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1 UNITED STATES OF AMERICA

2 NUCLEAR REGULATORY COMMISSION

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4 ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

5 (ACRS)

6 + + + + +

7 US-APWR SUBCOMMITTEE

8 OPEN SESSION

9 + + + + +

10 TUESDAY

11 JANUARY 15, 2013

12 + + + + +

13 ROCKVILLE, MARYLAND

14 The Subcommittee met at the Nuclear  
15 Regulatory Commission, Two White Flint North, Room T2B3,  
16 11545 Rockville Pike, at 8:30 a.m., John W. Stetkar,  
17 Chairman, presiding.

18 SUBCOMMITTEE MEMBERS:

19 JOHN W. STETKAR, Chairman

20 J. SAM ARMIJO, Member

21 DENNIS C. BLEY, Member

22 CHARLES H. BROWN, JR. Member

23 HAROLD B. RAY, Member

24 JOY REMPE, Member

25 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 JOSHUA KAIZER, NRO

6 RUTH REYES, NRO

7 JEFF SCHMIDT, NRO

8 ALSO PRESENT:

9 YUKO FUJITA, MNES

10 MASAYA HOSHI, MNES

11 DAN HUGHES, Information System Laboratories

12 ATSUSHI KUMAKI, MNES

13 YUTA MARUYAMA, MNES

14 MASATOSHI NAGAI, MNES

15 MASAMORI ONOZUKA, MNES

16 KEITH PAULSON, MNES

17 DAVID SEEL, MNES

18 RYAN SPRENGEL, MNES

19 TAKAYUKI SUEMURA, MHI

20 JUNICHI TAKEUCHI, MHI

21 KURT WALTER, MNES

22

23

24

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

(8:32 a.m.)

CHAIR 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 the subcommittee meeting.

ACRS members in attendance or Harold Ray, Dennis Bley, Sam Armijo, Bill Shack, Charlie Brown, and Joy Rempe. Mr. Girija Shukla of the ACRS Staff is the Designated Federal Official.

The subcommittee will discuss the VIPRE Code Topical Report MUAP-07009-P, Revision 0, "Mitsubishi Thermal Design Methodology" and the staff's SER associated with the topical report.

The subcommittee will also receive an informational briefing on the FINDS Topical Report MUAP-07034-P, Revision 3, "FINDS: Mitsubishi PWR Fuel Assemblies Seismic Analysis Code." We will hear presentations from Mitsubishi Heavy Industries and the NRC Staff. We have received no written comments or requests for time to make oral statements from members of the public regarding today's meeting.

The subcommittee will gather information, analyze relevant issues and facts and formulate proposed positions and actions as appropriate for deliberation

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1 by the full committee. The rules for participation in  
2 today's meeting have been announced as part of the notice  
3 of this meeting previously published in the Federal  
4 Register.

5 Parts of this meeting may need to be closed  
6 to the public to protect information proprietary to MHI  
7 or other parties. I would ask the NRC Staff and the  
8 Applicant to identify the need for closing the meeting  
9 before we enter into such discussions and to verify that  
10 only people with the required clearance and need to know  
11 are present.

12 A transcript of the meeting is being kept  
13 and will be made available, as stated in the Federal  
14 Register notice. Therefore, we request that the  
15 participants in this meeting use the microphones located  
16 throughout the meeting room when addressing the  
17 subcommittee. The participants should first identify  
18 themselves and speak with sufficient clarity and volume  
19 so they may be readily heard.

20 A telephone bridge line has also been  
21 established for this meeting. To preclude interruption  
22 of the meeting, the phone will be placed in a listen-in  
23 mode during the presentations and committee  
24 discussions.

25 Please silence your cell phones during the

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1 meeting.

2 We also have an item on the agenda at the  
3 end of our discussions that we are going to review some  
4 preliminary answers, responses for thermal hydraulics,  
5 questions from our July and October subcommittee  
6 meeting. So I just wanted to alert everyone to that  
7 item on the agenda.

8 And with that, --

9 MR. HAMZEHEE: I'll take it from here.

10 CHAIR STETKAR: Hossein has spoken up. I  
11 will ask Hossein Hamzehee to start to the meeting.

12 MR. HAMZEHEE: Thank you, sir. I don't  
13 have a lot to say. I just want to thank John and the  
14 ACRS Subcommittee members for the opportunities to  
15 discuss these topical reports with you this morning.

16 And we have all the staff sitting in the back and we  
17 will be here to present and also they are SCF. They are  
18 sitting outside, a lot of them.

19 With that, Ruth, anything you would like  
20 to add? Back to John.

21 CHAIR STETKAR: Thanks, Hossein. And with  
22 that, we will turn it over to Mitsubishi.

23 MR. SPRENGEL: Good morning. This is Ryan  
24 Sprengel with MNES. I would like to echo Hossein's  
25 thank you for this meeting. And we are looking forward

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1 to a productive year and especially the next couple of  
2 months, I think, the first half of this year with  
3 productive interactions, hopefully. So, I will go  
4 ahead and turn it over to Takeuchi-san.

5 MR. TAKEUCHI: Yes.

6 CHAIR STETKAR: Also, just again to warn  
7 you, I know that you have some information that is open.

8 Just be aware of anything that we tread upon in the  
9 open session that might be proprietary. Just alert us  
10 to that and we will cover it in closed session after  
11 you close the meeting. Okay, thank you.

12 MR. TAKEUCHI: Okay. Good morning,  
13 everyone. Thank you for giving me the opportunity to  
14 present this material.

15 I have the open session material and the  
16 closed session material. So first thing, the open  
17 session, I will briefly explain the outline of the  
18 Topical Report. And in the closed session, I will go  
19 into the detail of the Topical Report.

20 Okay, so in my presentation, I will  
21 introduce the contents of the Topical Report MUAP-07009,  
22 thermal design methodology.

23 And I am lead presenter, Junichi Takeuchi.

24 I am a senior engineer in Mitsubishi Heavy Industries,  
25 MHI, and in charge of thermal-hydraulic design. And

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1 we have two technical experts here. Mr. Takayuki  
2 Suemura, he is an engineering manager, MHI and he is  
3 in charge of thermal-hydraulic methodology and software  
4 development. And Mr. Masaya Hoshi is senior technical  
5 advisor with Mitsubishi Nuclear Energy Systems, MNES,  
6 and he is charge of thermal hydraulic design also.

7 Okay. So basically our Topical Report  
8 presents the comprehensive description of the thermal  
9 design methodology utilized by MHI, which is based on  
10 already approved code and methodology for other vendors  
11 and currently used in the United States, which is the  
12 VIPRE-01 subchannel analysis code which is approved for  
13 EPRI and for DNB correlations WRB-1 and WRB-2, which  
14 are approved for Westinghouse. And we also  
15 supplementary use W-3 correlation which is a very  
16 classical correlation just for low pressure events.  
17 And for the design procedure we use Revised Thermal  
18 Design Procedure RTDP which is already approved for  
19 Westinghouse.

20 And our Topical Report addresses that all  
21 this methodology applicable to DNB analysis and  
22 transient fuel temperature analysis for MHI-designed  
23 PWR cores.

24 Okay. So the main part of our Topical  
25 Report is the VIPRE-01M, which is MHI version of

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1 VIPRE-01.

2 So the VIPRE-01M is essentially identical  
3 to VIPRE-01 in essential thought which constitutive  
4 equations and numerical schemes but we incorporated  
5 additional functions shown here, which is DNB  
6 correlations for design applications WRB and WRB-2.  
7 And fuel thermal properties for design applications  
8 actually VIPRE-01 has its own thermal properties but  
9 we incorporate our own thermal properties which is  
10 consistent to our fuel design code.

11 And the important part of the change --

12 MEMBER SHACK: Is that an option or you have  
13 actually replaced them?

14 MR. TAKEUCHI: It is an option.

15 MEMBER SHACK: It is an option.

16 MR. TAKEUCHI: Correct. So the important  
17 part of our thermal property is that it accounts for  
18 the degradation effect of thermal conductivity of the  
19 fuel, depending on burnup.

20 And we also added some options to perform  
21 the hot spot peak cladding temperature analysis for  
22 after DNB and some user interfaces are more defined.

23 MEMBER ARMIJO: I just want to make sure  
24 I understood. Since the thermal degradation is a fuel  
25 property and function of burnup, why would that be an

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1 option in your analysis? Why wouldn't it be just a  
2 standard input?

3 MR. TAKEUCHI: Well it is added as option  
4 but we use it as a standard.

5 MEMBER ARMIJO: Okay, so you never would  
6 use an -- do an analysis without thermal conductivity  
7 degradation?

8 MR. TAKEUCHI: Yes, for design application  
9 we always use the thermal conductivity accounting for  
10 the degradation effect.

11 MEMBER REMPE: If a person that picks an  
12 option that is inappropriate, are there warnings that  
13 show up in the code? Does the code stop? Does it check  
14 to see that you picked the right option? Does it stop  
15 or how does this work?

16 MR. TAKEUCHI: We can choose different  
17 options I we intend to do so. But the input are always  
18 checked before it runs. So --

19 MEMBER REMPE: Checked by the code or  
20 checked by another engineer?

21 MR. TAKEUCHI: Checked by engineers.

22 MEMBER REMPE: Okay. Also, and I don't  
23 know if this goes in the open session or the closed  
24 session, but there was an issue about a frozen version  
25 of the code and when the staff was reviewing it, they

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1 found that multiple versions had been used and could  
2 you clarify how that happened and how that won't happen  
3 again?

4 MR. TAKEUCHI: Yes, we basically -- can you  
5 explain that frozen version issue? So your question  
6 is that we clarified that. This issue is addressed  
7 properly.

8 MEMBER REMPE: Well there was a point in  
9 some of the documentation we were provided that said  
10 that Mitsubishi has a frozen version of the code. You  
11 have a lot of good quality assurance to keep you using  
12 that frozen version but yet the staff found that you  
13 had used multiple versions of the code in some of the  
14 information they were checking. And so I would like  
15 to understand how that even occurred with your quality  
16 assurance system. And then apparently, there was some  
17 sort of flaw in the quality assurance and how do you  
18 know that won't happen again?

19 MR. TAKEUCHI: Okay, our code development  
20 started before our quality assurance program is actually  
21 finalized. So it actually happened before that, the  
22 final quality assurance program was fixed.

23 So over the course of the development, the  
24 first part of the code development was not be under the  
25 current final version of the quality assurance program.

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1 So that was the start of the issue.

2 We basically confirmed that our code  
3 changes are acceptable in quality assurance program and  
4 we performed the -- we re-performed the calculation that  
5 was done in the old version.

6 MR. SPRENGEL: Let me clarify a little a  
7 bit. Because what Takeuchi-san is talking about is more  
8 tied to the implementation of the US-APWR Quality  
9 Assurance Program. So there was a transition period.

10 But what Joy is asking about is actually  
11 it is tied more to our licensing documentation, where  
12 we had used different versions over time --

13 MEMBER REMPE: Despite that you were  
14 supposed to have one version that was frozen.

15 MR. SPRENGEL: There is always one version  
16 that is frozen and up-to-date. But it had been revised  
17 and we had not gone back and redone the previous  
18 submittals. And so that was the kind of gap in the  
19 internal procedures. So that was fixed.

20 And we did go back and look at the different  
21 submittals that were made the results that were found  
22 using the code. So and then that was fixed.

23 So that was the problem was aligning the  
24 most current code to also match up with all you  
25 submittals for the licensing.

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1 MEMBER ARMIJO: All the previous analyses  
2 were done with frozen code, which at the time was the  
3 reference code?

4 MR. SPRENGEL: At the time, yes.

5 MEMBER ARMIJO: Right, so it wasn't  
6 something that was just out of control. But you then  
7 had to go back and update it with the newest version.

8 MR. SPRENGEL: To line up with licensing  
9 documentation with a version of the code, yes.

10 MEMBER ARMIJO: Okay.

11 MR. SPRENGEL: So it was all controlled.

12 MEMBER REMPE: So this won't happen again.

13 MR. SPRENGEL: The only missing link was  
14 to make sure that you had alignment between the most  
15 recent version in the QA process and the licensing  
16 submittals.

17 MEMBER REMPE: So this wouldn't happen  
18 again, --

19 MR. SPRENGEL: Correct.

20 MEMBER REMPE: -- as to either issue.

21 MR. SPRENGEL: Correct, yes.

22 MEMBER REMPE: But I wanted to have some  
23 confidence.

24 MR. SPRENGEL: So it was a change in the  
25 licensing procedures within MHI.

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1           So as an additional step to look at the code  
2           that you are using and if there was changes in the  
3           QA-controlled code, that you also then have to update  
4           all of your licensing submittals or do a review to  
5           confirm that there is no impact.

6           MEMBER REMPE: Thank you.

7           MR. TAKEUCHI: Can I move on? Okay, so  
8           VIPRE-01 is already approved by NRC for EPRI, which is  
9           approved as a generic code. So when each vendor applies  
10          it for their own calculation, each vendor has to justify  
11          their own -- their way of using it, and justify the model  
12          option that they use. So that is the condition in the  
13          VIPRE-01 SER. So we basically discussed the SER  
14          conditions in Topical Report and addressed that how we  
15          complied with the VIPRE-01 SER. And these are the main  
16          topic of the Topical Report.

17          And so I picked two examples of the most  
18          important parts of the SER conditions here, which is  
19          model used for licensing analysis must be justified.

20          And in the topical report, we justify our model options  
21          by sensitivity analysis and benchmark with other  
22          NRC-approved codes.

