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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

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US-APWR SUBCOMMITTEE

OPEN SESSION

+ + + + +

THURSDAY

OCTOBER 18, 2012

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ROCKVILLE, MARYLAND

The Subcommittee met at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B3, 11545 Rockville Pike, at 8:30 a.m., John W.
Stetkar, Chairman, presiding.

SUBCOMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

J. SAM ARMIJO, Member

SANJOY BANERJEE, Member*

DENNIS C. BLEY, Member

JOY REMPE, Member

MICHAEL T. RYAN, Member

WILLIAM J. SHACK, Member

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1 NRC STAFF PRESENT:

2 GIRIJA SHUKLA, Designated Federal Official

3 JAMES GILMER, NRO

4 HOSSEIN HAMZEHEE, NRO

5 STEPHEN MONARQUE, NRO

6 RUTH REYES, NRO

7 JEFFREY SCHMIDT, NRO

8

9 ALSO PRESENT:

10 CARL BEYER, PNNL

11 JOHN CAREW, BNL

12 DAVID DIAMOND, BNL

13 HIROSHI FUJISHIRO, MHI

14 HIROSHI HAMAMOTO, MHI

15 MASAYA HOSHI, MHI

16 MASAYUKI KAUCHI, MHI

17 ATSUSHI KUMAKI, MHI

18 CHIKARA KURIMURA, MHI

19 LOUIS C. LANESE, MNES

20 KEVIN LYNN, MNES

21 YUTA MARUYAMA, MNES

22 NOZOMU MURAKAMI, MHI

23 MASATOSHI NAGAI, MNES

24 TAKAYUKI NAKANO, MHI

25 JUNTO OGAWA, MHI

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1 KEITH PAULSON, MNES
2 ETSURO SAJI, MHI
3 RYAN SPRENGEL, MNES
4 REBECCA STEINMAN, MNES
5 TAKAYUKI SUEMURA, MHI
6 KURT WALTER, MNES
7 ROBERT A. WEINER, MHI
8 DOUGLAS WOOD, MHI
9 DON WOODLAN, Luminant Power

10

11 *Participating via telephone

12

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Meeting Adjourned 98

P R O C E E D I N G S

8:30 a.m.

CHAIRMAN STETKAR: The meeting will now come to order. This is a meeting of the United States Advanced Pressurized Water Reactor Subcommittee. I am John Stetkar, chairman of this subcommittee meeting.

ACRS members in attendance are Dennis Bley, Sam Armijo, Mike Ryan, Bill Shack and Joy Rempe. I believe that Dr. Sanjoy Banerjee will be joining us on the bridge line at some time during the meeting. I'm not sure if he's on right now, but I've been told he will be joining us. Mr. Girija Shukla of the ACRS staff is the designated federal official.

The Subcommittee will discuss Chapter 4, Reactor, of the Safety Evaluation with open items associated with the US-APWR Design Certification and the Comanche Peak Combined License Application.

The Subcommittee will also discuss topical report MUAP-07008-P, Mitsubishi fuel design criteria and methodology; Topical Report MUAP-07010-P, non-LOCA methodology, and the staff Safety Evaluation Reports associated with those topical reports.

You will hear presentations from Mitsubishi Heavy Industries, Luminant Generation Company and the NRC staff.

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1 We have received no written comments or
2 requests for time to make oral statements from members
3 of the public regarding today's meeting.

4 The Subcommittee will gather information
5 and analyze relevant issues and facts and formulate
6 proposed positions and actions as appropriate for
7 deliberation by the full committee.

8 The rules for participation in today's
9 meeting have been announced as part of the notice of
10 this meeting previously published in the Federal
11 Register.

12 Parts of this meeting may need to be
13 closed to the public to protect information
14 proprietary to MHI or other parties.

15 I'm asking the NRC staff and the applicant
16 to identify the need for closing the meeting before we
17 enter into such discussion.

18 Only people with the required clearance
19 and need to know are present. A transcript of the
20 meeting is being kept and will be made available as
21 stated in the Federal Register Notice.

22 Therefore, we ask that participants in the
23 meeting use the microphones located throughout the
24 meeting room when they address the Subcommittee.

25 The participants should first identify

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1 themselves and speak with sufficient clarity and
2 volume so that they can be readily heard. A telephone
3 bridge line has also been established for this
4 meeting.

5 To preclude interruption of the meeting,
6 the bridge line will be placed in a listen-in mode
7 during the presentation and during the discussions.

8 Please silence your cell phones during the
9 meeting. We will now proceed with the meeting. We're
10 going to hear first from Luminant Generation regarding
11 Chapter 4 for their combined License Application, and
12 I'll ask Steve Monarque if you have any questions -
13 any opening statements.

14 MR. MONARQUE: Thank you, Chairman.

15 My name is Stephen Monarque. I'm the lead
16 project manager for the Comanche Peak COL review. I
17 want to thank the ACRS Subcommittee members for giving
18 us the opportunity to present the self-reported Safety
19 Evaluation to the Subcommittee here today. Last
20 month, at the full committee meeting, we made progress
21 - a lot of progress on the project.

22 And having said that, I want to introduce
23 my branch chief, Hossein Hamzehee.

24 MR. HAMZEHEE: I am glad to be back.

25 CHAIRMAN STETKAR: You have to come to the

1 microphone and speak with sufficient clarity and
2 volume to be readily heard.

3 MR. HAMZEHEE: I thank you and -

4 CHAIRMAN STETKAR: You should remember
5 this.

6 (Laughter.)

7 MR. HAMZEHEE: After three months, I forgot
8 all the rules and regulations.

9 CHAIRMAN STETKAR: Don't say that. This is
10 a public meeting.

11 MR. HAMZEHEE: I don't have anything more
12 to say. I just want to thank the ACRS members and
13 I'll be here for most of the day today.

14 CHAIRMAN STETKAR: Thanks, Hossein.

15 MR. MONARQUE: And with that, I'll go ahead
16 and turn it over to Luminant for their presentation
17 before the staff presents theirs.

18 CHAIRMAN STETKAR: Great. Don.

19 MR. WOODLAN: Good morning.

20 I'm Don Woodlan. I'm the licensing
21 manager for the NuBuild project for Luminant and we're
22 here to talk about Chapter 4.

23 (Discussion off the record.)

24 MR. WOODLAN: For the chapters I had first
25 choice on, I picked this one. As you know from having

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1 reviewed it, this is probably the most straightforward
2 chapter in our FSAR in that we are completely adopting
3 the standard plant design.

4 And as you read through it, it says we
5 incorporate by reference the material from the
6 standard plant design. Here is my slide.

7 We do not take any departures from the
8 standard plant and we do not provide any supplemental
9 information. And we have no contentions pending in
10 front of the ASLB Board.

11 I can elaborate, but that's it.

12 (Laughter.)

13 CHAIRMAN STETKAR: Brevity is appreciated.

14 Any of the members have any questions for
15 Luminant?

16 MEMBER ARMIJO: Don, what is the degree to
17 which you actually review - that Luminant staff have
18 actually reviewed Chapter 4?

19 MR. WOODLAN: Well, when you -

20 MEMBER ARMIJO: I can understand where you
21 say, look, this is a competent supplier, they've been
22 in business, they know their stuff, it's okay, or do
23 you actually dig into it a little bit?

24 MR. WOODLAN: I should probably mention a
25 little bit what the Luminant staff is. The actual

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1 Luminant employees, we have about a half a dozen
2 people working in Dallas that are managing this
3 project.

4 We've had more. When we started out, we
5 had a larger staff. And at that point, we did review
6 the entire range of products for the standard plant,
7 as well as the Comanche Peak production.

8 And our staff really is much larger than
9 just the Luminant employees, though. We have one
10 full-time contractor who works directly with me in
11 licensing, as well as MNES is contracted to us to
12 provide engineering support as we go through the
13 review.

14 So, although we reviewed these in depth up
15 front, we continue to follow the progress of the
16 entire standard plant design.

17 And in particular, we focus on the RAIs
18 and questions that come up during the review
19 especially if they relate to long-term operation of
20 the plant or operability. We probably bring more
21 experience with respect to that than a lot of the
22 engineers already have.

23 So, we try to review it from that
24 perspective, look at tech specs especially very
25 closely, because we will be operating to those, and

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1 how we have to develop our operating procedures and
2 programs associated with the standard -

3 MEMBER ARMIJO: But primarily more from an
4 operator's point of view than a designer's point of
5 view.

6 MR. WOODLAN: Yes, unless there's an issue.

7 MEMBER ARMIJO: Yes.

8 MR. WOODLAN: And when the issues come up
9 especially in the RAIs, we do get involved depending
10 on how much we think we can offer.

11 MEMBER ARMIJO: Okay. Thank you.

12 MR. WOODLAN: Okay.

13 CHAIRMAN STETKAR: Anything else for Don?

14 (No response.)

15 CHAIRMAN STETKAR: Don, I really appreciate
16 you coming up and giving us a presentation. As you
17 know, this is a necessary part of our deliberations.
18 It's important for us to have the opportunity to ask
19 you the questions and you have the opportunity to
20 field them.

21 And with that, thank you.

22 MR. WOODLAN: Pleasure to be here. Thank
23 you.

24 CHAIRMAN STETKAR: I guess we'll now hear
25 form the staff on Chapter 4 on the COLA.

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1 (Pause in the proceedings.)

2 CHAIRMAN STETKAR: Ruth.

3 MS. REYES: I'm waiting for the
4 presentation to be loaded.

5 CHAIRMAN STETKAR: Oh. I think you have
6 control.

7 MEMBER SHACK: This is a low-budget
8 operation. This appears to be a very sophisticated
9 situation -

10 MS. REYES: But it's not.

11 MEMBER SHACK: It's not. It's a low-budget
12 operation. It's empowering. You have control over
13 everything.

14 (Discussion off the record.)

15 MS. REYES: Okay. So, I apologize. I
16 didn't know that. Okay. So, well my name is Ruth
17 Reyes. I am the Chapter 4 chapter PM for the design
18 certification and also the COL application review.
19 And I'll be presenting the Chapter 4, Reactor.

20 On this page, the lead project manager is
21 Steve Monarque. Like I said, I'm the chapter PM. And
22 the supporting technical staff, same reviewers as for
23 the design certification. They are all here in the
24 audience in case the ACRS staff have any questions.

25 In the next slide I listed all the

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1 sections. And like Luminant said, all the sections
2 are being incorporated by reference with no
3 departures.

4 And the only open item on the Safety
5 Evaluation is because the evaluation of the design
6 certification has not been completed. So, we are
7 tracking that as an open item. So, that's the only
8 open item on the Safety Evaluation. And that's all I
9 have.

10 Any questions?

11 CHAIRMAN STETKAR: And that's a standard
12 open item in every chapter of the COLA.

13 MS. REYES: Correct.

14 CHAIRMAN STETKAR: Any members have any
15 questions for the staff?

16 (No response.)

17 CHAIRMAN STETKAR: If not, thank you very
18 much for the summary.

19 MR. MONARQUE: And no open items for COL,
20 okay.

21 CHAIRMAN STETKAR: No open items.

22 MR. MONARQUE: No action items from ACRS
23 members.

24 CHAIRMAN STETKAR: Try as we might.

25 MR. MONARQUE: Okay. Thank you.

1 CHAIRMAN STETKAR: This one went very, very
2 well. Thank you.

3 And with that, we'll start the discussion
4 of Chapter 4 from the design certification where I'm
5 confident we'll actually have a more active
6 discussion.

7 So, I ask MHI to come up and get your
8 slides up for that.

9 (Pause in the proceedings.)

10 (Discussion off the record.)

11 CHAIRMAN STETKAR: All right. We are
12 running uncharacteristically ahead of schedule. So,
13 I don't see Jeff Ciocco over there. I don't know
14 whether -

15 MR. HAMZEHEE: Jeff is out. Steve was
16 acting for Jeff, and then I am Jeff's backup.

17 CHAIRMAN STETKAR: Okay. Yes, that's
18 appropriate defense in depth. I don't know if NRC
19 management wants to make any introductory remarks,
20 Stephen?

21 MR. MONARQUE: No, I just want to thank
22 again the Committee members for allowing this
23 opportunity to present the DCD to the Subcommittee.

24 And do you have anything else, Hossein?

25 MR. HAMZEHEE: No.

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1 MR. MONARQUE: And with that, I'll go ahead
2 and turn it over to MHI.

3 CHAIRMAN STETKAR: Great. Thank you very
4 much. So, we'll turn the meeting over to MIH, and I
5 don't know who is leading the discussion.

6 MR. LANESE: I am. Good morning. My name
7 is Lou Lanese. I am the lead chapter engineer for
8 Chapter 4 for MNES. And we have our panel of experts
9 here who will introduce themselves.

10 MR. NAGAI: My name is Masatoshi Nagai with
11 MHI.

12 MR. NAKANO: Good morning. My name is
13 Takayuki Nakano, MHI, fuel engineer.

14 MR. MURAKAMI: Good morning. My name is
15 Nozomu Marakami. I am also a fuel engineer.

16 CHAIRMAN STETKAR: Thank you. And I'll ask
17 you, please, make sure you speak up enough so that we
18 pick you up. The transcript for the meeting comes
19 directly from the microphones. So, we need to make
20 sure we hear you fairly clearly. Thank you.

21 MR. LANESE: Okay. Well, thank you for
22 having us here. We will be going through, obviously,
23 Chapter 4 section by section and providing a summary
24 of the information that's there and the open items for
25 each section.

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1 There are only 17 open items that are
2 identified at this point and they all belong to
3 Sections 4.2 and 4.4. So, we will address each one of
4 those hopefully fairly briefly.

5 Section 4.1 of the DCD is a summary of the
6 US-APWR fuel design. It is essentially very similar
7 to other large PWR designs, except that it's at a
8 higher power level and the active fuel length of 14
9 feet allows it to have a lower linear heat rate.

10 So, we have improved thermal margins and
11 we achieve the larger power level with more rods and
12 more active fuel length.

13 MEMBER ARMIJO: What are your peak powers?
14 An average linear 4.6 is certainly very conservative,
15 but, you know, what's the variation from average to
16 peak?

17 MR. LANESE: The variation of average to
18 peak power.

19 MEMBER ARMIJO: Yes, because an individual
20 fuel rod, of course its performance is controlled by
21 its peak power. So, what would the peak power be, your
22 design peak power for a fuel rod in this core?

23 MR. NAGAI: Okay. Is the question about FQ
24 or F delta H?

25 MEMBER ARMIJO: No, just kilowatts per foot

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1 - peak kilowatts per foot for fuel element in this
2 core.

3 MR. NAGAI: In US-APWR -

4 MEMBER ARMIJO: Please come up to the -

5 MR. KAUCHI: My name is Masayuki Kauchi.
6 I'm responsible for nuclear engineering. I wasn't sure
7 I heard the question, but I think your question is
8 maybe relative peak for maybe the power design limit
9 for the relative peaking is fuel rod power. It is
10 1.73.

11 So, if you can just multiply --

12 MEMBER ARMIJO: So, it's 1.73 times 4.6.

13 MR. LANESE: Right.

14 MR. KAUCHI: This will be fuel rod average
15 load.

16 MEMBER ARMIJO: Okay.

17 MR. KAUCHI: If you would like to know the
18 local peak power, then FQ is 2.6.

19 MEMBER ARMIJO: So, local peak power would
20 be 2.6 times this average.

21 MR. KAUCHI: Yes.

22 MEMBER ARMIJO: So, basically nodal peak
23 power was 2.6 times 4.6 -

24 MR. KAUCHI: Yes.

25 MEMBER ARMIJO: - as a design basis.

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1 MR. KAUCHI: Yes.

2 MEMBER ARMIJO: Okay. I'll be busy
3 multiplying here.

4 (Laughter.)

5 MEMBER ARMIJO: This may take a while. I
6 was not good at math. Thank you. That's all I need
7 to know right now.

8 CHAIRMAN STETKAR: I have a spreadsheet
9 that's 11.96, or 12 for rounding.

10 MEMBER ARMIJO: See, that's what I was
11 trying to get at. These peak powers are what controls
12 some of the performance limits.

13 MR. LANESE: And aside from the, you know,
14 the 14-foot active fuel length, the only unique
15 feature is that the core has a stainless steel radial
16 neutron reflector.

17 The other design features are all very
18 similar again to existing US designs; fuel enrichment,
19 the number of control rods, the type of burnable
20 poison and the CRDMs are conventional materials.

21 MEMBER ARMIJO: Your gadolinia is higher
22 than past practice. It's 10 -

23 MR. LANESE: 10 percent is the maximum.

24 MEMBER ARMIJO: It's 10 percent. Do you
25 have experience, operational experience with that high

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1 gadolinia content in your Mitsubishi fuel?

2 MR. NAKANO: It's 10 weight percent in
3 Japanese plant.

4 MR. MURAKAMI: Yes, this is Murakami
5 speaking. We have experience to use our - such high
6 gadolinia content. We have since 2004 in commercial
7 reactor in Japan.

8 MEMBER ARMIJO: Okay. And performance has
9 been good?

10 MR. MURAKAMI: There is no significant
11 difference among the 10 percent or eight percent or
12 six usually use gadolinia content. It's not so far
13 away from us.

14 MEMBER ARMIJO: Okay. Thank you.

15 MR. LANESE: The next slide shows the
16 calculation approach that are being used in support of
17 the application, the two topical reports.

