

Official Transcript of Proceedings  
NUCLEAR REGULATORY COMMISSION

Title: ACRS Power Uprate Subcommittee  
Open Session

Docket Number: N/A

Location: Rockville, MD

Date: November 17, 2010

Work Order No.: NRC-555

Pages 1-19

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

1  
2 DISCLAIMER

3  
4  
5 UNITED STATES NUCLEAR REGULATORY  
6 COMMISSION'S ADVISORY COMMITTEE ON REACTOR  
7 SAFEGUARDS  
8  
9

10 The contents of this transcript of the  
11 proceeding of the United States Nuclear Regulatory  
12 Commission Advisory Committee on Reactor Safeguards,  
13 as reported herein, is a record of the discussions  
14 recorded at the meeting.  
15

16 This transcript has not been reviewed,  
17 corrected, and edited, and it may contain  
18 inaccuracies.  
19  
20  
21  
22  
23

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

[www.nealrgross.com](http://www.nealrgross.com)

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION  
+ + + + +  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)  
POWER UPRATE SUBCOMMITTEE  
+ + + + +  
OPEN SESSION  
+ + + + +  
WEDNESDAY  
NOVEMBER 17, 2010  
+ + + + +  
ROCKVILLE, MARYLAND  
+ + + + +

The Subcommittee met at the Nuclear  
Regulatory Commission, Two White Flint North, Room  
T2B1, 11545 Rockville Pike, at 8:30 a.m., Said  
Abdel-Khalik, Chairman, presiding.

SUBCOMMITTEE MEMBERS:

SAID ABDEL-KHALIK, Chairman  
SANJOY BANERJEE, Member  
JOHN D. SIEBER, Member

ACRS CONSULTANT PRESENT:

GRAHAM B. WALLIS

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS  
1323 RHODE ISLAND AVE., N.W.  
WASHINGTON, D.C. 20005-3701

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12

ACRS STAFF PRESENT:

ZEYNA ABDULLAHI, Designated Federal Official

HOLLY CRUZ

TAI L. HUANG

JOSE MARCH-LEUBA

**ANTHONY ULSES**

**ALSO PRESENT:**

**YOUSEF FARAWILA, AREVA**

**DOUG PRUITT, AREVA**

**DAN TINKLER, AREVA**

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

(202) 234-4433

[www.nealrgross.com](http://www.nealrgross.com)

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

8:30 a.m.

CHAIRMAN ABDEL--KHALIK: The meeting will now come to order. This is a meeting of the power uprate Subcommittee of the advisory Committee on reactor safeguards. I am Said Abdel--Khalik, Chairman of this Subcommittee.

ACRS members in attendance are Sanjoy Banerjee and Jack Sieber. Also in attendance are ACRS consultants Graham Wallis and, soon to join us, Tom Kress.

DR. WALLIS: I think he's gone to the other meeting.

MEMBER SIEBER: He went to the other meeting, next door.

CHAIRMAN ABDEL-KHALIK: Zeyna Abdullahi is the designated Federal official for this meeting. In today's meeting, the Subcommittee will hear presentations by, and hold discussions with, AREVA and the NRC staff on the review of topical report EMF-3028-P, RAMONA5-FA, a computer program for BWR transient analysis in the time domain.

In a letter report dated December

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 17<sup>th</sup>, 2007, ACRS had expressed it's views on  
2 related topical reports. One, BAW-10255--P,  
3 Revision 2, cycle specific divom methodology  
4 using the RAMONA5-FA code and 2, ANP-10262(P),  
5 enhanced option three long-term stability  
6 solution.

7 In today's meeting, we expect the  
8 staff and AREVA to include in their discussion  
9 how the recommendations in our letter have been  
10 addressed in the current review of RAMONA5-FA.  
11 The rules for participation in today's meeting  
12 have been announced as part of the notice  
13 previously published in the Federal Register.

14 Portions of today's meeting will be  
15 closed to the public in order to protect  
16 material that's proprietary to AREVA. A  
17 transcript of the meeting is being kept.  
18 Therefore, we request that participants in this  
19 meeting use the microphones located throughout  
20 the meeting room when addressing the  
21 Subcommittee.

22 The participants should first  
23 identify themselves and speak with sufficient  
24 clarity and volume so that they may be readily

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS  
1323 RHODE ISLAND AVE., N.W.  
WASHINGTON, D.C. 20005-3701

1 heard. We have received a request from a member  
2 of the public, Mr. Robert Leyse, to make a  
3 statement during today's meeting.