23          And the second point here is newly  
24          introduced CHF correlations must be validated. Since  
25          we incorporated WRB-1 and WRB-2 correlations, we

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1 qualified these correlations by analyzing DNB test data  
2 with VIPRE-01M. And eventually we show that the  
3 original DNBR correlation limit of 1.17, which is  
4 approved for WRB-1 and WRB-2 are conservative for  
5 VIPRE-01M analysis of Mitsubishi fuel.

6 Another important part of this Topical  
7 Report is that since we incorporate these model options  
8 into VIPRE-01, we qualify that our models works properly  
9 in VIPRE-01M by showing that DNBR is also similar or  
10 slightly conservative in comparison with other  
11 NRC-approved codes.

12 And for safety -- for steady state analysis,  
13 the results are compared against THINC code results for  
14 various plant conditions. And for transient analysis,  
15 typical locked rotor analysis were performed and  
16 results were compared against FACTRAN and THINC code  
17 results.

18 Okay, so in conclusion, we summarize the  
19 Topical Report by saying MHI thermal design methodology  
20 consists of RTDP, VIPRE-01M and WRB-1 and WRB-2  
21 correlation. And VIPRE-01M is an extension of  
22 VIPRE-01. And the VIPRE-01M model options selected for  
23 licensing analysis are well-accepted and conservative.

24  
25 WRB-1 and WRB-2 correlations and their

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1 original DNBR correlation limit of 1.17 are conservative  
2 for Mitsubishi fuel in conjunction with VIPRE-01M.

3 And in summary, we say we conclude that the  
4 MHI's methodology is applicable to the core thermal  
5 hydraulic design analysis and all non-LOCA safety  
6 analysis relevant to DNB. So this is our conclusion  
7 of the Topical Report.

8 So this is the end of the open session  
9 presentation.

10 CHAIR STETKAR: Any question for MHI, at  
11 least for the open material?

12 MEMBER REMPE: Before we get into the  
13 closed material, could I ask the Staff a question just  
14 to give some perspective of what we are going to hear  
15 herein the closed part?

16 CHAIR STETKAR: Sure.

17 MEMBER REMPE: In your documentation, you  
18 regularly have said small changes to VIPRE can give  
19 big changes to the results. And they said well, we have  
20 only made a few small changes, although frankly to me  
21 they look kind of substantial.

22 What kind of small changes can give big  
23 changes to VIPRE results and so as you go through the  
24 closed session, could you give some examples from the  
25 other things you have done with VIPRE or you saw some

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1 big changes?

2 MR. KAIZER: Josh Kaizer, NRC staff. What  
3 we are personally concerned about is anytime you make  
4 a change to a code, you never really know what your result  
5 is. So when they made small changes to VIPRE-01 I think  
6 a better way to say that would be they actually continued  
7 -- finished VIPRE-01. VIPRE-01 as it sits in the SER  
8 says you can't use this. EPRI has a lot of different  
9 models in it. There is a lot of two-phases flow, a lot  
10 of CHF models. And in the SER we said you have to choose  
11 which two-phase flow model, which pressure drop model,  
12 void quality. You select that and then you justify that  
13 and that is what MHI did.

14 So I don't consider VIPRE-01M so much an  
15 extension of VIPRE-01. I consider VIPRE-01 incomplete  
16 and VIPRE-01M is the complete version, like VIPRE-01D,  
17 which is Dominion, and VIPRE-01W, which is a  
18 Westinghouse version.

19 And then they had to not only justify why  
20 they selected that model, but ultimately, and this is  
21 what you will hear probably over and over again, they  
22 had to validate that and they validated with their CHF  
23 data.

24 So if they were to have quote-unquote, "made  
25 a change" that would give them erroneous results, we

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1 would not expect to see them to be able to predict CHF  
2 data anywhere near as well as they predicted it.

3 MEMBER REMPE: Okay.

4 MR. KAIZER: Does that answer your  
5 question?

6 MEMBER REMPE: Yes, sir. Thank you.

7 CHAIR STETKAR: Anything else? With that,  
8 we will go onto closed session and I will ask the Staff  
9 and MHI to verify whether or not anyone needs to leave  
10 the room.

11 (Pause.)

12 CHAIR STETKAR: Seeing no one heading for  
13 the doors, I am assuming we are all okay. So we are  
14 now in closed session and we can begin the closed session  
15 discussion.

16 Actually, let's hold off. We need to check  
17 the bridge line to see who might be out there on the  
18 bridge line. Let me ask this. Ryan, is anyone who is  
19 out there from MHI needed to possibly answer questions?  
20 Because we can just close the bridge line.

21 MR. SPRENGEL: We don't need the bridge  
22 line.

23 CHAIR STETKAR: Why don't we do that? Just  
24 close the bridge line. Because if they don't need any  
25 technical resources to answer questions, it is just a

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1 lot safer if we just close it.

2 (Whereupon, the foregoing meeting went off the record  
3 at 8:54 a.m. for a closed session and went  
4 back on the record at 10:42 a.m., continuing  
5 the open session.)

6 CHAIR STETKAR: We're back in session and  
7 we will hear from the Staff. I guess we probably just  
8 for interest should reopen the bridge line, if there  
9 were people.

10 MR. SHUKLA: There is only one consultant  
11 from the Staff that should be on the bridge line. He  
12 is here?

13 MR. SCHMIDT: Yes, we don't need a bridge  
14 line.

15 CHAIR STETKAR: You may not need it but  
16 according to our public process, we normally keep it  
17 open. Did we have anybody --

18 MR. SHUKLA: Not really until somebody  
19 requests it.

20 CHAIR STETKAR: Did we have anybody on it  
21 before?

22 MR. SHUKLA: No.

23 CHAIR STETKAR: Oh, there was nobody? I  
24 just wanted to check. Thank you.

25 MS. REYES: Okay, thank you very much.

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1 Good morning everyone. My name is Ruth Reyes. I am  
2 the project manager for the review of the VIPRE Topical  
3 Report. Here with me are part of the technical staff  
4 involved in the review. From NRO, we have Jeff Schmidt  
5 and from NRR Josh Kaizer. We also had Anthony Attard.  
6 He was a senior technical reviewer from NRR who was  
7 involved in the review but he retired last year. So  
8 he is not here with us today. And also we have ISL,  
9 which is here with us, who helped the staff in the review.

10  
11 So having said that, I am going to let the  
12 staff start with their presentation of the ACRS review.

13 MR. KAIZER: To perform this review, the  
14 staff used the guidance in SRP 15.0.2, which is actually  
15 very good guidance. And that is why you will notice  
16 that there are a couple rounds of RAIs and round three  
17 was when we really started using this SRP guidance.  
18 So we asked a lot of questions specifically dealing with  
19 what the SRP said you should ask.

20 We also looked at previous reviews for  
21 VIPRE-01, Westinghouse's VIPRE-W, Duke and Dominion  
22 each have their own versions of VIPRE as well. We issued  
23 five rounds of RAIs, which MHI each answered and we  
24 performed two quality assurance audits. We also went

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1 to Germany and observed the DNB testing in their KATHY  
2 loop.

3 MEMBER BLEY: Okay. The way you began  
4 this, is that a new section of the SRP?

5 MR. KAIZER: It is not. This is the first  
6 time that I am aware of that the Staff has used an SRP  
7 as much as I did in writing the SER.

8 MEMBER BLEY: Okay.

9 MR. KAIZER: Like I mean, all my sections  
10 and criteria come right from there. I am hoping that  
11 we are going to continue it because I think it works  
12 really nicely but that part was different.

13 MEMBER REMPE: Were the number of RAIs  
14 considerably more than what you had like say with AREVA  
15 or Westinghouse or some other place?

16 MR. KAIZER: For a lot of cases, I think  
17 there were more RAIs. I think that was really two  
18 reasons. First, was the number of reviewers that had  
19 a hand in the pot. It started with Ed Throm and Ralph  
20 Landry. It then switched from Ed Throm to Tony Attard  
21 and then came from Tony Attard and myself who it finally  
22 landed with. And it was also the fact that MHI was a  
23 new vendor to the NRC. The way I tried to treat it in  
24 my mind is Toys "R" Us is coming in and asking and they

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1 want to use this nuclear code. And so I understand MHI  
2 has significant more experience than Toys "R" Us but  
3 it was just something that I had to say in my mind because  
4 we didn't have any real experience or relationship with  
5 them like we have with Westinghouse and AREVA and GE.

6 The Topical itself describes VIPRE-01M and  
7 its applicability to PWRs. This -- I just want to show  
8 you guys. This is one of the reports that the Topical  
9 is based on. This is actually Volume 1 of VIPRE-01 by  
10 EPRI. And this is just the mathematical modeling.  
11 There is about five volumes of VIPRE-01M. This is the  
12 most interesting because it goes through all the  
13 derivations. So VIPRE-01M is heavily based on this  
14 because they used the same modeling. They just choose  
15 which of the closure models they are going to use.

16 As you have already heard, it is used to  
17 perform non-LOCA transient and accident analysis for  
18 the US-APWR. So in the Topical Report they talked about  
19 their core modeling, their transient fuel rod modeling,  
20 the thermal-hydraulics used. And it is consistent with  
21 previous approved versions of VIPRE-01.

22 VIPRE-01M is a subchannel code. I get to  
23 break out my toys. This is what a subchannel looks like.

24 I don't know if you actually have kind of seen one.

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1 I made one just so I knew what it looks like. This  
2 is six rods and you can see the subchannels between them.

3 So they are modeling the heat transfer and fluid flow  
4 inside this little subchannel. They are actually --  
5 you model the hot assembly, which when you move stuff  
6 -- because I made the model I get to show it.

7 This is the hot assembly.

8 CHAIR STETKAR: You actually made that?

9 MR. KAIZER: Yes. This is not  
10 prototypical of what they are doing because that is  
11 proprietary. This is another one I had from my  
12 subchannel notes from Dr. Hochreiter.

13 But you can kind of see how you have  
14 individual subchannels where you would have the hot  
15 channel. Then you start lumping things. This is  
16 one-eighth of a hot channel. It is placed in the center  
17 of the core. That is typically done but it is also a  
18 conservatism because your hot assembly is usually not  
19 in the center of the core. And then you would start  
20 to lump the other assemblies and calculate the heat  
21 transfer and fluid flow through those.

22 So they typically use subchannel models to  
23 predict design margin for DNB. They can also use it  
24 for peak clad temperature analysis. For example,

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1 locked rotor. I believe the only other transient they  
2 use it for is rod ejection. When they do the locked  
3 rotor transient, because they can't -- the code itself  
4 can't change the fuel properties like you would need  
5 to, they automatically assume certain things. I  
6 believe they closed the gap or they increased the gap  
7 heat transfer tremendously. They assumed DNB at the  
8 beginning of the transient. Those type of things.

9 US-APWR, one of the questions we asked and  
10 this is what we have seen in previous reviews. It is  
11 very similar to our current PWR. We just wanted to make  
12 sure okay there is no new phenomenon, no new mechanism  
13 that isn't really accounted for here. Again, VIPRE-01  
14 was generically approved. Each vendor must justify the  
15 use of the specific models. MHI told us what models  
16 they were going to use. They are proprietary. We do  
17 have a closed slide if you really want to see those.

18 They are the models we would expect them to use. And  
19 ultimately, and I would say this is the message from  
20 the staff, the justification, the selection of these,  
21 the selection of pretty much all of their parameters  
22 rests on their CHF test data because that is where  
23 everything comes together. And they demonstrated  
24 through their CHF test data that they had adequate models

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1 to predict DNB.

2 The validation, again, they used their, I  
3 believe Z2 and Z3 grids, tested them at KATHY. The test  
4 range spanned the range of applicability of WRB-1 and  
5 WRB-2. It was on 14-foot data because that is what their  
6 data was. I think both WRB-1 and WRB-2 have also been  
7 approved for 14-foot data. I am almost positive that  
8 that was in the range for those.

9 But they have demonstrated it and this was  
10 something that we kind of -- Tony and I talked a little  
11 bit about. They didn't give us enough data to I would  
12 say come up with their own CHF correlation because that  
13 is not what they were after. I mean, it was a couple  
14 hundred points but we weren't really thinking of it in  
15 terms of okay, can this data stand alone and say we can  
16 make our own CHF correlation just from the data we gave  
17 us. What we kind of considered it was okay, is this  
18 data enough to show that their fuel assembly behaves  
19 like the other fuel assemblies and behaves well  
20 considering how much we know about WRB-1 and WRB-2.  
21 And from that aspect, we definitely believe that the  
22 test range was more than adequate.

23 Yes, and the testing confirmed that they  
24 can use the WRB-1 and WRB-2 correlations with VIPRE.

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1 MEMBER REMPE: You mentioned you went over  
2 there to visit KATHY and observe it. It does adhere  
3 to NQA-1 because of AREVA already having that  
4 certification. But what exactly did you do to give  
5 yourself confidence that they were doing a good job on  
6 the testing?

7 MR. KAIZER: I wasn't able to go.

8 MEMBER REMPE: You didn't go?

9 MR. SCHMIDT: No, actually it was Tony  
10 Attard, myself, and Jim Gilmer went. You know, the main  
11 thing we were considering the repeatability tests. We  
12 didn't do anything more as far as like looking at the  
13 qualification of the --

14 MEMBER REMPE: You didn't go check the  
15 instrumentation to see it was calibrated or whatever?

16 MR. SCHMIDT: No, no, no, we didn't. You  
17 know, I was really relying on Tony Attard, who had been  
18 there many times and was very knowledgeable on the  
19 facility. But we did not or I did not do anything  
20 additional to make sure that the measurements were, the  
21 measurement uncertainty was any different than what had  
22 typically been performed.