18 The FINE topical report 008 is going to be
19 discussed this afternoon. The FINDS report on the
20 seismic response is scheduled for discussion in
21 January and we don't intend to be talking about the
22 structural response today. This is, you know, core
23 design.

24 And then there are - the PARAGON report
25 provides the nuclear constants for the core, and the

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1 hot channel thermal hydraulics is done with VIPRE and
2 described in a technical report.

3 MEMBER ARMIJO: Of these four topical
4 reports, which are the ones that are already approved?
5 The table says, approved or under review.

6 MR. LANESE: Yes, 008 and 034 are still
7 being reviewed.

8 MEMBER ARMIJO: Okay.

9 MR. MURAKAMI: Yes.

10 MR. LANESE: And the technical reports of
11 PARAGON and VIPRE, are they approved yet?

12 MR. NAGAI: My name is Masatoshi Naga, MHI.
13 The technical reports for PARAGON/ANC is a part of
14 Section 4.3. So, it has not been approved yet, but
15 it's being used.

16 CHAIRMAN STETKAR: Are those - I'm trying
17 to look up my references. Are they technical reports,
18 or topical reports?

19 MR. LANESE: The last two are technical.

20 CHAIRMAN STETKAR: They're technical. So,
21 they'll be folded in with the staff's review -

22 MR. LANESE: Correct.

23 CHAIRMAN STETKAR: - of the respective
24 sections. The topical reports get a separate review.

25 MR. NAGAI: Just to clarify, for FINE and

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1 FINDS we have -

2 CHAIRMAN STETKAR: Those are topical.

3 MR. NAGAI: And for VIPRE-01M, we have all
4 the topical report.

5 CHAIRMAN STETKAR: VIPRE is a - that's what
6 I thought. VIPRE is a topical report.

7 MR. NAGAI: But for PARAGON/ANC we have
8 technical report.

9 CHAIRMAN STETKAR: So, that's folded in
10 supporting information for the respective chapter.
11 And VIPRE has not yet been approved? Maybe I'll look
12 to the staff.

13 MS. REYES: The two topical reports, we are
14 presenting one today. The other two topical reports
15 we're presenting in January.

16 Right now the review is done. It has been
17 concluded, but is in concurrence and we haven't issued
18 the SE for those topical reports.

19 CHAIRMAN STETKAR: Great. Thank you.

20 MEMBER ARMIJO: So, which is the approved
21 topical report?

22 CHAIRMAN STETKAR: There aren't any.

23 MEMBER ARMIJO: There aren't any?

24 CHAIRMAN STETKAR: No.

25 MEMBER ARMIJO: So, they're not yet

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1 approved.

2 CHAIRMAN STETKAR: We'll be hearing in
3 January -

4 MEMBER ARMIJO: Okay.

5 CHAIRMAN STETKAR: - the review of FINDS -
6 let me get my - you have to excuse me because I can't
7 see two things at once here. I'm old.

8 VIPRE and FINDS in January. And we'll be
9 hearing about FINE this afternoon.

10 MEMBER ARMIJO: Okay. Very good.

11 MR. LANESE: There are no open items in
12 Section 4.1, which is the summary description of the
13 core.

14 Section 4.2 deals with fuel system design.
15 The concept in the US-APWR fuel is to provide flexible
16 core operation by having the large core and the high
17 gadolinia content.

18 97 percent theoretical density in the fuel
19 allows a higher fuel economy. And the zirc-4 grids
20 are proving grids and provide high neutron economy.

21 Reliability for this fuel is improved with
22 corrosion-resistant material. And the one unique
23 feature on this - shown on this slide is that there
24 are 11 grids for the 14-foot fuel assembly as opposed
25 to 10 grids with the - with the assemblies that - 14-

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1 foot assemblies you've reviewed previously.

2 CHAIRMAN STETKAR: You'll find that we're
3 adept at interrupting you.

4 MR. LANESE: Oh.

5 CHAIRMAN STETKAR: So, if there's silence,
6 the appropriate strategy is to charge through as fast
7 as you can.

8 (Laughter.)

9 MEMBER ARMIJO: You didn't go quite fast
10 enough.

11 CHAIRMAN STETKAR: See, you didn't go fast
12 enough.

13 MEMBER ARMIJO: I have just one question,
14 and you may get to it later or in the presentation.
15 There is an open item related to the grid structural
16 integrity and deformation of the grid under some
17 seismic loads.

18 Are we going to discuss that later in your
19 presentation?

20 MR. LANESE: There's an open item
21 associated with that and I think the staff is probably
22 going to discuss it as well, but we'll have a chance
23 to talk about that, yes.

24 MEMBER ARMIJO: Okay. Well, I'll just
25 withhold until you're ready.

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1 MR. LANESE: Okay.

2 The next slide just highlights all of the
3 things we've said previously. This is very similar to
4 fuel that you have seen before. The big difference,
5 I guess, is having an additional grid spacer.

6 We do have the 10 percent gadolinia
7 content and the higher theoretical density for the
8 fuel.

9 This section meets the requirements of the
10 Standard Review Plan 4.2 in terms of content. We
11 addressed the GDC-10 reactor design to show that we
12 don't damage the fuel. 17 to provide an appropriate
13 reactivity control from both rods and from ECCS.

14 And GDC 35, emergency core cooling, we
15 demonstrate that we have abundant cooling so that
16 there's no fuel damage, and 10 CFR 50.46.

17 The Standard Review Plan deals with system
18 fuel damage, rod failure and fuel coolability. System
19 damage means that the fuel is - would prevent all the
20 mechanisms listed on that slide by properly designing
21 the fuel so that during power operation none of those
22 things will occur. And, again, these are the standard
23 items that are addressed in the SRP.

24 In terms of fuel failure, these are not
25 addressed directly in Chapter 14. But, again, the

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1 fuel design assures that during accidents and
2 transients that you don't have fuel failure as a
3 result of any of these mechanisms such as hydriding or
4 cladding collapse or embrittlement, fuel rod
5 ballooning, et cetera.

6 This slide shows the relationship of the
7 various codes and topical reports and technical
8 reports that are being used to support Chapter 14.

9 And, again, as we mentioned earlier in the
10 discussion, our focus is on the fuel design itself,
11 not on the structural design of the assemblies or the
12 core.

13 MEMBER REMPE: I have a question.

14 MR. LANESE: Yes.

15 MEMBER REMPE: When I was looking through
16 some of the documents, maybe this is obvious, but this
17 is a topical report, the staff is reviewing it and the
18 staff and the intended MHI is not to just have FINE
19 approved for the design certification. It's for use
20 in subsequent issues such as there's licensing issues
21 you're going to apply FINE to address it in the
22 future.

23 And if so, is the staff reviewing the QA?
24 Because I know like in tomorrow's documents, they talk
25 about the QA with MARVEL, but I didn't see that in the

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1 documentation in exchanges from the staff.

2 Maybe I missed it. There's a lot of
3 information we were given for the FINE code.

4 MR. SPRENGEL: This is Ryan Sprengel, MNES.
5 So, first I'll answer our question that, yes, they are
6 topical reports and I think there is potential in the
7 future for Mitsubishi to apply these codes to other
8 fuel outside the US-APWR.

9 MR. SCHMIDT: This is Jeff Schmidt from the
10 NRC. We're only approving FINE for the US-APWR fuel.

11 MEMBER REMPE: For design certification, or
12 can Constellation use it for future licensing issues
13 that come up?

14 MR. SCHMIDT: I'm not sure I understand the
15 -

16 MR. SPRENGEL: Well, let me clarify. Right
17 now Mitsubishi is only requesting it be approved for
18 US-APWR.

19 MEMBER REMPE: For design certification -

20 MR. SPRENGEL: Correct.

21 MEMBER REMPE: - or for our future - for
22 just whenever there's another issue?

23 MR. SPRENGEL: Well, I guess if
24 Constellation built a US-APWR, they would use it. But
25 if they do not have a US-APWR, then they would not use

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1 it right now.

2 MEMBER REMPE: Right. That's what I'm
3 asking, yes.

4 MR. SCHMIDT: That's correct, if that's
5 what you're asking is -

6 MEMBER REMPE: And so, you've gone through
7 this -

8 MR. SCHMIDT: - only for the US-APWR.

9 MEMBER REMPE: - going to be QA controlled
10 and all those kind of things are going to be part of
11 the staff's review on how they might use it in the
12 future that - there were a lot of issues with MARVEL,
13 more than what I saw with FINE, where certain options
14 were invoked, coefficients were changed to do this and
15 that and the other.

16 And I didn't see that so much with FINE,
17 but I just am wondering how good the pedigree and the
18 control of it would be. And that's always part of the
19 staff's review.

20 MR. SCHMIDT: Right, yes.

21 MEMBER REMPE: Okay.

22 MR. SCHMIDT: Again, it's just for the US-
23 APWR for Constellation uses it for - on the US-APWR.

24 MEMBER REMPE: Right.

25 MR. SCHMIDT: They can't use it for

1 anything else.

2 MEMBER REMPE: Right. Again, I understand
3 that. But I'm just thinking five years down the road
4 it will be controlled carefully, is what I'm asking.

5 MR. SCHMIDT: They'll have to come back
6 five years down the road.

7 MEMBER REMPE: Okay.

8 MR. SPRENGEL: And let me expand upon that
9 a little bit. We have had inspections of our QA
10 program. So, that has been looked at in the broad
11 sense, and then there have been some specific targeted
12 areas as well that have been looked into.

13 MEMBER REMPE: Okay. Thanks.

14 MR. SHUKLA: Yes, and just for the record
15 it's Comanche Peak, not Constellation.

16 MEMBER REMPE: I'm sorry, did I say the
17 wrong -

18 CHAIRMAN STETKAR: Luminant.

19 MEMBER REMPE: Luminant, I'm sorry.

20 MR. SPRENGEL: I thought Constellation was
21 a good point because -

22 (Laughter.)

23 MEMBER REMPE: Sorry about that.

24 MR. SPRENGEL: Maybe you knew something we
25 didn't. I don't know.

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1 MEMBER REMPE: Okay.

2 CHAIRMAN STETKAR: Consider it as
3 marketing, but not all that effective.

4 MEMBER SHACK: Maybe this is a good time to
5 ask you a little bit about FINDS, although you say
6 that we're not here to discuss that today. But I was
7 just curious since it's fuel inelastic deformation
8 under seismic condition, you obviously plan to have
9 this thing deform plastically under the SSE, which is
10 what it seems to do. It does buckle. It take it
11 that's standard Japanese design practice.

12 What assures me that I have margin beyond
13 the SSE for this shutdown? I normally think that most
14 of our seismic design sort of takes you to elastic.
15 And then when you go plastic, that sort of gives me
16 extra margin. Now, I'm going plastic right at the
17 SSE.

18 As I try to read 08007, it seems to me
19 there's some sort of geometric limit. You talk about
20 maximum credible deformation.

21 Is that the argument that although it
22 deforms plastically, it's limited. And so, you still
23 have margin beyond the SSE, or that's not something to
24 be discussed?

25 MR. LANESE: I think until the analysis is

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1 reevaluated by MHI, that it's better to discuss that
2 in January when they're sure what it is they want to
3 present.

4 MEMBER SHACK: To do, okay.

5 MR. LANESE: Okay.

6 MR. SPRENGEL: That's a fair question and
7 we'll take that on for our future discussions. In
8 January, we should be discussing FINES being the
9 methodology.

10 But as you've said, you know, we've
11 communicated to the staff about new seismic inputs
12 that are underway related to 3.7 and 3.8, and those
13 will be incorporated into the results technical report
14 that shows what happened.

15 So, I think we can have discussions in the
16 future and we'll be aware of that for our preparation.

17 MEMBER ARMIJO: Now, is the same issue,
18 does it exist in Japanese plants where you have
19 deformation of the grids in an SSE?

20 MR. LANESE: In the Japanese plant, do we
21 have plastic deformation under SSE condition?

22 MR. MURAKAMI: In general terms, or is - if
23 very high seismic or acceleration, is assumed that
24 such case is considered a case in Japan.

25 I don't have any specific -

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1 MEMBER SHACK: But very high means SSE, or
2 beyond SSE?

3 MR. MURAKAMI: Very high meaning beyond
4 SSE.

5 MEMBER ARMIJO: Well, my question was
6 limited just to SSE. In the Japanese plants, first of
7 all, do you use the same grid subject to similar or
8 identical loads, or not?

9 MR. SPRENGEL: Real quick, I have one note.
10 This is Ryan Sprengel again.

11 When we're talking about the buckling that
12 we've seen in our analysis, that is based on
13 nonexistent sites.

14 So, when we look at site-specific
15 analysis, the results are different. So, we have a
16 very, you know, conservative spectrum of analysis and
17 site conditions - or, sorry, site parameters that
18 we're assuming in the DCD for the standard design.
19 So, that is a factor in it.

20 MEMBER SHACK: But since the code is fuel
21 inelastic deformation under seismic condition, it sort
22 of sounds like you're designing for it to go plastic.

23 MR. SPRENGEL: Right, and then we've done
24 further evaluations for what happens after that
25 deformation. That is correct, right.

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1 And we've looked at the effects and looked
2 at how we can handle -

3 MEMBER SHACK: But you do design it to go
4 plastic, is I think where Sam and I are coming from,
5 yes.

6 MEMBER ARMIJO: That's what we're trying to
7 find out.

8 MR. SPRENGEL: Okay.

9 MR. LANESE: And the original question was
10 in the Japanese plants, do you predict plastic
11 deformation of the fuel?

12 MEMBER ARMIJO: Exactly.

13 CHAIRMAN STETKAR: At the SSE.

14 MR. LANESE: At the SSE.

15 MR. NAKANO: Excuse me. This is Nakano
16 speaking. That kind of information includes
17 proprietary in Japan. So, we cannot answer the
18 question at this time.

19 And also the member here, MHI member here
20 --

21 MEMBER ARMIJO: Mr. Nakano, could you speak
22 a little louder or with the microphone closer?

23 MR. NAKANO: Sorry.

24 MEMBER ARMIJO: We can barely hear you.

25 MR. NAKANO: The question - your question

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1 includes proprietary information in Japan. So, we
2 cannot answer that here.

3 And also, MHI engineer here doesn't have
4 such specific information. So, if you want an answer,
5 yes, we can respond, but we should ask to information
6 to Japan.

7 CHAIRMAN STETKAR: That would be fine.

8 MEMBER ARMIJO: So, we table it until
9 January?

10 CHAIRMAN STETKAR: Yes. Either table it
11 until January or - I don't know whether the January
12 meeting will be closed.

13 MR. SHUKLA: There's no meeting in January
14 though.

15 MR. NAKANO: We will have meeting. And
16 regarding with seismic information and the grid
17 information, we will have a meeting in next January.

18 CHAIRMAN STETKAR: Yes, let's discuss the
19 schedule later off line. For the purposes since the
20 schedule seems to be in question, I'll - what I'll do
21 is I'll ask MHI to - if this is proprietary
22 information, can you just use it as a takeaway and
23 communicate with us separately?

24 We can keep the proprietary information
25 proprietary that way.

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1 MR. SHUKLA: Or if they have information,
2 they can provide this afternoon or tomorrow morning.
3 That will be both proprietary sessions.

4 CHAIRMAN STETKAR: Oh, okay.

5 MEMBER ARMIJO: This afternoon is
6 proprietary?

7 MR. SHUKLA: Yes.

8 CHAIRMAN STETKAR: Oh, okay. If you have
9 the information -

10 MEMBER ARMIJO: We can discuss this
11 afternoon.

12 CHAIRMAN STETKAR: Or tomorrow.

13 MALE PARTICIPANT: They have to go back to
14 Japan, I think.

15 MR. SPRENGEL: Okay. We'll look into that
16 and follow up.

17 CHAIRMAN STETKAR: Look into it. I mean,
18 if we can get it closed out either today or tomorrow
19 morning, anyway, that would be more timely, anyway.
20 Otherwise, we'll decide how else to communicate.

21 MEMBER ARMIJO: What I'm really trying to
22 get at is this is - is this grid unique to the US-APWR
23 fuel and very, let's say, optimized for economy, but
24 somewhat fragile, or is this grid consistent with
25 current Japanese practice that it's - or in use today

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1 in Japanese plants?

2 If it is in use today in Japanese plants,
3 then they must be designed for some plastic
4 deformation if they're doing - if it applies to the
5 APWR fuel.

6 So, I'm just trying to find out - I'm
7 looking for experience with this particular grid and
8 this design practice.

9 MR. NAKANO: We are looking for to find
10 that information.

11 MEMBER ARMIJO: Okay.

12 MS. REYES: This is Ruth Reyes. There's
13 just one issue that I would like to clarify, because
14 I think I believe the staff said that we can discuss
15 this in January.

16 In January, what we are presenting is the
17 topical report that discussed the seismic code. But
18 in reality, this information is for the technical
19 report and the staff won't get the technical report
20 until later in 2013.

21 CHAIRMAN STETKAR: That's part of Chapter
22 3.

23 MS. REYES: Well, it's really Chapter 4
24 pertaining to the report, which is 0809, but we won't
25 get the updated or the revision of that report until

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1 later in 2013.

2 So, in January won't be ready to discuss
3 the issue. Again, what we are discussing, January is
4 the topical report that discuss the code.

5 CHAIRMAN STETKAR: Understand that, okay.
6 So, for clarification we won't really hear about the
7 design applications until the next iteration on your
8 review; is that - of Chapter 4; is that correct?

9 MR. SCHMIDT: This is Jeff Schmidt with the
10 NRC.

11 Yes, it's really going to be under
12 Technical Report 08007, which right now I think the
13 preliminary date is July of 2013.