4 Mr. Leyse will make his statement  
5 during the open portion of the meeting. He has  
6 provided a written statement which was provided  
7 to all the participants. Mr. Leyse will be  
8 prompted as to when to make his statement. He  
9 will connect it through a bridge line. Please be  
10 advised that aside from Mr. Leyse's statement,  
11 the bridge line will be placed in listen only  
12 mode to preclude interruption of the meeting.

13 We have also provided another bridge  
14 line for the closed session to representatives  
15 of AREVA. We ask that the telephone participants  
16 identify themselves before the start of the  
17 meeting.

18 We will now proceed with the  
19 meeting, and I call on Mr. Tai Huang of the NRC  
20 staff to start his presentation. Let's first try  
21 to see who's on the bridge line. If you are on  
22 the bridge line, if you please identify  
23 yourself.

24 Anyone on the bridge line? Let's

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 wait to make sure that it is actually open. Mr.  
2 Huang, please proceed.

3 MS. CRUZ: If you don't mind, I'll  
4 introduce the--I'm the AREVA project manager for  
5 the Office of NRR.

6 CHAIRMAN ABDEL-KHALIK: Yes, Holly.

7 MS. CRUZ: And, we as, as you  
8 mentioned, we are here to discuss the AREVA  
9 proprietary topical report, EMF-3028-P, RAMONA5-  
10 FA which is a computer program for BWR transient  
11 analysis in the time domain.

12 For the opening session, for the  
13 open session this morning, the, presenting on  
14 behalf of the NRC, Dr. Tai Huang and Dr. Jose  
15 March Leuba from Oak Ridge National labs. Dr.  
16 Huang is in the Division of safety systems in  
17 the reactor systems Branch and I believe the  
18 reactor systems Branch, Branch chief Tony Ulses  
19 would like to make some opening remarks.

20 MR. ULSES: Yes, Thanks, Holly. I just  
21 wanted to take this opportunity to thank the  
22 Subcommittee for the time that you've given us  
23 to come talk to you and present the results of  
24 the staff review.

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS  
1323 RHODE ISLAND AVE., N.W.  
WASHINGTON, D.C. 20005-3701

1                   And, I just wanted to, you know,  
2                   just kind of start with my impressions of what  
3                   we're hoping you're going to hear today is that  
4                   the staff I think did a very exhaustive review  
5                   on this code and that the conclusions are really  
6                   based on, in large part, on comparisons to  
7                   measured data.

8                   And so, with that, I'd like to turn  
9                   this over to Dr. Huang for his presentation.  
10                  Thank you.

11                  DR. HUANG: Good morning, I'm Tai  
12                  Huang from the system Branch. And I've got to  
13                  come back here to present a staff review based  
14                  on that the previously presentation through the  
15                  ACRS back in November 14 on the Subcommittee  
16                  meeting and December 6<sup>th</sup> 2007, and we, our SCR  
17                  presented staff result of a review to this  
18                  Committee.

19                  And after that, the meeting, ACRS  
20                  area concern three area. One is bypass boiling,  
21                  regarding to the impact to the local power  
22                  arrange meter and calibration issue. Second will  
23                  be the oscillation, dryout, and the deep weight  
24                  mechanism from the test results.

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1                   And, number three will be RAMONA5-FA  
2 for the code review--

3                   DR. WALLIS: Are you going to do a  
4 full code review at this meeting? A full code  
5 review of the, of the documentation of the code?

6                   DR. HUANG: Yes, I think so.

7                   DR. WALLIS: Because the code, it's  
8 full of typos and very strage assumptions and  
9 things, and are you really going to do that  
10 here?

11                   DR. HUANG: I'm going to address as  
12 much as possible--

13                   DR. WALLIS: I didn't see any, any,  
14 nothing came to me from the staff about the  
15 review of the code itself. It was all devoted to  
16 the DIVOM issue. That's okay, but the code  
17 itself is, has some very strange things about  
18 it. Are you really going to go into that today?

19                   DR. HUANG: We going to address the--

20                   DR. WALLIS: --let's see how we do--

21                   DR. HUANG: --restricted to the  
22 DIVOM--

23                   DR. WALLIS: --it's also, I thought  
24 it was restricted to DIVOM--

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 DR. HUANG: Yes--

2 DR. WALLIS: --but you go into the  
3 code itself, you can start with the first three  
4 equations and ask where they come from. Okay.