23 So the Staff was more in a, I would say,  
24 an observer role than a QA role over there.

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1 MR. KAIZER: From my understanding with  
2 talking with Tony, when we have a chance to go look at  
3 CHF test data and testing, we usually take it but it  
4 is more of a learning experience for us, as opposed to  
5 an actual audit experience.

6 We did perform QA audits for MHI because  
7 we needed to treat them again as a new vendor. We  
8 performed two QA audits. The first one where we looked  
9 at the RELAP and VIPRE-01 and we kind of looked at okay,  
10 how did you modify the code? What were the aspects at  
11 work there. And then because of some RAIs we needed  
12 to resolve and also because of the confusion about the  
13 frozen code issue, we went back and we looked  
14 specifically at okay, VIPRE-01 give us, let us -- we  
15 went through two of their transients.

16 I know we looked -- well, we looked in detail  
17 at locked rotor and also just basically how would an  
18 analyst perform this review. Where would they go and  
19 get that stuff from, that kind of thing. We didn't  
20 discover any significant issues. And we did make, as  
21 we have already discussed that condition limitation just  
22 based on the confusion with the frozen code issue  
23 earlier.

24 That is, for the open portion, I do have

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1 closed slides, but there are just more details about  
2 the CHF test data. The Staff found that MHI's thermal  
3 design methodology is acceptable licensing analysis.

4 We are familiar with how they are doing their subchannel  
5 code. We are familiar with how they are doing their  
6 meshing, why they chose the radial nodes they chose,  
7 why they chose the axial nodes they chose. We do believe  
8 VIPRE-01M is acceptable for performing AOO and accident  
9 analysis and ultimately, we believe that the WRB-1 and  
10 WRB-2 are acceptable for predicting CHF behavior based  
11 on the DNB test data.

12 It is brief. It is quick. That is my last  
13 slide. I am more than happy to take any more questions  
14 for comments.

15 MEMBER REMPE: I am curious. Maybe I am  
16 mis-remembering but I thought they had submitted  
17 something to the staff on their hopes to have a  
18 transition core. And maybe I misread something.

19 MR. KAIZER: This came down to an issue of  
20 the documentation MIH had access to versus what they  
21 did not have access to. Like they had for the fuel rod  
22 bow, they had access to the previously approved fuel  
23 rod bow topical. So they submitted that to us. They  
24 did not have access to the transition core topical.

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1 And so when they could not submit that, the Staff then  
2 wrote a conditional limitation just to be clear. It  
3 is okay, you cannot use, you have to submit an approved  
4 transition core methodology, whether they want to come  
5 up with one of their own or if they want to find a way  
6 to get access to an approved one. That was that issue.

7 MEMBER REMPE: Okay.

8 CHAIR STETKAR: Oftentimes it requires  
9 people need a little time to collect their thoughts.  
10 Any other questions for the staff?

11 MR. KAIZER: I guess as you are thinking,  
12 I will try to give you more interesting things.

13 CHAIR STETKAR: I was going to say, you have  
14 toys.

15 MR. KAIZER: I have more toys. One of the  
16 interesting things MHI did in their CHF test report,  
17 which I am very grateful to them for and I think is very  
18 good work, is since they have started using CHF tests,  
19 they use a five by five grid assembly and they have these  
20 little things and they are called -- well they are  
21 support grids. And it is basically to show that -- to  
22 stop the buckling that would occur from the large  
23 magnetic forces. And these were brought up in the  
24 review of WRB-1, which I want to say was 1979, briefly

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1 addressed, the staff looked at it and said oh yes, they  
2 will be fine and then nothing really was ever done.  
3 And MHI actually went back and demonstrated how the  
4 support grid does not really add to the CHI performance  
5 of you fuel.

6 So that is pretty much what a support grid  
7 looks like. This is about the size of a CHF test bundle.  
8 I have a real grid spacer, if anybody wants to see it.  
9 These are all just all my cool toys.

10 This is 17 by 17.

11 MEMBER ARMIJO: Is that the new Z?

12 MR. KAIZER: This is not. This was a junk  
13 grid spacer AREVA was getting rid of. And because it  
14 has no monetary value -- I have a letter right here.

15 (Laughter.)

16 CHAIR STETKAR: You buried that in your  
17 luggage.

18 MR. KAIZER: No, I mean it is nice -- I am  
19 actually not even sure if it is -- for all I know it  
20 could be a Westinghouse grid spacer. They are like  
21 here, take this.

22 This one I got off of eBay.

23 (Laughter.)

24 MR. KAIZER: But so this is about the size

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1 of -- I am sure that theirs is going to be similar.  
2 But I have all these things if anybody wants to look  
3 at it.

4 CHAIR STETKAR: Those little touches.

5 MR. KAIZER: Yes, the vein design, the vein  
6 angle. How these little nubs, that has been a big deal  
7 because those prevent their grid-to-rod fretting. I  
8 think that is it for all my cool toys.

9 CHAIR STETKAR: That's great. Any other  
10 questions for the Staff? Hearing none, thank you very  
11 much. That was efficient.

12 What I would like to do is first of all,  
13 because this is the end of the discussion of the thermal  
14 design methodology, just ask if there are any public  
15 questions, comments.

16 Hearing none, we will end this session.  
17 And now, in terms of logistics, we need to end promptly  
18 at noon. I will ask MHI whether you would like to start  
19 the briefing on FINDS code.

20 MR. SPRENGEL: Yes.

21 CHAIR STETKAR: Okay, that is a good  
22 answer. We will do that, then. We will get as far as  
23 we can. As I said, we have another conflicting meeting.

24 MR. SPRENGEL: Right. So this is a closed

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1 session as well.

2 CHAIR STETKAR: We do need to end promptly  
3 at noon. So we will just adjust the time.

4 MR. GILMER: Jim Gilmer with Staff. We had  
5 arranged for --

6 CHAIR STETKAR: Hold on, Jim. Sorry.

7 MR. GILMER: We had arranged for our  
8 contractor at Pacific Northwest to be on the bridge line  
9 at one. So if I can take a few minutes, I can probably  
10 get them to call in now.

11 CHAIR STETKAR: Yes, if that will help.

12 MR. GILMER: Yes, I think it will.

13 CHAIR STETKAR: Give them a call. We will  
14 go into recess while we reorganize here.

15 (Whereupon, the foregoing meeting went off the record  
16 at 11:07 a.m. for a closed session and went  
17 back on the record at 1:36 p.m., continuing  
18 the open session.)

19 CHAIR STETKAR: I don't think there is  
20 anyone on the bridge line but as of this time, the meeting  
21 is open.

22 What we would like to do, I think, we had  
23 a couple of items. And if Joy can bear with me, Joy  
24 and Sanjoy Banerjee have been working diligently over

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1 the last couple of months and I would like to publicly,  
2 since we are on the record now, thank you very much for  
3 the amount of effort that you folks and Girija has been  
4 supporting them. There has been a lot of communications  
5 on these topics over the last couple of months and I  
6 really appreciate the effort that everybody has put in.

7 What I would like to do is go through those  
8 items pretty much one by one, so we have clarity where  
9 we are. And if there is any open issues that need further  
10 evaluation that we are real clear on what needs to be  
11 done. We are going to hand out a table so that you all  
12 have it.

13 MEMBER REMPE: But we are going to -- may  
14 I suggest something Mr. Subcommittee chairman? Why  
15 don't you start with the October one, because it is a  
16 good example that will be fairly quick and then let's  
17 go through the July ones, okay? And we will get the  
18 table out in a bit.

19 CHAIR STETKAR: Yes, there is only one from  
20 October.

21 MEMBER REMPE: Right. And let's go  
22 through it.

23 CHAIR STETKAR: It is a two out of four  
24 thing, if that is what you are talking about.

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1 MEMBER REMPE: Yes, because it is, I think,  
2 a good response where they gave us sufficient  
3 information and it would be a good example to go through  
4 first.

5 CHAIR STETKAR: That is not on your table.

6 MEMBER REMPE: It's not on my table, right.

7 CHAIR STETKAR: You are right. That is  
8 what I was going to suggest.

9 MEMBER REMPE: Okay.

10 CHAIR STETKAR: Thank you, it is an  
11 excellent suggestion.

12 MEMBER REMPE: I thought you were going the  
13 other way.

14 CHAIR STETKAR: No, I wasn't.

15 MEMBER REMPE: Okay.

16 CHAIR STETKAR: I wanted to get that one  
17 out of the way first. And we don't have this in  
18 writing. Let me pull up my file here so I can refresh  
19 my memory on the specifics.

20 There was one -- I will give you, kind of  
21 orient you. There was one question that we had, there  
22 were statements in the SER and in responses to RAIs,  
23 and in fact in your response to us, regarding this notion  
24 of if you have a single failure in the reactor protector

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1 system, any one of the remaining four channel -- any  
2 one -- I think the way it is phrased is any of the  
3 remaining channels will trip the reactor.

4 And a question that, according to the tech  
5 specs and your response, was something of the order of  
6 according to the tech specs, if a channel is inoperable,  
7 we need to put the channel in test -- or I am sorry --  
8 we need to trip the channel. And, therefore, successful  
9 operation of any of the remaining channels will trip  
10 the reactor.

11 The problem is, the way I read the tech  
12 specs, and this might be my misinterpretation of the  
13 tech specs is the tech specs require by law, require  
14 that three channels of the reactor protection system  
15 shall be operable. Three not four.

16 If during a real event now, if I have one  
17 channel inoperable, I am operating my nuclear power  
18 plant and a channel becomes inoperable, normally I have  
19 four. The tech specs don't tell me that I need to trip  
20 that channel that becomes inoperable because I only need  
21 three to be operable. So I am in a gray area now. What  
22 happens in the real world if that channel becomes  
23 inoperable?

24 According to the tech specs, I don't find

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1 anything that says I must place that channel in trip.

2 So I am operating under the presumption that I will  
3 not trip that channel. That leaves me three channels.

4 If now I have an event and I take my single  
5 failure as one of those three channels, I need a trip  
6 signal from the remaining two. That was the genesis  
7 of my question. And it all hinges on this fact that  
8 the tech specs require three channels to be operable  
9 and they are silent on what happens if one of the four  
10 channels in the real world becomes inoperable. I can't  
11 find a requirement that says place that channel in a  
12 trip condition. If one of the required channels is  
13 inoperable, it clearly says trip it. Follow me?

14 MEMBER BROWN: The point is it could be out  
15 of service without a trip.

16 CHAIR STETKAR: The point is that during  
17 normal operation I have four channels. What happens  
18 in the real plant if one of those four channels becomes  
19 inoperable? My reading of the tech specs are that they  
20 are silent. They do not require me by law, by license,  
21 by anything, to place that one channel in the trip  
22 condition because I still satisfy my operability  
23 requirements. I still have three operable channels.

24 So in principle, according to my reading

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1 of the tech specs, I can be operating 365 days out of  
2 the year. I am going to push maintenance rule and those  
3 sorts of issues off to the side but I can be operating  
4 365 days in the year with three and only three operable  
5 channels and the remaining channel not in trip. In  
6 other words, bypassed, basically. And if that is the  
7 case, if that is allowed by the tech specs, then I still  
8 -- I am not arguing with the notion that you don't meet  
9 the single failure criterion. You certainly do meet  
10 the single failure criterion because no single failure  
11 will prevent you from tripping that reactor but the way  
12 that all the responses and the wording in the SER has  
13 been stated, it is implied that any one of the remaining  
14 channels is sufficient to trip the reactor. And I don't  
15 think that is necessarily true in the context of the  
16 logical relationships that fall out of those tech spec  
17 requirements.

18 MR. SPRENGEL: So the question what is the  
19 control to put the one inoperable channel with the trip.

20 CHAIR STETKAR: Well, it is how the tech  
21 specs are interpreted. And having operate a nuclear  
22 power plant in a previous life and I always have to admit  
23 that that was a very long ago previous life, most people  
24 who operate nuclear power plants, unless they are told

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1 explicitly do X will not do X, especially if by doing  
2 X it makes them more vulnerable to tripping the plant,  
3 which putting one of your channels in trip would do.

4 MEMBER BROWN: I would take a slightly  
5 different tack and that it could be out of service and  
6 it could not be possible to put that in trip due to the  
7 nature of the failure. And, therefore, you are  
8 operating on three and you will have to require simple  
9 failure in the other. I'm just saying that is another  
10 aspect of having one channel, whether it has been put  
11 in trip or whether it is out of service and you can't  
12 put it in trip, or whether it is being repaired or what  
13 are those circumstances.

14 So I would not be comfortable if somebody  
15 says the only way this plant is protected is if a channel  
16 is out of service and it is placed in trip and that is  
17 the only requirement. I think that is nuts. You ought  
18 to be able to operate with three channels and then have  
19 two out of three be their protection mode.

20 And the implication from what you went  
21 through is that that is almost well no, while you may  
22 only need one, we are still going to have people place  
23 that discrepant channel in trip. And I just don't think  
24 --

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1 CHAIR STETKAR: I think we might be talking  
2 of different purposes here.

3 MEMBER BROWN: I don't know.

4 CHAIR STETKAR: Ryan, do you understand  
5 sort of my logical arguments?

6 MR. SPRENGEL: Now I understand two  
7 arguments. Because the second argument is to maintain  
8 that two out of three.

9 MEMBER BROWN: Well, if you have got four  
10 channels, the whole idea, I mean I have lived with four  
11 channels my whole life. If one is out of service for  
12 whatever reason, you don't necessarily put a trip into  
13 it. If I have got -- now I am down to three and two  
14 out of three will trip me.