14 CHAIRMAN STETKAR: Okay. And the next time
15 that we'll actually be presented with that information
16 will be in the next phase of Chapter 4 from our
17 purpose; is that correct?

18 MR. SCHMIDT: Yes, it would effectively,
19 you know, we have that as an open item. You'll see it
20 in our presentation.

21 And so, that would just maintain as an
22 open item until we're successfully able to close it in
23 sometime next year.

24 CHAIRMAN STETKAR: So, just for logistics
25 here, that means that we won't have a formal

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1 information about that part of the design with respect
2 to the US-APWR certified design until our next phase
3 of the review.

4 That doesn't leave MHI off the hook for
5 the question about what's done in Japan. So, I'd
6 appreciate some feedback on that.

7 MR. SPRENGEL: I think we can address these
8 items and we will have a revision to the report. And
9 so, I think that will be made available on - and I
10 think we were speaking to the present planning.

11 If there's some additional meeting that's
12 needed, I mean, we can do that. That's something that
13 we can look at after we provide the revision to the
14 results.

15 CHAIRMAN STETKAR: Thank you.

16 MR. LANESE: So, the open items, both of
17 them on this page are associated with the FINDS
18 topical report and with the technical report that we
19 have just discussed. And that does show January and
20 July 2013.

21 And the other open item which has been
22 closed and resolved by the staff was the question
23 relating to the use of thousand-hour fretting data and
24 how it was applied to the fuel.

25 MHI responded in July. And as I said, the

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1 staff has indicated to us that that's closed and
2 resolved.

3 There was also a question associated - an
4 open item associated with flow-induced vibration in
5 the fuel.

6 MHI responded and indicated that the
7 excitation for fatigue failure was several orders of
8 magnitude difference than the actual excitation in the
9 fuel, the amplitude in the fuel. And staff hasn't
10 closed that item yet. I believe it's still under
11 review.

12 There was also a question associated with
13 the buckling loads on the fuel and whether it was
14 worse at beginning or end of life.

15 That RAI was also responded to and no
16 changes of the DCD. It was an expansion, an
17 explanation of the methodology and staff is reviewing
18 that response.

19 These next few items are related again to
20 the topical reports - or technical reports, excuse me,
21 on the structural response of the fuel. So, they will
22 be dealt with in the future.

23 The next open item had to do with liftoff
24 of the fuel under hydraulic forces and what was the
25 limiting condition.

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1 MHI responded indicating that the limiting
2 condition for fuel liftoff was using the mechanical
3 design flow during their cold startup condition. And
4 that's also under review by the staff.

5 There was another question related to the
6 hydraulic forces on the fuel. MHI responded
7 explaining how they calculated those forces using beam
8 theory and test data. And that response is under
9 review by the staff.

10 The next open item had to do with hydrogen
11 absorption and the control rod guide thimble and what
12 the appropriate limit should be. MHI responded and
13 that's a closed/resolved issue as indicated by the
14 staff.

15 The next one is also a closed/resolved
16 item related to the burnable absorber, the amount of
17 gas released. It had to do with when the gas was
18 released and how long that absorber might be -
19 burnable absorber rod might be in the core. And MHI
20 responded and that issue was resolved.

21 Open Item Number 12 was related to
22 stresses on the control rod cladding. Additional
23 clarifying information was provided and staff is
24 reviewing that response.

25 There was a question about the effect of

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1 a tenth of a second delay in the control rod insertion
2 time and if that was accounted for.

3 MHI responded and indicated that the
4 actual rod time - insertion times to dash pod entry
5 versus the assumptions in the safety analysis report
6 were conservative.

7 The rods insert in about 1.6, 1.7 seconds.
8 The safety analysis assumes three-second insertion
9 time. So, there's a large margin which is - that
10 tenth of a second additional delay would be
11 incorporated in that margin.

12 Now, the last open item had to do with
13 ensuring core coolability during a LOCA. Staff has
14 issued that question and MHI is preparing a final
15 response for that.

16 MEMBER ARMIJO: Okay. Could you go back to
17 your Slide 21?

18 MR. LANESE: Which open item are we -

19 MEMBER ARMIJO: The hydrogen absorption
20 limit in the guide thimble. Yes, that one. Now,
21 that's closed and the staff is satisfied with the
22 response, apparently.

23 So, can MHI tell us why, you know, what
24 justified that limit? I'm just trying to understand
25 why it was closed and -

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1 MR. LANESE: The 800 ppm limit isn't the
2 one that was eventually used. It was adjusted to ---
3 ppm to be consistent with the limit on the fuel.

4 And then if you need additional -

5 (Discussion off the record.)

6 MR. LANESE: All right. The rest is
7 proprietary. We will discuss that in -

8 MEMBER ARMIJO: Okay. So, let's just hold
9 that question until we get into the afternoon session
10 and maybe you can answer it then, but I'd like to
11 understand exactly how it was closed and what was
12 adjusted.

13 MR. LANESE: We have some additional
14 slides.

15 MEMBER ARMIJO: Okay.

16 CHAIRMAN STETKAR: For your information, we
17 don't always see all of the RAIs and responses,
18 because we - if we did that, we'd never sleep.

19 So, some of the questions that you'll hear
20 from us if you haven't been in these sessions before,
21 may elaborate on information that you've already
22 presented in an RAI response.

23 We just don't typically see those unless
24 we specifically request them. If we ask the staff,
25 they would send them to us.

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1 MEMBER ARMIJO: We have a bunch of them.

2 CHAIRMAN STETKAR: We don't necessarily
3 want to see all of those.

4 MEMBER ARMIJO: Just some of them that get
5 our interest and we want to understand how it was
6 closed.

7 CHAIRMAN STETKAR: Well, we can bring this
8 up this afternoon -

9 MEMBER ARMIJO: Sure.

10 CHAIRMAN STETKAR: - in the closed
11 session.

12 MR. LANES: Okay. And that would close out
13 all the open items on 4.3. And we can go to Section -
14 I'm sorry, we're starting 4.3. We just closed out
15 4.2.

16 (Discussion off the record.)

17 CHAIRMAN STETKAR: Any members have any
18 other questions on 4.2?

19 MEMBER ARMIJO: Well, I have a number of
20 questions on the 07008 report, MUAP-07008-P, which is
21 the FINE.

22 CHAIRMAN STETKAR: Yes.

23 MEMBER ARMIJO: We're going to talk about
24 that this afternoon?

25 CHAIRMAN STETKAR: That's this afternoon.

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1 MEMBER ARMIJO: Okay. So, I can just hold
2 off, yes.

3 CHAIRMAN STETKAR: That's this afternoon.
4 Otherwise he'll just say it's all proprietary and
5 we'll talk about it this afternoon anyways.

6 MEMBER ARMIJO: Okay, okay. We'll just
7 wait.

8 (Pause in the proceedings.)

9 MR. LANESE: Do you want to introduce
10 yourself?

11 MR. KAUCHI: Again, my name is Masayuki
12 Kauchi and I'm responsible for nuclear designing.
13 Thank you very much for taking time for us today.

14 CHAIRMAN STETKAR: And, again, I'd ask you
15 to make sure you speak up enough so that we pick you
16 up on the microphone so that the transcript is
17 accurate. Thank you.

18 MR. LANESE: So, the intent of the nuclear
19 design is to provide limits on the power distribution
20 so that we don't damage fuel during the power
21 operation, assure that we have reactivity coefficients
22 that protect the fuel, and assure that we have control
23 systems that can maintain appropriate reactivity and
24 prevent any power oscillations during normal
25 operation.

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1 The low power density of these assemblies
2 allows a 24-month operation. And the power
3 distributions during normal operation are maintained
4 with design limits. And those limits are used in the
5 initial conditions for the Chapter 15 safety analysis.
6 So, there is the 2.6, you know, factor we were talking
7 about earlier.

8 The next slide just illustrates the fact
9 that with the use of burnable poison, the moderator
10 and temperature coefficients are negative throughout
11 the entire operating cycle.

12 This illustrates the rod patterns for a
13 quarter quadrant and we maintain shutdown margin 1.6
14 percent with most reactive rod stuck out.

15 In terms of power perturbations, the
16 horizontal oscillations are stable throughout the fuel
17 cycle. And the axial oscillations while they are
18 divergent during cycle burnup, are slow enough that
19 they can easily be controlled with rod motion similar
20 to existing large APWRs. The frequencies are just a
21 little different. Nothing dramatic.

22 And there are no open items in Section
23 4.3. I take it I should move on rather than -

24 MEMBER ARMIJO: You're on a roll.

25 MR. LANESE: Okay. We can go to Section

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1 4.4, thermal hydraulic design. We're going to make
2 another change here.

3 (Pause in the proceedings.)

4 MR. SUEMURA: Good morning. I am Takayuki
5 Suemura, MHI. I am a thermal hydraulic engineer.

6 MR. HOSHI: Good morning. My name is Masay
7 Hoshi, thermal hydraulic engineer right now in MNES.

8 CHAIRMAN STETKAR: Before we start this
9 section of the discussion, one of our members, Dr.
10 Banerjee, may have some questions in this area. I
11 don't know whether he does or not.

12 I've received a note that he'll be calling
13 in on our bridge line around ten o'clock. So, it's
14 just a warning that we may go back and revisit some of
15 this section once he comes online.

16 I don't know if he has any questions or
17 not, but he's our thermal hydraulics expert and he had
18 other commitments. He couldn't make it to the meeting
19 today and will be calling in.

20 So, this is just a bit of a warning that
21 we may have to retract over this part of the -

22 MR. LANESE: Would you prefer that we went
23 to 4.5 and 4.6 and come back, or just continue on?

24 CHAIRMAN STETKAR: You know, that might be
25 a good idea to keep the process moving. That's an

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1 excellent idea. Let's do that. That will buy us some
2 time and -

3 MR. LANESE: Okay.

4 CHAIRMAN STETKAR: - we might take an
5 early break then and give us a little bit of -

6 (Laughter.)

7 MR. KURIMURA: So, my name is Chikara
8 Kurimura, mechanical engineer of MHI for 4.5 and 4.6.

9 MR. LANESE: Sections 4.5 and 4.6 of the
10 DCD describe the materials that are used in the
11 control rod drive mechanism and in the reactor
12 internals, and then refer to other sections for any
13 detailed evaluation.

14 The earlier sections in the DCD would
15 refer to the technical and topical reports instead.
16 So, that's just a little difference in the way they're
17 structured.

18 But the materials in the control rod
19 drives and in the internals are materials that have
20 been used in existing PWRs for long periods of time
21 and there's extensive operating experience with them.

22 The control rod drive system, the pressure
23 boundary materials use either Type 316, Type 316-LN.
24 The welding materials use austenitic steel and
25 appropriate welding specifications.

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1 The non-pressure boundary materials may
2 use austenitic, martensitic, nickel-based alloys, and,
3 in some cases, cobalt-based alloys.

4 Reactor internals were chosen obviously to
5 prevent any existing problems with - in operating
6 plants with corrosion. So they, again, use the
7 strain-hardened materials, nickel alloys. It complies
8 with the ASME code and with any of the ASME code cases
9 spelled out and approved in Reg Guide 1.84.

10 And long-term reliability from irradiation
11 is assured by complying with the guidelines developed
12 in EPRI MRP 175 for screening for aging of components.

13 MEMBER SHACK: I did have a question about
14 the neutron absorber that you essentially make up, I
15 guess, from rings which are then held together with
16 tie rods.

17 Where are the tie rods at? Are they
18 through the rings? Are they on the outside of the
19 rings?

20 MR. KURIMURA: Through the ring.

21 MEMBER SHACK: Through the rings. So,
22 they're not visible. They're not open for visual
23 inspection.

24 MR. KURIMURA: There are some holes around
25 tie rod sort -

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1 CHAIRMAN STETKAR: You have to be at the
2 microphone, but you can use the mouse to point. It's
3 a lot easier.

4 MR. KURIMURA: So, the tie rod goes through
5 the hole. So -

6 MEMBER SHACK: Well, I guess let me tell
7 you where I'm heading from this question, you know.
8 In one of the RAIs you give the expected fluence at
9 the inside of that absorber, which again you have in
10 brackets. So, I'll assume I can't say it out loud.

11 But then you note that it's going to
12 decrease by an order of magnitude by the time you get
13 to the tie rods. But even if I take that bracketed
14 number and I reduce it by an order of magnitude, then
15 I look at 175. That doesn't give me a warm, fuzzy
16 feeling.

17 So, I would like to be able to inspect
18 these. But if they're inside the rings, then how am
19 I going to inspect them?

20 MR. KURIMURA: Over the estimated effect.
21 I can't say the value of that, because -

22 CHAIRMAN STETKAR: Just a moment, please.

23 (Discussion off the record.)

24 CHAIRMAN STETKAR: If it requires some
25 discussion, you can discuss it and answer it after the

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1 break or this afternoon sometime.

2 MR. SPRENGEL: Because I think the basic
3 question is just, can you inspect them?

4 MEMBER SHACK: Right, because I think they
5 do need to be inspected.

6 MR. LANESE: Based on the fluence level.

7 MEMBER SHACK: Based on the fluence level
8 that appears to be there.

9 MR. KURIMURA: So, the fluence level is
10 discussed in RAI, but I can't say it now because it's
11 proprietary information. And inspection is area of
12 3.9.5.

13 MR. LANESE: So, the inspection of those
14 bolts is described in 3.9.5?

15 MR. KURIMURA: So, discussion of that -

16 MR. SPRENGEL: We'll take notes and can
17 explain it to you later.

18 MEMBER SHACK: Okay.

19 MR. LANESE: All right. There were no
20 open items identified in Section 4.5 of the DCD
21 otherwise.

22 MEMBER ARMIJO: The bottom line is you're
23 not using any unique materials that you haven't used
24 before in the - in Japanese plants; is that correct?

25 MR. KURIMURA: We use approved material for

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1 it.

2 MEMBER ARMIJO: I had a question about the
3 strain-hardened austenitic stainless steels which are
4 for obviously high-strength applications.

5 MR. KURIMURA: For the fourth one in the
6 reactor internals.

7 MEMBER ARMIJO: And you've used that at the
8 same level of strain-hardening in the past?

9 MR. KURIMURA: Yes.

10 MEMBER ARMIJO: So, it's common use in
11 Japanese plants?

12 MR. KURIMURA: Yes.

13 MEMBER ARMIJO: I just wanted to -

14 MR. SPRENGEL: I'll reiterate the point
15 that we're not trying to apply any revolutionary
16 materials at this point.

17 MEMBER ARMIJO: That's just a general
18 question I -

19 MR. SPRENGEL: They've all been -

20 MEMBER ARMIJO: - often like to ask in
21 case there's anything new and unique.

22 MR. SPRENGEL: I understand.

23 MEMBER ARMIJO: Okay.

24 MEMBER SHACK: And they have set up a peak
25 stress on that that's consistent with the ASME code.

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1 So, it's -

2 MEMBER ARMIJO: And is that the same
3 stresses used on those bolts through the -

4 MEMBER SHACK: I can't find out anything
5 about those tie rods. I don't know where they are.
6 I don't know what they look like.

7 MEMBER ARMIJO: What material?

8 MEMBER SHACK: How they're loaded, they're
9 a mystery to me. But the only thing I can guess is
10 that they probably are susceptible to the radiation-
11 assisted stress corrosion cracking from a fluence
12 point of view.

13 MEMBER ARMIJO: Sure.

14 CHAIRMAN STETKAR: Would it help with
15 saying how many drawings that they present and -

16 MEMBER ARMIJO: Yes.

17 MEMBER SHACK: Yes, I couldn't find a
18 drawing anywhere that showed me these things.

19 CHAIRMAN STETKAR: Even if you could dig it
20 up, you know, tomorrow.

21 MR. SPRENGEL: We'll follow up on that and
22 see if we can provide something today.

23 CHAIRMAN STETKAR: Thanks.

24 MR. LANESE: Okay. Well, then the next
25 section would be on functional design of the

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1 reactivity control systems.

2 Again, this is standard design that has
3 been used in other operating PWRs. There are two
4 forms of reactivity control. One is the rods, and the
5 other is the chemical reactivity control injected by
6 the ECCS.

7 The control rod drive mechanisms are
8 described in the DCD. The control system is described
9 in Section 7. And the CRDM cooling is described in
10 Section 9.4. ECCS is in 6.3.

11 The only other point about this section is
12 that the CVCS is not credited in any of the Chapter 15
13 safety analyses for reactivity control.

14 And there were no open items in Section
15 4.6. So, we're back to 4.4.

16 CHAIRMAN STETKAR: And I think, you know,
17 just in the interest of efficiency, what I'll do is
18 take an early break. Nobody ever complains about
19 taking a break. Just so we allow Dr. Banerjee to come
20 online and avoid possibly repetition of information.

21 So, what I'll do is let's take a break
22 until ten o'clock. I'll be really generous about
23 this. We're well ahead of schedule.

24 MEMBER ARMIJO: Thank you, Mr. Chairman.

25 CHAIRMAN STETKAR: So, we'll recess and -

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1 MR. SHUKLA: Do we need to tell Banerjee
2 about -

3 CHAIRMAN STETKAR: Yes, give him a call.

4 MEMBER BLEY: He sent an email. You've got
5 it on your computer saying -

6 CHAIRMAN STETKAR: We can communicate with
7 him. We're recessed until ten o'clock.

8 (Whereupon, the proceedings went off the
9 record at 9:37 a.m. for a brief recess and went back
10 on the record at 10:03 a.m.)

