refurbish Auxiliary Feedwater Pumps**
- **Remove Auxiliary Feedwater Control Valve Travel Stops**
- **Safety Related Piping Support Modifications**
- **Jet Impingement Shields**
- **Technical Support Center Shielding Modifications**
- **Install Additional Spent Fuel Pool Cooling Capacity**



Modifications will be made in support of power generation at the EPU power level

- **Steam Path**
 - Replace High Pressure Turbine
 - Electro Hydraulic Control (EHC) System and Control Valves
 - Digital Turbine Controls
 - Replace Moisture Separator Reheaters (MSRs)
- **Condensate and Feedwater**
 - Replace Main Condensers and Condenser Cleaning System
 - Replace Condensate Pumps and Motors
 - Replace Feedwater Pump Rotating Assemblies
 - Modify Main and Bypass Feedwater Control Valves / Actuators
 - Replace High Pressure Feedwater Heaters
 - Replace Gland Steam Condenser and Piping
 - Steam Jet Air Ejector Tube Bundle Replacement

- Continued on next page -



Modifications will be made in support of power generation at the EPU power level (continued)

- **Heater Drains**
 - Modify Heater Drain Piping
 - Heater Drain System Control Valve and Digital Upgrade
- **Other Balance of Plant items**
 - Balance of Plant (BOP) Setpoints
 - BOP Piping Supports
- **Auxiliary Support Systems**
 - Replace Turbine Plant Cooling Water Heat Exchangers
 - Replace Control Rod Drive Mechanism Fan Motors and Coolers

Modifications will be made in support of power generation at the EPU power level (continued)

- **Electrical Modifications**
 - Generator upgrades including
 - Stator rewind
 - Rotor replacement
 - New current transformers
 - New Hydrogen coolers
 - New exciter air coolers
 - Iso-Phase Bus Duct Modifications
 - Main Step-up Transformer Cooling and Tap Changer Modifications
 - Replace Unit Auxiliary Transformers
 - Switchyard Modifications

Open items from the draft EPU Safety Evaluation (SE) and ACRS sub-committee meeting addressed

- **Open items resolved (refer to Staff presentation)**
 - Updated Spent Fuel Pool heat exchanger license condition
 - HELB - High Energy Line shield being utilized
 - Loss of Load Analysis conservatisms confirmed
- **Two open items from draft SE under Staff review**
 - New fuel storage area criticality analysis use of alternate burnable absorbers
 - FPL issued response describing analysis process to be followed under 10 CFR 50.59
 - Technical Specification wording permits the implementation of alternative burnable absorbers to effectively control power peaking within the reactor core
 - Large Break LOCA analysis addressing nuclear fuel thermal conductivity degradation—discussed in next section

Agenda

- Introduction Mike Kiley
- EPU Overview and Plant Modifications..... Steve Hale
- ➔ **Safety Analysis Overview..... Carl O’Farrill**
- Acronyms

Safety analyses are conservative and improved

- **Key changes beneficial to safety analysis**
 - Improved methods
 - Reduction of peaking factors (Heat Flux Hot Channel Factor (F_q) and Hot Channel Enthalpy Rise Factor ($F_{\Delta H}$))
 - Reduction in axial offset operating limits
- **Conservative inputs/assumptions**
 - Conservative physics parameters
 - Bounding plant operating parameters
 - Conservative trip setpoints
- **Conservative analysis DNBR limit**
 - Safety Analysis Limit (SAL) for DNBR is set conservatively to maintain margin to the DNBR design limit

Conservative analysis methods applied for non-LOCA events with all results meeting acceptance criteria (continued)

	Event	Criteria	Result
Decrease (Loss) in RCS Flow (Reduced Primary Cooling)	Loss of Flow (Cond III) 1) WRB-1 DNB Correlation 2) ABB-NV DNB Correlation non-mixing vane grid spans	DNBR (SAL*) Upgrade Fuel ≥1.40/1.40 (typical/thimble)	1.698/1.712
	Locked Rotor (Cond IV)	DRFA Fuel ≥1.50/1.50 (typical/thimble)	1.743/1.710
Overheating (Reduced Secondary Cooling)	Loss of Load (Cond II)	RCS Pres ≤ 2748.5 psia Rods-in-DNB ≤ 15%	2694.1 psia 0%
	Loss of Feedwater (Cond II)	RCS Pres ≤ 2748.5 psia MSS Pres ≤ 1208.5 psia	2746.6 psia 1197.1 psia
	Loss of AC Power (Cond II)	Przr Mix Vol ≤ 1300 ft ³ Przr Mix Vol ≤ 1300 ft ³	1198.5 ft ³ 1185.9 ft ³
	ATWS	RCS Pres ≤ 3215 psia	3174.5 psia

* Safety analysis limit DNBR has margin compared to the DNBR design limit



Conservative analysis methods applied for non-LOCA events with all results meeting acceptance criteria (continued)

Overcooling	Event	Criteria	Result
	HFP MSLB (Cond III or IV)	DNBR (SAL*) Upgrade Fuel ≥ 1.40 DRFA Fuel ≥ 1.50 LHR ≤ 22.72 kW/ft	1.836 2.117 22.68 kW/ft
	HZP MSLB (Cond IV) WLOP DNB Correlation	DNBR (Correlation Limit) Upgrade Fuel ≥ 1.18 (typical/thimble) DRFA Fuel ≥ 1.18 (typical/thimble) LHR ≤ 22.72 kW/ft	1.464/1.411 1.382/1.328 22.198 kW/ft

* Safety analysis limit DNBR has margin compared to the DNBR design limit



Conservative analysis methods applied for non-LOCA events with all results meeting acceptance criteria (continued)

Reactivity Addition	Event	Criteria	Result
	Rod Withdrawal @ Power (Cond II)	DNBR (SAL*) ≥ 1.40 RCS Pres ≤ 2748.5 psia	1.48 2740.92 psia
	Rod Ejection (Cond IV)**	Fuel Enthalpy ≤ 200 cal/g Fuel Melt (at hot spot) $\leq 10\%$	178.33 cal/g 8.44%

*Safety analysis limit DNBR has margin compared to the DNBR design limit

**Includes effect of Thermal Conductivity Degradation (TCD)



Small Break LOCA safety margin is assured by key changes

Parameter	Pre - EPU	EPU
Analyzed Core Power (MWt)	2300	2644
Hot Channel Enthalpy Rise Factor [$F_{\Delta H}$]	1.70	1.65
Axial Offset (%)	20	13
Steam Generator Tube Plugging Level (%)	20	10
HHSI	One HHSI Pump	Two HHSI Pumps

Small break LOCA analysis performed using NRC-approved NOTRUMP evaluation model demonstrated acceptable results

	Pre - EPU	EPU	Limit
Limiting Break Size	3-Inch	4-Inch	-
PCT (°F)	1688	1231	2200
Maximum Transient Local Oxidation (%)	2.02	0.07	17.0
Maximum Core-Wide Oxidation (%)	< 1.0	< 1.0	1.0



Large Break LOCA Analysis Performed Using NRC Approved Best Estimate ASTRUM with results meeting acceptance criteria*

10 CFR 50.46 Requirement	Pre-ASTRUM/EPU Value	EPU Value	Acceptance Criteria
95/95 Peak Cladding Temperature (°F)	2040	2152	< 2200
50 th Percentile Peak Cladding Temperature (°F)	1612	1633	-----
95/95 Maximum Local Oxidation (%)	11	10.5	< 17.0
95/95 Core Wide Oxidation (%)	0.70	0.40	< 1.0
Coolable Geometry	Long term cooling is maintained via operator actions. No impact on coolable geometry.		
Long-Term Cooling			

* Includes effect of Thermal Conductivity Degradation (TCD)



The effects of fuel pellet thermal conductivity degradation (TCD) has been assessed

- **Data from experiments conducted at the Halden test facility in the 1990's indicated that TCD at higher burnups may not be sufficiently accounted for in industry nuclear fuel analysis codes**
- **Information Notice 2009-23, Nuclear Fuel Thermal Conductivity Degradation, indicated codes approved by NRC before 1999 may not adequately address this effect**
- **Previous assessments indicated sufficient conservatism existed within the current Westinghouse fuel performance methods to compensate for the TCD effect**
- **Westinghouse is developing an upgraded version of the PAD code which will explicitly account for TCD to be submitted in 2013 to NRC for approval**

The effects of fuel pellet thermal conductivity degradation (TCD) has been assessed

- **Recent conservative estimates indicate that the impact of TCD on fuel average temperatures may be higher**
 - Assessments continue to indicate that the fuel average temperature at higher burnup remains below the fuel average temperature at zero burnup
- **NRC Staff issued Information Notice 2011-21, Realistic Effects of ECCS EM Effects Resulting from Nuclear Fuel TCD, on December 14, 2011**
- **FPL addressed the impact of TCD on the Turkey Point EPU safety analyses**

