

NUCLEAR REGULATORY COMMISSION

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Safeguards (OPEN SESSION)

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

November 14, 2007

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

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UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)
MEETING OF THE SUBCOMMITTEE ON THERMAL HYDRAULICS

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OPEN SESSION

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WEDNESDAY

NOVEMBER 14, 2007

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The meeting was convened in Room T-2B3 of
Two White Flint North, 11545 Rockville Pike,
Rockville, Maryland, at 8:30 a.m., Dr. Said Abdel-
Khalik, Chairman, presiding.

MEMBERS PRESENT:

- SAID ABDEL-KHALIK, Chairman
- OTTO MAYNARD, Member
- MICHAEL CORRADINI, Member
- MARIO BONACA, Member
- SAM ARMIJO, Member
- SANJOY BANERJEE, Member
- OTTO L. MAYNARD, Member
- JOHN D. SIEBER, Member

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CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

GRAHAM WALLIS

DAVID DIAMOND

NRC STAFF PRESENT:

HOLLY CRUZ

TAI HUANG

ALSO PRESENT:

JOSE MARCH-LEUBA

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

8:30 a.m.

CHAIR ABDEL-KHALIK: The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards Thermal Hydraulics Subcommittee. I am Said Abdel-Khalik, Chairman of the Subcommittee's review of Areva Stability Topical Reports ANP-10262(P) and BAW-10255(P), Rev. 2.

Subcommittee members in attendance are Jack Sieber, Sanjoy Banerjee, Sam Armijo, Mario Bonaca, Otto Maynard, and Michael Corradini. Also in attendance are ACRS consultants Graham Wallis and David Diamond.

The purpose of today's meeting is to hear presentations by and hold discussions with AREVA, the NRC staff, their consultants and other interested persons regarding these matters. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full Committee.

Zena Abdullahi is the designated federal official for this meeting. The Subcommittee will be reviewing material AREVA considers as proprietary. Therefore, those portions of the meeting which AREVA presents the specifics of their methodology will be

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1 closed. The proposed times for the closed sessions
2 are identified in the agenda.

3 A transcript of the meeting is being kept
4 and will be made available as stated in the Federal
5 Register notice. It is requested that speakers first
6 identify themselves and speak with sufficient clarity
7 and volume so that they can be readily heard.

8 I would like to point out that the
9 presentations by AREVA and the staff have more than
10 100 slides. Given the time constraint the speaker
11 should not dwell on tutorial material. We will now
12 proceed with the meeting and I call upon Ms. Holly
13 Cruz, the NRC project manager, to provide a brief
14 introduction.

15 MS. CRUZ: Good morning. My name is Holly
16 Cruz. I am the AREVA project manager. To begin, I
17 wanted to provide a brief description of a topical
18 report. A topical report is a report on a specific
19 safety related subject submitted to the NRC and
20 reviewed independently of any operating license
21 review.

22 A topical report provides the technical
23 basis for nuclear power plant licensing actions, can
24 be used by multiple licensees, and minimizes NRC and
25 industry time and effort like providing a streamlined

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1 review.

2 The two topical reports that will be
3 discussed today are Topical Report BAW-10255, Rev. 2,
4 Cycle-Specific DIVOM Methodology using the RAMONA5-FA
5 Code, and Topical Report ANP-10262, Rev. 0, Enhanced
6 Option III, Long Term Stability Solution. The NRC
7 provided draft safety evaluations on both topical
8 reports to AREVA on November 9, 2007.

9 With that I will introduce Tai Huang and
10 Jose March-Leuba to provide the overview on the
11 topical reports.

12 DR. HUANG: I'm Tai Huang, Acting
13 Assistant, and original reviewer for the Stability
14 Solution. In 1980 time frame to today we start
15 obligation from informational lead. The staff review
16 is always consistent because the reviewer and the
17 consultation from the same sources.

