

**NUCLEAR REGULATORY COMMISSION**

ORIGINAL

Title: Advisory Committee on Reactor Safeguards  
Subcommittee on Power Upgrades

Docket Number: (not applicable)

PROCESS USING ADAMS  
TEMPLATE: ACRS/ACNW-005

SISP - REVIEW COMPLETE

Location: Rockville, Maryland

Date: Tuesday, November 29, 2005

Work Order No.: NRC-751

Pages 1-225

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

TROY

ACRS OFFICE COPY  
RETAIN FOR THE LIFE OF THE COMMITTEE

DISCLAIMER

UNITED STATES NUCLEAR REGULATORY COMMISSION'S  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS

November 29, 2005

The contents of this transcript of the proceeding of the United States Nuclear Regulatory Commission Advisory Committee on Reactor Safeguards, taken on November 29, 2005, as reported herein, is a record of the discussions recorded at the meeting held on the above date.

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

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

UNITED STATES OF AMERICA  
NUCLEAR REGULATORY COMMISSION

+ + + + +

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS (ACRS)  
SUBCOMMITTEE ON POWER UPRATES

+ + + + +

TUESDAY,

NOVEMBER 29, 2005

+ + + + +

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

MEMBERS PRESENT:

- RICHARD S. DENNING, Chairman
- THOMAS S. KRESS
- VICTOR H. RANSOM
- JOHN D. SIEBER
- GRAHAM B. WALLIS

ACRS STAFF PRESENT:

- RALPH CARUSO, ACRS Staff

ACRS CONSULTANTS PRESENT:

- SANJOY BANERJEE, ACRS Consultant
- GRAHAM M. LEITCH

**NEAL R. GROSS**

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

1     NRC STAFF PRESENT:

2             ZENA ABDULLAHI, NRR

3             CHRISTOPHER BOYD, NRR

4             RICK ENNIS, NRR

5             STEPHEN HAMBRIC, NRR

6             CORNELIUS HOLDEN, NRR

7             TAI HUANG, NRR

8             JESS GEHIN, NRR

9             TOM MULCAHY, NRR

10            MUHAMMAD RAZZAQUE. NRR

11            VIKRAM SHAH, NRR

12            THOMAS SCARBROUGH, NRR

13            GEORGE THOMAS, NRR

14            JOHN WU, NRR

15            SAMIR ZIADA, NRR

16

17

18

19

20

21

22

23

24

25

**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     ENTERGY/GE STAFF PRESENT:

2             ENRICO BETTI

3             ALAN BILANIN

4             FRAN BOLGER

5             MICHAEL DICK

6             MARGARET HARDING

7             JERRY HEAD

8             BRIAN HOBBS

9             KARL KUEHLERT

10            BRIAN MOORE

11            DOUG NEWKIRK

12            CRAIG NICHOLS

13            DAN PAPONE

14            LOUIS QUINTARA

15

16

17

18

19

20

21

22

23

24

25

**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)

I-N-D-E-X

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

<u>AGENDA ITEM</u>	<u>PAGE</u>
Introduction	5
R. Denning (ACRS)	
1. Opening Remarks	8
C. Holden (NRR)	
2. Introduction	12
R. Ennis (NRR)	
3. Steam Dryer and Vessel Internals	16
B. Hobbs (Entergy)	
4. Mechanical and Civil Engineering	95
T. Scarbrough (NRR)	
5. GE Methods and Reactor Issues	179
J. Head (Entergy)	

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

(8:31 a.m.)

INTRODUCTION

CHAIRMAN DENNING: Good morning. The meeting will now come to order. This is a meeting of the Advisory Committee on Reactor Safeguards Subcommittee on Power Uprates.

I am Dr. Richard Denning, Chairman of the Subcommittee. Committee members in attendance -- well, Dr. Graham Wallis isn't quite in attendance. He would be here this morning. He was held up by the fog. That is not a typical problem of Dr. Wallis', being held up by fog. Dr. Tom Kress, retired head of Applied Systems Technology from Oak Ridge National Laboratory. Dr. Victor Ransom is not here yet. He will be here in a few minutes, who is Professor Emeritus, Purdue School of Nuclear Engineering; Mr. Jack Sieber, retired Senior Vice President, Nuclear Power Division, Duquesne Light Company. We also have ACRS consultants here today in attendance: Dr. Sanjoy Banerjee and Mr. Graham Leitch.