Assessment of the impact of TCD indicates acceptable results for Turkey Point EPU analyses

- **TCD impact on Turkey Point EPU analyses has minimal or no impact on most areas**
 - Fuel thermal hydraulic design
 - Core physics design
 - SBLOCA
 - Post LOCA long term cooling analysis
 - Containment pressure for MSLB
 - Radiological consequences
 - SGTR
 - Containment pressure for LBLOCA
 - Non-LOCA

Assessment of the impact of TCD indicates acceptable results for Turkey Point EPU analyses

- **Detailed assessments completed on impacted areas**
 - Fuel mechanical design
 - Fuel power to melt limit
 - Rod internal pressure
 - Clad strain/stress/fatigue
 - Safety Analyses
 - Rod Ejection
 - LBLOCA—Most significant area of impact
- **Analyses submitted to NRC in December 2011 and January 2012; NRC audit conducted in January 2011**
 - NRC Staff review underway

Agenda

- Introduction Mike Kiley
- EPU Overview and Plant Modifications..... Steve Hale
- Safety Analysis Overview..... Carl O’Farrill

➔ Acronyms

Acronyms

AFW	Auxiliary Feedwater	MSIV	Main Steam Isolation Valve
AST	Alternative Source Term	MSLB	Main Steam Line Break
ATWS	Anticipated Transient without Scram	MSR	Moisture Separator Reheater
BOP	Balance of plant	MWe	Megawatts electric
CLB	Current Licensing Basis	MWt	Megawatts thermal
DNB	Departure From Nucleate Boiling	NAMS	Nuclear Assets Management System
DRFA	Debris Resistant Fuel Assembly	NPSH	Net Positive Suction Head
ECCS	Emergency Core Cooling System	NSSS	Nuclear Steam Supply System
EHC	Electro Hydraulic Control	PCT	Peak Cladding Temperature
EPU	Extended Power Uprate	PNSC	Plant Nuclear Safety Committee
F	Fahrenheit	PPM	Parts per Million
FΔH	Hot Channel Enthalpy Rise	Pres	Pressure
FQ	Heat Flux Hot Channel Factor	PSIA	Pound per square inch - absolute
ft	Feet	PWR	Pressurized Water Reactor
GPM	Gallons per minute	RCS	Reactor Coolant System
HFP	Hot Full Power	RIS	Regulatory Issue Summary
HHSI	High Head Safety Injection	RS	Review Standard
HZP	Hot Zero Power	RTS	Return to Service
in	Inch	RWST	Refueling Water Storage Tank
Keff	K-effective	SAL	Safety Analysis Limit
ksi	Kilo pounds per square inch	SDM	Shutdown Margin
LAR	License Amendment Request	Sec	Second
lb/hr	Pounds per hour	SG	Steam Generator
LEFM	Leading Edge Flow Meter	SLB	Steam Line Break
LHR	Linear Heat Rate	V	Velocity
LOCA	Loss of Coolant Accident	ZrB ₂	Zirconium Diboride
MSCV	Main Steam Check Valve	ρ	Density



Background of the 10 CFR 50.46c Proposed Rule and Related Activities

January 19, 2012

Tara Inverso
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Meeting Purpose

- Present the 10 CFR 50.46c proposed rule to ACRS
- Provide an overview of the related safety assessment/audit

Meeting Agenda

1. Background of 50.46c Rulemaking Activities
2. Overview of 50.46c Proposed Rule
3. Overview of BWR/PWR Owners' Group Report
4. Overview of Safety Assessment
5. Proposed Implementation Schedule

Rulemaking Purpose

- Revise ECCS acceptance criteria to reflect recent research findings
- **SECY-02-0057**
 - Replace prescriptive analytical requirements with performance-based requirements
 - Expand applicability to all fuel designs and cladding materials
- Address concerns raised in two PRMs: PRM-50-71 and PRM-50-84

Public Interaction

- Advance Notice of Proposed Rulemaking Published
 - August 13, 2009 (74 FR 40765)
 - Requested specific comment on 12 issues/questions
- Public Workshop
 - April 28-29, 2010
- Public Meetings on Safety Assessment
 - August 12, 2010; December 2, 2010; March 3, 2011

Recent ACRS Interaction

- **Research Findings – Regulatory Basis for 50.46c Rule**
 - Presented RIL-0801 and NUREG/CR-6967 on December 2, 2008 (sub-committee) and December 4, 2008 (full committee)
 - “Mechanical Behavior of Ballooned and Ruptured Cladding” presented on June 23, 2011 (sub-committee) and July 13, 2011 (full committee)
- **Draft regulatory guidance:**
 - Presented to ACRS on May 10, 2011 (sub-committee) and June 8, 2011 (full committee)
- **Proposed Rule:**
 - Presented to ACRS sub-committee on December 15, 2011

Fuel Fragmentation, Relocation, and Dispersal

- Further research is necessary to understand fuel dispersal and its significance
- The staff recommends that the 50.46c rulemaking proceed to address the known embrittlement phenomenon
 - As written, the proposed rule satisfies all objectives/Commission direction



Rulemaking Schedule

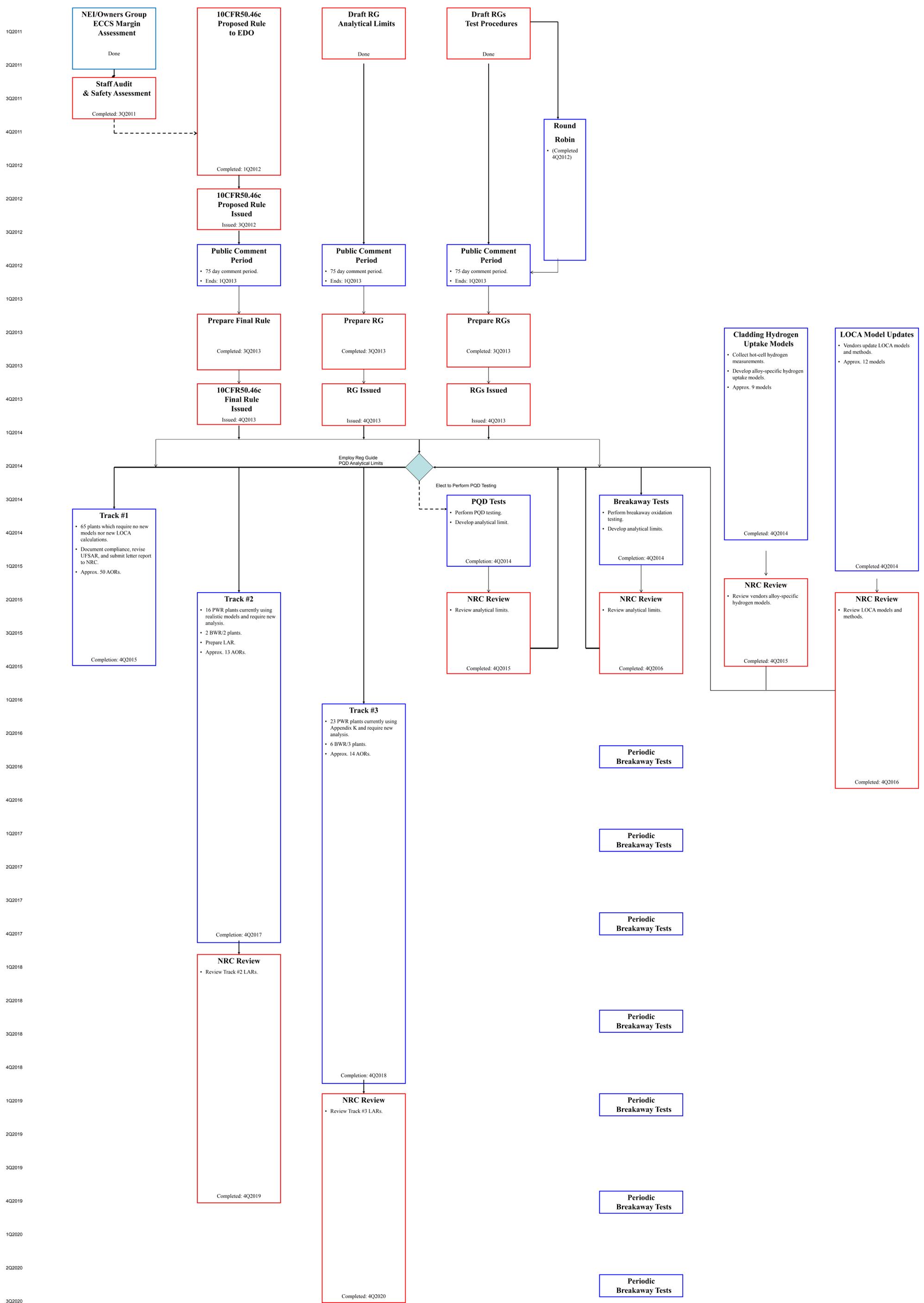
- Proposed Rule Due to the Executive Director for Operations:
 - February 29, 2012



Questions?