15 CHAIR STETKAR: And indeed that is --

16 MEMBER BROWN: I don't require a manual  
17 trip in that out of service channel.

18 CHAIR STETKAR: No, we are saying the same  
19 thing. The tech specs are very clear to me. Now maybe  
20 I am misinterpreting them. The tech specs say that you  
21 need three operable channels. And if a required channel  
22 is inoperable, you place that channel in trip. That  
23 is my reading of the tech specs and if I am not reading  
24 them correctly, please help me. Which essentially

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1 leaves you, in some sense, half-primed for a trip because  
2 a trip signal from either of the remaining two channels  
3 will trip you. That is why people don't like to put  
4 the channels in trip but that is okay. That is the way  
5 the tech specs seem to be written to me.

6 But now if I have three operable channels,  
7 no channels in trip, and I have a real event, now we  
8 are in design basis space, so I have a real event and  
9 I must presume a single failure. And the single failure  
10 that I take is one of those three channels. And that  
11 failure does not trip me because it is a failure. Then  
12 I need a legitimate valid trip signal from the remaining  
13 two channels, essentially a trip from two out of the  
14 three channels.

15 And I said, it is not a single -- you meet  
16 all of the single failure criteria. I am just trying  
17 to make sure that I understand how the plant will be  
18 operated and make sure that the decisions are made in  
19 licensing space for the plant are not based on words  
20 that may be logically optimistic.

21 MR. SPRENGEL: So the problem is we are  
22 focusing on being in the condition of having three  
23 channels operable and we are assuming that we have the  
24 fourth one tripped, where you are saying that may not

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1 be --

2 CHAIR STETKAR: The way I read your  
3 response was it presumed that any of the four channels,  
4 if they became inoperable, would be placed in trip  
5 because that is the way that the response was basically  
6 worded. But my reading of the tech specs would not  
7 require that they put it in trip and there may be many,  
8 many operational considerations where they would not  
9 want to put it in trip because you don't like sitting  
10 in a place where a trip signal from another channel will  
11 bring the plant down.

12 MR. SPRENGEL: But I guess to be clear,  
13 though, it is not necessarily -- is it mostly a wording  
14 concern?

15 CHAIR STETKAR: It is absolutely, Ryan, a  
16 wording concern.

17 MR. SPRENGEL: So we have two, that it may  
18 be this or we could be in a situation of having three  
19 operable channels, have the one channel failure and then  
20 we would require two.

21 CHAIR STETKAR: Require two, that's right.  
22 I am not raising this as a fundamental licensing single  
23 failure issue. I'm raising it as wording that is  
24 pervasive through both the MHI documentation and the

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1 staff's SER that implies that any one of the remaining  
2 channels, and that is sort of the way that it is cast,  
3 will give you the safety thing.

4 MR. SPRENGEL: Okay, because it is built  
5 up presuming one.

6 Okay, so we back up and have the two  
7 different scenarios are covered but they just need to  
8 be acknowledged.

9 CHAIR STETKAR: You are covered. You are  
10 absolutely covered. I have absolutely no question  
11 about single failure vulnerability at all. I just want  
12 to make sure that the licensing basis for the failure  
13 --

14 MEMBER BLEY: If in fact there was a good  
15 reason for that, the tech specs ought to probably be  
16 different. And if there is not, the first licensee that  
17 comes in will probably come in with a change to get rid  
18 of that.

19 MR. SPRENGEL: Okay, so we need to confirm  
20 the scenarios and then I understand.

21 CHAIR STETKAR: Okay. It all hinges on  
22 what people will or are required to do when the first  
23 of the four channels become inoperable.

24 MR. SPRENGEL: Okay. So we will confirm,

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1 I guess, not only what they will but what are they able  
2 to do. Because if they are able, to as you say, continue  
3 operating with the one inoperable channel but not in  
4 trip, we need to acknowledge that scenario.

5 CHAIR STETKAR: Able, you mean, legally  
6 able.

7 MR. SPRENGEL: Yes.

8 CHAIR STETKAR: Yes, I mean they are  
9 certainly able.

10 MR. MARUYAMA: Yuta Maruyama. I  
11 understand. I will check with our engineers and get  
12 back to you by in Region IV.

13 CHAIR STETKAR: Great. Sorry to drag you  
14 through this. It is just sometimes the words are  
15 important, even though we all agree that the technology  
16 is okay because we don't want to give people the  
17 impression that there might be some misinterpretation  
18 of the way the plant actually works or the way the  
19 operators will indeed operate the plant. That is the  
20 only reason why I am sort of --

21 MR. SPRENGEL: Okay, now that was the July  
22 meeting. Right?

23 CHAIR STETKAR: That was actually the  
24 October meeting. I believe that was October.

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1 MR. SPRENGEL: Okay, we will move on. It  
2 is not important, I don't think.

3 CHAIR STETKAR: Okay. I think that was  
4 October.

5 MR. SPRENGEL: We have July, so --

6 UNIDENTIFIED SPEAKER: It was actually  
7 July's meeting.

8 CHAIR STETKAR: Was it July's meeting?  
9 Okay.

10 MR. HAMZEHEE: Just make sure that --

11 CHAIR STETKAR: Speak and identify  
12 yourself. We are on the record. This is Hossein  
13 Hamzehee from NRC.

14 CHAIR STETKAR: Thank you.

15 MR. HAMZEHEE: I just want to make sure this  
16 is not a two-way communication between you and MHI and  
17 the Staff is not taking any action on this except, if  
18 necessary, clarification on the wording of the SE.

19 CHAIR STETKAR: That is exactly right,  
20 Hossein. I was trying to understand it. This is a  
21 question that we had to MHI. They have given us some  
22 feedback on it.

23 It does have implications on the wording  
24 in the SE because the SE reproduces that notion of

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1 failure or under a single failure condition a valid  
2 single from any one of the remaining channels will give  
3 you a trip. But at the moment, we are talking MHI.

4 You probably need to clean up the wording  
5 in the SER but we will --

6 MR. SCHMIDT: This is Jeff Schmidt from the  
7 NRC. Yes, we will clean up the wording in the SE.

8 CHAIR STETKAR: Now regardless of whether  
9 that was October or July because I have lost complete  
10 track of time, that was the only one that I had. And  
11 I think the remaining items that we communicated with  
12 you last week or the week before, I don't remember when  
13 the emails were flying around, all have to do with the  
14 table of thermal hydraulic questions. There are five  
15 or six or eight, depending on how you count them or split  
16 them.

17 MEMBER REMPE: There is one that Sam had  
18 about the fuel.

19 CHAIR STETKAR: But that is postponed, I  
20 think, until -- unless you have something. You have  
21 something on the PCI?

22 MR. SPRENGEL: We would like to discuss it.

23 CHAIR STETKAR: Oh okay, good. The last  
24 note I saw was you wouldn't necessarily be ready to do

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1 that. So if you are, that is good.

2 MR. SPRENGEL: We do not have results or  
3 analysis to present but we do want to discuss this.

4 CHAIR STETKAR: Okay, good. Let's do  
5 that.

6 MR. SPRENGEL: I think we can stay on our  
7 previous topic and we will save PCI to the end.

8 MEMBER REMPE: Okay.

9 CHAIR STETKAR: Okay.

10 MEMBER REMPE: So in October there was a  
11 question which we don't need to discuss but it was about  
12 the nodalization in MARVEL. And you guys went through  
13 and did sensitivity studies. And they did a very nice  
14 response back. And that is why we don't need to discuss  
15 it. But there was this other table of questions that  
16 we provided to you.

17 CHAIR STETKAR: Now, before you do that,  
18 let's hand out the table. I want to make sure everybody  
19 has it --

20 MEMBER REMPE: Can we go through the first  
21 one first?

22 CHAIR STETKAR: No, because I want to have  
23 the table -- you wrote it up.

24 MEMBER REMPE: Okay.

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1 CHAIR STETKAR: Everybody put it together.

2 I'm not --

3 MEMBER REMPE: Okay.

4 MEMBER ARMIJO: Do we have copies of that?

5 CHAIR STETKAR: Yes we do. If we can  
6 distribute that Girija.

7 It is just a lot easier for people to read  
8 the words and take notes. That is the reason I want  
9 to make sure that we have it.

10 MEMBER REMPE: I agree that it is going to  
11 be eventually needed.

12 CHAIR STETKAR: And as long as we are going  
13 to discuss all of them, we will discuss it.

14 I think pretty much anybody except Joy,  
15 Girija and I need a copy of the table.

16 MR. HAMZEHEE: Hi, this is Hossein Hamzehee  
17 again from NRC. John, does the staff have a copy of  
18 this table? Did you ever communicate this to the Staff?

19 CHAIR STETKAR: No, not at the moment.  
20 Right at the moment, this is another thing that we are  
21 talking to the Applicant about.

22 MEMBER REMPE: The first table didn't --  
23 this is a table that --

24 MR. SPRENGEL: The Staff are aware of the

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1 topics.

2 MEMBER REMPE: The topics, the questions,  
3 did they not get a copy? I don't know but there were  
4 like some questions we documented from the meeting.  
5 Did the Staff have a copy of that? Then MHI came back  
6 with some --

7 CHAIR STETKAR: That I don't know. The  
8 first iteration you may have received.

9 MEMBER REMPE: Girija, did they not -- the  
10 staff -- the history of this is there was a meeting and  
11 there were a lot of questions raised and we were asked  
12 to come up with documented questions. And did the Staff  
13 see those documented questions?

14 MR. SHUKLA: The Staff was given a hard  
15 copy.

16 MEMBER REMPE: Of the table. So you have  
17 seen the original ones.

18 MR. SCHMIDT: Yes, we have seen the table.

19 MEMBER REMPE: Okay and then we got an email  
20 in the last couple of months that were like for draft  
21 responses, which I have included in this revised table.  
22 And then we went through those draft responses. And  
23 if we go through the first one, for example, the question  
24 was on refluxing. And we would ask about during what

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1 phases of the small-break LOCA does the reflux  
2 condensation occur? What are the rates for steam and  
3 counter-current flow rates? We would like a ratio of  
4 the hot leg and steam generator flow areas to the core  
5 power and compare with the conventional four-loop plant  
6 and clarify the logic for selecting the hot leg sizing.

7 And then the response was that MHI believed that the  
8 requested information had already been provided in RAI  
9 questions 15.0605 and RAI CA1.

10 And so we went back and looked at those  
11 documents and we couldn't find the response to our  
12 questions to put it briefly. I mean we guessed what  
13 pages of those documents you were referencing and maybe  
14 we guessed wrong but we thought we had it right. But  
15 we didn't see a clear, concise response to our questions.

16 Are we missing something on that one?

17 MR. SPRENGEL: I missed the question.

18 MEMBER REMPE: You can see our ACRS  
19 response. We didn't see a response to our question  
20 Did you have a particular place in those documents you  
21 wanted to point out to us that responded to our question?

22 MR. MARUYAMA: This is Yuta Maruyama from  
23 MNES. I saw the ACRS response here. We do not have  
24 special LOCA engineer from MHI today. So I would like

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1 to bring those answers back to MHI then talk to MHI.

2 Then we will get you back what is our  
3 intention or we modify our response to your question.

4 MEMBER REMPE: Okay because it is my  
5 understanding you never really issued your response.  
6 It was just a draft.

7 CHAIR STETKAR: No, no. It is my  
8 understanding that you were targeting roughly the end  
9 of January for a submittal that addresses these things.

10 The reason I wanted to get them out at the table at  
11 this meeting is we have the opportunity to at least  
12 discuss the items face to face and if there is any need  
13 for clarification or if it would have any effect on your  
14 plans, it is good to get those issues resolved here.

15 It is a lot more efficient than trying to do a round  
16 robin by emails or sending tables back and forth.

17 MR. SPRENGEL: I agree.

18 CHAIR STETKAR: So that is the whole idea  
19 of having of this discussion.

20 MR. SPRENGEL: Okay.

21 CHAIR STETKAR: And I recognize you don't  
22 necessarily have the right people here today to answer  
23 these things.

24 MR. SPRENGEL: Yes, that's okay. And the

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1 other key piece of feedback which we are also going to  
2 incorporate in to the VIPRE table will be to pull more  
3 information into this with a reference for more detail.

4 MEMBER REMPE: That is, I think, the point  
5 of the discussion today.

6 MR. SPRENGEL: But give you once place to  
7 just look at the information.

8 CHAIR STETKAR: That helps an awful lot.  
9 I mean, we get -- I hate to keep whining. But we get  
10 so much information that we need to plow through,  
11 thousands and thousands of pages a month, literally,  
12 that it is really difficult for us to organize our time  
13 and wade through large documents.

14 MEMBER REMPE: But in this particular case,  
15 I didn't see numeric answers.

16 MR. SPRENGEL: Okay.

17 MEMBER REMPE: I saw more hand-waving  
18 discussions or whatever and we really do want to see  
19 the answers to the questions. Okay?

20 MR. SPRENGEL: Okay.

21 MEMBER REMPE: And I think actually, I mean  
22 we can go through the rest of these but that is basically  
23 the bottom line. There were some where you did address  
24 things but a lot of places there needs to be more detailed

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1 responses back to the questions raised.

2 CHAIR STETKAR: Does it make sense, Joy,  
3 to actually just go through them? I mean, this is the  
4 first chance MHI has had to see --

5 MR. SPRENGEL: No, it's okay. But looking  
6 through it, some of this is additional analyses and you  
7 are just basically recognizing that that is --

8 MEMBER REMPE: And that can come later in  
9 your response back. I think one of the reasons we have  
10 put this in this table today and we have brought this  
11 back to John ahead of time was to hopefully not have  
12 another round of this back and forth to request that  
13 you do provide more information on the cases that you  
14 are or wait and say we are going to get that analysis  
15 later.