5 DR. HUANG: So the staff--

6 MEMBER BANERJEE: Did, did you get a  
7 chance to see, or, the consultant's report on  
8 this code?

9 DR. HUANG: Yes--

10 MEMBER BANERJEE: Did you make  
11 availabel the, Graham's report on the quote,  
12 which, I, I've took a look at?

13 DR. WALLIS: That was my beginning,  
14 you know, we, we started to review this three  
15 years ago when we were interested, and we wrote  
16 a letter. And then, interest evaporated, so I  
17 stopped the review. So what you saw there was my  
18 beginnings of a review--

19 MEMBER BANERJEE: The, the review  
20 will be almost as long as the documentation of  
21 the code. Detail. So. It may be an ambitions  
22 target to try to review the code here.

23 DR. WALLIS: And I don't think we  
24 can. I don't think--

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 MEMBER BANERJEE: Why don't we just  
2 focus on DIVOM?

3 DR. HUANG: Okay. All right. So I'll  
4 just the, stories straight, you know? Following  
5 this ACRS meeting, we have three issue and come  
6 out to that one of the issue about DIVOM for the  
7 review on that, and at that time, staff issued  
8 an II on January 29, to address these three  
9 issues.

10 And, two of them, one of them is the  
11 bypass boiling issue, and oscillation dryout,  
12 these were issue that resulted from that II  
13 response. And then after 10% penalty because the  
14 DIVOM slope for that, the 48 review of this,  
15 RAMONA5-FA not done, so they start impose 10%  
16 penalty.

17 And since then, we--

18 DR. WALLIS: But you can remove the  
19 10% penalty by looking at the data.

20 DR. HUANG: Yes.

21 DR. WALLIS: But you cannot remove it  
22 by saying that RAMONA5-FA is okay for all  
23 purposes.

24 DR. HUANG: No.

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 DR. WALLIS: No. So you haven't  
2 really done a thorough review of RAMONA. I mean,  
3 for these applications. So, what you've done is  
4 a review of the, the applicability of the code  
5 to the DIVOM issue. That's all you've done.

6 DR. HUANG: Yes. Yes. That's correct.  
7 Yes. And we have a fully operation from AREVA  
8 stuff, and then our help, assistance from our  
9 consulting, and to the review for the RAMONA,  
10 RAMONA5-FA application to a cycle specific DIVOM  
11 calculations.

12 So, the detail will be, you know, I  
13 think, provided by AREVA and staff following the  
14 cross-section, cross-section--

15 CHAIRMAN ABDEL-KHALIK: Are we going  
16 to start with the staff presentation--

17 DR. HUANG: No.

18 CHAIRMAN ABDEL-KHALIK: --for, with  
19 AREVA presentation--I guess I--okay. At this  
20 time, we will go to a closed session.

21 (Whereupon, the above entitled  
22 matter under investigation went into closed  
23 session at 8:42 a.m., and was re-opened at 12:09  
24 p.m.)

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 CHAIRMAN ABDEL-KHALIK: And we will  
2 open the microphone to hear from the member of  
3 the public who had submitted with a new comment.  
4 Is the phone line open? Mr. Leyse, are you on  
5 the line? Mr. Leyse, are you on the line?

6 MR. LEYSE: Hello?

7 CHAIRMAN ABDEL-KHALIK: There are two  
8 people on the line. If you would identify  
9 yourselves, please?

10 MR. LEYSE: Robert H. Leyse is here  
11 and he's ready to talk.

12 CHAIRMAN ABDEL-KHALIK: And who else  
13 is on the line?

14 PARTICIPANT: That's us. We are.

15 CHAIRMAN ABDEL-KHALIK: Yes, we are?  
16 Okay. Mr. Leyse--

17 MR. LEYSE: I could not hear who's  
18 the second speaker on the line is.

19 CHAIRMAN ABDEL-KHALIK: Apparently  
20 there is no one else on the line, Mr. Leyse.

21 MR. LEYSE: Good. Okay. Shall I  
22 proceed?

23 CHAIRMAN ABDEL-KHALIK: Yes, please.

24 MR. LEYSE: Okay. I can't quite hear

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 you, but I think you can hear me, so I'll go.  
2 I'm Bob Leyse and I've been in this business  
3 since 1950. I'll race through the slide in ten  
4 minutes. This slide covers two PRM from Bob  
5 Leyse, as many as urge to I guess goes after  
6 this meeting, and that will certainly take  
7 longer than ten minutes.