Tara Inverso, Project Manager

301-415-1024; tara.inverso@nrc.gov





Overview of the 10 CFR 50.46c Proposed Rule

January 19, 2012

Paul Clifford
Division of Safety Systems
Office of Nuclear Reactor Regulation

Agenda

- ECCS Design Function
- Structure of Performance-Based Rule
- Overview of 50.46c Rule Language

ECCS Design Function

- Emergency Core Cooling System consists of SSCs designed to replenish liquid inventory and maintain core temperatures at an acceptable level during and following a postulated LOCA.



Rule Structure

Performance-based nature necessitated major restructuring of proposed 50.46c rule.

Rule Structure (cont.)

50.46c ECCS Performance During LOCA

(a) Applicability

(b) Definitions

(c) Relationship to Other NRC Regulations

(d) ECCS Design

(e) [reserved]

(f) [reserved]

(g) Fuel System Design – (current designs)

(h) [reserved]

(i) [reserved]

(j) [reserved]

(k) Use of NRC Approved Fuel

(l) Authority to Impose Restrictions on Operation

(m) Reporting

(n) [reserved]

(o) Implementation

Rule Structure (cont.)

Emergency Core Cooling System:

1. Define **principal** performance objectives

- Maintain acceptable core temperature during a LOCA.
- Remove decay heat following a LOCA.

2. Define **principal** analytical requirements for ECCS performance demonstration

> > Dependent of Fuel Design < <

Rule Structure (cont.)

For each fuel design:

1. Define **specific** performance requirements and analytical limits which form the basis of “acceptable core temperature” based upon all established degradation mechanisms and unique features.

2. Define **specific** analytical requirements which impact the predicted performance of the fuel under LOCA conditions.

Rule Structure (cont.)

Current Fuel Designs:

- Based upon extensive empirical database, including recent findings from High Burnup LOCA Research Program, 50.46c defines specific performance and analytical requirements for current fuel designs.

New Fuel Designs:

- Additional research may be necessary to identify all degradation mechanisms and any unique features.
- New performance objectives, analytical limits, and analytical requirements would need to be established based upon this research.
- Several paragraphs reserved within 50.46c for future rulemaking on new fuel designs.



50.46c Rule Language

Paragraph (a)

(a) Applicability. The requirements of this section apply to the design of a light water nuclear power reactor (LWR), and to the following entities who design, construct or operate an LWR: each applicant for or holder of a construction permit under this part, each applicant for or holder of an operating license under this part (until the licensee has submitted the certification required under 10 CFR 50.82(a)(1) to the NRC), each applicant for or holder of a combined license under 10 CFR part 52, each applicant for a standard design certification (including the applicant for that design certification after the NRC has adopted a final design certification rule), each applicant for or holder of a standard design approval under 10 CFR part 52, and each applicant for or holder of a manufacturing license under 10 CFR part 52.

- Achieves rulemaking objective to expand applicability beyond “zircaloy or ZIRLO” to all LWRs
- Eliminates need for exemption requests for new zirconium alloys.

Paragraph (b)

(b) Definitions. As used in this section:

(1) *Loss-of-coolant accident* (unchanged)

(2) *Evaluation model* (unchanged)

(3) *Breakaway oxidation*, for zirconium-alloy cladding material, means the fuel cladding oxidation phenomenon in which weight gain rate deviates from normal kinetics. This change occurs with a rapid increase of hydrogen pickup during prolonged exposure to a high temperature steam environment, which promotes loss of cladding ductility.

- Defines new cladding embrittlement mechanism.

Paragraph (c)

(c) Relationship to other NRC regulations. The requirements of this section are in addition to any other requirements applicable to an emergency core cooling system (ECCS) set forth in this part. The analytical limits established in accordance with this section, with cooling performance calculated in accordance with an NRC approved evaluation model, are in implementation of the general requirements with respect to ECCS cooling performance design set forth in this part, including in particular Criterion 35 of appendix A of this part.

- Clarifies approval of evaluation model.

Paragraph (d)

(d) Emergency core cooling system design.

(1) ECCS performance criteria. Each LWR must be provided with an ECCS designed to satisfy the following performance requirements in the event of, and following, a postulated loss-of-coolant accident (LOCA). The demonstration of ECCS performance must comply with paragraph (d)(2) of this section:

(i) Core temperature during and following the LOCA event does not exceed the analytical limits for the fuel design used for ensuring acceptable performance as defined in this section.

(ii) The ECCS provides sufficient coolant so that decay heat will be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

- Defines ECCS performance objectives.

- Core temperature must remain below fuel-specific analytical limits.
- Sufficient capability for long-term cooling.

Paragraph (d) (cont.)

(2) ECCS performance demonstration.

ECCS performance must be demonstrated using an evaluation model meeting the requirements of either paragraph (d)(2)(i) or (d)(2)(ii), paragraph (d)(2)(iii), and paragraph (d)(2)(iv), and satisfy the analytical requirements in paragraph (d)(2)(v) of this section. The evaluation model must be reviewed and approved by the NRC.

(i) *Realistic ECCS model.* A realistic model must include sufficient supporting justification to show that the analytical technique realistically describes the behavior of the reactor system during a loss-of-coolant accident. Comparisons to applicable experimental data must be made and uncertainties in the analysis method and inputs must be identified and assessed so that the uncertainty in the calculated results can be estimated. This uncertainty must be accounted for, so that when the calculated ECCS cooling performance is compared to the applicable specified and NRC-approved analytical limits there is a high level of probability that the limits would not be exceeded.

(ii) *Appendix K model.* Alternatively, an ECCS evaluation model may be developed in conformance with the required and acceptable features of appendix K ECCS Evaluation Models.

- Requires ECCS demonstration using approved evaluation model (either App.K or realistic).

Paragraph (d) (cont.)

(iii) *Core geometry and coolant flow.* The ECCS evaluation model must address calculated changes in core geometry and must consider those factors that may alter localized coolant flow or inhibit delivery of coolant to the core.

- Requires factors which impact predicted core geometry and coolant flow be included in the evaluation model.
 - Fuel-specific factors defined in subsequent sections.

Paragraph (d) (cont.)

(iv) *LOCA analytical requirements.* ECCS performance must be demonstrated for a range of postulated loss-of-coolant accidents of different sizes, locations, and other properties, sufficient to provide assurance that the most severe postulated loss-of-coolant accidents have been identified. ECCS performance must be demonstrated for the accident, and the post-accident recovery and recirculation period.

- Clarifies demonstration during and following postulated LOCA.

Paragraph (d) (cont.)

(v) *Modeling requirements for fuel designs-uranium oxide or mixed uranium-plutonium oxide pellets within zirconium-alloy cladding.* If the reactor is fueled with uranium oxide or mixed uranium-plutonium oxide pellets within cylindrical zirconium-alloy cladding, then the ECCS evaluation model must address the fuel system modeling requirements in paragraph (g)(2) of this section.

- Pointer to analytical requirements for current fuel designs.

Paragraph (d) (cont.)

(3) Required documentation.

- (i)(A) (unchanged from Appendix K)
- (B). (unchanged from Appendix K)
- (ii). (unchanged from Appendix K)
- (iii). (unchanged from Appendix K)
- (iv). (unchanged from Appendix K)
- (v). (unchanged from Appendix K)
- (vi) For operating licenses issued under this part as of **[EFFECTIVE DATE OF RULE]**, required documentation of Table 1 must be submitted to demonstrate compliance by the date specified in Table 1.

- Specifies documentation requirements for Appendix K and realistic models.
- Pointer to implementation schedule.

Paragraph (g)

(g) Fuel system designs: uranium oxide or mixed uranium-plutonium oxide pellets within cylindrical zirconium-alloy cladding.

(1) Fuel performance criteria. Fuel consisting of uranium oxide or mixed uranium-plutonium oxide pellets within cylindrical zirconium-alloy cladding must be designed to meet the following requirements:

(i) *Peak cladding temperature.* Except as provided in paragraph (g)(1)(ii) of this section, the calculated maximum fuel element cladding temperature shall not exceed 2200° F.

- Specifies performance requirements and analytical limits used to judge ECCS performance for current fuel designs.
- Research confirmed embrittlement above 2200 °F.
- PCT limit also prevents runaway oxidation and high temperature failure.

Paragraph (g) (cont.)