16 CHAIR STETKAR: And I think the other from  
17 your perspective, I know you are trying to read through  
18 this in real time but at least from my perspective, this  
19 table now represents both necessary and sufficient  
20 answers, which kind of gives you a target for closure.

21 At least it is a subcommittee -- full committee can  
22 raise issues later but at least as far as issues that  
23 have been raised in the subcommittee, this should help  
24 to draw us to closure.

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1 MR. SPRENGEL: That is good to hear. If  
2 we could look at number four, specifically it looks like,  
3 maybe it is a wording clarification of the request to  
4 see additional analyses but we are not performing  
5 additional analysis. There is additional explanation  
6 but I don't know if it is just the terminology.

7 MEMBER REMPE: I think that is a wording  
8 -- that is a wording thing.

9 MR. SPRENGEL: Okay.

10 MEMBER REMPE: I'm sorry for that. But you  
11 are right, it is just the additional explanation which  
12 could be an assessment or an analysis but yes. Okay?

13 MR. SPRENGEL: Okay.

14 MEMBER REMPE: But we would like --

15 CHAIR STETKAR: You start thinking running  
16 codes, don't you?

17 MEMBER REMPE: Yes, you don't need to run  
18 a code but you will have to give us the detailed  
19 explanation.

20 MR. SPRENGEL: Okay. Okay and then number  
21 five, the date for the subcommittee meeting for the  
22 accumulator has not been defined.

23 CHAIR STETKAR: Right.

24 MR. SPRENGEL: So that -- I won't say

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1 anything more but so I guess that though will be taken  
2 off in terms of the LOCA connection and discussion.  
3 Is that what I am getting?

4 CHAIR STETKAR: Yes, I think that is fair  
5 to -- we will try to pull that together whenever the  
6 subcommittee meeting on the accumulator. So just push  
7 that one.

8 MR. SPRENGEL: Okay.

9 CHAIR STETKAR: Just make sure you address  
10 it whenever we have that meeting.

11 MR. SPRENGEL: Okay and then number six is  
12 tied to the discussion we need to have today.

13 Seven is the same wording, explanation  
14 versus analysis.

15 CHAIR STETKAR: Right.

16 MR. SPRENGEL: And it looks like number  
17 eight is similar to one where we will need to pull  
18 together some information to present it better, as well  
19 as include some of the feedback there. Okay.

20 Okay, I don't think we need to have any more  
21 discussion now on this. This was helpful.

22 CHAIR STETKAR: Is that pretty clear?

23 MR. SPRENGEL: Yes.

24 CHAIR STETKAR: Okay.

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1 MR. SPRENGEL: I do not want to necessarily  
2 maintain our end of the month commitment. But if there  
3 is a change, we will let you know.

4 CHAIR STETKAR: You know, Ryan, I still  
5 come back to where we are in the whole review process.

6 These are issues that we are raising to send out a flag  
7 to MHI that there are issues that we need to have  
8 resolved, at least to our satisfaction by the time the  
9 final safety evaluation is issued with the certified  
10 design. The sooner we get them resolved, the better  
11 for everybody. You know, we are where we are in terms  
12 of the design certification process.

13 MR. SPRENGEL: Okay.

14 CHAIR STETKAR: There is nothing magic  
15 about an end of January date.

16 MR. SPRENGEL: Agreed but I just want to  
17 be clear.

18 CHAIR STETKAR: I think, you know, in both  
19 of our interests, the sooner the better is fine. But  
20 that is your, obviously your call.

21 MR. SPRENGEL: Yes and if we need to split  
22 it up or something, we will do that. We will communicate  
23 any change from end of January.

24 CHAIR STETKAR: Okay, Hossein.

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1 MR. HAMZEHEE: Hossein Hamzehee from NRC  
2 again. I just want to make sure just for clarification  
3 and also for admin control, in the future I would like  
4 to make sure that any of these questions are worked  
5 through by the Staff so that if there are any impact  
6 on the Staff's conclusions, SER, they are adequately  
7 reflected and reviewed. So in the future, please make  
8 sure that we are kept in the loop. Because none of these  
9 things are on the docket yet. And if something comes  
10 out, the Staff has to be ready to respond and take the  
11 appropriate action.

12 CHAIR STETKAR: Okay, thank you. Point  
13 taken.

14 MR. HAMZEHEE: Yes, thank you.

15 MR. SPRENGEL: PCI.

16 CHAIR STETKAR: PCI. Dr. Armijo.

17 MEMBER ARMIJO: I have asked my questions  
18 several times as clearly as I can.

19 MR. SHUKLA: Let me ask one question. How  
20 are you going to respond to us, through the Staff or  
21 through us?

22 MR. SPRENGEL: The same way we have done  
23 with all of our other responses. We send a letter to  
24 the staff.

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1 MEMBER ARMIJO: Okay, that's fine.

2 MEMBER REMPE: The letter from Rebecca came  
3 to the Staff with the preliminary response, so the Staff  
4 has seen that part. It was just this table.

5 CHAIR STETKAR: The problem is this table  
6 has undergone numerous iterations over the last 30 to  
7 45 days and it has been hard enough for the two people  
8 iterating on it to keep it straight.

9 MEMBER REMPE: And actually I guess I  
10 thought it was, if you had come back and said well you  
11 missed this on the first item, that there was that type  
12 of information, that is why I thought --

13 CHAIR STETKAR: That was one the reasons  
14 why I wanted to bring it up in the meeting with it in  
15 front of us. Because if there had been some  
16 miscommunication or misinterpretation, it was good to  
17 get it out.

18 MR. SPRENGEL: Okay.

19 CHAIR STETKAR: PCI.

20 MR. SPRENGEL: Okay, we are at a little bit  
21 of a loss for the requested PCI evaluation. I guess  
22 we went looking. We went back and looked at  
23 Mitsubishi's experience with it. And I guess we have  
24 had 19,000 assemblies and 500 cores and we have never

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1 had any issue with PCI.

2 We understand there is a request for  
3 evaluation but it is difficult because --

4 MEMBER ARMIJO: You know, in the case of  
5 normal operation, and I am not disagreeing with you,  
6 in normal operation you have the benefit of a 2,000 psi  
7 external pressure. PWR is notorious -- not notoriously  
8 -- fortunately don't have the same PCI vulnerability  
9 as BWRs. Okay? But it does, it has happened in PWR  
10 fuel. Most recently in several BWRs, your competitor's  
11 fuel is related to defective pellets. And it is well  
12 known in the industry, that is in the last several years.

13 So PCI can occur in PWR fuel but it is rare.

14 In the transients, anticipated operational  
15 occurrences, you are going to much higher powers than  
16 you normally would operate. And in those events, you  
17 can be susceptible to PCI fuel failures and you do not  
18 address them in your fuel design methodology. You make  
19 some statements that there is no specific PCI design  
20 criterion and don't have to worry about it because we  
21 meet the cladding strain criteria and the fuel melting  
22 temperature criteria and neither of those will protect  
23 you from PCI because PCI occurs at much lower strains  
24 than the one percent and that is demonstrated in a number

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1 of Studsvik power ramp test programs.

2           So what I am looking for is just a set of  
3 charts that says these are all the AOOs that our US-APWR  
4 is susceptible to. This set, the transient is so fast  
5 that it is over before anything can happen. The power  
6 may go up and down in a few microseconds or seconds and  
7 so that is not a concern. But there is some where the  
8 power goes up a considerable amount and I am talking  
9 nodal power, peak nodal power. I am not talking  
10 averages or anything else. The power goes up a  
11 substantial amount and it holds for a period of time.

12          And that can be as short as a few minutes and you are  
13 in a range for experimental work has demonstrated that  
14 you can have PCI fuel failures. And depending on the  
15 number of fuel assemblies and fuel rods that are exposed  
16 to that transient, you could see a lot of fuel.

17           Now it may be that you have really good  
18 answers to these things but you can't do it just by making  
19 a statement. You have got to show these are the AOOs.

20          This is the power that we start out with. This is the  
21 power we end up with. So that is the delta power. The  
22 duration of the transient is so many seconds or minutes,  
23 at which time it is either terminated by automatic  
24 systems or terminated by operator action or something.

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1 And so there will be a certain class of events that  
2 you may be susceptible to PCI.

3 It may be you have a good answer to all of  
4 these things. Maybe you are not susceptible to anything  
5 but you haven't provided anything in your documentation  
6 to demonstrate that.

7 MR. SPRENGEL: All right, there is no  
8 regulatory basis, though, for us to follow. I mean we  
9 don't have any guidance to do this analysis. And I  
10 understand in general terms what the request is but when  
11 we get to specifics I don't know how to define what is  
12 analyzed.

13 MEMBER ARMIJO: You can't make it any  
14 clearer. You know if you are saying that as long as  
15 I am below one percent cladding strain I am okay, I don't  
16 have to do anything, I don't find that an acceptable  
17 answer.

18 Your job is to design the fuel so it  
19 addresses all fuel failure mechanisms, not just the ones  
20 that are cited in the regulations.

21 So you know, I just think you are ducking  
22 the issue and I don't see why. You have got the  
23 analytical tools to tell you what the strains will be.

24 For example, we said calculate what the localized

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1 stresses and strains are on the cladding ID'd during  
2 these transients. And I am not talking about every  
3 transient because there is a whole class of them that  
4 are so fast and they are over before anything can happen.

5 I am talking about the ones that there is a significant  
6 time at which you are at high power during the transient.

7 MR. SPRENGEL: Is there other guidance that  
8 other vendors have followed to do this analysis?

9 MEMBER ARMIJO: I know of one vendor who  
10 has a very specific good answer because they have tested  
11 their fuel to powers much, much higher than normal  
12 operation and demonstrated their fuel is resistant.  
13 Now that is a different cladding design than you have.

14 It was designed to be resistant to PCI even under  
15 operational transients.

16 Now that was a BWR. BWR's are more  
17 susceptible. But you are going under the assumption,  
18 Ryan, that the PWR fuel is not susceptible to this  
19 problem and I disagree with that.

20 MR. SPRENGEL: Based on our vast  
21 experience, we are confident that we are not  
22 susceptible. But we have found it tough to comply with  
23 the request because we do not have a complete document  
24 telling us what analysis to do and how to define our

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1 starting points and what to compare it to. There is  
2 not enough there for us to go on.

3 So, I am looking if there is any guidance  
4 that other vendors have followed and maybe that the Staff  
5 has approved.

6 MEMBER ARMIJO: Well I am not sure if the  
7 Staff can provide other vendors' approaches. I don't  
8 know if that is appropriate or not.

9 MR. SCHMIDT: This is Jeff Schmidt. I am  
10 sorry to interrupt but we are having the same problems,  
11 in some senses. For PWR fuel, the Staff is having  
12 problems defining what a success criteria or acceptable  
13 criteria are.

14 I understand that there is information for  
15 BWRs but obviously, BWRs seem to be having more of a  
16 problem than PWRs. And I am not aware of a PWR vendor  
17 who has established any criteria for PCI.

18 MEMBER ARMIJO: Well you know, let me give  
19 you a good example. Let's say you had a particular  
20 transient that went from a normal operating power, let's  
21 pick a number, six kilowatts a foot up to 12 kilowatts  
22 a foot in this transient in a very short time frame and  
23 the transient lasted for -- pick a number -- five minutes  
24 before it was terminated either by operator action or

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1 some device.

2 Well the specific test results are very  
3 clear. During that time, fuel cladding will fail and  
4 it is based on strain. And the strains at which these  
5 failures occur are small, much, much smaller than one  
6 percent to the order of a tenth of a percent. And so  
7 that would be a criteria.

8 If you calculate your strains are trivial,  
9 then you would say hey, I don't have this problem because  
10 I don't -- you should be able to calculate localized  
11 strain during these transients. That is available with  
12 your codes. You should be able to calculate that  
13 routinely. It is the same code that calculates the one  
14 percent cladding stream. It only takes a chemical  
15 effect into account, rather than just a pure mechanical.

16 MR. SCHMIDT: Right, but we don't -- we can  
17 calculate the local strains but we don't know for PWR  
18 fuel what the value we should be comparing to. That  
19 is kind of the crux is we can do the comparison that  
20 you are requesting but I don't know if there is a way  
21 that I am aware of to say you know, yes or now we are  
22 susceptible to PCI based on that Studsvik data.

23 And the other problem with the Studsvik data  
24 is, a lot of that data is proprietary.

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1 MEMBER ARMIJO: No, it isn't. It is  
2 published. Yes, I have got to correct you on that.

3 MR. SCHMIDT: Okay.

4 MEMBER ARMIJO: That is all open literature  
5 and published. There may be some proprietary data that  
6 some vendors have squirreled away but this is all  
7 well-known data.

8 MR. SCHMIDT: And it is relevant to PWR?

9 MEMBER ARMIJO: Sure. It is just -- PCI  
10 is a stress corrosion cracking problem. You get a  
11 certain amount of strain. You got the chemical  
12 environment of fission products cladding on the cladding  
13 ID. You get that strain occurs. It is localized and  
14 you can form a crack. It doesn't care whether it is  
15 a Zircaloy-2 or Zircaloy-4. Stress relief,  
16 re-crystalize, all of this has been addressed in the  
17 past.

18 And so normal operation isn't a predictor  
19 that you are protected in a transient. It is much higher  
20 power than you normally operate. The question is --

21 MEMBER SHACK: But Sam, how about the  
22 argument with so many thousands of hours of operation,  
23 I mean these plants have seen transients.

24 MEMBER ARMIJO: Well if they have, that is

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1 part of the answer.