8           However, them efforts can easily  
9 justify why I have time to be billing to ACRS.  
10 The slide has the ML numbers. There are two  
11 others. The 2200 degree Fahrenheit PCT load is  
12 too high and crud has a substantial impact on  
13 the PCT during a LOCA.

14           Moving for a moment to today's  
15 meeting, most of the AREVA presentation is  
16 reasonably not available to the public. However,  
17 I think it is likely that none of the copy teams  
18 include the impact of a range of crud deposits.

19           Okay, back to the slide. This is  
20 called the power uprate Committee, which  
21 presupposes that power uprates are in order.  
22 What we really need is a power level review  
23 Committee. The 2200 degree Fahrenheit PCT load  
24 is too high.

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1           The 2200 PCT limit is based on  
2           embrittlement criteria. To figure just equation  
3           was placed into 50 part 06, and it has been  
4           convenient unless in licensing. According to  
5           analyses funded by NRC, when the Baker Just  
6           correlation was devised, the predicted runaway,  
7           thermal runaway, begins at 2600 degrees  
8           Fahrenheit, while the alternative Captain  
9           Alexander cart foul correlation of reg guide  
10          1.157 yields runaway at 2700.

11           However, an array of experiments  
12          having multilevel assemblies of rods with  
13          zirconium alloy cladding revealed that  
14          thermorunaway begins well below the 2600 to 2700  
15          degree Fahrenheit range. Perhaps the most,  
16          perhaps the most impressive is rods LP hyphen LP  
17          hyphen 2, where thermorunaway of the fuel bundle  
18          was initiated in a 2060 to 2240 degree  
19          Fahrenheit range.

20           The series of CORA experiments are  
21          caused zirconium alloy cladding a bundle of  
22          electrically heated rods yielded thermorunaway  
23          over a range from 1800 to 2200 degrees  
24          Fahrenheit. The NRC, the NRC staff is taking PRM

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 5093 very seriously and so should the ACRS.

2 The user needs requests from NRR to  
3 REF's is high priority. The requested  
4 deliverable for this user need was the technical  
5 megareport and the initial due date for a  
6 thoroughly researched Federal report was  
7 September 30, comma, 2010.

8 However, on October 27<sup>th</sup>, 2010, the  
9 NRC published for public comment a notice of  
10 consolidation of petitions for rulemaking. The  
11 petitions, the PRM's to be considered are PRM  
12 5093, powered by Mark Edward Leyse, November  
13 15<sup>th</sup>, 2009, and PRM 90--PRM 5095, compiled on  
14 June 7<sup>th</sup>, 2010, by Mark Edward Leyse, agreement  
15 shouted on behalf of the New England coalition.

16 What Mark Leyse filed on June 7<sup>th</sup>,  
17 2010, was not a PRM, it was a 2.206 petition. It  
18 appears that by consolidating these actions by  
19 Mark Leyse, the NRC has extended the deadline  
20 for producing the technical metal report  
21 regarding PRM 5093.

22 Nevertheless, the priority is  
23 established by the technical specs that are in  
24 the record, and diligent and timely attention by

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 the ACRS is most certainly called for under it's  
2 mandate, I quote, to initiate reviews of  
3 specific generic matters or nuclear facility  
4 safety related items, end of quote.

5 Moving to the impact of crud, PRM  
6 5084 details the impact of crud on the steady  
7 state temperature distribution and stored energy  
8 in the fuel at the offset of a postulated POLCA.  
9 Crud increases the operating fuel rod surface  
10 temperature at fuel rod stored energy.

11 Crud decreases the overall heat  
12 transfer coefficient of the fuel rod. Crud  
13 adversely impacts the coolant flow distribution  
14 throughout the core. Crud is a fuel rod  
15 locations with heavier crud layers have less  
16 flow, that's a parenthesis.