(ii) *Cladding embrittlement.* Analytical limits on peak cladding temperature and integral time at temperature shall be established which correspond to the measured ductile-to-brittle transition for the zirconium-alloy cladding material based on a NRC-approved experimental technique. The calculated maximum fuel element temperature and time at elevated temperature shall not exceed the established analytical limits. The analytical limits must be approved by the NRC. If the peak cladding temperature, in conjunction with the integral time at temperature analytical limit, established to preserve cladding ductility is lower than the 2200° F limit specified in (g)(1)(i), then the lower temperature shall be used in place of the 2200° F limit.

- Maintains cladding ductility as performance objective.
- Captures research finding.
 - Hydrogen enhanced beta-layer embrittlement.
- RG provides acceptable analytical limits.
- RG provides acceptable experimental technique.

Paragraph (g) (cont.)

(iii) *Breakaway oxidation.* The total accumulated time that the cladding is predicted to remain above a temperature at which the zirconium-alloy has been shown to be susceptible to breakaway oxidation shall not be greater than a limit which corresponds to the measured onset of breakaway oxidation for the zirconium-alloy cladding material based on a NRC-approved experimental technique. The limit must be approved by the NRC.

- Maintains cladding ductility as performance objective.
- Captures research finding.
 - Breakaway oxidation (hydrogen uptake)
- RG provides acceptable experimental technique.

Paragraph (g) (cont.)

(iv) *Maximum hydrogen generation.* The calculated total amount of hydrogen generated from any chemical reaction of the fuel 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.

- Maintains existing requirement for combustible gas.

Paragraph (g) (cont.)

(v) *Long-term cooling.* An analytical limit on long-term peak cladding temperature shall be established which corresponds to the measured ductile-to-brittle transition for the zirconium-alloy cladding material based on a NRC-approved experimental technique. The calculated maximum fuel element temperature shall not exceed the established analytical limit. The analytical limit must be approved by the NRC.

- Maintains cladding ductility as performance objective.

Paragraph (g) (cont.)

(2) Fuel system modeling requirements. The evaluation model required by paragraph (d)(2) of this section must model the fuel system in accordance with the following requirement:

(i) If an oxygen source is present on the inside surfaces of the cladding at the onset of the LOCA, then the effects of oxygen diffusion from the cladding inside surfaces must be considered in the evaluation model.

- Specifies analytical requirements for current fuel designs.
- Captures research finding.
 - Oxygen ingress from cladding inside surface reduced time-at-temperature to nil ductility.

Paragraph (g) (cont.)

(ii) The thermal effects of crud and oxide layers that accumulate on the fuel cladding during plant operation must be evaluated. For purposes of this paragraph crud means any foreign substance deposited on the surface of fuel cladding prior to initiation of a LOCA.

- Achieves rulemaking objective to address petition for rulemaking.

Paragraph (k)

(k) Use of NRC-approved fuel in reactor. A licensee may not load fuel into a reactor, or operate the reactor, unless the licensee either determines that the fuel meets the requirements of paragraph (d) of this section, or complies with technical specifications governing lead test assemblies in its license.

- Clarifies requirement on use of NRC approved fuel designs for which specific ECCS performance requirements have been established.
- Recognizes importance of LTAs for collecting irradiated data to approve new fuel designs.

Paragraph (I)

(I) Authority to impose restrictions on operation. The Director of the Office of Nuclear Reactor Regulation (for licenses issued under 10 CFR part 50) or the Director of the Office of New Reactors (for licenses issued under 10 CFR part 52) may impose restrictions on reactor operation if it is found that the evaluations of ECCS cooling performance submitted are not consistent with the requirements of this section.

- Separates authority between NRR and NRO for imposing restrictions on operation.

Paragraph (m)

(m) Reporting.

(1) Each entity subject to the requirements of this section, which identifies any change to or error in an evaluation model or the application of such a model, or any operation inconsistent with the evaluation model or resulting noncompliance with the acceptance criteria in this section, shall comply with the requirements of this paragraph.

- Clarifies existing reporting requirements.

Paragraph (m) (cont.)

(2) For the purposes of this section, a significant change or error is one which results in a calculated –

(i) Peak fuel cladding temperature different by more than 50 °F from the temperature calculated for the limiting transient using the last NRC-approved model, or is a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective temperature changes is greater than 50 °F; or

(ii) Integral time at temperature different by more than 0.4 percent ECR from the oxidation calculated for the limiting transient using the last NRC-approved model, or is a cumulation of changes and errors such that the sum of the absolute magnitudes of the respective oxidation changes is greater than 0.4 percent ECR.

- Maintains threshold for significant change in calculated PCT at 50°F.

- Adds a new threshold for significant change in calculated integral time at temperature of 0.4% ECR.

Paragraph (m) (cont.)

(3) Each holder of an operating license or combined license shall measure breakaway oxidation for each reload batch. The holder must report the results to the NRC annually i.e., anytime within each calendar year, in accordance with § 50.4 or § 52.3 of this chapter, and evaluate the results to determine if there is a failure to conform or a defect that must be reported in accordance with the requirements of 10 CFR part 21.

- Adds new reporting requirement for measured breakaway oxidation.
- Recognizes potential manufacturing-related changes in breakaway susceptibility.



Paragraph (o)

(o) *Implementation.*

LATER



Implementation of 10 CFR 50.46c

January 19, 2012

Paul Clifford
Division of Safety Systems
Office of Nuclear Reactor Regulation

Agenda

1. Work Scope

2. Strategy

3. Implementation – Existing Plants

4. Implementation – New Plants

Work Scope

Industry:

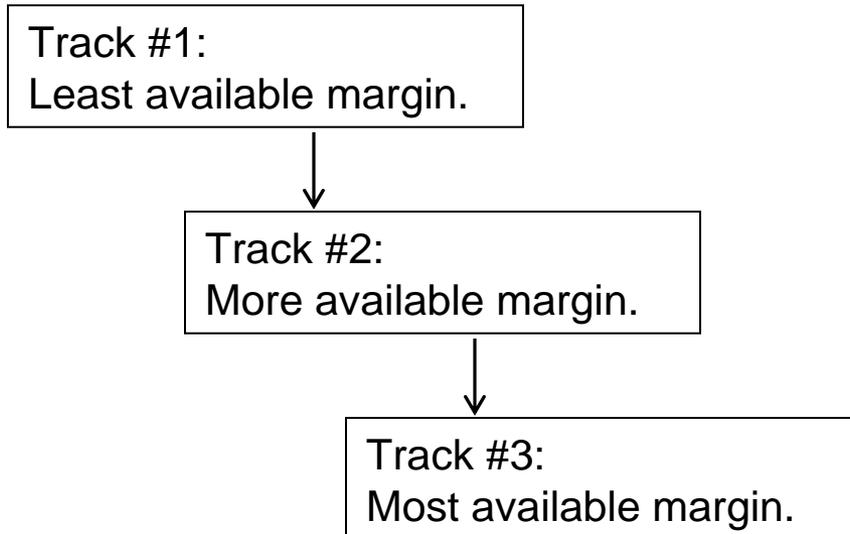
1. Develop alloy-specific hydrogen uptake models.
2. Update LOCA models.
3. Establish PQD analytical limits.
4. Establish breakaway oxidation analytical limits.
5. Perform plant-specific LOCA analyses.
6. Prepare LARs.
7. Revise UFSARs.
8. Ongoing breakaway tests.

NRC:

1. Review alloy-specific hydrogen uptake models.
2. Review LOCA models.
3. Review breakaway test results
4. Review PQD and breakaway analytical limits.
5. Review LARs.

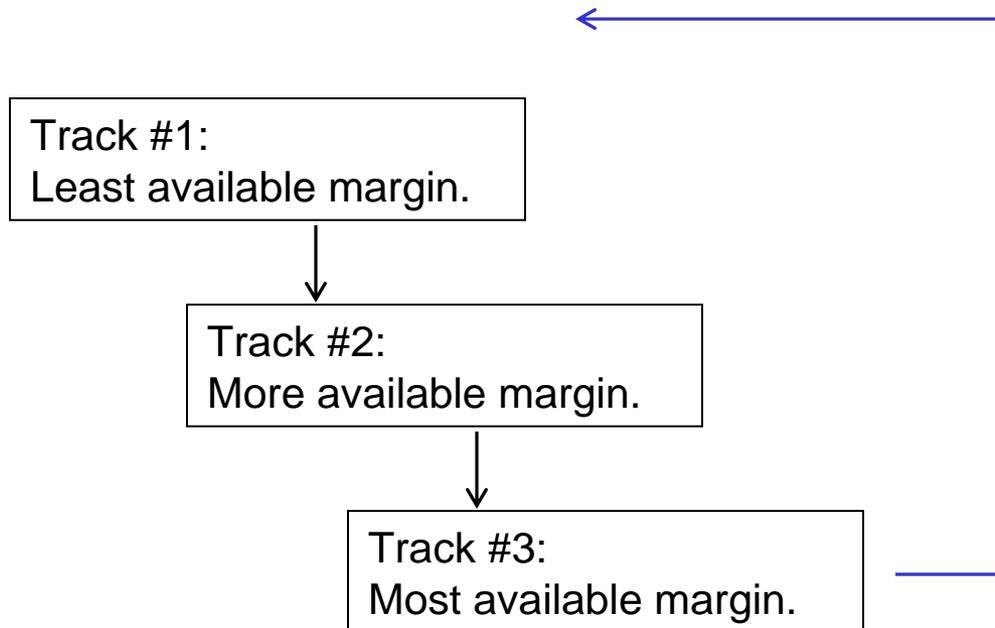
Strategy

- Based upon ANPR comments which identified workforce limitations to complete parallel analyses, a staged implementation plan would be the most effective and efficient way to implement 50.46c.
- Plants with the least available safety margin would be required to be in compliance earliest.



