Official Transcript of Proceedings

NUCLEAR REGULATORY COMMISSION

Title: Meeting of the Subcommittee on Thermal Hydraulics, Advisory Committee on Reactor Safeguards (OPEN SESSION)

Docket Number: (not applicable)

Location: Room T-2B3
Two White Flint North
11545 Rockville Pike
Rockville, Maryland

Date: Wednesday, November 14, 2007

Work Order No.: NRC-1864 Pages 1-25

CLOSED SESSION: Pages: 26-202

NEAL R. GROSS AND CO., INC.
Court Reporters and Transcribers
1323 Rhode Island Avenue, N.W.
Washington, D.C. 20005
(202) 234-4433

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)

MEETING OF THE SUBCOMMITTEE ON THERMAL HYDRAULICS

+ + + + +

OPEN SESSION

+ + + + +

WEDNESDAY

NOVEMBER 14, 2007

+ + + + +

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

CONSULTANTS TO THE SUBCOMMITTEE PRESENT:

GRAHAM WALLIS

DAVID DIAMOND

NRC STAFF PRESENT:

HOLLY CRUZ

TAI HUANG

ALSO PRESENT:

JOSE MARCH-LEUBA

TABLE OF CONTENTS

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

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

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

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

review.

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

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

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

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

Here I express my great expression of my appreciation to consultant from Oak Ridge National

Lab, Dr. O.J. McCuver. With his big help we have finished a lot of BWR Owners' Group solutions starting from generic study up to and including the two topical today we are going to present here. The first one is the Enhanced Option III, Long Term Stability Solution which is a new long-term study of solution algorithm applicable to flow domains like MELLLA+.

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

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

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

DR. WALLIS: That red dot there is the end of a rod line which comes down from MELLLA+. Right? It's the end of a rod line which comes down when you lose your pumps or something.

DR. HUANG: Yes.

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

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

MEMBER BANERJEE: If you go back to the previous slide, please, that extended operating domain there is actually formed by -- I mean, identified

because you have many different things coming in as limits, CPR, LOCA, low-flow LOCA and so on. The stability aspect of that is only one part of the analysis. Right?

DR. MARCH-LEUBA: Correct. But we do have BWR Owners' Group Solutions already approved in the books up to the 8th of July. That is what we are presenting to you, Enhanced Option III, to be able to operate on this line a long-term solution that will allow us --

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

DR. MARCH-LEUBA: Absolutely.

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

DR. MARCH-LEUBA: Correct.

MR. CORRADINI: In the MELLLA+ region.

MEMBER BANERJEE: In the MELLLA+ region.

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

DR. MARCH-LEUBA: Yes.

DR. WALLIS: You do not need Option III?

DR. MARCH-LEUBA: Not Enhanced Option III.

DR. HUANG: We will explain to you --

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

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

The next slide shows that the domain for EPU MELLLA+, Option I, II, III. In the MELLLA region there are two authorities. The first one is called GE DSS/CD, detect suppress solution confirmation density has been approved. This one for Enhanced Option III that is under review right now. What is the difference between that and Option III the next slide will show you.

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

That is what the difference is. EO III

will have a measure to take care of these two issues. One is how to deal with the high probability of single channel hydraulic instability. Also they take care of the extended domain because the endpoint would be exceeding the --

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

MR. CORRADINI: Can you go back to the red dot?

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

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

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

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

MR. CORRADINI: We want Jose to jump around.

DR. WALLIS: Keep him moving.

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

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

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

DR. WALLIS: Okay.

MEMBER BANERJEE: Where is the single channel?

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

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

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

DR. WALLIS: The red dot is in there.

MR. CORRADINI: So then just to repeat for my understanding. Everybody else gets it but I don't

get it. The first red dot is clearly okay or is on the border of okay. The next red dot is okay for single channel but there would be methods for detect and suppress for core-wide instabilities. The third red dot is unclear at this point given the methodologies we are about to look at.

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

MR. CORRADINI: Okay. Thanks.

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

MEMBER BANERJEE: It would be really nice if you could show on this map regions of each of these three instabilities and the overlap so we understand what we are getting into.

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

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

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

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

MR. CORRADINI: And then one last thing

for my understanding. Let's go to the -- you can stay where you are -- the lowest red dot. That one when you cross that boundary that is a core power instability, the core power or the magnitude could fluctuate because you enter into a region. Is that correct?

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

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

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

DR. WALLIS: So when you have this word ill-behaved DIVOM solution, does that refer to this single channel area then?

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

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

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

DR. MARCH-LEUBA: Yes.

MEMBER BANERJEE: Nobody else has single

channel?

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

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

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

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

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

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

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

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

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

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

MEMBER BONACA: Just so I stop looking at it.

CHAIR ABDEL-KHALIK: Please continue.

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

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

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

DR. WALLIS: Thank you.

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

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

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

DR. MARCH-LEUBA: Code experiments.

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

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

DR. WALLIS: Part of the literature says it is the upper limit of all the points but if we have a few points which are crossing it, then it is no longer the upper limit. I guess we will get to that in the closed session.

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

DR. WALLIS: We are not reviewing RAMONA

so we have to believe the results?

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

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

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

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

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

DR. HUANG: Yes.

DR. WALLIS: Maybe a chance thing.

DR. HUANG: Right.

MEMBER BANERJEE: When do we get a chance to actually review this code because it seems to be used for this purpose without really going into an in-depth review. We wouldn't do that to TRACG so why don't we do it to RAMONA?

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

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

DR. HUANG: No.

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

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

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

MR. DIAMOND: The neutron kinetics is certainly new.

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

MR. PRUITT: Doug Pruitt, AREVA. The thermal hydraulic solution is the same. As far as the balance equations it's just the closure correlations

that have been changed.

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

CHAIR ABDEL-KHALIK: When the time comes.

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

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

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

DR. HUANG: Back to the same petition, I presented here a long time ago, 10 years ago the BWR Owners' Group Solutions. At that time the TRACG has been applied time to time whether they approve or not. We haven't approved anything at that time. Since duration we are going to check the position.

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

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

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

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

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

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

MR. DIAMOND: It was the ABB?

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

MEMBER BONACA: I understand.

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

DR. MARCH-LEUBA: What is?

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

DR. WALLIS: I don't want to have to write a review of RAMONA which reveals significant problems

with the documentation if it's already been approved.

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

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

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

MEMBER BANERJEE: When was it approved?

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

CHAIR ABDEL-KHALIK: At some point it would be a good idea to know exactly what has been approved and the differences between the RAMONA5-FA and the RAMONA3 that has been approved.

DR. MARCH-LEUBA: That's another

presentation.

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

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

DR. HUANG: Yes.

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

DR. HUANG: When we present later --

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

DR. HUANG: For instance --

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

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

DR. MARCH-LEUBA: The exclusion region is used to guarantee that the analysis basis are within

their assumption.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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