The purpose of this meeting is to discuss the extended power uprate application for the Vermont Yankee nuclear power station. The Subcommittee will hear presentations by and hold discussions with

**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 representatives of the NRC staff and the Vermont  
2 Yankee licensee, Entergy Nuclear Northeast, regarding  
3 these matters.

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

8 Ralph Caruso is the designated federal  
9 official for this meeting.

10 The rules for participation in today's  
11 meeting have been announced as part of the notice of  
12 this meeting previously published in the Federal  
13 Register on November 14 and November 28, 2005. The  
14 meeting was also announced in an NRC press release  
15 issued on November the 18th, 2005.

16 Portions of this meeting may be closed to  
17 discuss proprietary information. In fact, they will  
18 be closed to discuss proprietary information.

19 A transcript of the meeting is being kept  
20 and will be made available as stated in the Federal  
21 Register notice. It is requested that speakers first  
22 identify themselves and speak with sufficient clarity  
23 and volume so that they can be readily heard. It is  
24 especially important today for people to speak up into  
25 the microphones because this meeting is being

**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 broadcast via a conference call link. The conference  
2 call will allow stakeholders to listen to the  
3 discussion today and tomorrow, but we will not be  
4 taking comments over the telephone.

5 When it becomes necessary to close the  
6 meeting to discuss proprietary information,  
7 stakeholders on the conference call will begin to hear  
8 recorded music and a message explaining that the  
9 meeting is closed until we return to open session.

10 We have received several requests from  
11 members of the public to make oral statements today.  
12 And they will have the opportunity to make those  
13 comments tomorrow afternoon.

14 Other interested stakeholders can submit  
15 written comments to the ACRS and at the NRC's  
16 Washington, D.C. address or by e-mail to Mr. Caruso at  
17 the address listed on the agenda. These comments will  
18 be provided to all of the members before the meeting  
19 of the full Committee on December 7th, 2005.

20 This is the second of two ACRS  
21 subcommittee meetings that will consider the Vermont  
22 Yankee power uprate request. On November 15 and 16,  
23 the Subcommittee met in Brattleboro, Vermont. The  
24 full ACRS is scheduled to consider this application on  
25 December 7th, 2005 in Rockville, Maryland. And that

**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 meeting will also be open to the public.

2 We have a very packed agenda for these two  
3 days and a number of major issues to discuss. I  
4 apologize to the staff and the speakers in advance.  
5 At some point we are undoubtedly going to cut short  
6 presentations if it looks like those aren't the most  
7 relevant issues. And I also ask you to give us some  
8 help, too. If there's something that is  
9 straightforward and does not look like an issue, let's  
10 go through it quickly to save time for the discussion  
11 of the major issues.

12 We will now proceed with the meeting. I  
13 call upon Mr. Holden of the NRC staff to begin.

14 1. OPENING REMARKS

15 MR. HOLDEN: Good morning. My name is  
16 Cornelius Holden. I'm the Deputy Director of the  
17 Division of Operating Reactor Licensing in the Office  
18 of Nuclear Reactor Regulation.

19 The NRR project manager for the power  
20 uprate review is Rick Ennis. He will discuss the  
21 specific agenda in a moment. However, I would like to  
22 note that we plan to discuss the areas of the review  
23 not covered in the ACRS meeting held in Vermont two  
24 weeks ago.

25 As I mentioned at the Subcommittee

**NEAL R. GROSS**

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

1 meeting, NRR just recently entered an organizational  
2 restructuring. This resulted in numerous changes to  
3 division branch names. Since the Vermont Yankee  
4 review was performed using the review standard RSO 01  
5 and the standard is organized by the previous branch  
6 names, we decided to use the previous organizational  
7 names in our slides for the technical review branches.

8 During the meeting in Vermont, there were  
9 questions raised regarding the NRR staff, when the NRR  
10 staff was going to revise the safety evaluation, to  
11 reflect some recent supplements to the application  
12 that provided the licensee's risk assessment  
13 associated with crediting containment overpressure.

14 As I noted during the last meeting, there  
15 are no open items in the draft safety evaluation. On  
16 this issue, the staff made its findings based on its  
17 own assessment of the risk of crediting containment  
18 overpressure, as discussed in safety evaluation  
19 section 2.13.

20 However, the staff requested Entergy to  
21 provide its assessment based on generic discussion of  
22 this topic related to the proposed revision of reg  
23 guide 1.82. Specifically, during the October 7th ACRS  
24 full Committee meeting, Dr. Sheron stated that as part  
25 of the planned revisions to reg guide 1.82, the staff

**NEAL R. GROSS**

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

1 proposed to take a more risk-informed approach to  
2 determine whether or not credit for containment  
3 overpressure is acceptable. As part of this proposal,  
4 the staff stated its intent to request licenses  
5 demonstrate that crediting containment overpressure  
6 meets the five key principles in reg guide 1.174.