11 CHAIRMAN STETKAR: Okay, we're back in
12 session. I believe that Dr. Banerjee will join us in
13 five to ten minutes, but I thought - first, I thought
14 I heard that you may have some clarifications on
15 information that was - for information that was raised
16 earlier.

17 MR. SPRENGEL: Right. A couple items just
18 to do some immediate follow-up. Some of them we'll
19 defer, but first item tied to the question of do we
20 design for plastic deformation.

21 We're going to cover that - since a lot of
22 that design work is actually proprietary, we're going
23 to specifically address that in the closed session
24 later today.

25 CHAIRMAN STETKAR: Okay.

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1 MR. SPRENGEL: So, we'll speak to that
2 item. And of course a lot of that detail will come
3 when we actually cover the topical report later, and
4 then when we submit the revision to the results.

5 CHAIRMAN STETKAR: Well, okay, the topical
6 report is just on the methodology.

7 MR. SPRENGEL: Correct.

8 CHAIRMAN STETKAR: Okay.

9 MR. SPRENGEL: Correct.

10 CHAIRMAN STETKAR: All right.

11 MR. SPRENGEL: And then another question
12 was related to the grid design and if it was a unique
13 or different grid design. And the answer is no.

14 MEMBER ARMIJO: This is a standard grid
15 design.

16 MR. SPRENGEL: There are, you know, very
17 minute - I think you would be familiar with the minute
18 changes that are always happening.

19 MEMBER ARMIJO: Tweaks, yes.

20 MR. SPRENGEL: But, no, it is not a
21 different design. It is a standard design that
22 Mitsubishi has.

23 MEMBER SHACK: But it's a longer assembly,
24 right?

25 MR. SPRENGEL: The overall fuel - yes.

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1 MEMBER SHACK: Yes.

2 MR. SPRENGEL: That's correct, right, but
3 the grids themselves.

4 Um, let's see. And then there's another
5 question related to comparisons to the Japanese plants
6 and their seismic performance, basically. And it was
7 indicated, but I just wanted to confirm that we're not
8 able to speak to that.

9 So, if there is a specific request, we
10 would need that documented and then we can pursue -
11 there was a request related to the performance of the
12 Japanese plants and how their fuel performs on their
13 seismic conditions and we can't disclose that.

14 That's proprietary, the Japanese
15 utilities. So, we won't be coming back to that.

16 MEMBER SHACK: Well, but you could answer,
17 perhaps, what the design approach is.

18 MR. SPRENGEL: And we'll touch on that
19 later, yes.

20 MEMBER SHACK: You'll touch on that later.

21 MR. SPRENGEL: Yes, agreed.

22 And then the last one was the recent
23 discussion related to tie rods. And I think there is
24 some discussion related to some proprietary numbers
25 and we can discuss that later once it's closed, if

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1 needed.

2 But the direct question of is there
3 ability to do visual inspection of the tie rods, the
4 answer is no.

5 And then that's all of our follow ups
6 right now. Again, we'll touch on some of this later
7 in the closed session.

8 MEMBER SHACK: And there's no capability to
9 do an ultrasonic down the tie rod?

10 MR. KURIMURA: The tie rods are
11 replaceable.

12 (Discussion off the record.)

13 MEMBER REMPE: It's replaceable, is what
14 you're saying?

15 MR. KURIMURA: The tie rods can be
16 replaceable and we can attach a sensor on the top of
17 the tie rod. Make it accessible.

18 MEMBER SHACK: So, you can put a sensor on
19 it? It's designed to do that? You have that
20 capability?

21 MR. KURIMURA: Yes, top of the tie rod is
22 flat. So, we can attach that.

23 MR. SPRENGEL: The answer is yes, there can
24 be a sensor put on it. I'm not sure of the details
25 and I think we can take that as an action to follow up

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1 on.

2 I do want to point out that through
3 discussions with the staff, we have added a diagram in
4 3.9.1 and I don't know if you want - it's in an RAI
5 response. So, we can provide that to you so you can
6 see the diagram, but it has been added to the DCD.

7 MEMBER SHACK: Or at least identify the -
8 I think we probably have it.

9 MR. SPRENGEL: Oh, I agree, yes. So,
10 that's something that we'll do before the meeting is
11 over to get you the RAI number. And then you can see
12 the diagram that was added showing, you know, the
13 location and some detail of it.

14 We'll take the action, though, to follow
15 up on not visual inspection, but, you know, some other
16 evaluation that can be done.

17 MEMBER SHACK: Okay.

18 CHAIRMAN STETKAR: Yes, if you can get us
19 the RAI number, that would at least -

20 MEMBER SHACK: And then we can discuss the
21 fluence numbers then in the closed session this
22 afternoon.

23 MR. SPRENGEL: Yes, that's correct. Yes.

24 MEMBER SHACK: Okay.

25 MEMBER ARMIJO: But, Bill, where the

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1 connections would be at the top and the bottom for
2 bolts and things like that, that's where the highest
3 stressed would be.

4 MEMBER SHACK: Which is a tie rod, you
5 know. It's going to be stressed the whole -

6 MEMBER ARMIJO: But it's a smooth bar.

7 MR. SPRENGEL: All right. I think we've
8 addressed the inspection part of it. So, now we'll
9 transition to discussing, you know, the conditions
10 experienced in the closed session.

11 CHAIRMAN STETKAR: Yes.

12 MR. SPRENGEL: Okay.

13 CHAIRMAN STETKAR: Good plan.

14 Let's start the presentation on the
15 thermal hydraulic design. Dr. Banerjee will join us
16 when he joins us, and see how much we get through
17 before he joins in.

18 MR. LANESE: Okay. So, we're on Section
19 4.4, thermal hydraulic design. And the intention of
20 this slide is to present the idea that we meet our
21 design basis by maintaining DNB with a 95 percent
22 confidence level for normal and operating AOOs. We do
23 that with a WRB-2 correlation and that we account for
24 appropriate uncertainties in poor conditions in the
25 CHF prediction of DNB.

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1 The safety analysis limits are set
2 accounting for penalties for rod bow and for any
3 transition core geometry. And there is additional
4 margin for some core operating flexibilities built
5 into those numbers as well.

6 Fuel melting is prevented at a 95/95
7 percent level for normal and AOO operation and that
8 analysis is performed in the FINE code.

9 Finally, those analyses are done choosing
10 appropriate core flow rates. And analyses in Chapter
11 15 say, you know, demonstrate that we have adequate
12 core cooling depending on the transient or accident
13 that's involved.

14 MEMBER REMPE: Isn't one of the limits on
15 the FINE code that the cladding temperature has to be
16 below like 1100 C that the staff's put on it for using
17 that code?

18 Isn't that what - I know we'll be - maybe
19 I shouldn't be bringing that up now, but what I'm
20 trying to say is how can you use the code with some of
21 the limits the staff is putting on the code for
22 predicting fuel melting?

23 So, is there a way to say that in the open
24 such as -

25 CHAIRMAN STETKAR: We can rely on people to

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1 tell us that they can't answer.

2 MEMBER REMPE: Okay.

3 CHAIRMAN STETKAR: You can ask anything.

4 MEMBER REMPE: Okay. So, are the limits
5 the staff has put on the code for when it can be
6 applied going to interfere with using the code? Which
7 is why I asked the question earlier today.

8 And maybe the staff should answer that
9 question, but it's something that I was just kind of
10 wondering when I was reading through.

11 MR. SPRENGEL: We'll discuss it later.

12 MEMBER REMPE: Okay.

13 CHAIRMAN STETKAR: The nice thing sitting
14 where we are is we can ask the questions and -

15 MEMBER REMPE: I shouldn't have -

16 CHAIRMAN STETKAR: No, that's fine. If
17 it's proprietary, they can tell us. If it's more
18 appropriate for the staff to answer it, they can tell
19 us.

20 MR. SPRENGEL: Okay. Just to get into any
21 of that discussion it will go quickly to proprietary.
22 So, we'll specifically address that in the FINE
23 discussion when we get there.

24 MEMBER REMPE: Okay.

25 CHAIRMAN STETKAR: In the FINE?

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1 MR. SPRENGEL: Yes.

2 CHAIRMAN STETKAR: Okay.

3 MR. SPRENGEL: Today.

4 CHAIRMAN STETKAR: Today. So, hold it
5 until this afternoon.

6 MEMBER REMPE: Hopefully I won't forget.

7 CHAIRMAN STETKAR: Write notes.

8 (Laughter.)

9 MR. LANESE: Okay. So, in the thermal
10 hydraulic analysis, again we addressed the
11 uncertainties associated with the DNBR, the fuel and
12 cladding temperatures and the hydraulics and we have
13 conservative evaluations for all those limits.

14 RCS flow measurement is also addressed in
15 Chapter 14. The power distribution is tested in
16 Chapter 14. And component and fuel inspections are
17 discussed in Section 4.2.

18 The related and required safety limits
19 that assure - that account for these uncertainties are
20 specified in the tech specs. So, we have appropriate
21 operating limits.

22 The next slide gives a comparison of some
23 of the key features of US-APWR fuel and typical 12 and
24 14-foot fuel in other large PWRs.

25 Again, you know, the thermal design flow

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1 is proportionately higher to support the higher core
2 power. The linear heat rate and the DNBRs are all
3 within - when taken as a conglomerate, are small
4 differences from existing plants. And that's really
5 the message from this slide. No dramatic changes.

6 Then the open items for this section, the
7 first one had to do with the appropriateness of the
8 rod bow penalty that was being used.

9 And MHI responded to that with no changes
10 of the DCD, just an expansion on an explanation on how
11 it was applied. And the staff has that under
12 consideration.

13 The thermal design methodology review is
14 still ongoing. And the final open item was one
15 related to DCD RAIs in Section 14.2 on pre-op testing.
16 And that's been closed and resolved by the staff.

17 CHAIRMAN STETKAR: Okay. I don't know
18 whether Sanjoy is on the line yet. Sanjoy, if you are
19 -

20 MR. SHUKLA: He has called in.

21 CHAIRMAN STETKAR: And we would hear that?

22 MR. SHUKLA: Yes.

23 CHAIRMAN STETKAR: Okay.

24 Let's do this: We'll go on to the staff
25 and - as long as none of the other members have any

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1 questions for MHI on any of the topics in Chapter 4.
2 Anyone?

3 (No response.)

4 CHAIRMAN STETKAR: Well, thank you very
5 much for your presentation. I'll warn you, you may be
6 back up if Dr. Banerjee has any specific questions
7 that we can answer in open session.

8 If he has questions that pertain to the
9 closed session, we'll elicit those questions from him
10 sometime before this afternoon and make sure that
11 they're brought up in closed session, because I don't
12 think he'll be joining us this afternoon.

13 And with that, again, thank you very much.
14 I apologize for a little bit of the disorganization
15 here this morning. It's sometimes difficult shuffling
16 around our specific subject matter experts, but I
17 really appreciate your patience and thank you for a
18 good presentation.

19 And with that, I guess we'll hear from the
20 staff on Chapter 4. Ready for - we're ahead of
21 schedule, I know. I see people shuffling.

22 Do you have everybody that you need?

23 MS. REYES: Right now we do.

24 MR. SCHMIDT: Yes, just give me about a
25 minute.

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1 CHAIRMAN STETKAR: Okay. We're on the
2 record here.

3 MS. REYES: Okay. Just one thing since,
4 like you say, we're ahead of time, we were expecting
5 our contractors to call in. So, we have to let them
6 know that -

7 CHAIRMAN STETKAR: On Chapter 4?

8 MS. REYES: Yes.

9 CHAIRMAN STETKAR: Okay.

10 MR. SCHMIDT: Yes.

11 MS. REYES: But they are in the west coast.
12 So, it's kind of early for them. So, we're hoping
13 that -

14 MEMBER ARMIJO: Oh, come on. They can wake
15 up.

16 (Laughter.)

17 (Discussion off the record.)

18 (Pause in the proceedings.)

19 CHAIRMAN STETKAR: Bear with us another
20 couple of minutes. There was a question about whether
21 or not the bridge line is active. Apparently if
22 there's no activity, it's so smart it hangs up.

23 (Discussion off the record.)

24 CHAIRMAN STETKAR: I believe we're ready.
25 We'll just monitor that line. You might hear dial

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1 tones or something. I'm not quite sure what's going
2 to happen, seems to be a theme for today, but we'll
3 get started.

4 And I don't know if Ruth or Jeff or who's
5 going to kick it off.

6 MS. REYES: I will start.

7 Once again, good morning. My name is Ruth
8 Reyes and I am the chapter PM for Chapter 4. And the
9 lead project manager is Jeff Ciocco. He was not able
10 to be here today.

11 And the technical staff, I have two here
12 with me, James Gilmer and Jeff Schmidt. And the rest
13 of the staff, there are some in the audience here.

14 Right now the only sections that the staff
15 has open items are on Sections 4.2 and 4.4, and those
16 are the sections that we are going to be discussing
17 here.

18 Having said that, I'll leave Jeff Schmidt
19 to start his presentation.

20 MR. SCHMIDT: Okay. I'm Jeff Schmidt from
21 NRO Reactor Systems. And with me is Jim Gilmer also
22 from Reactor Systems. We were the primary reviewers
23 of 4.2.

24 We had consultant help from PNNL from both
25 a fuel system standpoint, you know, guide tubes,

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1 grids, and then also PNNL from a fuel rod performance
2 standpoint, the FINE code we'll be talking about this
3 afternoon.

4 (Telephone interruption.)

5 CHAIRMAN STETKAR: Bear with us for just a
6 second here.

7 (Discussion off the record.)

8 CHAIRMAN STETKAR: Okay. Sanjoy, where we
9 are now just to orient you, MHI has given their
10 presentation on Chapter 4.

11 So, if you have any questions for them on
12 the thermal hydraulic design of the fuel, what we'll
13 do is table them for the moment.

14 MEMBER BANERJEE: Okay.

15 CHAIRMAN STETKAR: We're covering
16 proprietary information on thermal hydraulic design
17 this afternoon. So, if you have any questions
18 regarding the topical report, I'll ask you to kind of
19 communicate them to us before the afternoon session.

20 As I understand it, you will not be
21 available this afternoon; is that correct?

22 MEMBER BANERJEE: Right.

23 CHAIRMAN STETKAR: Okay.

24 MEMBER BANERJEE: But I will be available,
25 but it will be after probably four o'clock.

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1 CHAIRMAN STETKAR: No, that's too late.
2 We're way ahead of schedule. So, I just wanted to
3 orient you. Where we are now is the staff is just
4 starting their presentation on Chapter 4.

5 So, I'll let them continue. And then if
6 you have specific questions for MHI, we will call them
7 back up after the staff -

8 MEMBER BANERJEE: Okay, sure.

9 CHAIRMAN STETKAR: After the staff
10 finishes.

11 MEMBER BANERJEE: Go ahead, John, and I'll
12 follow along. And then if something comes up for MHI,
13 I'll get back to you later on.

14 CHAIRMAN STETKAR: Okay, good. Thank you.

15 MEMBER BANERJEE: After the staff
16 presentation.

17 CHAIRMAN STETKAR: Great. Thank you very
18 much.

19 MEMBER BANERJEE: All right. Thank you.

20 CHAIRMAN STETKAR: Jeff, sorry for the
21 interruption.

22 MR. SCHMIDT: No problem. I'm going to be
23 discussing 4.2, and then Jim will be discussing 4.4.
24 Since we have no open items for 4.3, I can handle any
25 4.3 questions you might have. So - or at least I hope

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1 so. I probably shouldn't say that so confidently,
2 huh?

3 CHAIRMAN STETKAR: That's a bold statement.

4 MR. SCHMIDT: that was kind of a bold
5 statement. I'd like to retract that - no, just
6 kidding.

7 So, you know, I'm going to talk about 4.2,
8 which is the fuel pellet, the fuel assembly, fuel
9 cladding and control rods and any other in-reactor
10 components.

11 So, we go to Slide 4. As Mitsubishi
12 already pointed out, there's two topical reports that
13 support the DCD 4.2. One is the FINE fuel rod
14 performance code, which is 07008, and then there's the
15 07034 which is the FINDS. We usually call them E and
16 D just to be clear.

17 And, you know, 07034 is really how the
18 structure behaves under seismic events. It's
19 basically the methodology.

20 And there's two technical reports that
21 support Chapter 4.2. And then there's 07016 which is
22 kind of the fuel system design. It looks at things
23 like the actual, say, for a given core, what type of
24 hydrogen limits you'll get for the clad, stress and
25 strain on the guide tube material. It's kind of like

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1 the application of Topical Report 07008, the fuel rod
2 performance code.

3 And then as we discussed this morning,
4 there is MUAP-08007 which is the application of the D,
5 or the FINDS code, to the actual fuel behavior whether
6 you have, you know, plastic grid deformation, what the
7 stresses are in the guide tubes during, you know,
8 combined LOCA/seismic events. So, it's the
9 application of FINDS, okay.

10 And, again, this is kind of a repeat of
11 what you saw earlier from Mitsubishi as the open
12 items. As Ruth mentioned this morning, MUAP-07034
13 which is the structural seismic and LOCA code, is
14 still under review. It's with projects going through
15 the process. Should shortly, I think, be going to
16 OGC.

17 MUAP-08007 which is the application for
18 the seismic methodology as we talked about this
19 morning, that's being revised where the staff is
20 expecting a revision sometime next year. And we'll
21 talk more about that even in the staff presentation
22 coming up here too.