2 MEMBER SHACK: But I mean statistically you  
3 sort of know that you have years and years of operating  
4 experience without this happening and yet --

5 MEMBER ARMIJO: You know if somebody can  
6 say look, here is the only transient that lasts more  
7 than a few seconds. Okay, we had it last year or in  
8 previous years several times and nothing happened.  
9 That is a good answer. I wouldn't be too upset about  
10 that. But I don't think you have the operation.

11 You know, these anticipated occurrences  
12 don't always happen. But if they do, how have you  
13 analyzed it against this fuel failure mechanism? And  
14 there is no analysis here. There is just a bald  
15 statement that says hey, we meet the one percent  
16 criteria, the melting temperature, and therefore, they  
17 are okay.

18 MEMBER SHACK: Well you know, everybody  
19 knows that one percent isn't aiming at the mechanism  
20 you are talking about. It is looking at a different  
21 mechanism.

22 MEMBER ARMIJO: Right. And what I am  
23 trying to get across to the MHI and to the Staff is that  
24 you have a much more aggressive mechanism operating at

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1 lower strains.

2 So you know, that is where I am at. Maybe  
3 the rest of the committee isn't in sync but I have asked  
4 a very specific request for an analysis.

5 MR. SPRENGEL: And I guess I want to make  
6 clear that we are prepared to do analysis but without  
7 the analysis being clearly defined and an acceptability  
8 criteria, we don't feel comfortable moving forward on  
9 that.

10 MR. HAMZEHEE: John?

11 CHAIR STETKAR: Yes.

12 MR. HAMZEHEE: Hossein Hamzehee from NRC.

13 At least for my educational purpose, is this something  
14 you need for new reactors or is this something that is  
15 for all of the reactors as well?

16 MEMBER ARMIJO: It is generic. It is not  
17 a new reactor thing but in the case of a new reactor,  
18 you have -- you know, this is a very conservatively  
19 designed core. I want to make that clear. I am not  
20 saying you are on the edge.

21 You may have probably the best way to answer  
22 this than anybody the way you have designed this core  
23 but it hasn't been addressed. It hasn't been addressed  
24 in any way. It has just been ignored. And you say

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1 Mitsubishi does not apply a PCI-specific design  
2 criteria. PCI is addressed by two criteria, cladding  
3 remaining below one percent strain, and fuel centerline  
4 melting will not occur. I mean, that is just  
5 inadequate.

6 It may be adequate for the Staff but I  
7 believe it is inadequate.

8 MR. HAMZEHEE: Okay, I have some follow-up  
9 questions. I think because you want to make sure that  
10 if there are some areas that we need to spend some time  
11 and maybe include it in our regulatory requirements,  
12 we do so. As of now, I don't believe this issue has  
13 been included in --

14 MEMBER ARMIJO: It is not in your  
15 regulatory requirements.

16 MR. HAMZEHEE: -- or any of our reg guides.

17 MEMBER ARMIJO: It is not in your  
18 regulatory requirements.

19 MR. HAMZEHEE: So I don't blame MHI if they  
20 don't have adequate guidance as to what to do and how  
21 to document it. So I would like to go back and talk  
22 about this among our technical staff and see if there  
23 is some follow-up that the Staff should act on.

24 CHAIR STETKAR: In the sense, Hossein, of

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1 it is a generic concern, so in some sense it is not  
2 necessarily strictly related to this particular design  
3 certification. However, I can cast it in a question  
4 related to this design as is there anything in this  
5 design, the AOO transient response of this design or  
6 anything in the design of the fuel itself that would  
7 indicate a different vulnerability.

8 MR. HAMZEHEE: I see.

9 CHAIR STETKAR: You know, so you could ask  
10 the question that way and remove the genericism from  
11 it --

12 MR. HAMZEHEE: Yes.

13 CHAIR STETKAR: -- and still say well, can  
14 MHI go through their list of AOOs and see if there are  
15 any, based on their plant design, their automatic trip  
16 set points, their assumed manual actions and so forth,  
17 is there any part of this particular design, coupled  
18 with their specific fuel design that would leave them  
19 more vulnerable to this issue than let's say a generic  
20 plant.

21 MR. HAMZEHEE: I see.

22 CHAIR STETKAR: And I don't want to  
23 speculate. There may not be but I think one of the things  
24 that Sam is asking for is is that type of information.

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1           For example, if the core could remain at,  
2 pick an absurd, 150 percent power for 30 minutes because  
3 of some specific element of this particular plant  
4 design, I think we would have a real problem. You know,  
5 and that has to do with the specific response to AOOs  
6 on this design.

7           MEMBER ARMIJO: I think John brought up a  
8 key point. You know, in the case of the BWRs, people  
9 always thought that this PCI problem would not exist  
10 during transients because they would be over so quickly  
11 and stress corrosion is a time-dependent failure  
12 mechanism, until they did the experiments. And they  
13 did power ramp tests that lasted from 30 seconds to three  
14 minutes. And almost all of the fuel rods that were  
15 tested that way had PCI cracks either all the way through  
16 or partially through. And that is documented. We can  
17 provide information on that.

18           So the problem is, this is a much more  
19 aggressive failure mechanism and we don't even talk  
20 about it. We don't even say hey look, these are the  
21 only transients that have a certain duration that have  
22 a sufficient, a significant increase in power above our  
23 normal operating power but we have had them before and  
24 nothing has happened. That would be a good answer.

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1           But if it has never happened, how can you  
2 say you are safe? That is really my point.

3           MEMBER BLEY: Did the guys who did those  
4 experiments map those ramps they did on any AOOs or these  
5 really severe accident conditions?

6           MEMBER ARMIJO: No, they were in the range  
7 of AOOs. And I know one vendor in fact does actually  
8 analyze it.

9           MEMBER BLEY: They once actually had these  
10 happen.

11           MEMBER ARMIJO: No, they didn't. They  
12 didn't have them happen but that was a concern. In fact  
13 it was an early concern by the NRC that these transients  
14 would cause large numbers of fuel failures.

15           And so in the BWRs, people will find a liner, a  
16 zirconium liner cladding. And that gives you lots of  
17 margin. And that is how some people just address it.

18           And so yes, they are in good shape.

19           In the PWRs, you know, they don't have a  
20 design fix in their cladding. And if they ever have  
21 one of these transients and it meets these  
22 characteristics, they could have a lot of fuel failures.

23           And so what I am looking for is an analysis that says  
24 hey, this is how -- we understand PCI is a failure

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1 mechanism. This is what we calculate. It is a strain  
2 that is possible during our worse transient of  
3 significant duration and it is trivial. It is far less  
4 than 0.1 percent, or it will never last more than 30  
5 seconds because our automatic systems will terminate  
6 the event, or whatever other reasons you have. But you  
7 have got to write it down. What is your basis for coming  
8 to that conclusion.

9 MR. SPRENGEL: Right. And again, I don't  
10 have a problem with the evaluation if we found a way  
11 to scope it and define the criteria. But I do have a  
12 problem with proceeding with this additional analysis  
13 without that in place and also being ahead of the Staff  
14 and the industry.

15 So I don't want to make that move in this  
16 manner.

17 MEMBER ARMIJO: Well that is up to you guys.

18 MR. HAMZEHEE: Hossein Hamzehee again from  
19 NRC. I have one question and one suggestion.

20 My question is: To your knowledge has of  
21 the PWRs have done any evaluation that is even close  
22 to what you have in mind?

23 MEMBER ARMIJO: Not to my knowledge, no.

24 MR. HAMZEHEE: Okay. And my suggestion is

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1 if you want to get something close, one way to address  
2 it, as John mentioned, is be a little more specific such  
3 as for instance how long do you believe or do you expect  
4 your transients to last and get some kind of timeline  
5 for those and then maybe that would then lead to the  
6 question that if none of them last longer than 30 seconds  
7 or a minute, then it is a moot point.

8 MEMBER ARMIJO: That is a good approach,  
9 Hossein. For example, we wrote a little memo to the  
10 -- I guess it was addressed to the Staff.

11 CHAIR STETKAR: Ruth had it.

12 MEMBER ARMIJO: Yes, it says the ACRS was  
13 expecting -- this was maybe the point -- a set of charts  
14 that showed what transients produced the greatest PCI  
15 challenge. And by that, I meant what is the maximum  
16 nodal power in kilowatts per foot that you achieved.

17 What is the maximum nodal power delta, delta kilowatts  
18 per foot during the transient and the duration at which  
19 you are at maximum power? That is just data, no  
20 criteria.

21 And if you go through your list of all your  
22 transients and say there is nothing here, guys, there  
23 is no transient that last more than 30 seconds, I don't  
24 care.

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1 MR. HAMZEHEE: That you don't worry about.

2 MEMBER ARMIJO: Yes, it is all over. There  
3 is no energy. You could start there.

4 But if you wind up that you say hey look,  
5 I have got this transient that took me from a peak nodal  
6 power level of six kilowatts a foot up to 14 kilowatts  
7 a foot, and the duration was several minutes --

8 MR. HAMZEHEE: Half an hour or so.

9 MEMBER ARMIJO: No, Hossein, we are talking  
10 three, four minutes, and it goes right through the  
11 cladding. Okay, then you have got a potential problem.

12 MR. HAMZEHEE: Then make it an issue for  
13 all the reactors.

14 MEMBER ARMIJO: Like I said, it is generic.  
15 Unless this was a unique machine. I don't think it  
16 is.

17 CHAIR STETKAR: Well, when I say unique  
18 machine, this is a machine. They have set points on  
19 trips. They have a set of -- they have an energy input  
20 called a core. They have a set of inputs on trips.  
21 They have a list of AOOs. And they have a fuel design.

22 And all of those things are in some sense generic but  
23 the actual set points and the actual behavior of this  
24 particular machine is a little bit different than

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1 somebody else's.

2 MEMBER ARMIJO: Yes, could be.

3 CHAIR STETKAR: Could be, yes. Now  
4 whether it is different enough to raise a concern, we  
5 don't know. I honestly don't expect that it would be  
6 much different but we don't know.

7 MR. SPRENGEL: All right.

8 CHAIR STETKAR: And to bring it back to you  
9 know an MHI design-specific type question, I think that  
10 is the area where we have to focus.

11 MEMBER ARMIJO: To get at Ryan's concern  
12 and I do appreciate his concern, I don't want to  
13 calculate something that could get me in trouble when  
14 I don't know what trouble is but you certainly can put  
15 a table together of all your AOs and what the power  
16 increases are, what the duration is and see if you can  
17 just cut it off at that point and say our system  
18 terminates all these things before anything can happen.

19 MR. SPRENGEL: Okay.

20 DR. NAGAI: My name is Masatoshi Nagai with  
21 MNES licensing. I guess I understand the concern but  
22 however you rephrase the question, we would need  
23 established threshold against which we can compare any  
24 parameter against to determine that our US-APWR PW core

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1 is vulnerable to PCI. Without a threshold, I don't  
2 think we can determine, we can come to any conclusion.

3 That is my guess.

4 So I was wondering if you could provide me  
5 any insight on how to determine the data.

6 MEMBER ARMIJO: Well I think the first  
7 request would be more like a scoping kind of thing that  
8 says, we have 15 transients that we analyzed or 20,  
9 whatever the number is. And of those, all but these  
10 two or three are over in seconds, terminated for whatever  
11 reason, natural phenomena or automatic systems  
12 terminate it in a few seconds.

13 DR. NAGAI: Okay.

14 MEMBER ARMIJO: But these two require  
15 operator action and may not be terminated for five  
16 minutes, ten minutes. At that point, I would say that  
17 is an area where you want to really look at analysis  
18 and look at what the strains or what the powers are.

19 DR. NAGAI: Okay.

20 MEMBER ARMIJO: And then yes, you could  
21 have a real problem.

22 DR. NAGAI: Okay.

23 MEMBER ARMIJO: This is not a hypothetical  
24 thing. And the data on the criterion would be in the

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1 order of a strain lasting for several minutes.

2 DR. NAGAI: I am not an expert in fuel  
3 integrity type of things but I guess it depends on the  
4 local conditions you are looking at. So it may be  
5 possible that even though you get only three seconds  
6 at high power, you may be vulnerable to PCI, depending  
7 on the threshold you are looking at. I'm not sure.

8 MEMBER ARMIJO: You are right.

9 DR. NAGAI: That is why --

10 MEMBER ARMIJO: But you know your peak  
11 powers aren't going to go to 50 kilowatts a foot. They  
12 are going to be down in the 14, 15, something like that.

13 I have looked at your documents.

14 DR. NAGAI: Okay.

15 MEMBER ARMIJO: So that is not too far from  
16 the range before there is test data from Studsvik.

17 DR. NAGAI: Okay. That is why what Ryan  
18 was saying was that we need fresh, clear guidance to  
19 establish threshold so that we can analyze our AOOs.

20 And I guess at least my personal opinion  
21 is that we would like to address, if we have to, we would  
22 like to address this issue through appropriate  
23 regulatory process. That is my personal opinion, if  
24 anybody else wants to add something.

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1 MEMBER ARMIJO: Well we have written a  
2 white paper and the ACRS issued a white paper a few years  
3 ago on this general topic focused on BWRs. We could  
4 provide that to -- the Staff, of course has access.

5  
6 MEMBER SHACK: Sam, would you be happy just  
7 to see a history of power for each of the AOOs --

8 MEMBER ARMIJO: Yes.

9 MEMBER SHACK: -- and then you could make  
10 the judgment as to whether you thought there was a  
11 problem and discuss it further from there?

12 MEMBER ARMIJO: Sure, --

13 MEMBER SHACK: But if the powers are low  
14 and the times were short.

15 MEMBER ARMIJO: Exactly. I think it may  
16 be that this system has got built-in margin through the  
17 fact that the transients don't last very long and they  
18 aren't very big. I just don't know enough about it.