7           Entergy's supplements 38 and 39, issued in  
8 late October, provided the licensee's risk assessment  
9 of crediting containment overpressure using the  
10 guidance in reg guide 1.174.

11           The NRR staff has reviewed the licensee's  
12 supplements and issued a request for additional  
13 information on November 25th. The licensee has  
14 scheduled a response date of December 2nd. Although  
15 this would not give the staff time enough to revise  
16 the draft safety evaluation before the full Committee  
17 for ACRS on December 7th, we hope to have enough time  
18 to review the submittal and at least provide our  
19 findings verbally to the full Committee.

20           Any changes to the draft safety evaluation  
21 would further bolster our current finding. And it  
22 would be consistent with the ACRS letter of September  
23 20th.

24           Unless there are any questions, I would  
25 like to turn it over to Rick Ennis.

**NEAL R. GROSS**

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

1 CHAIRMAN DENNING: I have a quick question  
2 about this issue of 1.174. I notice in 39, the staff  
3 states that they are making a risk-informed  
4 presentation. And in RSO 01, in the older version  
5 there, it definitely says that these are not  
6 risk-informed applications.

7 Help me again. Is that a policy that is  
8 changing as far as the staff is concerned? And can  
9 they risk-inform a piece of it and not all of it?

10 MR. ENNIS: This is Rick Ennis, the NRR  
11 project manager.

12 I believe we discussed this a little bit  
13 at the meeting a couple of weeks ago. It's not the  
14 intent to risk-inform the entire EPU application, the  
15 overall EPU. For this specific subject, we said that  
16 if a licensee was going to request credit for  
17 containment overpressure, we would ask them to provide  
18 risk information on that aspect of the EPU but not the  
19 overall EPU.

20 CHAIRMAN DENNING: But that's quite  
21 consistent with what RSO 01 says about how to use risk  
22 information.

23 MR. ENNIS: Right, right.

24 2. INTRODUCTION

25 MR. ENNIS: Good morning. My name is Rick

**NEAL R. GROSS**

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

1 Ennis. And I am the Project Manager for the Vermont  
2 Yankee EPU in the NRC's Office of Nuclear Reactor  
3 Regulation, NRR.

4 I would like to discuss the agenda for the  
5 meeting today and tomorrow. Today the first  
6 presentation will be a discussion by Entergy  
7 pertaining to issues associated with the steam dryer  
8 and reactor vessel internals.

9 And following Entergy's presentation, the  
10 NRR staff will provide a discussion of the review  
11 performed by the Mechanical and Civil Engineering  
12 Branch, as discussed in safety evaluation section 2.2.  
13 Much of that discussion will focus on our review  
14 pertaining to the steam dryer and potential adverse  
15 flow effects at EPU conditions.

16 Entergy will then follow with a discussion  
17 related to the analytical methods and codes used by  
18 their fuel vendor, General Electric, GE, as well as  
19 other reactor issues. The NRR staff will follow that  
20 presentation with a discussion of the review performed  
21 by the Reactor Systems Branch, as discussed in safety  
22 evaluation section 2.8. And a large portion of that  
23 presentation will focus on the GE methods issues.

24 Tomorrow Entergy and its contractors have  
25 four presentations planned. Each will be followed by

**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 an NRR staff presentation on related topics. The  
2 first Entergy presentation will be on flow-accelerated  
3 corrosion and pressure temperature limit curves. That  
4 will be followed by NRR's Mechanical and Chemical  
5 Engineering Branch's presentation related to the  
6 review of areas covered in safety evaluation section  
7 2.1.

8 Next, Entergy will provide a presentation  
9 on station blackout and grid stability. And NRR staff  
10 will then present the review by the Electrical  
11 Engineering Branch, as discussed in safety evaluation  
12 section 2.3.

13 Entergy's third presentation will be on  
14 operations training, emergency operating procedures,  
15 operator actions, and operator time lines. The NRR  
16 staff will then provide a discussion on the review  
17 related to human performance, as discussed in safety  
18 evaluation section 2.11.

19 Entergy's contractor, Erin Engineering,  
20 will provide a discussion on probabilistic safety  
21 assessment, PSA. The NRR staff will then discuss its  
22 review of its risk evaluation related to the proposed  
23 EPU, as discussed in safety evaluation section 2.13.