18 Here I express my great expression of my
19 appreciation to consultant from Oak Ridge National
20 Lab, Dr. O.J. McCuver. With his big help we have
21 finished a lot of BWR Owners' Group solutions starting
22 from generic study up to and including the two topical
23 today we are going to present here. The first one is
24 the Enhanced Option III, Long Term Stability Solution
25 which is a new long-term study of solution algorithm

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1 applicable to flow domains like MELLLA+.

2 Second topical will be the Cycle Specific
3 DIVOM Methodology using RAMONA5-FA Code which is AREVA
4 authority for calculating the DIVOM correlations which
5 is the required component for the tech solution to get
6 up the trips at home. As you know, the stability
7 become very important issues especially in this
8 extending operating.

9 As you can see from the red line and the
10 red dot over there because today we have from original
11 license and power operation from the lower line there
12 and then extended through the MELLLA+ and then
13 extension EPU up to the MELLLA+. You see that two
14 pump trip situation. You end up with the red dot line
15 on the natural circulation way up inside its stability
16 boundary over there. It becomes very important. What
17 to do then, you know? We have to find a good solution
18 to resolve these issues.

19 The first one here on the bottom up to the
20 EPU we have to find out another solution how to deal
21 with these regions. Second, we have to deal with
22 MELLLA+ domain here. We are stuck with the Owners'
23 Group and industry result and solution. Next time we
24 show you three options.

25 DR. WALLIS: That red dot there is the end

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1 of a rod line which comes down from MELLLA+. Right?
2 It's the end of a rod line which comes down when you
3 lose your pumps or something.

4 DR. HUANG: Yes.

5 DR. WALLIS: It's not just sitting there
6 by itself.

7 DR. HUANG: End of the pump. Next slide.
8 You see that the BWR Owners' Group and staff came up
9 with a solution to take care of this up to the
10 extender and then up to the solution so there are
11 three options. Option I, E(1)(a)(1)(d), Option II and
12 Option III. As you know, in the United States all the
13 power plants are all incremented. These three options
14 depend on their need.

15 MEMBER BANERJEE: If you go back to the
16 previous slide, please, that extended operating domain
17 there is actually formed by -- I mean, identified
18 because you have many different things coming in as
19 limits, CPR, LOCA, low-flow LOCA and so on. The
20 stability aspect of that is only one part of the
21 analysis. Right?

22 DR. MARCH-LEUBA: Correct. But we do have
23 BWR Owners' Group Solutions already approved in the
24 books up to the 8th of July. That is what we are
25 presenting to you, Enhanced Option III, to be able to

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1 operate on this line a long-term solution that will
2 allow us --

3 MEMBER BANERJEE: All I'm saying is
4 applying MELLLA+ to any fuel different from what we
5 approved MELLLA+ for would involve considerations
6 other than stability.

7 DR. MARCH-LEUBA: Absolutely.

8 MEMBER BANERJEE: So you are very focused
9 on just dealing with the stability solution here that
10 is proposed.

11 DR. MARCH-LEUBA: Correct.

12 MR. CORRADINI: In the MELLLA+ region.

13 MEMBER BANERJEE: In the MELLLA+ region.

14 DR. WALLIS: So is it clear then that you
15 don't need Option III for an EPU?

16 DR. MARCH-LEUBA: Yes.

17 DR. WALLIS: You do not need Option III?

18 DR. MARCH-LEUBA: Not Enhanced Option III.

19 DR. HUANG: We will explain to you --

20 DR. WALLIS: You will explain to me Option
21 III sometime? That's what I have some problem with.

22 DR. HUANG: We can keep going and then
23 catch your questions there.

24 The next slide shows that the domain for
25 EPU MELLLA+, Option I, II, III. In the MELLLA region

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1 there are two authorities. The first one is called GE
2 DSS/CD, detect suppress solution confirmation density
3 has been approved. This one for Enhanced Option III
4 that is under review right now. What is the
5 difference between that and Option III the next slide
6 will show you.

7 Enhanced Option III is evolution step
8 which relies on existing mass authority and also the
9 hardware for Solution III so you tie in these
10 together. The next bullet say EO-III introduce
11 measures of addressing the reduced ability associated
12 with extended flow in the condition and the higher
13 probability or single channel hydraulic instability
14 excitation.