19 So I was just looking for an analysis with either  
20 historical data or design data.

21 MEMBER SHACK: Because what always  
22 concerns me is you can do this for a sort of stylized  
23 set of accidents, you know, a transient that lasts for  
24 minutes with so much power, is there some way to dream

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1 up a transient --

2 MEMBER ARMIJO: No, no, no. I don't want  
3 to make a hypothetical.

4 MEMBER SHACK: But if you only want to look  
5 at the stylized AOOs that they go through anyway, then  
6 that is a doable thing.

7 MEMBER ARMIJO: I am only looking for the  
8 ones that they actually go through right now. I am not  
9 trying to invent a new AOO.

10 CHAIR STETKAR: I think that is all that  
11 we, in practice, could ask.

12 MEMBER ARMIJO: Well, we can ask.

13 CHAIR STETKAR: We can ask for everything,  
14 sure. You have done it before.

15 MEMBER ARMIJO: But I am not asking for  
16 that.

17 MEMBER SHACK: I don't think we are going  
18 to do that now.

19 CHAIR STETKAR: That is what you are asking  
20 for then, is for the AAOs that they already analyzed,  
21 --

22 MEMBER ARMIJO: Exactly.

23 CHAIR STETKAR: -- what does the power  
24 history look like?

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1 MEMBER ARMIJO: Yes, power, history  
2 including the time.

3 MEMBER SHACK: Well history sort of does  
4 include time.

5 MEMBER ARMIJO: Yes, you are right.  
6 History includes time. So you know, but that tells  
7 you whether you are not even close to this failure  
8 mechanism or whether yes, you are kind of in the ballpark  
9 and then it is up to you to decide whether you feel  
10 comfortable with that or not, whether there is a staff  
11 guidance. You know, you are the designers. You are  
12 responsible for the safety of the plant and the  
13 reliability of the fuel. Whether or not the staff has  
14 told you what the failure criterion to use.

15 MEMBER REMPE: So you are going to have,  
16 if they do this, are you going to rely on specific data  
17 for some other fuel or you want them to come up and show  
18 that they have done transient testing on their own fuel  
19 or are you just going to use a wag and say, it is thumbs  
20 up or thumbs down? Or is that going to be our decision?

21 MEMBER ARMIJO: They are the designers of  
22 this plant. They are responsible for the safety. They  
23 are responsible for fuel failures or lack of fuel  
24 failures. They are responsible for addressing all fuel

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1 failure mechanisms. And that is independent of whether  
2 the staff tells them to do it or not. I did that as  
3 a fuel designer when I was designing fuel. Okay?

4 And so you know, it is -- to their point,  
5 even when there is no clear guidance, you still have  
6 the responsibility to address an unknown failure  
7 mechanism. And if you can prove that this failure  
8 mechanism doesn't apply to you because the  
9 characteristics of the mechanism, what are the  
10 characteristics of your plant, then it is over. You  
11 have done it. But you have got to write it down. You  
12 have got to address it.

13 MR. SPRENGEL: But there is still no  
14 criteria to evaluate against. So I guess I am hesitant  
15 to start when I don't know -- there is no end.

16 MEMBER ARMIJO: Well you know, if you  
17 wanted a duration of which you quit worrying, it is less  
18 than a minute.

19 MR. SPRENGEL: But I know that we have AOOs  
20 that last more than a minute.

21 MEMBER ARMIJO: Then you are in trouble.

22 MR. SPRENGEL: But we have no evidence of  
23 this as an issue.

24 MEMBER ARMIJO: But if you had those AOOs

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1 in PWR fuel in your plants that lasted for several  
2 minutes and went to these kinds of powers, that is data.

3 Then you can cite that and say look, despite what you  
4 say, these things have happened and we have never failed  
5 a fuel. That is perfectly satisfactory. In fact,  
6 probably the best data.

7 So but if you have never had the event and  
8 you are claiming --

9 CHAIR STETKAR: You know the problem of  
10 saying you have thousands of operating hours is an AOO  
11 is something that is expected to happen once in the life  
12 of a plant. You don't have thousands of operating  
13 years.

14 MR. SCHMIDT: This is Jeff Schmidt from the  
15 NRC. My understanding was that BWRs see this in normal  
16 operation. So by extension, they are probably more  
17 susceptible in AOOs. Right?

18 MEMBER ARMIJO: The BWRs are more  
19 susceptible because they operate with an external  
20 pressure of 1,000 PSI and the PWR has a 2,000 PSI external  
21 pressure. So the stress during any power transient is  
22 mitigated by that extra pressure.

23 But again, it depends on how high you go  
24 in power before you get into enough tensile stress on

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1 the idea of the cladding for a period of time in which  
2 the fission products can initiate a crack when you  
3 wouldn't expect it.

4 If this happened -- if a severe AOO has  
5 happened in their plant lasting for much more than your  
6 one minute, two minute, three minutes, and nothing  
7 happened, that is very important information. That is  
8 what I -- I would just cite that and say here was the  
9 event. This is what happened and the fuel performed  
10 beautifully. You can't do better than that.

11 MR. SCHMIDT: I want to make sure I  
12 understand that BWRs have seen this in normal operation,  
13 though. Is that a correct statement?

14 MEMBER ARMIJO: They have seen -- the BWRs  
15 have had some AOOs but not to very high powers. But  
16 they know from normal operation that they are very  
17 susceptible to PCI. And so what they have instituted  
18 to just about everyone around the world to put in the  
19 liner cladding, which gives them a lot of margin in the  
20 material. PWRs haven't had them, except for  
21 Susquehanna, which they are on their own.

22 But the PWRs haven't had to do it because  
23 in normal operation, they have external pressure. They  
24 have always had fine motion drives. They have chemical

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1 shim to change power. They have had a lot of advantages  
2 that the BWR didn't have.

3 So the BWR is clearly more susceptible but  
4 the PWR isn't immune and it should just be addressed.

5 That is all I am saying.

6 MR. SCHMIDT: You know, I think again --

7 MEMBER ARMIJO: Even a narrative  
8 discussion, other than just saying hey we are not  
9 susceptible.

10 MR. SCHMIDT: No, I think the issue is the  
11 same almost for the Staff as it is for MHI is that I  
12 can postulate an AOO that can sit right below a trip  
13 set point and sit there indefinitely until somebody  
14 realizes they are at 108 percent power instead of 100  
15 percent power and then an operator action would have  
16 to occur.

17 You know, if you are telling me that I only  
18 have a minute, that is an AOO I can construct fairly  
19 easily.

20 MEMBER ARMIJO: Well I don't know if you  
21 have seen our white paper that we have put out.

22 MR. SCHMIDT: No, I haven't.

23 MEMBER ARMIJO: You know, Girija, why don't  
24 you send that to the Staff? And if the MHI people want

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1 to see that, it is in ADAMS. Because the data is two  
2 independent studies on BWR fuel tested with the very  
3 short transient test going to not particularly high  
4 powers either.

5 MR. SCHMIDT: Well I mean, give me some  
6 sense. In a PWR in this case you are probably going  
7 to go to the high flux set point of 109 percent power.

8 So the core power has gone up 109 percent. Now, if  
9 you are worried about say if this is an issue for higher  
10 burnup fuel or mid-burnup fuel -- let's call it  
11 mid-burnup.

12 MEMBER ARMIJO: It is mid-burnup. After  
13 high burnup, things start tapering down.

14 MR. SCHMIDT: Right. Right, so let's go  
15 to a mid-power. So for a nine percent increase, your  
16 mid-power pins will probably go up to maybe 12 percent  
17 because they won't have the Doppler feedback to keep  
18 them up. So they will go up a higher percentage than  
19 the core average power will go up. So let's say if my  
20 estimates are correct, you take a mid-power pin that  
21 is sitting probably at a core average power of around  
22 one, so you are at 4.65 kilowatts per foot and you go  
23 up 12 percent --

24 MEMBER ARMIJO: What is a peak nodal power

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1 at that point?

2 MR. SCHMIDT: Right, well that is what I  
3 am trying to estimate.

4 CHAIR STETKAR: That is where he is getting  
5 to.

6 MR. SCHMIDT: That is where I am going.  
7 You take the average kilowatts per foot times your FQ  
8 value, that is your nodal power. Right? So I am going  
9 up 12 percent in total core power or that pin really  
10 is going up 12 percent, and then times the same FQ I  
11 would normally take, which is 2.6 and calculate that.

12 Then I would compare it to this experimental  
13 data that you are referring to. But how long can I --  
14 is there data that tells me how long I can sit there  
15 and be okay?

16 MEMBER ARMIJO: The only data I know is that  
17 test data from Studsvik.

18 MR. SCHMIDT: And that gives duration as  
19 well as distance?

20 MEMBER ARMIJO: Yes, they timed it. These  
21 are tests done for an international program run by  
22 Studsvik and they used fuel cladding from, I think it  
23 was AREVA but it might have been German cladding  
24 Kraftwerk Union. And they timed the time in-between.

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1 They did very short transients just to address this  
2 issue of susceptibility to PCI during AOOs.

3 And they would terminate the test.  
4 Sometimes they could actually detect leakage. But the  
5 other times they would actually have to go into hot cells  
6 and they found that it was cracked three-quarters of  
7 the way through the cladding. And these were durations  
8 of very short time of 30 seconds to a few minutes.

9 In the BWR, then GE did a number of  
10 experiments and I was heavily involved in that. And  
11 we had got the same data with GE cladding, which is a  
12 different heat treatment and everything else. It was  
13 very consistent, a very short time.

14 And so if for example if the PWR peak powers  
15 never got above eight kilowatts a foot, even under the  
16 AOO transients and the pak nodes, they might be sitting  
17 pretty because those, you know, you need an absolute,  
18 you need to get to high power.

19 MR. SCHMIDT: Yes, I mean, it is going to  
20 probably be, you know if you take the 2.6 for FQ times  
21 your 4 point whatever it is, five, six times -- which  
22 is their average kilowatts per foot times.

23 MEMBER ARMIJO: I don't know what their  
24 peak factors are. It is all peak.

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1 MR. SCHMIDT: Yes. I mean your FQ limit  
2 in this plant is 2.6. So that is the maximum value you  
3 would pick. That is what is allowed by tech specs.

4 MEMBER ARMIJO: Okay, so you go 2.6 times  
5 your core average power --

6 MR. SCHMIDT: Right, times your core  
7 average to get your node.

8 MEMBER ARMIJO: -- that would be your peak  
9 node and then you multiply that by 12 percent.

10 MR. SCHMIDT: Right and then you multiply  
11 that by 12 percent.

12 MEMBER ARMIJO: Yes.

13 MR. SCHMIDT: You are probably sitting  
14 around probably around 10 to 11 kilowatts per foot.

15 MEMBER ARMIJO: Well I have seen data in  
16 some of the Mitsubishi documents that shows data points  
17 for fitting around what I think is about 13 kilowatts  
18 a foot.

19 MR. SCHMIDT: That might be the hot -- the  
20 lower burnup assembly.

21 MEMBER ARMIJO: No, I am talking  
22 mid-burnup.

23 MR. SCHMIDT: Oh, mid-burnup. Okay. I  
24 mean that is probably not too far off. I was estimating

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1 maybe around 11.

2 MEMBER ARMIJO: So if you are already at  
3 12, you are in the PCI regime. Okay and you go up another  
4 ten percent, you are in the PCI regime.

5 Now you have the benefit of that external  
6 pressure. As long as you have got that, you might be  
7 okay. But again, it is -- that is where you are  
8 vulnerable.

9 MR. SCHMIDT: I think that 13 or 14 was  
10 under AOOs, wasn't it though? The data that you are  
11 looking at, aren't those AOO data already?

12 MEMBER ARMIJO: If they are, it may be.  
13 It may be. I don't remember.

14 MR. SCHMIDT: Because I had put together  
15 a table that was estimating the kilowatts per foot that  
16 you got up to in transients. And I was taking AOOs as  
17 -- but I will have to go back. I will have to actually  
18 go back and look at that. But that is where I would  
19 think you would end up under an AOO under this plant  
20 because you are starting with a really low kilowatts  
21 per foot. It is definitely below current PWRs.

22 MEMBER ARMIJO: Yes, I don't deny that.  
23 This is very conservative. You have got a lot of fuel.  
24 You have got a fuel rod length that you -- this problem

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1 all is controlled by peak power.

2 MR. SCHMIDT: Right.

3 MEMBER ARMIJO: And you can have a really  
4 low average but if your peaking is really poor, peaking  
5 factor is high, you can get into it.

6 MR. SCHMIDT: There are a lot of plants out  
7 there like the 15 by 15 Westinghouse plants that run  
8 at a very high average kilowatts per foot that have a  
9 very, very similar FQ value. And I would hazard to guess  
10 also a very similar AOs.

11 MEMBER ARMIJO: You know and then if the  
12 staff has information that they have gone through these  
13 kinds of transients and nothing has never happened, that  
14 puts it to bed. I haven't seen that.

15 And I have asked in the only way that I know  
16 how to ask is do this analysis approach.

17 MR. SCHMIDT: I mean the only thing I can  
18 say is prior to coming to this job, I was on the  
19 zero-by-2010 INPO team because of some issues at Palo  
20 Verde that I was at. And you know, we looked at all  
21 kinds of fuel failure mechanisms. You know the  
22 predominant one for PWR is this grid-to-rod fretting,  
23 as you are probably aware. You know, and then we have  
24 had some crud issues over the years as fuel failures.

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1 We had some PCIM failures due to manufacturing defects.