17 Thus, crud leads to substantial  
18 increases in the PCT during a LOCA. In effect,  
19 no one that's cool wrote the rulemaking,  
20 performance based ECCS acceptance criteria, July  
21 29, 2009, NRC addresses PRM 5084 as follows. I  
22 quote, in summary to address the technical  
23 concerns related to crud in the PRM 5084  
24 petitioner's request for rulemaking, the NRC is

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS  
1323 RHODE ISLAND AVE., N.W.  
WASHINGTON, D.C. 20005-3701

1 considering amending number 50.46 to  
2 specifically identify crud as a parameter to be  
3 considered, if best estimate at Appendix K, part  
4 50 ECCS evaluations, model, ECCS evaluation  
5 models, end of quote.

6 PRM 5084 reports there have been a  
7 completed program during 2008 that will quote,  
8 determine the effect of temaceous crud on fuel  
9 surface heat transfer, end of quote. So far,  
10 they have found no open reporting of this.

11 AREVA and Westinghouse have  
12 brochures that describe ultrasonic fuel cleaning  
13 surfaces. The recent Westinghouse brochure lists  
14 more than 12 LWR's that have used ultrasonic  
15 fuel cleaning for crud removal from fuel  
16 elements and from the AREVA brochure, I quote,  
17 AREVA MP offers patented electric power research  
18 institute ultrasonic fuel cleaning to revamp  
19 uneven crud deposits that can negatively effect  
20 fuel performance.

21 All furniture sting is a patent  
22 application, I quote, chemical enhancement of  
23 ultrasonic fuel cleaning, end of quote. Here are  
24 a few sentences, so. Any corrosion products

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS  
1323 RHODE ISLAND AVE., N.W.  
WASHINGTON, D.C. 20005-3701

1 remaining after ultrasonic fuel cleaning will  
2 have exposed surfaces that are susceptible to  
3 chemical dissolution.

4 Another sentence. It is estimated  
5 that ultrasonic cleaning removes up to 80% of  
6 the total corrosion product inventory on the  
7 fuel. Vital seven side booming, in certain  
8 embodiments, the chemical addition steps could  
9 be applied to selected high flux assemblies that  
10 have high corrosion deposition, while other fuel  
11 assemblies could be cleaned only ultrasonically.

12 So that's the end of those quotes.  
13 The references by Mark Leyse and J.S. Leader are  
14 listed at the end of the handout. Each disclosed  
15 that crud significantly increases the local  
16 surface temperature of the cladding of the store  
17 energy within the fuel.

18 NRR and RES are continuing the  
19 preparation of the technical letter report that  
20 is to be the basis for a timely recommendation  
21 to the NRC commissioners regarding the  
22 disposition of PRM 5093.

23 In the meantime, ACRS should not  
24 concur with any power uprate proposal until PRM

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 5093 is resolved. I think I have a bit of time  
2 left, so I'll report, I've worked at G.E.  
3 Hamburg at several thing, Westinghouse in  
4 Monroeville, to Susquehanna River, Argonne, and  
5 the nuclear safety analysis center at Oak Ridge.

6 Elsewhere, during the 1970's, I  
7 invented graphing and marketed the red scale  
8 gamma thermometer. G.E., G.E. references my  
9 electric lead paper that describes that gamma  
10 thermometer that is central to their current  
11 licensing report, gamma--quote, gamma  
12 thermometer system for LRPM calibration and  
13 power shape monitoring, end of quote.

14 That's dated October 6<sup>th</sup>, 2010, with  
15 exception number ML 102810320, period.  
16 Parenthesis, I repeat, you may tell the full  
17 Committee to not concur with any power rate  
18 proposal until prm 5093 is resolved. Thank you.

19  
20 CHAIRMAN ABDEL-KHALIK: Thank you,  
21 Mr. Leyse. Are there any questions for Mr.  
22 Leyse?

23 MR. LEYSE: Okay. I'll also email  
24 this to the ACRS representative so if it's

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701

1 legal, they may use it for checking the  
2 transcript. Again, thank you.

3 CHAIRMAN ABDEL--KHALIK: Thank you  
4 very much. Thank you. At this point, we have  
5 concluded both the closed and open session, and  
6 we will see you again at the full Committee  
7 meeting in December. Meeting is adjourned.

8 (Whereupon, the above entitled  
9 matter was taken off the record at 12:21 p.m.)