24 I would like to note that the staff's risk  
25 evaluation presentation will discuss the overall EPU

**NEAL R. GROSS**

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

1 and won't include the risk aspects of crediting  
2 containment overpressure since that topic was  
3 discussed two weeks ago up in Vermont. And, as Mr.  
4 Holden mentioned, the NRR staff will provide further  
5 discussion on the risk aspects of crediting  
6 containment overpressure at the ACRS full Committee  
7 meeting on December 7th.

8 Tomorrow the NRR staff will also discuss  
9 the impact of the proposed EPU with respect to plant  
10 systems, source terms and radiological consequences,  
11 and health physics.

12 Unless there are any questions, I would  
13 like to turn it over to Entergy for their discussion  
14 on the steam dryer and reactor vessel internals.

15 CHAIRMAN DENNING: One comment, and that  
16 is at some point there are going to be some additional  
17 discussions of debris beds. And I know particularly  
18 after Dr. Wallis gets here, I know the consultant has  
19 some questions about this. Where do you see those  
20 best fitting into this agenda?

21 MR. ENNIS: There is no real best place.  
22 It would probably be sometime tomorrow, and we'll have  
23 to take a look at the agenda. Maybe we could shorten  
24 up some of our other presentations and put that in  
25 there.

**NEAL R. GROSS**

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

1 CHAIRMAN DENNING: Thank you.

2 MR. NICHOLS: Good morning. I'm Craig  
3 Nichols, the Entergy Vermont Yankee Power Uprate  
4 Project Manager.

5 Entergy would like to thank the Committee  
6 for this opportunity to continue our discussion about  
7 the Entergy Vermont Yankee extended power uprate. For  
8 today's first session, we will be discussing the steam  
9 dryer analysis, modification, and monitoring program.

10 I have with me Mr. Brian Hobbs, our  
11 engineering analysis supervisor; Mr. Enrico Betti, our  
12 senior structural engineer, who is the technical lead  
13 for the steam dryer analysis and monitoring.

14 Again, we appreciate the opportunity to be  
15 here today to continue our discussions. And, with  
16 that, I would like to turn it over to Mr. Hobbs.

17 3. STEAM DRYER AND VESSEL INTERNALS

18 MR. HOBBS: I'm Brian Hobbs, Entergy's  
19 supervisor of engineering analyses for the Vermont  
20 Yankee extended power uprate project. This morning,  
21 assisted by Mr. Enrico Betti, I will be providing an  
22 overview of Entergy's evaluation of the Vermont Yankee  
23 steam dryer structural integrity.

24 The topics I will present in this overview  
25 include industry steam dryer operating experience and

**NEAL R. GROSS**

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

1 regulatory oversight; Vermont Yankee steam dryer  
2 inspection results; Vermont Yankee steam dryer  
3 strengthening modification; the main steam vibration  
4 levels measured at Vermont Yankee and predicted for  
5 the future; structural integrity analysis of the  
6 Vermont Yankee dryer; and, finally, monitoring of the  
7 dryer during power ascension.

8           Entergy and our power uprate dryer team  
9 consisting of GE, LMS, Continuum Dynamics Inc., Fluent  
10 Structural Integrity Associates, Areva, JAR  
11 Engineering, and University Specialists, have put in  
12 a significant effort over the last 30 months on  
13 analyses, design modification, inspection, and  
14 monitoring to ensure continued Vermont Yankee dryer  
15 structural integrity and EPU operating conditions.

16           DR. BANERJEE: Do you have the documents  
17 available, the background analyses by Fluent and  
18 Structural Analysis Associates or whoever they are?

19           MR. HOBBS: Those were all submitted on  
20 our docket. So yes, those are available.

21           DR. BANERJEE: Okay. Can we have a look  
22 at those, Ralph?

23           MR. HOBBS: As a result of this effort, we  
24 have made major strides in understanding the forces  
25 acting on our dryer and sources of those loads. The

**NEAL R. GROSS**

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

1 key conclusions of this work are: number one,  
2 acoustic loads are the primary source of industry  
3 dryer degradation operating experience; number two, it  
4 is important to monitor acoustic loads to evaluate  
5 their effect on dryer structural integrity; number  
6 three, the acoustic circuit methodology used for  
7 Vermont Yankee and other BWRs can be used to project  
8 main steam system measurements onto the steam dryer;  
9 and, finally, higher steam flows at power uprate  
10 conditions can exacerbate flow-induced vibration  
11 vulnerabilities that exist at original license thermal  
12 power.