2 But in this team work that I had done prior  
3 to coming to the NRC, we had never been able to identify  
4 a PCI fuel failure in actual plant operation. I think  
5 that is probably --

6 MEMBER ARMIJO: BWRs? That is --

7 MR. SCHMIDT: No, no. P, I was on the P  
8 group.

9 MEMBER ARMIJO: No, in PWRs have had PCI  
10 fuel failures. Not PCMI, PCI fuel failures. The most  
11 recent ones have been proven to be caused by chipped  
12 pellets being the cause.

13 MR. SCHMIDT: Right.

14 MEMBER ARMIJO: But before then there were  
15 fuel failures. Not as frequent as BWRs.

16 MR. SCHMIDT: What --

17 MEMBER ARMIJO: The whole thing here is it  
18 is an event that if it occurs, have you analyzed it and  
19 you have a good justification. Whether it is qualitated  
20 by virtue of experience or qualitated by virtue of  
21 claiming you have got it semi-quantitated by saying the  
22 power, the duration of the event will be over in a very  
23 short time, at least it has been addressed, not just  
24 a claim that hey, we are less than one percent strained.

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1 That means we are okay. I just don't agree with that.

2 MR. SCHMIDT: Just to educate me, what time  
3 frame did you see the PCI failures in PWR fuel?

4 MEMBER ARMIJO: Most recent in the last  
5 eight years on not Mitsubishi fuel but two other PWR  
6 fuel vendors where the fuel was operated in the U.S.  
7 and there were a lot of assemblies affected.

8 MR. SCHMIDT: By PWR and PCI?

9 MEMBER ARMIJO: Yes, sir.

10 MR. SCHMIDT: Okay.

11 MR. SPRENGEL: At this time, I think  
12 Mitsubishi can take an action to look at the design  
13 aspects of it and confirm if there is anything different  
14 from other PWRs.

15 CHAIR STETKAR: I think that would be a good  
16 start.

17 MR. SPRENGEL: Beyond that, I guess we  
18 would ask for additional interaction with the Staff to  
19 define that --

20 CHAIR STETKAR: Yes, that sounds like a way  
21 to get us at least, hopefully a long ways towards --  
22 in relation to this.

23 MR. SPRENGEL: And Girija, you will provide  
24 that paper or the reference?

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1 MR. SHUKLA: Yes, the white paper.

2 MR. SPRENGEL: The white paper.

3 MEMBER ARMIJO: It is in ADAMS.

4 CHAIR STETKAR: We will find it.

5 MEMBER ARMIJO: And Zeyna can get it for  
6 you.

7 CHAIR STETKAR: We'll find it.

8 MR. HAMZEHEE: Girija, make sure we get a  
9 copy.

10 MEMBER ARMIJO: Yes.

11 MR. SPRENGEL: But to be clear, right as  
12 of now, we are not proceeding with additional analyses  
13 or evaluations outside of --

14 CHAIR STETKAR: Just the list of --

15 MR. HAMZEHEE: The RAI.

16 MR. SPRENGEL: No, I am talking about PCI  
17 specifically.

18 MEMBER ARMIJO: Are you not going to even  
19 list your AOOs and put a chart that says this AOO, this  
20 is the initial power, final power, duration?

21 MR. SPRENGEL: As Jeff mentioned, I am  
22 certain that we could create a situation with AOOs to  
23 get to an area you have mentioned but I don't know what  
24 to do with that.

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1 So I don't --

2 MEMBER ARMIJO: Well let's hope you never  
3 experience it.

4 MR. SPRENGEL: I don't think I can create  
5 -- I don't see the need of creating a table when I already  
6 know what would be in it.

7 CHAIR STETKAR: Because you already know  
8 there will be at least one.

9 MR. SPRENGEL: Yes, you can create an AOO  
10 to lead you to a higher power for an extended time.  
11 You can create it.

12 MEMBER ARMIJO: Can the plant create it?  
13 That's all I care about. I don't care about me doing  
14 some hypothetical thing. But if it can happen in the  
15 plant, that is all I want to know. Is it reasonable  
16 to expect that to happen in the plant?

17 MEMBER BLEY: Once in a lifetime of the  
18 plant.

19 MEMBER ARMIJO: Once in a lifetime of the  
20 plant.

21 MEMBER BLEY: If it is a lot less likely  
22 than that, --

23 MEMBER ARMIJO: Then forget it.

24 MEMBER BLEY: -- then it doesn't really

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1 belong as an AOO.

2 MEMBER ARMIJO: No, that's right.

3 MR. SPRENGEL: Then it gets into a risk  
4 assessment of sorts. And again, I get back to I don't  
5 know what the boundary of my evaluation is. And I don't  
6 know what actions we can take or not take. There is  
7 just so many unknowns that I --

8 MEMBER ARMIJO: That is why you are  
9 designers of nuclear power plants.

10 MR. SPRENGEL: But with our vast  
11 experience, --

12 MEMBER ARMIJO: I will submit you haven't  
13 got vast experience on AOOs and this phenomenon.

14 CHAIR STETKAR: I'm going to see if I can  
15 cut off the discussion because I think we all understand  
16 where we are.

17 MEMBER ARMIJO: We have beat this horse to  
18 death.

19 CHAIR STETKAR: One of -- and I hate to say  
20 these things but we are planning to have, I believe in  
21 April, a full committee meeting on US-APWR, one of these  
22 meetings where the full committee has a chance to weigh  
23 in on any interim items that we may have identified as  
24 sufficiently important enough to merit a full committee

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1 letter. And the full committee weighs in an writes  
2 letters, not individuals.

3 So we have raised a concern here at at least  
4 the subcommittee level. Whether or not that gets raised  
5 to a higher level as far as part of the ACRS, kind of  
6 an interim letter on issues to be resolved during the  
7 licensing process remains to be seen. I certainly can't  
8 talk for the full committee, as none of us individually  
9 can.

10 And that is, I think, all we can do right  
11 at the moment as far as at the subcommittee level.

12 MEMBER ARMIJO: Sure.

13 CHAIR STETKAR: I suspect that, you know,  
14 we will need to be communicating over the next month  
15 or so to make sure that we understand what items, what  
16 chapters and topical reports that would be presented  
17 at the full committee at that April meeting and take  
18 it from there.

19 Any other members have any other questions  
20 or comments? If not, is there anything else from the  
21 Staff? MHI? Members of the public?

22 With that, I would like to again thank you  
23 all. I think it has been an interesting discussion,  
24 especially the last hour and a half or so. It is the

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1 only way to get through a lot of these things. I know  
2 it is really, really frustrating to a lot of people but  
3 it is the only way to get them out on the table and work  
4 our way through it. We will get through it eventually.

5 And with that, thank you all and the meeting  
6 is adjourned.

7 (Whereupon, the foregoing meeting was adjourned at 2:53  
8 p.m.)

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Presentation to ACRS Subcommittee  
MUAP-07009  
Thermal Design Methodology  
(Open Session)

January 15, 2013

Mitsubishi Heavy Industries, Ltd.

# MHI Presenters



## Lead Presenter:

Junichi Takeuchi

Senior Engineer (MHI)

Thermal-hydraulic Design

## Technical Experts:

Takayuki Suemura

Engineering Manager (MHI)

Thermal-hydraulic Methodology and Software

Masaya Hoshi

Senior Technical Advisor (MNES)

Thermal-hydraulic Design

# Overview of the Topical Report



- Comprehensive description of the thermal design methodology utilized by MHI
  - Based on approved code and methodology
    - ✓VIPRE-01 subchannel analysis code (EPRI-2522-CCM-A)
    - ✓WRB-1 and WRB-2 DNB correlations (WCAP-8762-P-A and WCAP10444-P-A)  
(Supplementary, W-3 utilized for low pressure events)
    - ✓RTDP: Revised Thermal Design Procedure (WCAP-11397-P-A)
  - Applicable to DNB analysis and transient fuel temperature analysis for MHI-designed PWR cores

- MHI version of VIPRE-01
- Incorporated additional functions:
  - DNB correlations for design applications
    - ✓ WRB-1/WRB-2
  - Fuel thermal properties for design applications
    - ✓ Accommodate degradation effect of thermal conductivity of the fuel with burnup
  - Options added for hot spot PCT analysis after DNB
  - More user-friendly interfaces

# Compliance with VIPRE-01 SER



- Code extension and application comply with NRC-issued EPRI VIPRE-01 SER
- SER conditions are discussed and addressed in the Topical Report:
  - Model options used for licensing analysis must be justified
    - ✓ Justification for model options are described with sensitivity studies and/or benchmark with NRC approved codes
  - Newly introduced CHF correlations must be validated
    - ✓ WRB-1/WRB-2 correlations are qualified by VIPRE-01M analysis of DNB test data
    - ✓ Original DNBR correlation limit of 1.17 is conservative for VIPRE-01M analysis of Mitsubishi fuel

# Qualification for Design Application

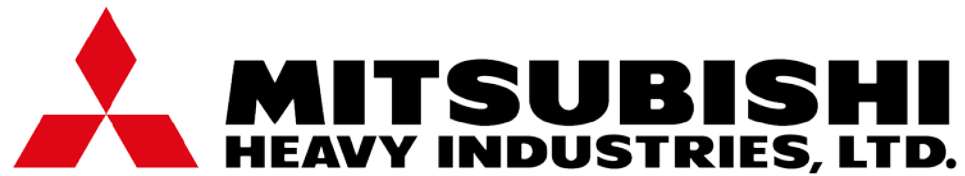


- DNBR results are similar or conservative in comparison with NRC approved codes
  - Steady state analysis results are compared against THINC code results for various plant conditions
  - Typical locked rotor analysis results (DNBR/PCT) are compared against FACTRAN and THINC code results

## Conclusion

- MHI thermal design methodology consists of:
  - RTDP
  - VIPRE-01M
  - WRB-1 and WRB-2 correlation
- VIPRE-01M is an extension of VIPRE-01.
- The VIPRE-01M model options selected for the licensing analysis are well-accepted and conservative
- WRB-1 and WRB-2 correlations and their original DNBR correlation limit of 1.17 are conservative for Mitsubishi fuel in conjunction with VIPRE-01M
- In summary, the MHI methodology is applicable to the core T/H design analyses and all non-LOCA Safety Analysis relevant to DNB





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# **Presentation to the ACRS Subcommittee**

**Topical Report MUAP-07009,  
Thermal Design Methodology (VIPRE-01M)  
Safety Evaluation**

January 15, 2013

# **NRC Staff Review Team**

## **Technical Staff**

- ♦ **Joshua Kaizer**  
NRR, Nuclear Performance and Code Review Branch
- ♦ **Anthony Attard** (retired)  
NRR, Nuclear Performance and Code Review Branch
- ♦ **Dan Hughes**  
Consultant, Information System Laboratories
- ♦ **Jeff Schmidt**  
NRO, Nuclear Performance and Code Review Branch

## **Project Manager**

- ♦ **Ruth Reyes**  
NRO, Division of New Reactor Licensing

# Overview of Staff Review Process

- Staff used SRP 15.0.2 *Review of Transient and Accident Analysis Methods* to review MUAP-07009.
  - ♦ Staff relied on the previous SER for VIPRE-01 and other similar approvals of VIPRE-01 (Westinghouse, Duke, Dominion).
- Staff issued five rounds of RAIs and performed two Quality Assurance audits.
- Staff observed DNB testing at the KATHY loop in Germany.

# Overview of MUAP-07009

- Describes VIPER-01M and its applicability to PWRs
  - ♦ VIPRE-01M is EPRI's VIPRE-01 (previously approved) with minor changes.
  - ♦ VIPRE-01M is used to perform non-LOCA transient and accident analysis for the US-APWR.
- Topical Report provides details on the following:
  - ♦ Core Modeling
  - ♦ Transient Fuel Rod Modeling
  - ♦ Thermal-hydraulic models used
- VIPRE-01M is consistent with previously approved versions of VIPRE-01.

# VIPRE-01M

- Subchannel code used to predict transient behavior.
  - ♦ Usually used for predicting margin to DNB.
  - ♦ Can be used for PCT analysis (e.g. Locked Rotor).
- US-APWR is very similar to a standard PWR.
  - ♦ No challenges in the review of VIPRE-01M due to the reactor type (typical PWR).
- VIPRE-01 was approved generically, but each vendor must justify the specific models used.
  - ♦ MHI listed the models used and provided some justification.
  - ♦ Ultimately, the justification for the selection of thermal-hydraulic models is the accurate prediction of data, which was accomplished through the CHF testing.

# VIPRE-01M Validation

- DNB Test Data
  - ♦ Need to validate the DNB predictions with the same computer code and same models.
  - ♦ Need to validate that the DNB model can be used to predict the DNB performance of a specific fuel type.
  - ♦ Test data spanned the application range of WRB-1 and WRB-2 CHF models (and some outside the range).
- MHI used the KATHY facility in Germany to confirm the applicability of the WRB-1 and WRB-2 DNB models for US-APWR fuel.
- The tests did confirm that the WRB-1 and WRB-2 DNB models could be used to conservatively predict the CHF performance of US-APWR fuel.

# QA Audit

- MHI is a “new vendor” to the NRC, therefore we performed two QA audits
  - ♦ M-RELAP-5 and VIPRE-01M audit focused on the QA aspects used to modify the codes.
  - ♦ VIPRE-01M audit focused on the QA aspects used to exercise the codes.
- No significant issues were discovered.
  - ♦ One issue which lead to a condition and limitation in the SER was use of a non-frozen version of VIPRE-01M during some of the analysis.



# Conclusions

- MHI Thermal Design methodology is acceptable for licensing analyses.
- VIPRE-01M is for performing AOO and accident analysis.
- WRB-1 and WRB-2 are acceptable models for predicting the CHF behavior of the US-APWR fuel.