10  
11  
12  
13  
14  
15

**NEAL R. GROSS**

COURT REPORTERS AND TRANSCRIBERS

1323 RHODE ISLAND AVE., N.W.

WASHINGTON, D.C. 20005-3701



**U.S.NRC**

UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

# **Review of RAMONA5-FA Application for DIVOM Calculations**

Dr. Tai L. Huang (NRR/ADES/DSS/SRXB)

Dr. Jose March-Leuba (ORNL)

ACRS TH Sub Committee Meeting

Nov 17, 2010

**OPEN SESSION**



# Introduction

- BWR Stability
  - Has potential of violating Specified Acceptable Fuel Design Limits (SAFDLs)
  - Affects day to day operation of BWRs
- Regulatory requirements are based on 10CFR50, Appendix A, General Design Criteria
  - GDC 10: Reactor designed such that fuel design limits are not exceeded during normal, abnormal, and Anticipated Operational Occurrences (AOOs)
  - GDC 12: Power oscillations either not possible OR reliably and readily detected and suppressed
- Staff review based on guidance from SRP 15.9



# U.S.NRC Background

UNITED STATES NUCLEAR REGULATORY COMMISSION  
*Protecting People and the Environment*

- The staff reviewed and issued a SER for two AREVA reports:
  - **ANP-10262(P)**, Rev 0, Enhanced Option III Long Term Stability Solution. Framatome ANP. January 2006
    - A new long term stability solution algorithm applicable to extended flow domains (EFD's) like MELLLA+
  - **BAW-10255(P)**, Rev 2, Cycle-Specific DIVOM Methodology Using the RAMONA5-FA Code. Framatome ANP. January 2006
    - AREVA's methodology for calculating the DIVOM correlation, which is a required component of detect and suppress solutions



- The Staff SER for Solution “Enhanced Option III” and “Areva DIVOM methodology” issued a condition to apply a 10% penalty on DIVOM slopes calculated using the RAMONA5-FA code
- The penalty was imposed because the RAMONA5-FA code had not been submitted for full review by the staff. Areva committed at the time to support a staff review
- This presentation addresses the staff SER on applicability of the RAMONA5-FA code for DIVOM slope calculations (ML0914704480)

I'm Bob Leyse and I have been in this business since 1950. I'll race through the slide in 10 minutes. The slide covers two PRMs by Mark Leyse. The Committee is urged to digest those after this meeting, and that will take longer than 10 minutes, however, the members can certainly justify applying that time in their billing to ACRS. The slide has the ML numbers.

There are two items: the 2200 degree Fahrenheit PCT limit is too high and crud has a substantial impact on the PCT during a LOCA. Moving for a moment to today's meeting, most of the AREVA presentation is reasonably not available to the public, however, I think it is likely that none of the KATHY games include the impact of a range of crud deposits.

OK, back to the slide. This is called the POWER UPRATE COMMITTEE, which presupposes that Power Uprates are in order. What we really need is a Power Level Review Committee.

The 2200 degree Fahrenheit PCT limit is too high. The 2200 PCT limit is based on embitterment criteria. The Baker-Just equation was placed into 50.46 and it has been convenient in licensing. According to analyses funded by NRC, when the Baker-Just correlation is applied, the predicted thermal runaway starts at 2600 degrees Fahrenheit, while the alternative Cathcart-Pawel correlation of Reg. Guide 1.157 yields runaway at 2700. However, an array of experiments having multirod assemblies of rods with zirconium alloy cladding reveal that thermal runaway begins well below the 2600 to 2700 range. Perhaps the most impressive is LOFT LP-FP-2 where thermal runaway of the fuel bundle was initiated in the 2060 to 2240 degree Fahrenheit range. The series of CORA experiments at Karlsruhe with Zirconium alloy cladding of bundled electrically heated rods yielded thermal runaway over a range from about 1800 to 2200 degrees Fahrenheit.

The NRC staff is taking PRM-50-93 very seriously, and so should the ACRS.

**The current User Need Request from NRR to RES is High Priority.**

*The requested deliverable for this user need is a technical letter report and the initial due date for a thoroughly researched final report was September 30, 2010.*

*However: On October 27, 2010, the NRC published for public comment a notice of consolidation of petitions for rulemaking. The PRMs to be consolidated are PRM-50-93 filed by Mark Edward Leyse on November 17, 2009, and PRM-50-95 filed on June 7, 2010, by Mark Edward Leyse and Raymond Shadis, on behalf of the New England Coalition. What Mark Leyse filed on June 7, 2010 was not a*

PRM, it was a 2.206 petition. It appears that by consolidating these actions by Mark Leyse, the NRC has extended the deadline for producing a Technical Letter Report regarding PRM-50-93. Nevertheless, the priority is established by the technical facts that are in the record and diligent and timely attention by the ACRS is most certainly called for under its mandate *“to initiate reviews of specific generic matters or nuclear facility safety-related items.”*

Moving to the impact of crud; PRM-50-84 details the impact of crud on the steady-state temperature distribution and stored energy in the fuel at the onset of a postulated LOCA.