23 One of our open items was grid to rod
24 fretting. In the Technical Report 07016 there was a
25 methodology by which MHI was going to predict fretting

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1 wear and clad reduction - fuel clad reduction.

2 The staff historically doesn't review and
3 approve methodologies that try to predict that. We
4 usually try to base it on the thousand hour grid to
5 rod fretting test.

6 So, what the staff asked for was based on
7 the experimental data that they had, the hydraulic
8 test data, extrapolate out, you know, based on what
9 type of fuel duty you would have, your clad thinning
10 based on grid to rod fretting and whether you met the
11 10 percent criteria.

12 So, that was an open item. It has since
13 been closed. They've done basically the experiment
14 and then conservative extrapolation methodology and
15 the staff has resolved that issue.

16 Just to make it clear, though, the staff
17 is not reviewing or approving the methodology in 07016
18 which tries to deterministically predict clad
19 fretting.

20 The following open item again was based on
21 the hydraulic testing. There was some statements in
22 the hydraulic testing which indicated that MHI
23 believed that the fuel vibration and assembly
24 vibration were acceptable, but there was no clear, in
25 the staff's mind, what the acceptance criteria was for

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1 that acceptability.

2 So, the follow-on here is really, you
3 know, what criteria are you using to evaluate
4 acceptability. So, that's still an open item.

5 MEMBER BANERJEE: So, what did they propose
6 as the acceptability criteria? This is Sanjoy.

7 MR. SCHMIDT: Yes, we haven't seen it yet.
8 I haven't reviewed that. They probably responded to
9 the RAI, but I haven't reviewed it yet, Dr. Banerjee.

10 MEMBER BANERJEE: Okay. Thank you.

11 CHAIRMAN STETKAR: Does MHI want to add
12 anything?

13 (No response.)

14 MR. SCHMIDT: The other open item that was
15 also covered by Mitsubishi was the BOL and EOL elastic
16 limits and the FINDS impact model to determine, you
17 know, under the various seismic and LOCA events how
18 many grids will actually buckle.

19 So, it's your, what we call, the p crit
20 design or p crit value which the grids will buckle at.
21 That's still an ongoing review item.

22 The next one which is MUAP-09002 which is
23 the seismic and accident load conditions for primary
24 components and piping which is really like at Chapter
25 3, we're just saying that that's still open and,

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1 hence, we can't resolve all of the fuel issues until
2 all of the other design features are incorporated or
3 changes based on 09002.

4 So, it's kind of just a tracking item that
5 we can't complete our design review until that's
6 completed.

7 Next slide. Again, this is really just a
8 tracking item to say what I just said there is that we
9 can't really complete the application for the fuel
10 which is the MUAP-08007 until the final soil profiles
11 of MUAP-09002 are complete.

12 In other words, we have to know what the
13 soil profiles look to do our final evaluation of fuel,
14 of seismic and LOCA response.

15 The other open item is the AOO holddown
16 spring evaluation. MHI also discussed that. Trying
17 to determine if under AOOs, if the spring will
18 plastically deform in such a manner that it would not
19 perform its function of keeping it basically seated
20 and on the pins. So, that's still under staff review.

21 Again, the next open item is related to
22 that same thing is plastic deformation of the holddown
23 spring during an RCP overspeed event. Those are still
24 waiting for staff review.

25 Go to the next slide. The staff had a

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1 guide tube hydrogen question that has since been
2 closed and resolved.

3 Mitsubishi had originally asked for a 800
4 ppm hydrogen limit in the guide tube. The staff asked
5 for additional data which supported that 800 ppm.

6 We've since gone to a number which is
7 lower than that and the staff is satisfied with that
8 lower number and probably should get into some of the
9 actual numbers that were agreed upon in the
10 proprietary discussion.

11 So, if you want the final numbers, I guess
12 we can discuss those.

13 CHAIRMAN STETKAR: Yes.

14 MR. SCHMIDT: The next open item was
15 burnable poison. The issue there was rod internal
16 pressure due to B10 release. And through follow-on
17 discussions, this has been resolved/closed.

18 Mitsubishi is taking a conservative
19 analysis that all the boron - all the B10 basically is
20 used up in its first cycle and that the rod internal
21 pressure doesn't exceed its design criteria.

22 And then the last item was control rod
23 cladding stresses and the material properties. That's
24 still under staff review. There's some questions on
25 the stress and strain values used for the control rod

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1 guide - or control rod cladding material.

2 As we talked about before and we're going
3 to talk about more as we go through the presentation
4 here is the staff has asked MHI to evaluate a tenth of
5 a second drop in the Chapter 15 accidents due to
6 plastic grid deformation. And we'll talk about that
7 in the upcoming slides here.

8 There's been some testing that's done to
9 show that there's about a 0.1-second delay in control
10 rod drop time. We're just asking that it be evaluated
11 in Chapter 15.

12 And the following or last open item is
13 fuel rod coolability under LOCA-induced loads. If you
14 look at some of the guidance, and we'll talk about
15 that in a second here, 4.2 looks at, say, typically
16 combined loads of LOCA plus SSEs.

17 What staff has asked is do we get any
18 plastic grid deformation under just LOCA loads? LOCA
19 loads only. And MHI is preparing a response for that.

20 So, I want to go back now to which is
21 MUAP-08007 which is the application for the seismic
22 code, and talk about some of the issues that the staff
23 is dealing with in the review of that document. So,
24 this relates to open item 4.2-2 which is MUAP-08007.

25 As MHI discussed this morning and you guys

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1 also discussed this morning that US-APWR does have -
2 is predicting plastic deformation of the assembly
3 grids under SSE-only loads. Not combined loads, but
4 SSE-only loads. That's the first application that the
5 staff is aware of that we're seeing deformation under
6 SSE-only loads.

7 So, when we went to look for guidance, we
8 ended up at GDC-2 which basically says, you know, you
9 shall evaluate SSEs with appropriate combination of
10 normal and accident conditions along with natural
11 phenomenon.

12 So, the natural phenomenon here being the
13 earthquake and the accident conditions being whatever
14 accident conditions you might have, say, in the
15 Chapter 15 accident analysis and LOCA.

16 So, really the staff is trying to
17 determine how to evaluate what appropriate combination
18 of effects of normal and accident conditions are with
19 natural phenomenon.

20 Assembly components are evaluated under
21 SSE, LOCA and the combined loads. As you can tell, we
22 had an RAI just on LOCA loads alone. We've had - SRP
23 guides you to looking at both SSE and LOCA loads. So,
24 we're looking at obviously all those loads both in
25 combination and in singular.

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1 SRP acknowledges the possibility of
2 plastic grid deformation under Appendix A. If you do
3 have plastic grid deformation, you look at things like
4 control rod insertability as a criteria, your LOCA
5 requirements, your 5046 LOCA requirements, and then it
6 doesn't really provide a lot of additional guidance
7 for the staff to review.

8 It's kind of unclear of how when you have
9 plastic deformation under SSE-only loads do you
10 evaluate, say, the remainder of the Chapter 15
11 accidents.

12 Next slide. SRP does provide a little
13 more guidance. It does say consequences of grid
14 deformation are small and gross deformation of many
15 assemblies would be needed to interfere with control
16 rod insertion.

17 It also goes on to say that, you know, you
18 obviously have to be able to demonstrate control rod
19 insertability under combined loads which would be SSE
20 plus LOCA loads.

21 Currently, licensed plants do not predict
22 grid deformation in rodded locations. So,
23 historically plants haven't had to concern themselves
24 with this potential, say, second part of the SRP which
25 says you check control rod insertability. There are

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1 plants out there that do deform grids, but they're not
2 in control rod locations.

3 MHI will have as of right now predicting
4 at least currently deformation in control
5 applications. So, that makes it somewhat different
6 for the staff's review.

7 MHI has performed, though, in around 1986
8 there was a bunch of tests done for deformed grids and
9 looked at control rod insertability.

10 So, there is pretty extensive test data
11 from 1986 that does look at things like plastic grid
12 deformation and control rod insertability.

13 The NRC has reviewed that report and found
14 that the deformations that MHI is predicting, that the
15 control rods will insert. There is a slight delay
16 time. And that slight delay time was the 0.1 seconds
17 I talked about earlier.

18 MEMBER SHACK: I mean, my confidence in
19 analysis is very high when we're in the linear space.

20 MR. SCHMIDT: Right.

21 MEMBER SHACK: When I'm starting to compute
22 deformations in plastic especially with buckling, I
23 get a whole lot more -

24 MR. SCHMIDT: Right.

25 MEMBER SHACK: - uncertain. And you're

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1 confident that the deformed grids in these tests were,
2 in fact, some sort of limiting values that -

3 MR. SCHMIDT: They were severely deformed.
4 There were multiple, I think - and MHI may be able to
5 help - five grids that were deformed axially.

6 So, it was a very extensive and limiting
7 test from a deformation standpoint, yes. And having
8 only a 0.1-second delay with those deformations is a
9 pretty small delay when you normally have like a four-
10 second drop time delay.

11 So, yes, the staff has spent a fair amount
12 of time reviewing that report and, you know, we're
13 pretty confident that that covers the bounding case
14 here for control rod insertability.

15 MEMBER BANERJEE: Was there a lot of
16 plastic deformation? Could it be calculated? Like
17 Bill, I always worry about, you know, calculations
18 done in the plastic regime.

19 MR. SCHMIDT: Right. Yes, I mean, FINDS
20 has the capability of predicting the plastic
21 deformation, but we're not really - while we're using
22 that as information, we're using it more of a go, no-
23 go for deformation.

24 You know, I don't want to go too far into
25 this subject because it's being reevaluated by MHI.

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1 So, what I'm saying right now is kind of the current
2 state of affairs, but that may change when we get the
3 revision to 08007.

4 But, yes, FINDS does theoretically have
5 the capability of predicting amount of deformation.

6 MEMBER BANERJEE: Okay, thanks.

7 MEMBER ARMIJO: These are all Zircaloy
8 grids, right?

9 MR. SCHMIDT: That's correct. They're all
10 Zircaloy.

11 MEMBER ARMIJO: So -

12 MR. SCHMIDT: Well, I shouldn't say - the
13 top and bottom are Inconel, but the middle ones with
14 the deformation, the maximum deformation are Zircaloy.

15 MEMBER ARMIJO: So, in service they're
16 going to oxidize, they're going to pick up some
17 hydrogen.

18 MR. SCHMIDT: Yes.

19 MEMBER ARMIJO: They're going to get some
20 radiation and hardening.

21 MR. SCHMIDT: Hardening, right.

22 MEMBER ARMIJO: And so, you get into
23 buckling with something that's potentially embrittled.

24 MR. SCHMIDT: Right.

25 MEMBER ARMIJO: I'm sure those are all the

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1 things you worry about, but -

2 MR. SCHMIDT: Yes.

3 MEMBER ARMIJO: Were the tests done on
4 grids that had in some way simulated that level of
5 service, or were they just took some Zirconium and
6 squeezed it and said, okay, it's buckled enough, we
7 can test that?

8 MR. SPRENGEL: I'd request that maybe we
9 defer some of this discussion. I mean, we're getting
10 into the methodology and the testing that was done.

11 So, we can answer this and have some
12 discussion on this topic today. A lot of it will be
13 covered in future discussions, but I think we can go
14 ahead and discuss some of those, but I'd request -

15 MEMBER ARMIJO: Sure.

16 MR. SPRENGEL: - that we move it to the
17 closed session.

18 MEMBER ARMIJO: We can wait.

19 CHAIRMAN STETKAR: That's fine.

20 I apologize. I didn't look far enough
21 ahead. I'll let you finish this and then I was going
22 to ask something else that's peripherally related.

23 MR. SCHMIDT: Should I go to the next
24 slide?

25 CHAIRMAN STETKAR: This topic, yes.

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1 MR. SCHMIDT: Yes, okay. So, we're on
2 Slide 12 now. Again, I kind of talked about already
3 appropriate combination of effects of normal and
4 accident conditions on the natural phenomenon.

5 Current plants I also talked about do
6 deform under SSE plus LOCA loads and non-limiting core
7 locations typically on the core periphery or the
8 assemblies in the baffle.

9 Deformation under SSE-only loads and
10 limiting core locations, as I mentioned, brings up
11 additional staff questions on how you evaluate, say,
12 just even full-power operation under a seismic event,
13 as well as the Chapter 15 accidents now that you have
14 plastically-deformed grids potentially in limiting
15 core locations.

16 So, those are all -

17 MEMBER BANERJEE: Were there any
18 experiments done on DNBR with the slightly deformed
19 grids or deformed grids?

20 MR. SCHMIDT: None that I'm aware of.

21 MEMBER BANERJEE: Okay. So, how does that
22 affect the evaluations of deformation?

23 MR. SCHMIDT: Well, that's part of the
24 staff's review of this 08007. We haven't come to a
25 conclusion on that, Dr. Banerjee.

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1 MEMBER BANERJEE: Okay. Thank you.

2 MR. SCHMIDT: Okay. On the next slide,
3 basically MHI as they talked this morning, is
4 currently revising 08007.

5 At the time of this presentation when this
6 was put together, we anticipated a July 2013 date
7 trying to address, I think, many of the questions that
8 we've all raised here today.

9 MEMBER BANERJEE: Are they going to do some
10 experiments, or is this just going to be sort of an
11 evaluation? I haven't been following this area of the
12 effect of deformation on the DNB and LOCA.

13 Is it purely so the analysis is being put
14 forward?

15 MR. SPRENGEL: This is a revision to
16 incorporate a new response spectra that's being
17 developed out of our 3738 review.

18 MEMBER BANERJEE: Right.

19 MR. SPRENGEL: So, the methodology is set
20 and the methodology has already been applied once in
21 a previous results report, but now we're going to
22 update the results using a new response input.

23 MEMBER BANERJEE: That's the effect of the
24 earthquake, right?

25 MR. SPRENGEL: Yes.

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1 MEMBER BANERJEE: On deformation. So, then
2 the effect of the deformation on DNBR and LOCA, how is
3 that evaluation being done?

4 I haven't followed it, unfortunately. So,
5 maybe it's all there for me to look at somewhere.

6 MR. SCHMIDT: This is Jeff Schmidt from the
7 NRC.

8 The staff does not know what MHI plans on
9 presenting going forward.

10 MR. SPRENGEL: Right. That's an ongoing
11 discussion tied to that open item. And as it's noted
12 there that we do have a public meeting that we're
13 trying to set up this coming November.

14 MEMBER BANERJEE: When is that? In
15 November -

16 MR. SCHMIDT: Yes.

17 MEMBER BANERJEE: - is the meeting?

18 MR. SCHMIDT: Yes.

19 MEMBER BANERJEE: Okay. Thank you. That
20 answered my question. Go ahead.

21 MR. SCHMIDT: Yes, I mean, as I think we're
22 all, you know, discussing here that core-wide plastic
23 deformation introduces significant technical,
24 regulatory and scheduling uncertainty in the review.

25 And as Ryan just alluded to, we have a

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1 meeting coming forward in November to try to find out
2 what, you know, potential path forward MHI might be
3 proposing.

4 MEMBER BANERJEE: Okay. Thanks.

5 MR. SCHMIDT: Yes.

6 So, as far as conditions and limitations
7 from a 4.2 standpoint, and this really comes from the
8 FINE review, but the staff has imposed s surveillance
9 program on oxide measurements both - if it's a 24-
10 month cycle, both after the first cycle and the second
11 cycle to measure oxide thickness.

12 Because the power histories that were
13 presented in FINE weren't necessarily - I should say
14 the US-APWR rod power histories could be different and
15 more limiting than the database that was in the FINE
16 topical report.

17 So, we've instituted a measurement
18 campaign to make sure that the model in FINE, the
19 oxide model in FINE is indeed conservative and that
20 the number that we can talk about in the proprietary
21 session is not violated.

22 So, that's the one condition and
23 limitation we put in 4.2 on fuel rod performance,
24 really.

25 CHAIRMAN STETKAR: Before we go to 4.4, I

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1 wanted to ask a question that's peripherally related
2 to this topic of plastic deformation, but is also
3 related to PRA-type analyses.

4 This is not the PRA section and I realize
5 we're looking at design basis accident analyses here,
6 but as part of the risk assessment to this design I
7 quite honestly don't recall whether MHI is proposing
8 a seismic margins assessment, or a complete
9 probabilistic assessment of seismic risk.

10 Regardless of their approach, they will
11 have to perform an evaluation of margins at both the
12 SSE acceleration and beyond the SSE acceleration.

13 So, I was curious whether the staff is
14 aware of any work in that area which might help to
15 improve your confidence even within the design basis
16 part of the analysis, or whether MHI had actually done
17 any of those analyses to give us some information
18 about the margins that might be available.

19 MR. SCHMIDT: I personally am not aware of
20 any.

21 CHAIRMAN STETKAR: And I realize it's kind
22 of at the interface between -

23 MR. SCHMIDT: Right.

24 CHAIRMAN STETKAR: - design analyses and
25 PRA, but I think what we're all hearing is there's

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1 concerns at the SSE. I think given that there would
2 be concerns beyond the SSE -

3 MR. SCHMIDT: Yes.

4 CHAIRMAN STETKAR: - which ought to be
5 evaluated as part of the risk assessment process. So,
6 I see several people getting up and down. I don't
7 know whether -

8 MR. SPRENGEL: I mean, I can speak to the
9 seismic margin analysis. I know the staff have
10 brought up before and we're aware of the interest in
11 it.