13 DR. BANERJEE: What do you mean by  
14 "acoustic loads"?

15 MR. HOBBS: Acoustic loads are loads that  
16 are created by acoustic excitation sources within the  
17 main steam system.

18 DR. BANERJEE: Which are what?

19 MR. HOBBS: For example, sheer layer  
20 instabilities caused by the flow across cavities in  
21 the main steam lines. For example, a safety relief  
22 valve or a safety valve or a branch line for a -

23 DR. BANERJEE: These are pressure waves  
24 arising out of turbulence, which then radiate?

25 MR. HOBBS: Yes. That can be a source of

**NEAL R. GROSS**

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

1       acoustics.

2                   DR. BANERJEE:  So these are air acoustic  
3       instabilities of some sort?

4                   MR. HOBBS:  Right.  And we'll be talking  
5       in some detail about acoustic sources and acoustic  
6       loads.

7                   DR. BANERJEE:  I'd be very interested to  
8       see how you calculate these.

9                   MR. HOBBS:  Okay.  And measure them also.

10                  DR. BANERJEE:  Also, yes.

11                  MR. HOBBS:  Right.

12                  MEMBER KRESS:  Is this a resonance  
13       phenomenon?

14                  MR. HOBBS:  We believe it is.

15                  MEMBER KRESS:  So do you have to calculate  
16       the resonant frequency of the dryer itself?

17                  MR. HOBBS:  Yes.  And we also calculate  
18       the resonant frequency of the potential excitation  
19       sources.  So we'll be talking about those.

20                  Industry experience shows that increased  
21       main steam and feedwater flow associated with power  
22       uprate results in increased flow-induced vibration.  
23       Flow-induced vibration causes fatigue of plant  
24       components, including steam dryers.  And industry  
25       operating experience has shown that fatigue can cause

**NEAL R. GROSS**

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

1 flows potentially leading to component degradation,  
2 such as has occurred on steam dryers at several plants,  
3 some at pre-EPU conditions and some at power uprate  
4 conditions.

5 Results of a survey of 13 BWR units  
6 currently operating at EPU conditions showed that  
7 instances of significant dryer degradation occurred at  
8 4 units and were attributed to operating at EPU higher  
9 steam flow conditions. The remaining nine EPU units  
10 reported no significant dryer degradation.

11 MR. LEITCH: Are you going to discuss your  
12 steam line velocities at Vermont as compared with the  
13 rest of the industry?

14 MR. HOBBS: We can discuss that, although  
15 steam line velocity is not as important a factor as we  
16 once thought it was. It's more important to look at  
17 the potential for acoustic excitation.

18 And we did look at specific velocities for  
19 Vermont Yankee relative to excitation frequencies for  
20 acoustic resonators. So we believe that it's possible  
21 to have excitation at velocities that, you know, may  
22 not be very high velocities but just happen to  
23 resonate a potential acoustic excitation source.

24 MR. LEITCH: But could you give me an idea  
25 of what are your velocities --

**NEAL R. GROSS**

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

1 MR. HOBBS: Sure.

2 MR. LEITCH: -- compared with Dresden or  
3 Quad Cities, for example?

4 MR. HOBBS: Okay. The pre-EPU, the  
5 current rate of steam velocity at Vermont Yankee is  
6 approximately 139 feet per second. The EPU-rated  
7 velocity for 120 percent power at Vermont Yankee will  
8 be on the order of 168 feet per second. That value is  
9 approximately the original rated steam flow at the  
10 Quad Cities and Dresden units, approximately 168 feet  
11 per second.

12 Their steam velocity at EPU conditions for  
13 those units is slightly over 200 feet per second.

14 MR. LEITCH: Okay. Thank you.

15 MR. HOBBS: Entergy has been closely  
16 involved in industry efforts to evaluate steam dryer  
17 susceptibility to flow-induced vibration, including  
18 extensive operating experience, review, and  
19 benchmarking, development of a sophisticated  
20 computational fluid dynamics modeling tool to ensure  
21 diverse analytical methods, playing a key role in EPU  
22 BWR owners' group and actively participating in  
23 industry dryer meetings.

24 We have incorporated applicable operating  
25 experience into our analyses, conducted two extensive

**NEAL R. GROSS**

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

1 dryer inspections, proactively installed a  
2 dryer-strengthening modification, and developed a  
3 comprehensive power ascension-monitoring plant. These  
4 will be discussed in this presentation.