Crud increases the operating fuel rod surface temperature and fuel rod stored energy. Crud decreases the overall heat transfer coefficient at the fuel rod. Crud adversely impacts the coolant flow distribution throughout the reactor core (fuel rod locations with heavier crud layers have less flow). Thus crud leads to substantial increases in the PCT during a LOCA.

In its Advance Notice of Proposed Rulemaking: Performance-Based ECCS Acceptance Criteria, July 29, 2009, NRC addresses PRM-84 as follows: *In summary, to address the technical concerns related to crud in the PRM-50-84 petitioner’s request for rulemaking, the NRC is considering amending § 50.46 to specifically identify crud as a parameter to be considered in best-estimate and Appendix K to Part 50 ECCS evaluation models.*

PRM-50-84 reports that EPRI will complete a program during 2008 that will “... determine the effect of tenacious crud on fuel surface heat transfer.” So far, I have found no open reporting of this.

AREVA and Westinghouse have brochures that describe ultrasonic fuel cleaning services. The recent Westinghouse\_brochure lists more than 12 LWRs that have used Ultrasonic Fuel Cleaning for crud removal from fuel elements. And from the AREVA brochure I quote, *“AREVA NP offers patented Electric Power Research Institute (EPRI) Ultrasonic Fuel Cleaning (UFC) to prevent uneven crud deposits that can negatively affect fuel performance.”*

Also interesting is a patent application: Chemical Enhancement of Ultrasonic Fuel Cleaning. Here are a few sentences (Only read the three sentences that are in bold.)

A method for cleaning an irradiated nuclear fuel assembly includes chemically enhancing a technique utilizing an apparatus including a housing adapted to engage a nuclear fuel assembly. A set of ultrasonic transducers is

positioned on the housing to supply radially emanating omnidirectional ultrasonic energy to remove deposits from the nuclear fuel assembly. **Any corrosion products remaining after ultrasonic fuel cleaning will have exposed surfaces that are susceptible to chemical dissolution.**

The mechanical cleaning is effective, but it is not 100% efficient because corrosion products remain on the fuel assemblies. **It is estimated that ultrasonic cleaning removes up to 80% of the total corrosion product inventory on the fuel**

According to the subject method, chemical addition is localized to the water in the ultrasonic cleaning chamber rather than throughout the primary system, which minimizes the total liquid waste generated by orders of magnitude. Less aggressive chemistries can be selected that take advantage of the ultrasonic fuel cleaning environment. Only the fuel assemblies are exposed to the chemicals, so there is less chemical cleanup required for the vessel or ex-core piping. **In certain embodiments, the chemical addition steps could be applied to selected high flux assemblies that have high corrosion deposition, while other fuel assemblies could be cleaned only ultrasonically.**

The references by Mark Leyse and J. S. Lee that are listed at the end of the handout each disclose that crud significantly increases the local surface temperature of the cladding and the stored energy within the fuel.

NRR and RES are continuing their preparation of the Technical Letter Report that is to be the basis for a timely recommendation to the NRC Commissioners regarding the disposition of PRM-50-93. In the meantime, ACRS should not concur with any Power Uprate proposal until PRM-50-93 is resolved.

I have about two minutes left. I have worked at GE, Hanford and San Jose; Westinghouse, Monroeville; DuPont, Savannah River; Argonne, and the Nuclear Safety Analysis Center at EPRI. Elsewhere, during the 1970s, I invented, branded and marketed the RADCAL GAMMA THERMOMETER. GE Hitachi references my IEEE paper that describes the gamma thermometer that is central to their current licensing report, "Gamma Thermometer System for LPRM Calibration and Power Shape Monitoring." October 6, 2010. Accession Number ML102810320.

For emphasis, I repeat, you may tell the Full Committee to not concur with any Power Uprate proposal until PRM-50-93 is resolved.

Thank you.