12 It's also tied to our seismic work that's
13 ongoing.

14 CHAIRMAN STETKAR: Yes.

15 MR. SPRENGEL: And we plan to have a
16 submittal for that around summer of next year. So, I
17 can get a firm date for you on that, but that will be
18 coming in.

19 So, that may not be part of our Chapter 19
20 discussion coming up, but there is a commitment to
21 provide that information.

22 CHAIRMAN STETKAR: Yes, because I think
23 we're up on Chapter 19 earlier than that.

24 MR. SPRENGEL: Yes. Yes, that's correct.

25 CHAIRMAN STETKAR: Okay. All right. So,

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1 it's just part of the ongoing story. I don't know if
2 the staff had anything to add.

3 (No response.)

4 CHAIRMAN STETKAR: Okay. Thanks. All
5 right. Thank you.

6 MS. REYES: Okay. And that concludes our
7 presentation for 4.2. We don't have any open items on
8 4.3. So, we don't have any presentation or a slide on
9 that section.

10 But if the staff has any questions related
11 to that section, we can address the questions now. If
12 not, we will continue with 4.4.

13 (No response.)

14 MS. REYES: Okay.

15 MR. GILMER: Okay. The key part of DCD
16 Section 4.4 is the reference to the thermal design
17 methodology topical report which basically is the
18 subchannel code VIPRE-01M which is MHI's version of
19 the standard VIPRE code.

20 It does have some enhanced model selection
21 features and the key modification is the APWR-specific
22 critical heat flux correlation.

23 The details of the code are discussed in
24 the topical report MUAP-07009. And for that topical
25 report, the staff safety evaluation is nearing

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1 completion. So, it should be available in the near
2 future.

3 CHAIRMAN STETKAR: Yes, we're currently
4 scheduled, I think, to review that in January.

5 MR. GILMER: You'll hear all the details -

6 CHAIRMAN STETKAR: We'll be doing that.

7 MR. GILMER: - at that time.

8 MEMBER BANERJEE: Sorry I missed that.
9 When was it scheduled for?

10 CHAIRMAN STETKAR: January 15th.

11 MEMBER BANERJEE: Sorry.

12 CHAIRMAN STETKAR: January 15, 1-5.

13 MEMBER BANERJEE: Okay. Thank you.

14 CHAIRMAN STETKAR: 2013.

15 MR. GILMER: The well-worn Westinghouse
16 WRB-1 and 2 correlations were actually shown by tests
17 to be appropriate for the APWR fuel. Appropriate and
18 conservative with the grids that APWR have.

19 MEMBER ARMIJO: You mean US-APWR?

20 MR. GILMER: US-APWR, yes. I'm sorry.

21 MEMBER ARMIJO: Just wanted to make sure.

22 MR. GILMER: Yes, it is.

23 The actual DNB tests, if memory serves me,
24 were done about two years ago at the KATHY facility in
25 Karlstein, Germany. And several members of the staff

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1 did witness those tests.

2 Next slide. The details of the test
3 report is in MUAP-11010 which is available in
4 SharePoint and ADAMS.

5 The staff evaluation of the test is
6 covered under the thermal design topical - MUAP-07009
7 which is coming out very soon.

8 Uncertainties in power, inlet temperature,
9 pressure flow, peaking factors, code uncertainties and
10 correlation of the uncertainties were evaluated by the
11 staff-approved Westinghouse Revised Thermal Design
12 Procedure. So, staff found that it was also
13 appropriate for the US-APWR fuel.

14 MEMBER BANERJEE: Were the tests in
15 Karlstein full length, or was it slightly reduced
16 length? Can that facility take the full length?

17 MR. GILMER: They were full length. 14
18 foot.

19 MEMBER BANERJEE: Okay. Because normally
20 I didn't realize the Karlstein facility can take 14
21 feet.

22 MR. GILMER: I believe they had to do some
23 physical modification, but they did accommodate it.

24 MEMBER BANERJEE: Okay. Fine. So, this
25 was full length prototypical in every way, right, with

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1 the mixing bins and everything there.

2 MR. GILMER: Yes.

3 MEMBER BANERJEE: Okay. Thanks. I haven't
4 looked at these tests, but interesting. Go ahead.

5 MR. GILMER: Okay. Now, Section 14.2 of
6 the DCD describes the traditional startup testing that
7 would be performed for core performance and staff
8 found it acceptable.

9 There were some issues - open issues in
10 14.2 that have been now closed related to the
11 instrumentation and procedures.

12 The GSI-191 LOCA-generated debris issues
13 are being addressed in Section 6.3 of the staff's
14 safety evaluation which I think will be discussed in -

15 MS. REYES: I believe it's March.

16 MR. GILMER: - March.

17 MEMBER BANERJEE: Okay.

18 MR. GILMER: The only open items in Section
19 4.4, the first one was related to less than one
20 percent rod bow penalty.

21 The staff had a question that it was
22 actually lower than we've traditionally seen with
23 Westinghouse plants.

24 That response had been received and still
25 under review by the staff, but we believe that it is

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1 acceptable preliminarily.

2 Another open item was the - basically the
3 tie-in to the approval for the topical report from the
4 thermal design methodology. That is about to be
5 closed with respect to Section 4.4.

6 And there was an open item on Section 4.5
7 which is on the - related to testing that was tied to
8 the open items in Chapter 14 that has now been
9 resolved.

10 MEMBER ARMIJO: Could you expand a little
11 bit on why you have this rod bow penalty on this?

12 MR. GILMER: Why?

13 MEMBER ARMIJO: Yes.

14 MR. GILMER: Well, it was one of several
15 uncertainties traditionally that's accounted for by an
16 assumed penalty and -

17 MEMBER ARMIJO: But it's not related to the
18 fact that the assembly is longer or grid spacing is
19 different or there's nothing unique, it's just sort of
20 a traditional penalty?

21 MR. GILMER: It's a traditional penalty.
22 We did ask the question about whether there are any
23 length-related differences in the bowing. So, there
24 was an RAI on that that we were satisfied was
25 acceptable.

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1 So, any other questions on this section?

2 MEMBER BANERJEE: What uncertainties - I
3 just want to go back with regard to the power
4 distribution with the 14-foot core. Are there
5 uncertainties in the power distribution that are
6 greater than with 12-foot cores or is that - are there
7 reactor physics calculations that power distribution
8 calculation was verified and validated?

9 MR. GILMER: Do you want to take that?

10 MR. SCHMIDT: Yes, I'll take that. This is
11 Jeff Schmidt.

12 Yes, as far as like the physics code and
13 the ANC code is well-validated for 12 or 14-foot fuel.
14 It's really insensitive to that.

15 The only difference would be, you know,
16 how many axial nodes you might put in your physics
17 model, but it's well-established that ANC can handle
18 14-foot fuel.

19 MEMBER BANERJEE: Okay. So, from the
20 uncertainty point of view, there is no increase
21 compared to 12-foot cores.

22 MR. SCHMIDT: No, there's no additional
23 increase.

24 MEMBER BANERJEE: Okay. Thank you.

25 And the flow measurement uncertainties are

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1 just whatever they are for any other plant. Are they
2 - how are they - what sort of uncertainties are
3 related to the flow measurement?

4 MR. SCHMIDT: I'm sorry, what type of
5 measurements?

6 MEMBER BANERJEE: Flow measurements.

7 MR. SCHMIDT: Flow measurements?

8 MEMBER BANERJEE: Yes.

9 MR. SCHMIDT: Flow measurements.

10 MR. GILMER: There were some instrument
11 uncertainties. The traditional ones that are
12 accounted for in this type of methodology.

13 MEMBER BANERJEE: But there is no
14 additional factor involved here other than the
15 traditional way to do this.

16 MR. SCHMIDT: No.

17 MR. GILMER: No, it follows the same
18 existing Westinghouse Revised Thermal Design
19 Procedure. Yes, there would be no reason for
20 additional flow uncertainties there.

21 MEMBER BANERJEE: Okay.

22 Do they actually make measurement in the
23 primary circuit or on the elbows and things? How do
24 they actually - do they have any such measurements
25 that they do?

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1 MR. SCHMIDT: Well, they do have the
2 measurements for, you know, hydraulic. They did
3 hydraulically test an assembly, the fuel assembly
4 itself. So, they have a good idea of pressure drop
5 across the assembly for their grid designs.

6 As far as the plant testing, that kind of
7 what Jim was referring to is Section 14.2, which is
8 the core flow and pressure drop of the kind of the as-
9 built US-APWR.

10 MEMBER BANERJEE: Yes, I'm just trying to
11 remember whether there are some pressure measurements
12 made around the loop to validate the flows.

13 Do they have any such measurements that
14 are being made? Pressure losses or -

15 MR. GILMER: There's pressure tests done in
16 14.2 for pre-operational tests.

17 MEMBER BANERJEE: Okay. Anyway, I need to
18 read up on this. Thanks. Carry on, please, yes.

19 MR. GILMER: Well, we're pretty much done
20 unless there are further questions.

21 CHAIRMAN STETKAR: I was going to say do
22 any of the members have any other questions for the
23 staff?

24 (No response.)

25 CHAIRMAN STETKAR: Sanjoy, do you have

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1 anything else specifically for MHI regarding the
2 fuels?

3 MEMBER BANERJEE: I don't at the moment,
4 John, but that doesn't mean I will not have at the end
5 of, you know, I missed the MHI presentation. So, I'm
6 going to go over it and is it okay if I ask any
7 questions just for clarification later on?

8 CHAIRMAN STETKAR: Well -

9 MEMBER BANERJEE: Is your crew there going
10 to vanish?

11 CHAIRMAN STETKAR: Well, stay on the line.
12 What I'd like to do is thank the staff if there are no
13 more questions for the staff.

14 And because this will be the end of our
15 open session for today, what I'd like to do is see if
16 there are any questions or statements from members of
17 the public who might be here.

18 I don't believe that we have anybody on
19 the bridge line that we need to open things up for.
20 So, if there's anyone from the public or any other
21 questions or comments?

22 (No response.)

23 CHAIRMAN STETKAR: Hearing none -

24 MS. REYES: I was going to add, but it
25 looks like the staff doesn't have questions, we don't

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1 have any open items in the remaining of the sections,
2 but the staff, the technical staff is here so in case
3 of the ACRS staff has questions on 4.5 and 4.6 which
4 we didn't discuss, but the staff is here.

5 CHAIRMAN STETKAR: I understand. And I'm
6 assuming that if anyone did have a question, they
7 would have raised it by now.

8 Now, again I'd like to thank the staff.
9 Now, we face a bit of a scheduling question. The
10 question is we were - according to the original
11 agenda, we were scheduled to break for lunch at 11:30
12 and reconvene at 12:30 to pick up the afternoon
13 session.

14 The material that we have left to discuss
15 today is the proprietary topical report and I'll now
16 ask both MHI and the staff for input about do you want
17 to start that discussion now and go to about noon and
18 break for lunch at 12:00, or should we break for lunch
19 now and reconvene at 12:30 according to the original
20 agenda? Long lunch.

21 And the reason I ask this is I don't know
22 whether you have other resources that are planning
23 their schedules around our agenda, people who might be
24 calling in or staff members who might be planning
25 their time.

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1 So, I need feedback from you. So, I'm
2 proposing either we start now and go to 12:00, or we
3 break now and reconvene at 12:30. And it's a resource
4 issue on the -

5 MR. SPRENGEL: We have our resource here
6 and we're ready. So, I defer to the staff.

7 CHAIRMAN STETKAR: Yes, we'll ask about the
8 staff.

9 (Discussion off the record.)

10 MEMBER BANERJEE: So, John, are we going
11 into closed session with MHI?

12 CHAIRMAN STETKAR: Yes, we are. The reason
13 I wanted to do this, Sanjoy, is if we can if it's
14 feasible to maximize your input in realtime.

15 MEMBER BANERJEE: Right.

16 CHAIRMAN STETKAR: Because, you know,
17 you're only available until noon, right?

18 MEMBER BANERJEE: Right.

19 CHAIRMAN STETKAR: Okay.

20 MEMBER BANERJEE: I can maybe stay until
21 12:15, but I really need to leave.

22 CHAIRMAN STETKAR: Yes. We'll see where we
23 get to a convenient break point in the presentations
24 around that time. So, we'll do that. For scheduling,
25 we'll do that.

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1 (Discussion off the record.)

2 CHAIRMAN STETKAR: While we're getting set
3 up here, we'll have MHI come up first. We're getting
4 the handouts.

5 What I'd also like to do is we're going to
6 go into closed session. So, I want to make sure that
7 the staff and MHI confirm that only people are here
8 who are authorized to hear this presentation.

9 So, if you'd check the audience and make
10 sure that there aren't any people who you don't want
11 here, I would appreciate that.

12 (Discussion off the record.)

13 CHAIRMAN STETKAR: And what I'll do is I'll
14 close the session now so that we can discuss the
15 proprietary material.

16 (Whereupon, the meeting went off the
17 record at 11:05 a.m. to begin the closed session
18 portion of the meeting.)

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US-APWR Subcommittee: Open Session

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

(ACRS)

+ + + + +

US-APWR SUBCOMMITTEE

OPEN SESSION

+ + + + +

FRIDAY

OCTOBER 19, 2012

+ + + + +

ROCKVILLE, MARYLAND

+ + + + +

The Subcommittee met at the Nuclear
Regulatory Commission, Two White Flint North, Room
T2B3, 11545 Rockville Pike, at 8:30 a.m., John W.
Stetkar, Chairman, presiding.

SUBCOMMITTEE MEMBERS:

JOHN W. STETKAR, Chairman

SANJOY BANERJEE, Member*

DENNIS C. BLEY, Member

JOY REMPE, Member

WILLIAM J. SHACK, Member

1 NRC STAFF PRESENT:

2 GIRIJA SHUKLA, Designated Federal Official

3 JEFF SCHMIDT, NRO

4 MICHAEL TAKACS, NRO

5

6 ALSO PRESENT:

7 DAVID CARAHER, ISL

8 HIROSHI FUJISHIRO, MHI

9 KEVIN LYNN, MHI

10 YUTA MARUYAMA, MNES

11 JUNTO OGAWA, MHI

12 RYAN SPRENGEL, MNES

13 REBECCA STEINMAN, MNES

14 DOUG WOOD, MHI

15

16 *Participating via telephone

17

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P R O C E E D I N G S

8:31 a.m.

CHAIR STETKAR: The meeting will now come to order. This is the second day of the meeting of the United States Advanced Pressurized Water Reactor Subcommittee. I'm John Stetkar, Chairman of the Subcommittee, for the record. Members in attendance are Dennis Bley, Bill Shack, Joy Rempe, and Sanjoy Banerjee has joined us via the bridge line.

Today we will be discussing topical report MUAP-07010-P, non-LOCA methodology. The material that will be presented today is proprietary to Mitsubishi Heavy Industries, and, therefore, this meeting will be closed to protect the proprietary nature of that material. Before we close the meeting, are there any comments that any of the members want to make on the public record or anyone else? If not, we'll close the meeting, and I'll ask MHI and the staff to confirm that there is no one in this room who should not be. We'll have the bridge line closed, except for Dr. Banerjee.

MEMBER BANERJEE: I'm on.

CHAIR STETKAR: Thank you.

(Whereupon, the foregoing matter was concluded at 8:33 a.m.)



Luminant



LUMINANT GENERATION COMPANY

Comanche Peak Nuclear Power Plant, Units 3 and 4

ACRS US-APWR Subcommittee



**FSAR Chapter 4 –
Reactor**

October 18, 2012



Comanche Peak 3&4 FSAR Chapter 4 Summary

- ❑ **Ch 4 of US-APWR DCD is incorporated by reference in the R-COLA with no departures or supplements**
- ❑ **No contentions pending before ASLB**



Presentation to the ACRS Subcommittee

**Comanche Peak Nuclear Power Plant, Units 3 and 4
COL Application Review**

Safety Evaluation Report with Open Items

CHAPTER 4: Reactor

October 18, 2012

Staff Support

- Lead Project Manager - Stephen Monarque
- Project Manager – Ruth Reyes
- Supporting Technical Staff:
 - ◆ Jeffrey Schmidt
 - ◆ Fred Forsaty
 - ◆ Jim Gilmer
 - ◆ Robert Davis
 - ◆ Joel Jenkins
 - ◆ John Budzynski

Sections Reviewed

- 4.1 Summary Description
- 4.2 Fuel System Design
- 4.3 Nuclear Design
- 4.4 Thermal-Hydraulic Design
- 4.5 Reactor Materials
- 4.6 Functional Design Of Reactivity Control System

❖ These sections are incorporated by reference with no departures or supplements



Presentation to ACRS Subcommittee
Chapter 4: Reactor

October 18, 2012
Mitsubishi Heavy Industries, Ltd.