Strategy (cont.)

- Recognizing that (1) plants with the least amount of safety margin are likely to require the most effort and calendar time to document compliance and (2) a substantial number of plants do not require new LOCA analyses, the implementation plan revised.



Strategy (cont.)

- Implementation plan designed to achieve the following objectives:
 1. Expedite implementation to as many plants as soon as possible,
 2. Prioritize implementation on plants with less inherent safety margin, and
 3. Balance work load.

Implementation – Existing Fleet

Implementation Track	Basis	Anticipated Level of Effort	Number of Plants		Compliance Demonstration
			BWR	PWR	
1	All plants which satisfy new requirements without new analyses or model revisions.	Low	27	38	No later than 24 months from effective date of rule
2	PWR plants using realistic LBLOCA models requiring new analyses. BWR/2 plants.	Medium	2	14	No later than 48 months from effective date of rule
3	PWR plants using Appendix K LB and SB models requiring new analyses. BWR/3 plants.	Medium - High	6	17	No later than 60 months from effective date of rule

Paragraph (o)

(o) Implementation

Reactors under Part 50:

- **Construction permits issued after the effective date of the rule must comply with the conditions of the rule.**
- **Operating licenses issued based on construction permits in effect as of the effective date of the rule must comply with the conditions of the rule no later than the date set forth in Table 1 of the rule.**
- **Operating licenses issued prior to the effective date of the rule must comply with the conditions of the rule no later than the date set forth in Table 1 of the rule.**
- **Operating licenses issued after the effective date of the rule must comply with the conditions of the rule.**

Paragraph (o)

(o) Implementation.

Reactors under Part 52:

- All applications docketed after the effective date of the rule must comply with the conditions of the rule prior to approval.
- Standard design renewals after the effective date of the rule must comply with the conditions of the rule prior to approval.
- Standard design applications pending at effective date of the rule must comply with the conditions of the rule when renewal is submitted.
- Combined licenses docketed after the effective date of the rule must comply with the conditions of the rule.
- Combined licenses docketed or issued prior to the effective date of the rule must comply with the conditions of 50.46 until completion of the refueling outage after the initial fuel load, at which time they must comply with the conditions of this rule.



Implementation Flow Chart



ECCS Performance Safety Assessment

January 19, 2012

Paul Clifford
Division of Safety Systems
Office of Nuclear Reactor Regulation

Agenda

1. Research Findings

2. Initial Safety Assessment

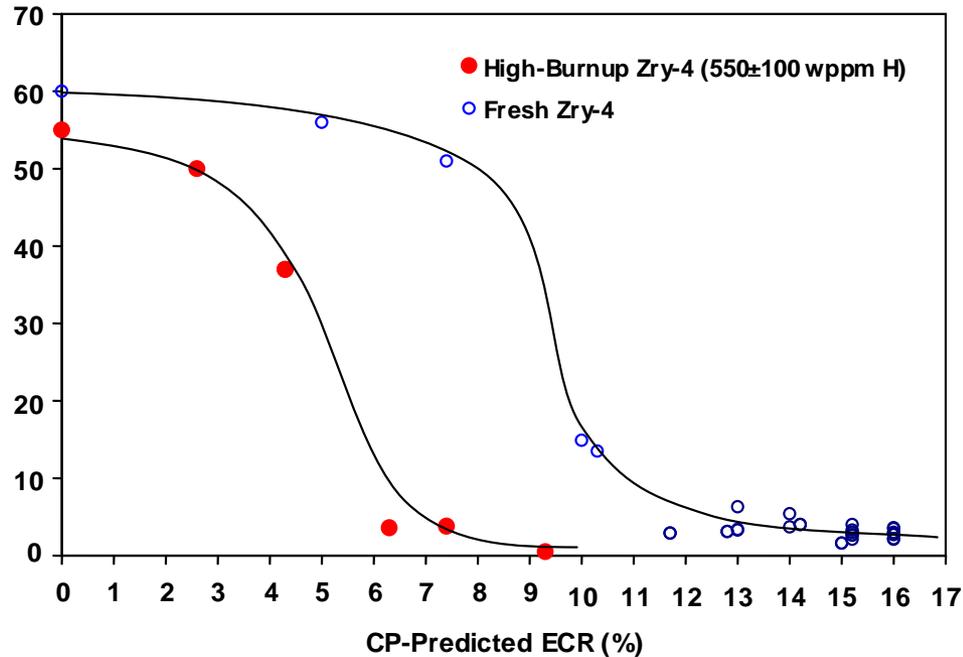
3. ECCS Performance Assessment

Research Findings

New Embrittlement Mechanisms:

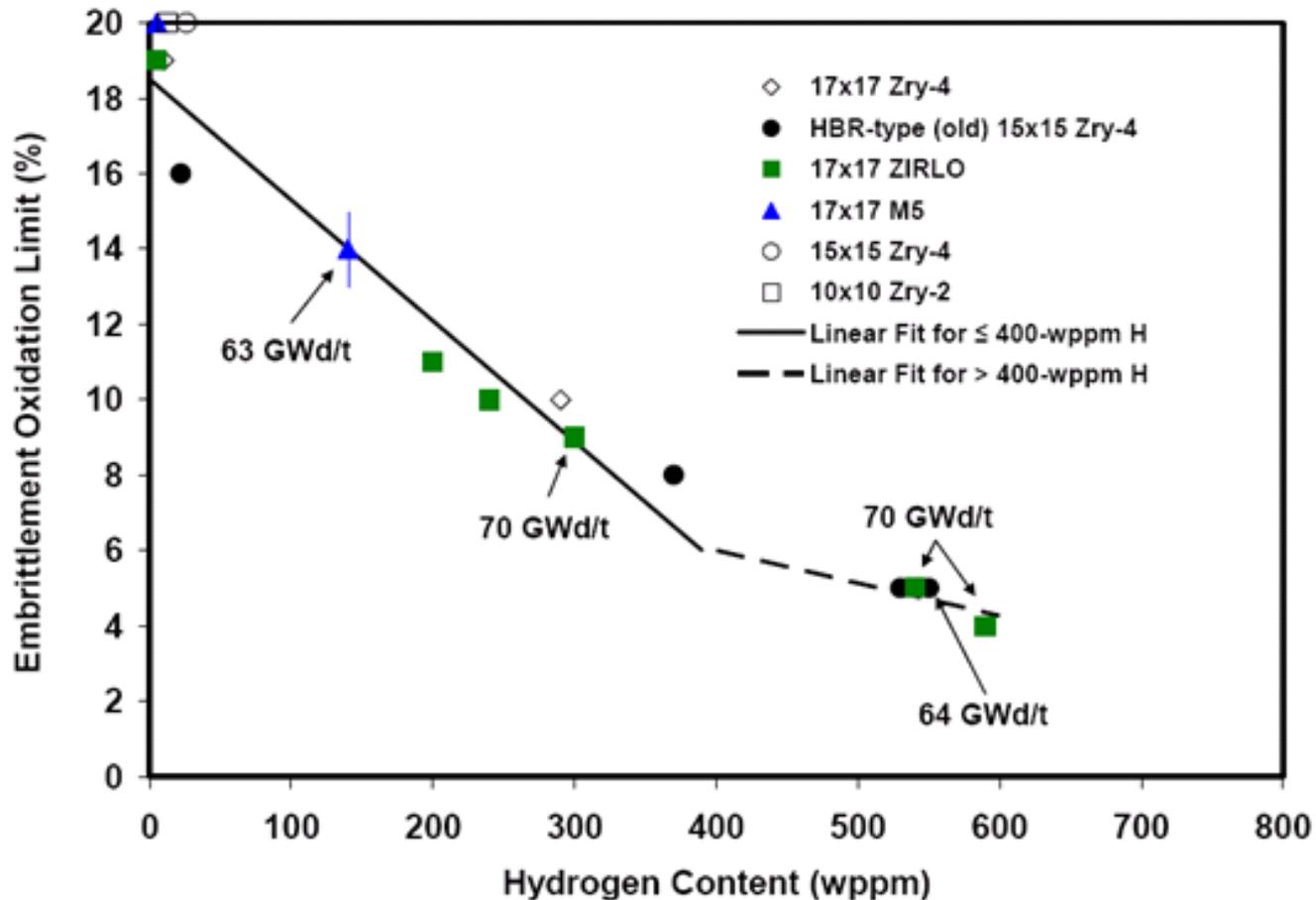
1. Hydrogen-enhanced beta layer embrittlement.