15 That is what the difference is. EO III
16 will have a measure to take care of these two issues.
17 One is how to deal with the high probability of single
18 channel hydraulic instability. Also they take care of
19 the extended domain because the endpoint would be
20 exceeding the --

21 DR. WALLIS: The red dot you showed us on
22 the earlier slide, does that have then this extended
23 flow window problem with single channel hydraulic
24 instability?

25 MR. CORRADINI: Can you go back to the red

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1 dot?

2 DR. WALLIS: Does the red dot have this
3 problem?

4 MR. CORRADINI: Which red dot are you
5 pointing at?

6 DR. WALLIS: Where is the region where you
7 get into the single channel? Where is it? That is an
8 exclusion which is already there because of decay
9 ratio. Right?

10 MEMBER BANERJEE: He goes jumping around.
11 Give him a mic.

12 MR. CORRADINI: We want Jose to jump
13 around.

14 DR. WALLIS: Keep him moving.

15 DR. MARCH-LEUBA: As we all know by now
16 because we have been spending the last two years
17 together, there are three types of instability. There
18 is the challenge stability which is deals with logic,
19 core-wide instability when the hard core goes up and
20 down, and out-of-phase when half the core goes up and
21 the other half goes down. This line is the line that
22 compasses all three of them. There is a region here
23 of channel instability. There is a region of --

24 DR. WALLIS: That line covers the maximum
25 decay ratio from any one of the three.

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1 DR. MARCH-LEUBA: From any of the three.

2 DR. WALLIS: Okay.

3 MEMBER BANERJEE: Where is the single
4 channel?

5 DR. MARCH-LEUBA: It would be inside and
6 it would be kind hollow but it might cross.

7 DR. WALLIS: It would be very useful to
8 show the single channel on there somehow so we can
9 tell when you worry about it.

10 DR. MARCH-LEUBA: It's somewhere up here.

11 DR. WALLIS: The red dot is in there.

12 MR. CORRADINI: So then just to repeat for
13 my understanding. Everybody else gets it but I don't
14 get it. The first red dot is clearly okay or is on
15 the border of okay. The next red dot is okay for
16 single channel but there would be methods for detect
17 and suppress for core-wide instabilities. The third
18 red dot is unclear at this point given the
19 methodologies we are about to look at.

20 DR. MARCH-LEUBA: That's a good way to put
21 it.

22 MR. CORRADINI: Okay. Thanks.

23 DR. MARCH-LEUBA: The way I explain it --

24 MEMBER BANERJEE: It would be really nice
25 if you could show on this map regions of each of these

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1 three instabilities and the overlap so we understand
2 what we are getting into.

3 MR. CORRADINI: We think we understand but
4 we are old and we forget.

5 DR. WALLIS: We think we will understand
6 by noon.

7 DR. MARCH-LEUBA: I can give you a case
8 but this is plant specific and psycho specific. It's
9 day specific in the cycle.

10 MEMBER BANERJEE: We are not looking for
11 exact. We just want a general idea.

12 MR. CORRADINI: And then one last thing
13 for my understanding. Let's go to the -- you can stay
14 where you are -- the lowest red dot. That one when
15 you cross that boundary that is a core power
16 instability, the core power or the magnitude could
17 fluctuate because you enter into a region. Is that
18 correct?

19 DR. MARCH-LEUBA: It could be core-wide.
20 It could be regional.

21 MEMBER BANERJEE: For Option I.A you deal
22 with mainly core-wide.

23 DR. MARCH-LEUBA: I.A could be regional or
24 core-wide.

25 DR. WALLIS: So when you have this word

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1 ill-behaved DIVOM solution, does that refer to this
2 single channel area then?

3 DR. MARCH-LEUBA: Can we go to the closed
4 session for that?

5 DR. WALLIS: You want closed session for
6 that? When you say ill-behaved, what do you mean by
7 ill-behaved?

8 MEMBER BANERJEE: It is single channel
9 DIVOM proprietary to AREVA?

10 DR. MARCH-LEUBA: Yes.

11 MEMBER BANERJEE: Nobody else has single
12 channel?

13 DR. MARCH-LEUBA: It is an issue of
14 proprietary nature, intellectual property. We will
15 discuss this in closed session.