MHI Presenters



Lead Presenter:

Lou Lanese

Technical Experts:

Nozomu Murakami

Takayuki Nakano

Masayuki Kauchi

Takayuki Suemura

Chikara Kurimura

Chapter 4 Reactor

- Section 4.1 – Summary Description
- Section 4.2 – Fuel System Design
- Section 4.3 – Nuclear Design
- Section 4.4 – Thermal-Hydraulic Design
- Section 4.5 – Reactor Materials
- Section 4.6 – Functional Design of Reactivity Control Systems

Open Items for Chapter 4

- There are no Open Items for Sections 4.1, 4.3, 4.5 and 4.6.
- There are 17 Open Items in total for Sections 4.2 and 4.4 (discussed in later slides)

Section 4.1 - Summary Description



➤ US-APWR Core and Fuel Design Summary

<i>Features</i>	<i>US-APWR</i>	<i>Typical 4 Loop Plant in U.S.</i>
Core thermal power (MWt)	4,451	3,565
Fuel rod lattice	17 x 17 (264 fuel rods)	17 x 17 (264 fuel rods)
Number of fuel assemblies	257	193
Number of RCCAs	69	53
Active fuel length (ft)	14	12
Average linear heat rate (kW/ft)	4.6	5.7

- Large thermal power by the large sized core
- Large thermal margins due to lower average linear heat rate

Section 4.1 - Summary Description



➤ US-APWR reactor core design features

- Some unique designs to the US-APWR are:
 - ✓ 257 fuel assemblies with 14 foot active fuel length
 - ✓ Stainless steel radial neutron reflector

- Most design features are essentially the same as U.S. operating PWRs:
 - ✓ 17x17 fuel assembly with 264 fuel rods, 24 control rod guide thimbles, and an instrument thimble in the center
 - ✓ UO₂ fuel with less than 5% enrichment of U-235
 - ✓ Burnable Absorbers:
 - Gadolinia (integrated in fuel)
 - Borosilicate glass (discrete)
 - ✓ Control rod drive system (CRDS) structural materials, reactor internals and core support materials

Section 4.1 - Summary Description



➤ Calculational Codes

- Approved or under review by the NRC:

<i>Category</i>	<i>Code</i>	<i>Description</i>	<i>Technical or Topical Report Number</i>
Fuel System (4.2)	FINE	Fuel rod integrity evaluation	MUAP-07008
Fuel System (4.2)	FINDS	Fuel assembly horizontal vibration evaluation due to a seismic event	MUAP-07034
Nuclear (4.3)	PARAGON/ANC	Nuclear constant generation and core simulations	MUAP-07019
T/H (4.4)	VIPRE-01M	Core thermal-hydraulic analyses including DNBR evaluation	MUAP-07009

Major RAIs for Section 4.1



➤ Open Items

- There are no Open Items for Section 4.1.



Section 4.2 – Fuel System Design

US-APWR Fuel Design Features

Flexible Core Operation

14ft Active Length
17x17 Rods Array

High Gadolinia
Content Pellet (up to 10wt%)

Enhanced Fuel Economy

High Density Pellet
(97%T.D.)

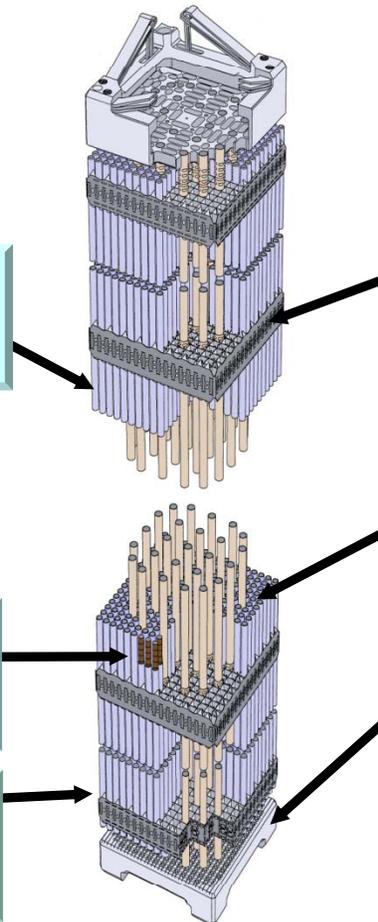
Zircaloy-4 Grid
(for Neutron Economy)

High Reliability

Grid Fretting Resistant
Design
(11 Grids & improved Grid
Spring Design)

Corrosion Resistant Cladding
Material (ZIRLO™)

Anti-debris Bottom Nozzle
with Built-in Filter



Fuel Design Specification



Fuel Assemblies	US-APWR	Typical Fuel Design in the U.S.
Fuel Rods Array in Fuel Assembly	17 x 17	←
Number of Fuel Rods per Fuel Assembly	264	←
Number of Control Rod Guide Thimbles	24	←
Number of in-core Instrumentation guide tube	1	←
Number of Spacer Grids	11	8 or 10
Fuel Rods		
Outside Diameter	0.374 in.	←
Cladding Thickness	0.022 in.	←
Active Fuel Length	14ft (4200mm)	12ft or 14ft
Enrichment	Max. 5 wt%	←
Gadolinia Content	Up to 10 wt%	Up to 8wt%
Pellet Density	97 % T.D.	95.5%T.D.
Materials		
Cladding	ZIRLO™	←

Design Requirements and Guidance



- US-APWR design meets the following requirements and guidance
 - 10 CFR Part 50
 - ✓ GDC 10: Reactor design
 - ✓ GDC 27: Combined reactivity control systems capability
 - ✓ GDC 35: Emergency core cooling
 - 10 CFR Part 50.46
 - Regulatory Guide 1.206 (1.70) Section 4.2
 - Standard Review Plan Section 4.2 (NUREG-0800)
 - ✓ Fuel System Damage
 - ✓ Fuel Rod Failure
 - ✓ Fuel Coolability

- For Fuel System Damage:
Analyses to determine if Fuel Damage Phenomena occur
 - Cladding Stress
 - Cladding Strain
 - Stress and Loading Limit for other than Cladding
 - Cladding Fatigue
 - Fretting Wear
 - Cladding Oxidation and Hydriding (and Crud Buildup)
 - Dimensional Changes
 - Rod Internal Pressure
 - Assembly Liftoff

- For Fuel Failure:
Potential Fuel Rod Failure Modes
 - Hydriding
 - Cladding Collapse
 - Overheating of Cladding
 - Overheating of Fuel Pellets (Melting)
 - Excessive Fuel Enthalpy
 - Pellet/Cladding Interaction (PCI)
 - Bursting
 - Fuel Rod Mechanical Fracturing

- For Fuel Coolability:
Design Considerations Affecting Fuel Coolability
 - Cladding Embrittlement
 - Violent Expulsion of Fuel
 - Generalized Cladding Melting
 - Fuel Rod Ballooning
 - Structural Deformation from External Forces

Relation between DCD and Fuel Topical/Technical Reports



DCD	Fuel system	NO, AOOs, Shipping & Handling		Seismic+LOCA
	Fuel Rod	FA Structural Parts ICCC (RCC, BA, PS,SS)		Rod, FA & ICC
4.2.1 Design Basis Criteria	MUAP-07008		MUAP-07016	MUAP-07008
4.2.2 Description and Design Drawings	MUAP-07018			
4.2.3 Evaluation				
Methodology	MUAP-07008		MUAP-07016	MUAP-07008
Calculational Code	FINE MUAP-07008	-----	-----	FINDS MUAP-07034
Evaluation Description and Results	MUAP-07016			MUAP-08007
	-----	MUAP-11017	-----	

Topical Reports	MUAP-07008(R2)	Mitsubishi Fuel Design Criteria and Methodology	2010/7
	MUAP-07034(R3)	FINDS: Mitsubishi Fuel Assemblies Seismic Analysis Code	2010/7
Technical Reports	MUAP-07016(R3)	US-APWR Fuel System Design Evaluation	2010/8
	MUAP-07018(R0)	US-APWR Fuel System Design Parameters List	2007/12
	MUAP-08007(R2)	Evaluation Results of US-APWR Fuel System Structural Response to Seismic and LOCA Loads	2010/12
	MUAP-11017(R0)	Hydraulic Test of the Full Scale US-APWR Fuel Assembly	2011/5

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-1	N/A	N/A	Completion of MUAP-07034	(1) Safety Evaluation : 12/15/12 (2) ACRS Sub. Meeting : 01/15/13 (3) ACRS Full. Meeting : TBD
4.2-2	N/A	N/A	Staff's evaluation of MUAP-08007-P, "Evaluation Results of US-APWR Fuel System Structural Response to Seismic and LOCA Loads."	MUAP-08007 will be revised in July 2013 due to revision of input wave for FA seismic response analysis. The wave change results from revision of the seismic analysis model for US-APWR plant.

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-3	929-6380	04.02-55	Using the 1000 hour fretting data gathered as part of the full-scale hydraulic testing of the US-APWR fuel assembly (MUAP-11017), provide a conservative extrapolation of the cladding wear for a conservative end of fuel assembly lifetime. Provide the basis for the extrapolation method used and explain how the extrapolated results compare to the acceptance criteria.	<ul style="list-style-type: none">➤ MHI provided additional details in the response submitted on July 10, 2012.➤ No impact on the DCD <p>Closed-Resolved</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-4	953-6437	04.02-64	The staff requested the basis for the applicant's conclusion that acceptable flow induced vibration of the fuel rod and fuel assembly will occur in the US-APWR fuel assembly over the entire range of expected operating conditions, including the acceptance criteria and source reference.	<ul style="list-style-type: none"> ➤ MHI provided additional details in the response submitted on September 27, 2012. ➤ No impact on the DCD <p>(Contents)</p> <p>MHI does not set a uniform and quantitative criterion of the vibration amplitude because the amplitude can not be discussed separately from the fuel cladding fretting wear. Since measured vibration amplitude in the hydraulic test agreed with the calculated value, it was regarded that the flow induced vibration amplitude of US-APWR fuel assembly was acceptable. In terms of fatigue failure of the grid spacer spring, since the limiting amplitude for fatigue failure of the grid spacer spring is 2 orders of magnitude larger than the amplitude at the grid spacer spring, which is provided by the hydraulic test, it is judged that there is no possibility of fatigue failure.</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-5	948-6383	04.02-60	For BOL and EOL conditions, provide the grid spacer's elastic limit values used in the FINDS impact model and the 95th percentile buckling load values used to determine the number of buckled grids.	<ul style="list-style-type: none">➤ MHI provided additional details in the response submitted on August 10, 2012.➤ No impact on the DCD <p>(Contents)</p> <p>The elastic limit value used in the FINDS impact model and in determining the number of buckled grids is obtained from the 95-percentile critical buckling force.</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-6	N/A	N/A	Staff's review of MUAP-09002-P, "Summary of Seismic and Accident Load Conditions for Primary Components and Piping."	The revised analysis result will be submitted in MUAP-08007(R3).
4.2-7	948-6383	04.02-62	The staff requested a revised structural analysis in MUAP-08007 which utilized the appropriate soil profiles.	The revised MUAP-08007 will be submitted in July 2013.

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-8	929-6380	04.02-54	MUAP-07016-P provides data which supports the conclusion that assembly liftoff does not occur during normal operation and AOOs, but does not describe the limiting AOO or if the cold startup condition bounds the limiting AOO. Provide a description of the AOOs evaluated, the limiting AOO and details of how the limiting AOO was determined.	<ul style="list-style-type: none"> ➤ MHI provided additional details in the response submitted on July 10, 2012. ➤ No impact on the DCD <p>(Contents)</p> <p>The limiting condition is the Mechanical Design Flow (MDF). Furthermore, the cold start-up condition in the assembly lift off evaluation is conservative from the view point of hydraulic lift force.</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-9	929-6380	04.02-56	Provide an explanation of how MUAP-011017, "Hydraulic Test of the Full Scale US-APWR Fuel Assembly" demonstrates that no additional holddown spring plastic deformation occurs under pump overspeed conditions.	<ul style="list-style-type: none"> ➤ MHI provided additional details in the response submitted on July 10, 2012. ➤ No impact on the DCD <p>(Contents)</p> <p>Plastic deformation of the holddown spring will not occur during lift off during a hot pump-over-speed condition based on the force balance calculation using load-deflection curve of the holddown spring obtained with classical beam theory, a FEM analysis and a mechanical test.</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-10	928-6378	04.02-52	MHI's hydrogen absorption limit for a control rod guide thimble is 800 ppm. Justify why the hydrogen limit of greater than 400 ppm is acceptable.	<ul style="list-style-type: none">➤ MHI provided additional details in the response submitted on June 19, 2012.➤ No impact on the DCD <p>Closed-Resolved</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-11	929-6380	04.02-53	MHI makes an assumption that the burnable absorber (BA) released gas reaches its maximum value within one cycle of operation. From the information provided, the staff could not reach that conclusion as removal burnable absorbers are not prohibited from insertion into multiple duty cycles. Provided the limiting BA internal pressure and whether internal or external pressure is limiting from a cladding strain perspective.	<ul style="list-style-type: none">➤ MHI provided additional details in the response submitted on July 10, 2012.➤ No impact on the DCD <p>Closed-Resolved</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4-2-12	948-6383	04.02-61	Staff requested detailed calculations of the acceptance limit stresses including the assumed material condition and S_y , S_u , and S_m at the operating temperature for control rod cladding.	<ul style="list-style-type: none">➤ MHI provided additional details in the response submitted on August 10, 2012.➤ No impact on the DCD

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-13	929-6380	04.02-57	Evaluate the impact of up to 0.1 second delay in control rod insertion on the scram worth versus position or time curve used in the Ch.15 analyses.	<ul style="list-style-type: none"> ➤ MHI provided additional details in the response submitted on July 10, 2012. ➤ No impact on the DCD <p>(Contents)</p> <p>The margin for the insertion time used in the safety analysis is larger than 1 second. The control rod insertion time delay does not impact the safety analysis.</p>

Major RAIs for Section 4.2



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
4.2-14	953-6437	04.02-65	The staff requests analysis that ensures coolability during worst case LOCA loading.	➤ Response is under preparation.



Section 4.3 – Nuclear Design

Section 4.3 – Nuclear Design



- Design bases of the US-APWR complies with SRP 4.3:
 - Power distributions are maintained within the design limits throughout the cycle
 - Reactivity coefficients are maintained negative during power operation including Hot Zero Power (HZP)
 - Control systems are capable of providing enough shutdown margin and of controlling power distribution oscillations

Section 4.3 – Nuclear Design



➤ Core Power Distributions

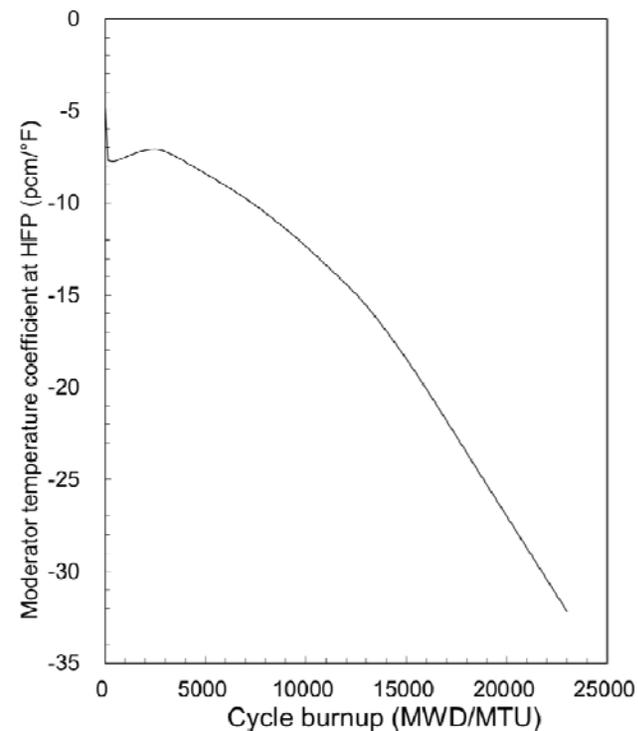
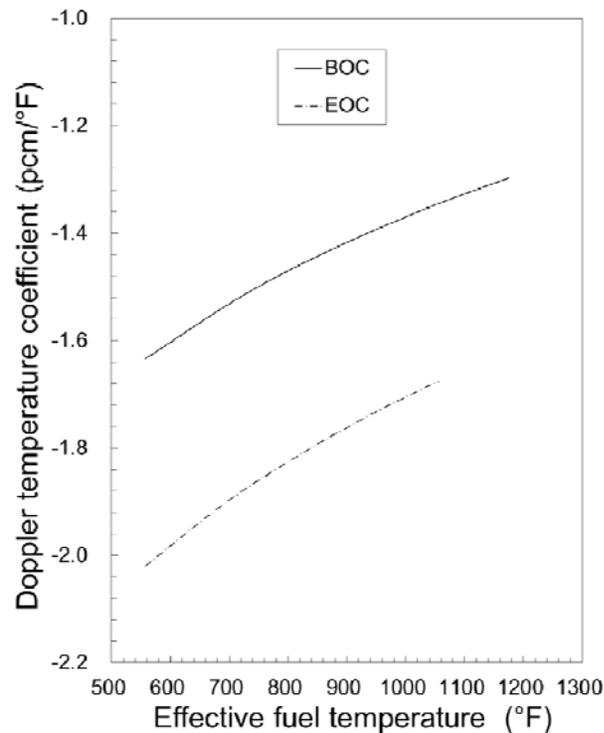
- The low power density allows flexible fuel management and operations
 - ✓ Up to 24 months operation (23,000 MWD/MTU) is available with two-batch reload under the constraints of U-235 enrichment less than 5 wt%
- The power distributions during Normal Operation are maintained within the design limits throughout the cycle:
 - ✓ Nuclear enthalpy rise hot channel factor $F_{\Delta H}^N$ is less than 1.73
 - ✓ Nuclear heat flux hot channel factor F_Q is less than 2.6
 - ✓ Maximum fuel rod burnup is less than 62,000 MWD/MTU
- The power distribution conditions during Normal Operation are used as the initiation of safety analyses discussed in Ch.15

Section 4.3 – Nuclear Design



➤ Reactivity Coefficients

- Fuel Doppler Temperature Coefficient
 - ✓ Negative throughout the cycle
- Moderator Temperature Coefficient
 - ✓ The coefficient is dependent on the soluble boron concentration
 - ✓ Burnable absorbers achieve a negative coefficient at BOC



Section 4.3 – Nuclear Design



➤ Reactivity Control System

- Consists of 69 RCCAs
- 24 absorber rods per assembly
- Provides enough shutdown margin throughout the cycle (greater than 1.60 % $\Delta\rho$)
- Rod insertion limit is a function of core power

	J	H	G	F	E	D	C	B	A
9	A		D		SA		D		
10								SB	
11	D		SC		B		C		
12								SD	
13	SA		B		C		A		
14						D			
15	D		C		A		B		
16		SB		SD					
17									

		Number of RCCAs
A	Control group, Bank A	9
B	Control group, Bank B	12
C	Control group, Bank C	12
D	Control group, Bank D	12
SA	Shutdown group, Bank A	4
SB	Shutdown group, Bank B	8
SC	Shutdown group, Bank C	4
SD	Shutdown group, Bank D	8
Total		69

Section 4.3 – Nuclear Design



➤ Stability

- Total core power perturbation
 - ✓ The core is inherently stable to total power because of negative power reactivity coefficient throughout the cycle

- Power distribution perturbation
 - ✓ Xenon-induced power distribution oscillations may occur; however they are readily detected by ex-core detectors
 - ✓ Horizontal oscillation
 - The core is stable throughout the entire cycle
 - ✓ Axial oscillation
 - The core is stable at BOC
 - Although the oscillation becomes divergent with cycle burnup, the control rod system easily controls the xenon transient
 - The stability characteristic is NOT unique to US-APWR and is similar to 12 ft PWRs

Major RAIs for Section 4.3



➤ Open Items

- There are no Open Items for Section 4.3.