- Pre-transient cladding hydrogen content impacts rate of embrittlement.
- Hydrogen absorption sensitive to alloy composition, fabrication, and in-reactor service.



Research Findings (cont.)

- Allowable time-at-temperature reduced from current regulatory requirement (17%ECR).

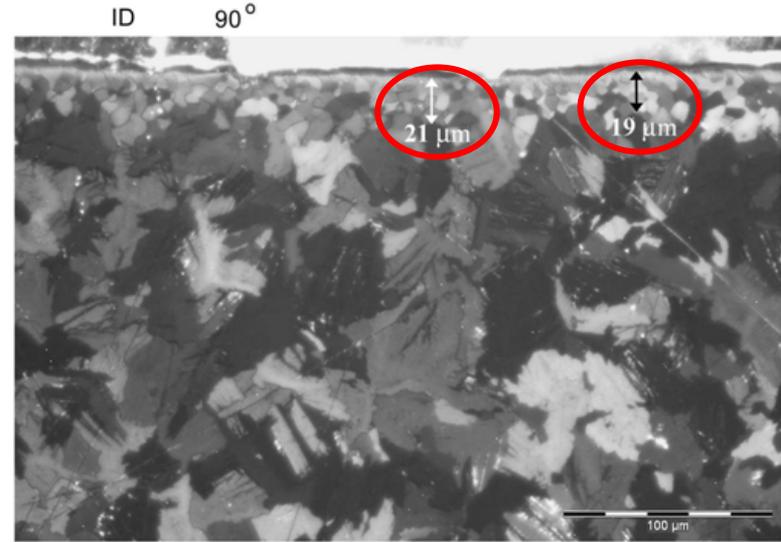
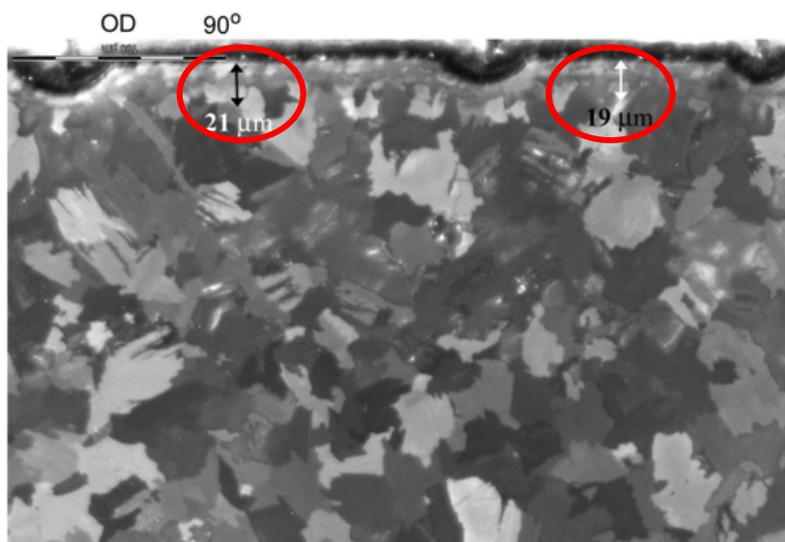


Research Findings (cont.)

New Embrittlement Mechanisms:

2. Cladding ID oxygen diffusion expedites embrittlement.

- Oxygen ingress from cladding ID reduces allowable time-at-temperature to nil ductility.
- ID oxygen source sensitive to burnup, power history, and fuel rod design.

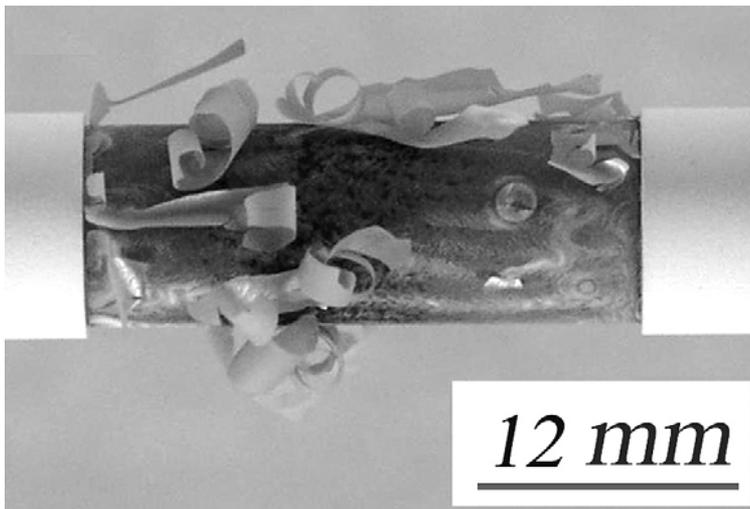


Micrograph images of Halden LOCA test specimens of outer cladding surface (left) and inner cladding surface (right) indicating oxygen-stabilized zirconium layers on both surfaces.

New Embrittlement Mechanisms

3. Degradation of protective oxide layer (breakaway oxidation).

- Breakaway oxidation results in cladding embrittlement due to hydrogen uptake.
- Susceptibility to breakaway sensitive to alloy composition and fabrication.



Alloy	Measured Breakaway Time
Zircaloy-2	>5,000 seconds
Zircaloy-4	5,000 seconds
ZIRLO™	3,500 seconds
M5	>5,000 seconds

Reaction to Research Findings

Response to new research data depends on the answers to the following questions:

1. Are the research findings credible?
2. Is the research complete?
3. Are current regulations adequate?
4. Is there an imminent risk to public health and safety?

Initial Safety Assessment

In response to RIL-0801, NRR completed initial safety assessment (July 2008)

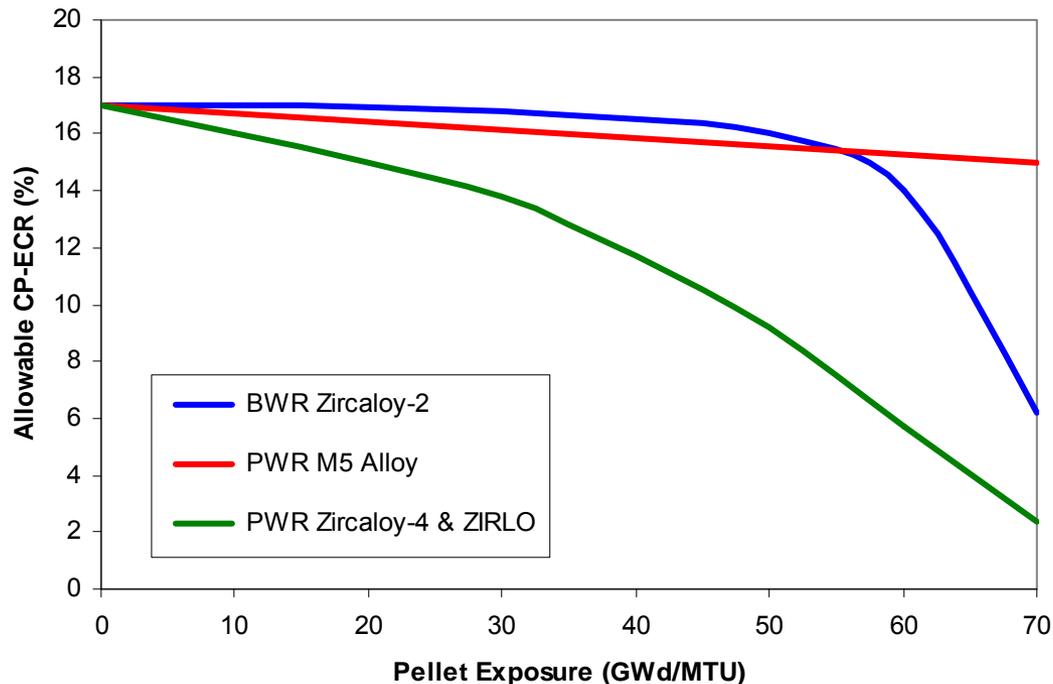
- Due to measured performance, realistic rod power history, and current analytical conservatisms, sufficient safety margin exists for operating reactors.
- No imminent safety risk.
- Proceed with rulemaking.
- Additional research needs:
 - PQD measurements at intermediate hydrogen levels.
 - Breakaway measurements on transient temperature profiles.
 - Treatment of fuel rod burst region.