16 DR. HUANG: That detail will be covered
17 when we continue. The single channel instability
18 bouncing around is normal.

19 DR. WALLIS: I think what we are trying to
20 do is focus on what is new because we understand
21 DIVOM. We understand the lower part. We want to know
22 what is new about that top red top and how do you fix
23 it.

24 CHAIR ABDEL-KHALIK: Can we wait until we
25 get to the closed session? Thank you.

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1 DR. HUANG: So now you know EO III
2 already and --

3 MEMBER BONACA: This is just a question I
4 have. There is an inconsistency

5 MEMBER BONACA: This is just a question I
6 have. There is an inconsistency between the slides
7 you are showing and what we have here. Are we looking
8 at the wrong thing?

9 DR. MARCH-LEUBA: Are you looking at the
10 open session?

11 MS. ABDULLAHI: No, they are looking at
12 the closed session.

13 DR. WALLIS: We don't have the open
14 session?

15 MEMBER BONACA: Just so I stop looking at
16 it.

17 CHAIR ABDEL-KHALIK: Please continue.

18 DR. HUANG: Before you can use the EO-III
19 and as a part of the integral portion of the
20 application will be the final curve. The final curve,
21 as we know, is the relationship between the hot bundle
22 observation magnitude and fluctuational change in the
23 critical power ratio. This is already documented in
24 the BWR Owners' Group document. This review we trace
25 the capability of the RAMONA5-FA system code to

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1 model --

2 DR. WALLIS: Let me go back to bullet one.
3 Bullet one is true if there is such a unique curve.
4 If there is a lot of variability, there is no unique
5 curve. If there is a relationship, then the DIVOM
6 curve describes it. If there is no clear
7 relationship, there is no DIVOM curve.

8 DR. MARCH-LEUBA: Then it becomes in
9 commission.

10 DR. WALLIS: Thank you.

11 MEMBER BANERJEE: I mean, the finding is
12 a purely empirical finding in that first bullet.

13 DR. MARCH-LEUBA: It is a correlation. I
14 don't call it a curve. I call it a DIVOM correlation.

15 MEMBER BANERJEE: And this is only
16 established on the basis of experiments or is it
17 established only on the code experiments then?

18 DR. MARCH-LEUBA: Code experiments.

19 MEMBER BANERJEE: So you have to believe
20 the code before you believe --

21 DR. MARCH-LEUBA: Correct. We will come
22 back to that.

23 DR. WALLIS: Part of the literature says
24 it is the upper limit of all the points but if we have
25 a few points which are crossing it, then it is no

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1 longer the upper limit. I guess we will get to that
2 in the closed session.

3 DR. HUANG: Okay. So now to the end is
4 DIVOM mass authority that operates the procedures for
5 processing the system code. To the end you have to
6 get DIVOM curve so that is DIVOM data consistent with
7 their intended application.

8 DR. WALLIS: We are not reviewing RAMONA
9 so we have to believe the results?

10 MEMBER BANERJEE: I don't know if we have
11 to believe it.

12 DR. HUANG: When the time goes we are
13 going to see that we are using the RAMONA5 as a
14 limiting use for this particular case.

15 DR. WALLIS: It doesn't imply any blessing
16 of RAMONA5.

17 DR. HUANG: That is the point of this
18 publication, limited use.

19 DR. WALLIS: Even for this application we
20 simply can say it seems to correlate some data.

21 DR. HUANG: Yes.

22 DR. WALLIS: Maybe a chance thing.

23 DR. HUANG: Right.

24 MEMBER BANERJEE: When do we get a chance
25 to actually review this code because it seems to be

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1 used for this purpose without really going into an in-
2 depth review. We wouldn't do that to TRACG so why
3 don't we do it to RAMONA?