Section 4.4 – Thermal Hydraulic Design

Section 4.4 – Thermal Hydraulic Design



Design bases are assured as follows:

- DNB does not occur at 95/95 basis for normal operation and AOOs.
 - DNBR evaluation is performed by VIPRE-01M code and WRB-2 correlation (MUAP-07009: under NRC review)
 - DNBR design limits are provided based on the approved revised thermal design procedure (RTDP), including the uncertainties of core conditions and CHF prediction by WRB-2. The limits are to be confirmed with plant specific instrumentation uncertainties.
 - Safety Analysis Limit (SAL) of DNBR is determined after accounting for DNBR penalties due to rod bow and transition core geometry, and reserving more core operational flexibilities.

- Fuel melting does not occur at 95/95 basis for normal operation and AOOs.
 - Fuel temperature analysis is performed with FINE code (MUAP-07008)

- Core flow rate is determined to ensure an adequate core cooling

Section 4.4 – Thermal Hydraulic Design



- Uncertainties associated with DNBR, fuel and cladding temperatures, and core hydraulics are provided to obtain conservative evaluations.
- Testing and verification are planned:
 - RCS flow measurement (Chapter 14)
 - Power Distribution Measurement (Chapter 14)
 - Component and Fuel Inspections (Section 4.2)
- Related safety limits, safety system setting, and limiting conditions for operation are provided in the Technical Specifications: Sections 2.0, 3.4, 3.5 and 4.2.

Section 4.4 – Thermal Hydraulic Design



- Thermal-Hydraulic Comparison between US-APWR and Other Designs
 - Comparable thermal margins are reserved to the typical plant in US.

Design Parameters	US-APWR	Typical 12-ft 4loop	Typical 14-ft 4loop
Core thermal output (MWt)	4,451	3,565	3,853
System pressure (psia)	2,250	2,250	2,250
Thermal design flow (10 ⁶ lbm/hr)	168.2	139.4	145.0
Core average coolant mass velocity (10 ⁶ lbm/hr-ft ²)	2.25	2.41	2.59
R/V average coolant temperature (F)	583.8	588.4	582.3-593.8
Core average linear heat rate (kW/ft)	4.65	5.69	5.20
Minimum DNBR at nominal condition (Thm)	1.98	2.33	2.11
Minimum DNBR during AOOs (Thm)	>1.33	>1.23	>1.24
Maximum peak linear heat rate during AOOs (kW/ft)	<21.9	<22.4	<22.0
Maximum fuel centerline temperature during AOOs (F)	<4,620	<4,700	<4,700
Core pressure drop (psi)	32.1	25.8	39.78

Major RAIs for Section 4.4



➤ Open Items

Open Item No.	RAI No.	Question	RAI Topic / NRC Concern	RAI Response / DCD Impact
OI 4.4-1	952-6333	04.04-42	Appropriateness of δ_{bow} calculation	(1) RAI response was submitted on 9/7, 2012 (2) No impact on DCD
OI 4.4-2	-	-	Completion of MUAP-07009 "Thermal Design Methodology" review	(1) Safety Evaluation : 12/15/12 (2) ACRS Sub. Meeting : 01/15/13 (3) ACRS Full. Meeting : TBD
OI 4.4-3	845-6116		Section 4.4.5 is pending acceptable resolution of DCD Section 14.2 RAIs.	Closed-Resolved



Section 4.5 – Reactor Materials

Section 4.5 – Reactor Materials



- All materials used in the US-APWR have been used successfully in both the United States and Japanese PWRs.
 - 4.5.1 Control Rod Drive System (CRDS) Structure Material
 - 4.5.2 Reactor Internals and Core Support Structure Material

Section 4.5 – Reactor Materials



➤ 4.5.1 Control Rod Drive System Structure Material

- All pressure boundary materials comply with the requirements of ASME code Section III
- The pressure housing material is type 316 or type 316LN austenitic stainless steel and the welding materials used for joining the austenitic stainless steels meet the requirements of the welding material specification SFA-5.9 (ER316L and EC316L)
- Non-pressure boundary materials in contact with the reactor coolant water are austenitic stainless steel, martensitic stainless steel, nickel based alloys, and cobalt based alloys

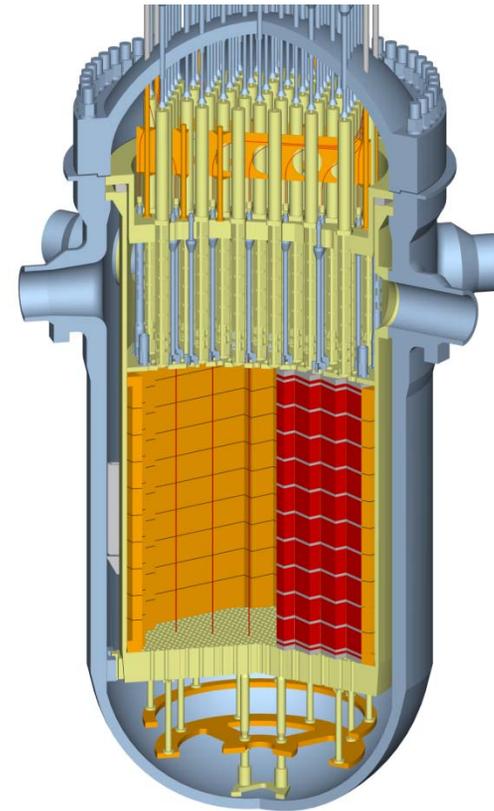
Section 4.5 – Reactor Materials



➤ 4.5.2 Reactor Internals and Core Support Materials

- Corrosive-resistant materials such as stainless for reactor internals
- Strain hardened austenitic stainless steel for threaded structural fasteners and bolts
- Nickel Alloy such as Alloy 690 is selected for its high and proven resistance against stress corrosion cracking
- Comply with the ASME, Section II supplemented by ASME Code Cases, as approved in RG 1.84
- Confirmed long term reliability for irradiation based on EPRI MRP175

➤ Selected materials have been widely used in many operating plants.



Section 4.5 – Reactor Materials



➤ Open Items

- There are no Open Items for Section 4.5.



Section 4.6: Functional Design of Reactivity Control Systems

Section 4.6: Functional Design of Reactivity Control Systems



- The reactivity control systems for the US-APWR include:
 - The mechanical reactivity control of the control rods
 - The chemical reactivity control of the emergency core cooling system (ECCS).
- **Control Rod Drive System (CRDS)**
 - Control Rod Drive Mechanism (CRDM) (Subsection 3.9.4)
 - The CRDS is part of the reactor trip system (Section 7.2)
 - Cooling System for the CRDS (Subsection 9.4.6)
- **Emergency Core Cooling System (ECCS)**
 - Safety Injection System (SIS) of the ECCS (Section 6.3)
- No credit for the reactivity control capabilities of the chemical and volume control system (CVCS) is taken for anticipated operational occurrences and postulated accidents described in Chapter 15.

Major RAIs for Section 4.6



➤ Open Items

- There are no Open Items for Section 4.6.

Acronyms



AO	:Axial Offset
AOO	:Anticipated Operation Occurrence
BOC	:Beginning of Cycle
DCD	:Design Control Document
DNB	:Departure from Nucleate Boiling
DNBR	:Departure from Nuclear Boiling Ratio
EOC	:End of Cycle
FQ	:Heat Flux Hot Channel Factor
F Δ HN	:Nuclear Enthalpy Rise Hot Channel Factor
HFP	:Hot Full Power
HZP	:Hot Zero Power
NO	:Normal Operation



Our Technologies, Your Tomorrow



Presentation to the ACRS Subcommittee

US-APWR Design Certification Application Review

Safety Evaluation with Open Items

Chapter 4: Reactor

October 18, 2012

Staff Review Team

- Lead Project Manager – Jeff Ciocco
- Project Manager – Ruth Reyes
- Supporting Technical Staff:
 - Jeffrey Schmidt
 - Fred Forsaty
 - Jim Gilmer
 - Robert Davis
 - Joel Jenkins
 - John Budzynski

Major Review Areas

- Review of fuel system thermal, mechanical, and materials behavior for normal operation, transient and accident conditions
- The fuel system consists of
 - Fuel pellet
 - Fuel rod/cladding
 - Fuel structure
 - Control rods
 - Other incore components

Chapter 4.2 Supporting Documents

- Topical Reports
 - MUAP-07008, “Mitsubishi Fuel Design Criteria and Methodology”, fuel rod performance code FINE
 - MUAP-07034, “FINDS: Mitsubishi PWR Fuel Assemblies Seismic Analysis Code”, fuel structure behavior for seismic accelerations
- Technical Reports
 - MUAP-07016, “US-APWR Fuel System Design Evaluation”, evaluation of fuel rod, assembly structure and other incore components for non-seismic events
 - MUAP-08007, “Evaluation Results of US-APWR Fuel System Structural Response to Seismic and LOCA Loads”, fuel assembly structure/ components for seismic events

Description of Open Items

- **Open Item 4.2-1, MUAP-07034, “US-APWR Fuel System Structural Response to Seismic and LOCA Loads“**
 - Staff Safety Evaluation in concurrence
- **Open Item 4.2-2, MUAP-08007, “Evaluation Results of US-APWR Fuel System Structural Response to Seismic and LOCA Loads”**
 - Discussed in later slides
- **Open Item 4.2-3, RAI 929-6380, Question 4.2-55. Grid to rod fretting wear**
 - Closed-resolved
- **Open Item 4.2-4, RAI 953-6437, Question 4.2-64. Acceptability of fuel and assembly flow induced vibration**
 - Staff reviewing MHI response

Description of Open Items

- **Open Item 4.2-5, RAI 948-6383, Question 4.2-60. BOL and EOL elastic limit loads used in the FINDS impact model, and buckling load values used to count the number of buckled grids**
 - Staff reviewing RAI response
- **Open Item 4.2-6, The staffs review of MUAP-09002-P, "Summary of Seismic and Accident Load Conditions for Primary Components and Piping"**
 - Tracking item which will be closed when the final safety evaluation for Topical Report MUAP-09002-P is issued

Description of Open Items

- **Open Item 4.2-7, RAI 948-6383, Question 4.2-62. The staff requested a revised structural analysis in MUAP-08007-P which utilized the appropriate soil profiles**
- **Open Item 4.2-8, RAI 929-6380, Question 4.2-54. AOO Holddown Spring Evaluation**
 - Staff reviewing RAI response
- **Open Item 4.2-9, RAI 929-6380, Question 4.2-56. Plastic Holddown Spring Deformation on RCP Overspeed**
 - Staff reviewing RAI response

US-APWR Chapter 4.2 Fuel System Design

Description of Open Items

- **Open Item 4.2-10, RAI 928-6378, Question 4.2-52. Guide Tube Hydrogen Limit**
 - Closed-resolved
- **Open Item 4.2-11, RAI 929-6380, Question 4.2-53. Burnable Absorber B¹⁰ Release and Internal Pressure**
 - Closed-resolved
- **Open Item 4.2-12, RAI 929-6380, Question 4.2-61. Control Rod Cladding Stresses and assumed Material Properties**
 - Staff reviewing RAI response

US-APWR Chapter 4.2 Fuel System Design

Description of Open Items

- **Open Item 4.2-13, RAI 928-6380, Question 4.2-57. Evaluate Control Rod Drop Time Delay of 0.1 secs on Chapter 15 Accidents**
 - Staff reviewing RAI response
- **Open Item 4.2-14, RAI 953-6437. Evaluation of Fuel Coolability under Worst LOCA-only Fuel Induced Loadings**
 - Waiting for RAI response

Open Item 4.2-2 , Fuel System Structural Response to Seismic and LOCA Loads

- US-APWR predicts plastic fuel grid deformation throughout the core under SSE only loads
 - First licensing application with SSE only deformation
- GDC 2, Design bases for protection against natural phenomena

“The design basis for these SSCs shall ... reflect appropriate combination of the effects of normal and accident conditions with the effects of the natural phenomena”
- Assembly components evaluated against SSE, LOCA, and SSE+LOCA loads
- SRP 4.2 acknowledges the possibility of plastic grid deformation
 - Control rod insertion
 - 50.46 LOCA requirements
 - Unclear guidance to evaluate effects of grid plastic deformation

Control Rod Insertion

- SRP 4.2 states,
 - Consequences of grid deformation are small and gross deformation of many assemblies would be needed to interfere with control rod insertion
 - Ability to insert control rods must be demonstrated under combined loads
- Currently licensed plants do not predict grid deformation in rodded core locations
- MHI performed full scale control rod insertability tests with deformed grids
 - Impact on control rod delay time was sufficiently small
 - NRC staff reviewed rod drop tests and found them acceptable

Accident Analysis

- SRP 4.2 provides unclear guidance to evaluate GDC 2 statement “appropriate combination of the effects of normal and accident conditions”
- Current plants may deform under SSE+LOCA forces in non-limiting core locations
- Deformation under SSE only forces, in limiting core locations, introduces DNBR and LOCA evaluation concerns

Review Status

- MHI currently revising MUAP-08007, “Evaluation Results of US-APWR Fuel System Structural Response to Seismic and LOCA,” scheduled completion is July 2013
 - Revised soil profiles and basemat design might alter predicted SSE applied loads
- Core wide plastic grid deformation introduces significant technical, regulatory, and scheduling uncertainty.
- Public meeting scheduled for November 2012 on path forward

Conditions and Limitations

Surveillance program to provide oxide measurements on interior and peripheral rods on the maximum power and burnup assemblies from the first and second cycle of US-APWR (assuming a 24 month fuel cycle) to confirm the FINE corrosion model

US-APWR Chapter Section 4.4 Thermal and Hydraulic Design

- VIPRE-01M code is used for analyses
 - MHI version includes enhanced model selection and fuel-specific critical heat flux correlation
 - Code is described in Topical Report MUAP-07009-P
 - Staff SER for VIPRE-01M completed as separate document referenced by DCD FSER
 - Westinghouse WRB-1 and WRB-2 correlations were shown by tests to be applicable to APWR fuel (with mixing vane grids)
- DNB tests were performed at KATHY facility (Karlstein, Germany) and were witnessed by staff. Evaluation is documented in FSER for MUAP-07009-P

US-APWR Chapter Section 4.4 Thermal and Hydraulic Design

- Staff evaluation of test report (MUAP-11010-P, “DNB Tests for US-APWR Fuel”) is provided in the Final Safety Evaluation Report for the VIPRE-01M code
- Uncertainties in power, inlet temperature, pressure, flow, peaking factors, code, and DNB correlation are evaluated by approved WEC Revised Thermal Design Procedure (RTDP)
- Core flow and pressure drop testing will be performed during initial startup (described in Section 14.2)
- LOCA-generated debris blockage is addressed in FSER Section 6.3

Description of Open Items

- 4.4-1: < 1% rod bow penalty – RAI response under evaluation by staff
- 4.4-2: Final staff acceptance of MUAP-07009-P is needed to complete the Section 4.4 review (resolved/closed)
- 4.4-3: Section 4.4.5 is pending acceptable resolution of Section 14.2 RAIs (resolved/closed)

Backup Slide

Technical Topics of Interest

Fluence Calculation Methodology

- The applicant employs a calculational methodology for determining the pressure vessel >1-MeV neutron fluence that generally conforms to the guidance of the NRC RG 1.190, “Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence.”
- Staff’s review concluded that the methodology is acceptable for determining the US-APWR pressure vessel fluence subject to the following:
 - When the actual as-built and operating fluence data becomes available bias and uncertainties shall be evaluated, and updated if non-conservative when compared to those in MUAP-09018, latest revision
 - A Chapter 5 COL item addresses the commitment to evaluate fluence bias and uncertainties documented in MUAP-09018 as US-APWR data becomes available