ECSS Performance Assessment

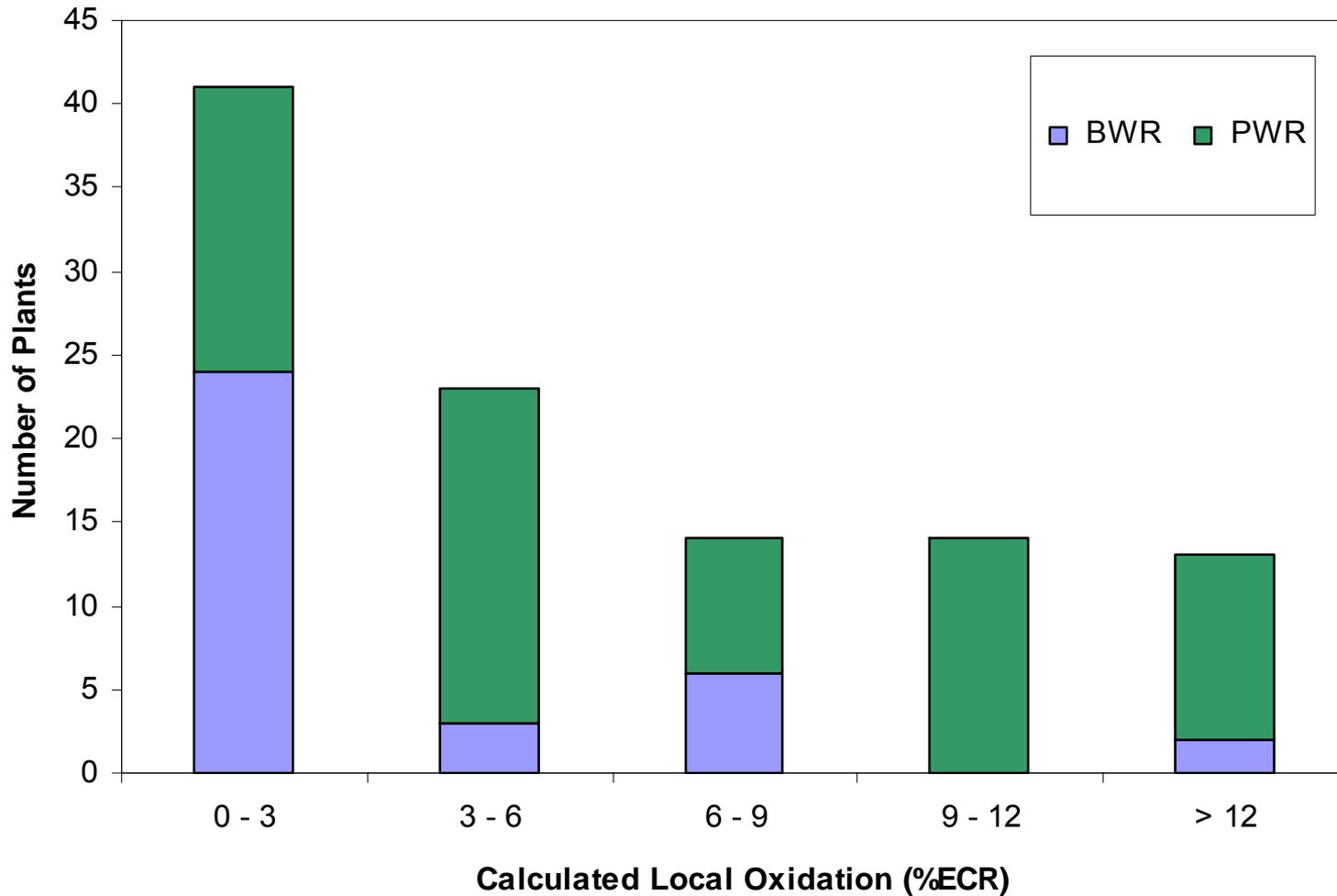
Revised Analytical Limits:

- Alloy-specific PQD analytical limit.
- Cladding ID oxygen ingress ≥ 45 GWd/MTU.
- Alloy-specific breakaway oxidation (time above 800°C).