4 DR. HUANG: Start to think about it to
5 take that one option. If that isn't good enough, that
6 same situation like TRACG to show your calculation and
7 to meet the requirement.

8 MEMBER BANERJEE: More than that we start
9 with the equations. This is a very different code
10 from any of the other codes that are being used and
11 there are issues. Are we allowed to talk about RAMONA
12 in open session or not?

13 DR. HUANG: No.

14 MEMBER BANERJEE: However, RAMONA was
15 basically developed by Brookhaven in 1983 and it was
16 published at that time. I don't see what is closed
17 about the equations. Are there secret equations?

18 MR. DIAMOND: Many of the equations that
19 are now part of the model are new.

20 MEMBER BANERJEE: I don't think the
21 momentum equation. I've checked it. The energy
22 equations are new. I suppose they have some
23 consistency in time. Right?

24 MR. DIAMOND: The neutron kinetics is
25 certainly new.

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1 MEMBER BANERJEE: I'm not talking about
2 neutron kinetics. Thermal hydraulic equations are new
3 or have they some unique feature which was not there?

4 MR. PRUITT: Doug Pruitt, AREVA. The
5 thermal hydraulic solution is the same. As far as the
6 balance equations it's just the closure correlations
7 that have been changed.

8 MEMBER BANERJEE: We can comment on the
9 structure of the equations in open session or not?

10 CHAIR ABDEL-KHALIK: When the time comes.

11 DR. HUANG: When we have time. We get
12 this over first.

13 MEMBER BANERJEE: But I think something
14 should be in the public record.

15 DR. WALLIS: There is a possibility that
16 we will look at RAMONA sometime in the future and have
17 a significant critique of it. I just wonder what that
18 does to approving its use now. If it turns out that
19 ACRS has some real problems with RAMONA in the future,
20 does that prejudice somehow its use for this purpose?

21 DR. HUANG: Back to the same petition, I
22 presented here a long time ago, 10 years ago the BWR
23 Owners' Group Solutions. At that time the TRACG has
24 been applied time to time whether they approve or not.
25 We haven't approved anything at that time. Since

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1 duration we are going to check the position.

2 MEMBER BANERJEE: TRACG was evolving from
3 a code that we had quite a lot of acquaintance with
4 from something we had seen over 20 years and approved
5 in various stages. This one is completely different.

6 DR. MARCH-LEUBA: That's not 100 percent
7 accurate. RAMONA is an approved code by NRC for a
8 different vendor and it was reviewed for AVV at the
9 time.

10 MR. CORRADINI: I think that is the basis
11 is what I understand.

12 DR. MARCH-LEUBA: RAMONA is the NRC
13 approved code for stability analysis for the --

14 DR. WALLIS: This is the Sturvich version
15 that is approved?

16 DR. MARCH-LEUBA: No, it's 103
17 conversation.

18 MR. DIAMOND: It was the ABB?

19 DR. MARCH-LEUBA: ABB is not a time in my
20 life.

21 MEMBER BONACA: I understand.

22 DR. WALLIS: If there are significant
23 problems with the documentation, this is a little
24 embarrassing then?

25 DR. MARCH-LEUBA: What is?

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1 MR. CORRADINI: I don't think they
2 understood your point.

3 DR. WALLIS: I don't want to have to write
4 a review of RAMONA which reveals significant problems
5 with the documentation if it's already been approved.

6 MR. DIAMOND: I think the only thing that
7 they are talking about that had been approved is the
8 structure of the thermal hydraulic equations but the
9 constitutive laws and the neutronic kinetics is all
10 totally different.

11 DR. WALLIS: Presumably someone has
12 proofread it because I'll be reading it and I'm going
13 to have some comments on it. We should probably move
14 on.

15 DR. HUANG: We are going to get you
16 additional information about which parts have been
17 approved. We are going back to the document.

18 MEMBER BANERJEE: When was it approved?

19 DR. HUANG: 1990 something. '95, '94. At
20 that time the Owners' Group was working with different
21 vendors so they submit different authority. At that
22 time RAMONA3 was used to get their calculation but we
23 will find that detail.