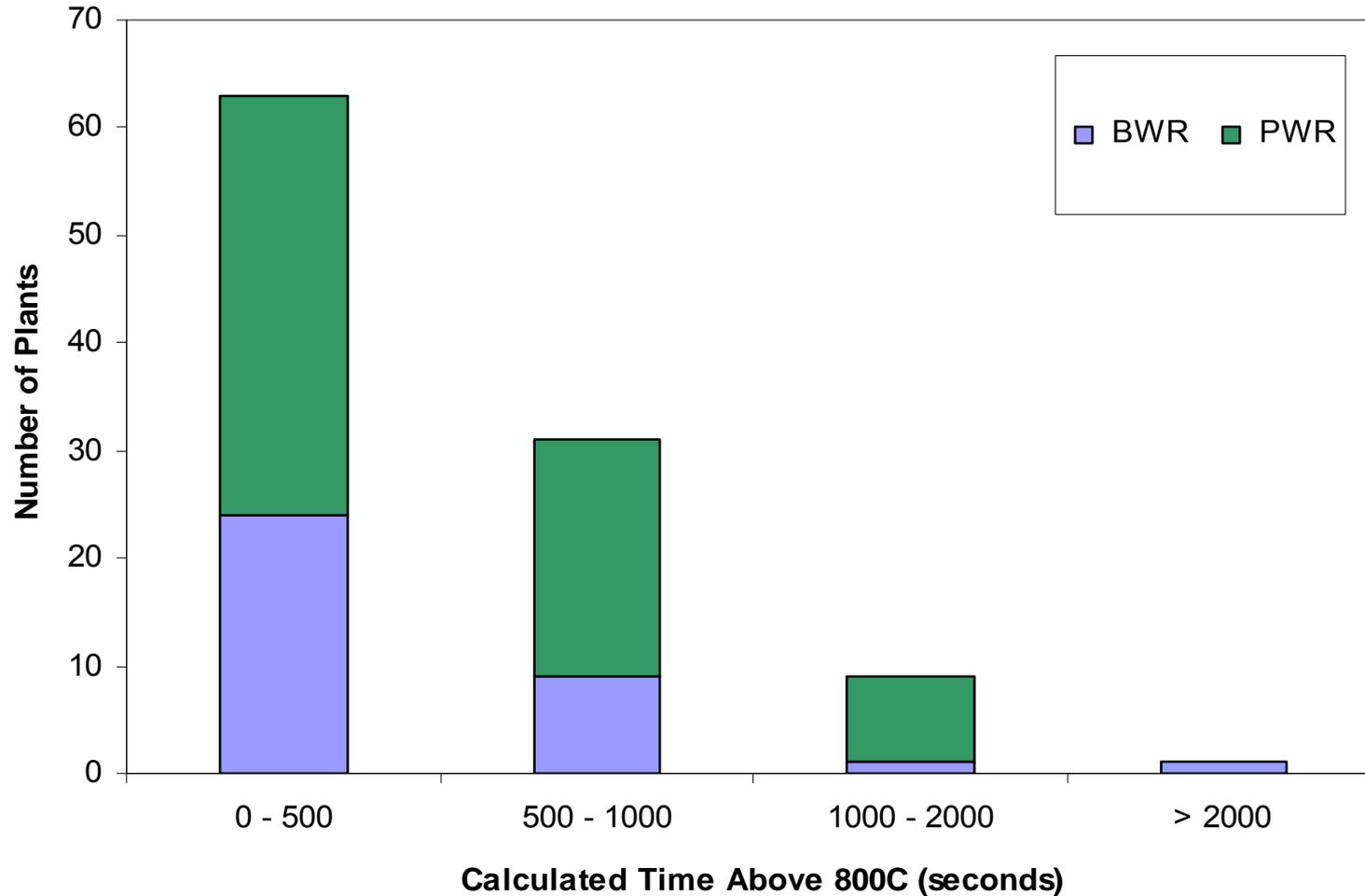
UFSAR AOR Results - MLO

UFSAR LOCA Analysis-of-Record



UFSAR AOR Results – Breakaway

UFSAR LOCA Analysis-of-Record



Post Quench Ductility

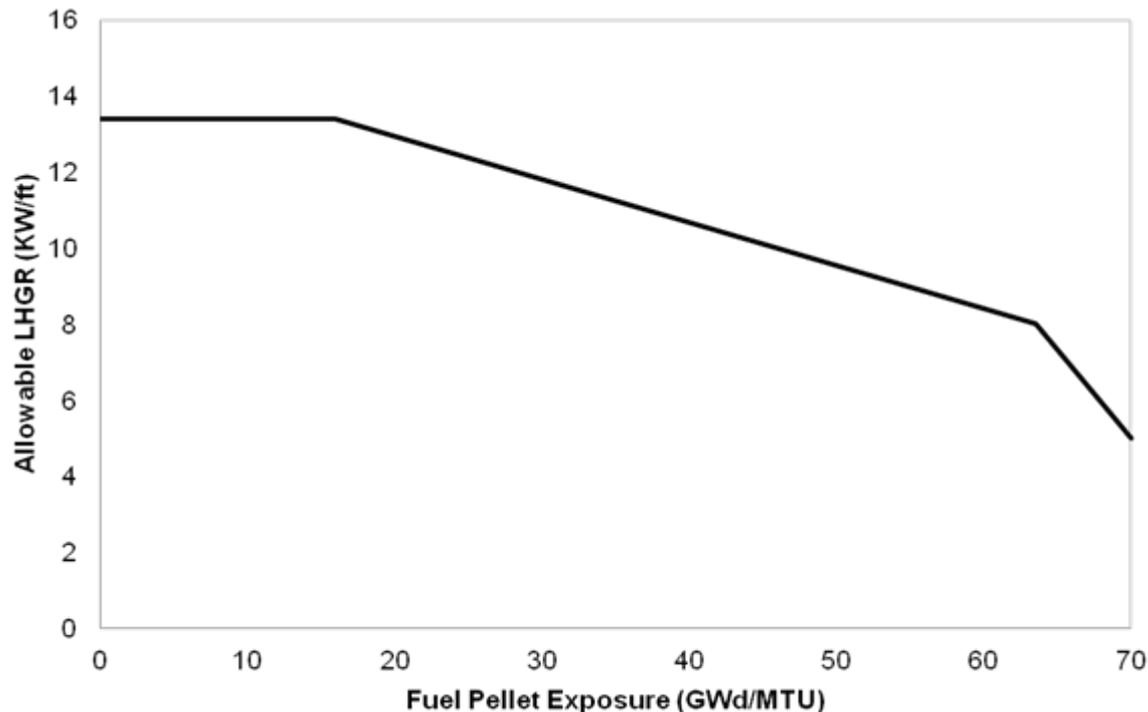
Revised PQD Analytical Limits:

- 65 of 104 plants (63% of entire operating fleet) needed no adjustment or new calculations.
 - 27 of 35 BWRs (77% of BWR fleet)
 - 38 of 69 PWRs (55% of PWR fleet).

- All 104 plants continue to satisfy 2200°F PCT criteria.

Revised PQD Analytical Limits:

- 8 BWRs performed new LOCA calculations which credit COLR Thermal-Mechanical Operating Limits (TMOL) reduced rod power at higher burnup to satisfy new analytical limits.
- Approved models with no analytical adjustments.



Revised PQD Analytical Limits:

- 31 PWRs either performed new LOCA calculations or identified credits to satisfy new analytical limits.
 - 9 PWRs performed new LOCA calculations which credit diminished fuel rod power at higher burnup.
 - 11 PWRs credit transition to improved evaluation models (e.g., ASTRUM LBLOCA or ANS 1979+2 σ decay heat SBLOCA).
 - 4 PWRs credit improved statistics in ASTRUM methods.
 - 7 PWRs credited multiple items.
- All of the calculations were performed and documented in accordance with the fuel vendor's 10 CFR 50 Appendix B quality assurance program.

Breakaway Oxidation

Measured Breakaway Time:

- All plants exhibit margin to breakaway.
- 103 of 104 plants predict a time duration above 800°C of less than 2,000 seconds.

Staff Audit

NRC staff audited Westinghouse, AREVA, and GEH calculations supporting OG reports.

- Confirmed that the revised PQD and breakaway analytical limits were in accordance with the research findings and that alloy-specific corrosion and hydrogen uptake models were accurate and supported by data.
- Evaluated the quantification, justification, and application of analytical credits.
- Reviewed a sampling of the new LOCA calculations and identified any changes to existing, approved models and methods.
- Compiled plant-specific data and evaluated each individual plant with respect to margin to the revised analytical limits.

ECCS Margin Database

ECCS Margin Database documents plant-specific information:

- Fuel vendor
- Fuel rod cladding alloy
- Evaluation model
- AOR results (calculated PCT, MLO, and time above 800°C)
- Plant grouping
- Margin to PQD analytical limit
- Margin to breakaway oxidation analytical limit
- Credited analytical adjustment(s)

Existing Commercial Fleet

- ECCS performance safety assessment **confirms** and **documents**, on a plant-specific basis, the continued safe operation of the U.S. commercial nuclear fleet.
- Future operation of Watts Bar Unit 2 and Bellefonte Units 1 and 2 expected to have sufficient margin to PQD and breakaway limits.
- Improved, corrosion resistant zirconium alloys being developed and implemented.

Certified Reactor Designs

- Advanced reactor designs include enhanced ECCS performance characteristics.
- Certified designs have significant margin relative to research data.

Design	PCT (°F)	ECR (%)
ESBWR	No uncover or heatup	
AP1000	1837	2.25
EPR	1695	1.53
US-APWR	1766	3.70

Conclusions

1. Research findings necessitate new ECCS requirements.
2. Majority of plants needed no new calculations or adjustments to show positive margin to the research data.
3. ECCS margin database confirms and documents, on a plant-specific basis, the continued safe operation of the U.S. commercial nuclear fleet.
4. NRC staff will continue to confirm plant safety until new regulations have been implemented.

Industry Comments on Proposed 10cfr50.46(c)

Gordon Cleifton
NEI
January 19, 2012

Discussion Issues

- Comment period length
- Implementation plan
- On-going reporting

Comment Period Length

- No safety concern; no rush needed
- Estimated ten year implementation
- Comments requested on:
 - 10cfr50.46(c) Rule
 - Three Regulatory Guides

DATES: Submit comments on the rule and draft guidance by [INSERT DATE 75 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]. To facilitate NRC review, please distinguish between comments submitted on the proposed rule and comments submitted on the draft guidance. Submit comments on the information collection aspects of this rule by [INSERT DATE 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].



Implementation Plan

- Three Implementation Tracks in Table 1:
 - 1 No later than 24 months (65 plants; 38-PWR & 27-BWR)
 - 2 No later than 48 months (15 plants; 14-PWR & 1-BWR)
 - 3 No later than 60 months (23 plants; 17-PWR & 6-BWR)
 - Note: Oyster Creek (BWR) not listed

- (4) Operating licenses issued under this part as of [EFFECTIVE DATE OF RULE] must comply with the requirements this section by no later than the applicable date set forth in Table 1. Until such compliance is achieved, the requirements of § 50.46 continue to apply.

On-going Reporting

- Adds new reporting requirement for measured breakaway oxidation
- Proposed Rule
 - (3) Each holder of an operating license or combined license shall measure breakaway oxidation for each reload batch. The holder must report the results to the NRC annually i.e., anytime within each calendar year, in accordance with § 50.4 or § 52.3 of this chapter, and evaluate the results to determine if there is a failure to conform or a defect that must be reported in accordance with the requirements of 10 CFR part 21.

Industry Comments on Proposed 10cfr50.46(c)

Gordon Cleifton
NEI
January 19, 2012

Overview of Industry Margin Assessment Reports

Gordon Clefton
NEI
January 19, 2012

Report Objective

- Show operating plants have margin with respect to research findings
 - Hydrogen concentration in cladding material plays a role in post quench ductility
 - Results suggest a change in the local oxidation acceptance criteria

Margin Assessment Process

- Fuel Suppliers/Plants surveyed existing
- Identified evaluation criteria
- Identified conservatisms and margins
- Grouped Plants for reporting results

Applied Conservatism Examples

- Appendix K vs. Best-Estimate Methodology
- Approved Best-Estimate Methodology Improvements
- Baker-Just vs. Cathcart-Pawel
- Reload Power History
- Peak Cladding Temperature Dependent Brittle-Ductile Transition
- ANS-1979 Decay Heat Plus 2σ Uncertainty
- Thermal-Mechanical Limits to Operation
 - LHGR limit

Plant Grouping Factors

- Large vs. Small Break Limited
- Plant Design/ECCS Features
- Type of Cladding Material
- Type of Evaluation Methodology
- Conservatism Credits

Margin to Proposed Criteria

- Embrittlement
 - Needed no adjustments
 - 41 of 69 PWR LBLOCA
 - 59 of 69 PWR SBLOCA
 - 27 of 35 BWRs
 - Remaining plants took credit for various conservatisms
- Breakaway Oxidation
 - No adjustments needed

Conclusion

- All operating Plants show margin with respect to new research findings concerning hydrogen concentration in cladding material
- The current operating fleet can meet the proposed change in the local oxidation acceptance criteria

Overview of Industry Margin Assessment Reports

Gordon Clefton
NEI
January 19, 2012