24 CHAIR ABDEL-KHALIK: At some point it
25 would be a good idea to know exactly what has been

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1 approved and the differences between the RAMONA5-FA
2 and the RAMONA3 that has been approved.

3 DR. MARCH-LEUBA: That's another
4 presentation.

5 DR. HUANG: One of the slides showing
6 RAMONA3 and 4, 5 and 5A. Next slide. The staff
7 conclude that EO-III is an acceptable authority to
8 detect and suppress oscillations should they occur and
9 satisfy the GDC-12. Also solution features provide
10 protection up to and including the conditions. On top
11 of that application --

12 DR. WALLIS: Excuse me. It says to detect
13 and suppress oscillations.

14 DR. HUANG: Yes.

15 DR. WALLIS: I thought that the whole
16 solution was to define an exclusion region. That is
17 very different from detecting and suppression.

18 DR. HUANG: When we present later --

19 DR. WALLIS: You are going to make it
20 clearer the difference between an exclusion region and
21 detecting and suppressing?

22 DR. HUANG: For instance --

23 DR. MARCH-LEUBA: It's a mixed solution.

24 DR. WALLIS: It's a mixed one. It's not
25 just detect and suppress.

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1 DR. MARCH-LEUBA: The exclusion region is
2 used to guarantee that the analysis basis are within
3 their assumption.

4 DR. WALLIS: We are going to get into that
5 later. I don't think detect and suppress is the
6 entire answer here.

7 DR. MARCH-LEUBA: The licensing basis is
8 detect and suppress. The exclusion region is there to
9 guarantee that the analysis assumptions used for the
10 fissile point hold.

11 DR. WALLIS: We'll get into that later
12 then.

13 DR. HUANG: And AREVA DIVOM authority is
14 consistent with previous BWR Owners' Group solution,
15 NETO-32465. That is DIVOM approach so that is
16 consistent with that.

17 MEMBER BANERJEE: I just wanted to ask a
18 question about the last bullet. I mean, could these
19 results also be teamed with STAIF or do you absolutely
20 need RAMONA?

21 DR. MARCH-LEUBA: You need RAMONA. You
22 need a time-dependent oscillation to see how much the
23 CPR changes the STAIF. Nothing else relating to
24 STAIF. You only have frequency remain. You could do
25 some transfer function analysis. STAIF does not

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1 calculate CPRs.

2 MEMBER BANERJEE: So DIVOM actually
3 requires calculation of the fluctuating flows and
4 directly calculates the critical heat flux and, hence,
5 the critical power ratio.

6 DR. MARCH-LEUBA: The underlying problem,
7 and I'll spend two minutes on this to set up the
8 discussion, is that DIVOM is a correlation that tells
9 you if my power is oscillating by X percent how much
10 is my CPR suffering from that. That is the question
11 you want to ask yourself. The problem is the reactor
12 doesn't care how much the power is oscillating.

13 The CPR really is changing because the
14 flow is oscillating, the relationship between
15 oscillation and power oscillation. When the power
16 oscillates it oscillates within 10 to the minus 5
17 second time. When the power oscillates it oscillates
18 with a 10 second time delay. There is a loose
19 correlation between them.

20 MEMBER BANERJEE: You are saying it's one-
21 way coupled.

22 DR. MARCH-LEUBA: It's coupled one way.
23 We have to set up with RAMONA a set of self-consistent
24 flow power oscillations that are consistent for your
25 reactor. RAMONA solves the reverse problem and tells

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1 us the answer that we want. That is the whole problem
2 is that we are serving an inverse problem.

3 CHAIR ABDEL-KHALIK: Because power is what
4 we measure and detect.

5 DR. MARCH-LEUBA: Power is what we count
6 on.

7 (Whereupon, at 8:59 the Subcommittee on
8 Thermal Hydraulics went into closed session.)

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CERTIFICATE

This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on
Reactor Safeguards

Docket Number: n/a

Location: Rockville, MD

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



Charles Morrison
Official Reporter
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