5 We have also responded to more than 150  
6 NRC staff requests for additional information, which  
7 posed challenging questions and required thoughtful  
8 answers.

9 Let me briefly review the configuration of  
10 the Vermont Yankee steam dryer. The dryer is located  
11 at the top of the reactor vessel. On the outlet of  
12 the steam separator, it's a static structure made of  
13 stainless steel that provides final removal of  
14 moisture before steam flows down the main steam lines  
15 to the turbine generator.

16 MEMBER SIEBER: We don't have these  
17 slides. You will have to provide them for the record.

18 MR. HOBBS: Vermont Yankee has a BWR 3  
19 square hood dryer design which is similar to other  
20 BWRs which have experienced significant degradation.

21 Next slide. The dimensions of the Vermont  
22 Yankee steam dryer are approximately 62 inches high,  
23 upper dryer height, and 201-inch diameter. The  
24 reactor steam flows through the five chevron dryer  
25 main banks with approximately 10 percent quality at

**NEAL R. GROSS**

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

1 the inlet of the dryer and greater than 99.9 percent  
2 quality at the outlet. The moisture is removed by  
3 internal drain pipes and ten drain channels.

4 Although this is not a safety-related  
5 component, the dryer is designed to withstand design  
6 basis event loads without generating loose parts.  
7 Dynamic flow-induced vibration loads have only  
8 recently been analyzed for BWRs such as Vermont  
9 Yankee's dryer.

10 A comprehensive visual inspection of all  
11 Vermont Yankee dryer internal and external locations  
12 was performed in 2004 in order to obtain baseline  
13 information on current material condition.

14 This was the first complete inspection of  
15 a steam dryer prior to operating at EPU conditions.  
16 Indications observed were either repaired or left as  
17 is justified by an evaluation, which concluded there  
18 would be no structural impact at either current  
19 license thermal power or EPU operating conditions.

20 Inspection of the dryer completed a recent  
21 refueling outage in 2005 looked at all the repaired  
22 and modified areas and indications left as is. The VY  
23 dryer-strengthening modification, which I will  
24 describe momentarily, was found to have no  
25 indications.

**NEAL R. GROSS**

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

1           The indications found in 2004 were found  
2 not to have grown. We also performed an augmented  
3 inspection of the dryer vane bank endplates based on  
4 discovery of additional minor indications as a result  
5 of enhanced visual inspection techniques.

6           MEMBER RANSOM: You indicate where these  
7 loads that you're talking about are caused by vortex  
8 shedding. There are many opportunities in a complex  
9 configuration like this. I'm wondering, can you  
10 identify the major ones that are the cause of the  
11 frequencies that are of concern? Are they the lips or  
12 the dead regions or where are they?

13           MR. HOBBS: We developed a computational  
14 Fluid Dynamics model, which gave us pressure loading  
15 as a function of vortex shedding on the steam dryer.  
16 And we will be talking about that momentarily.

17           But what we find is that those  
18 hydrodynamic forces there are not the key contributors  
19 to structural loads on the dryer. We find that it is  
20 the acoustic loads in the system that are key  
21 contributors.

22           MEMBER RANSOM: The interesting thing is,  
23 though, the acoustic loads have to have a driver.  
24 Something has to cause the pressure forces to be  
25 created. Normally those are the vortices that are

**NEAL R. GROSS**

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

1 shed. And so the frequency of those normally will be  
2 consistent with the source.

3 MR. HOBBS: That's correct.

4 MEMBER RANSOM: And resonance, of course,  
5 is achieved when you have a matching impedance and a  
6 driver. I would be interested to know how well you  
7 have identified those sources.

8 MR. HOBBS: Right. And we will be talking  
9 about both the vortex shedding, hydrodynamic sources  
10 and the acoustic cavity sources momentarily.

11 MR. LEITCH: Could you say again what you  
12 did in the Spring of '04? I missed that. Was that  
13 just an inspection or --

14 MR. HOBBS: Yes. In the Spring of '04, we  
15 conducted a comprehensive internal and external  
16 inspection. And that's also when we installed the  
17 strengthening modification that I will be describing  
18 shortly here.

19 MR. LEITCH: Okay.

20 MR. HOBBS: So we did find some  
21 indications on the dryer. Those indications were  
22 identified primarily as being caused by IGSCC. And  
23 there was no way to tell since we had never done such  
24 a comprehensive inspection previously how long those  
25 indications had existed.

**NEAL R. GROSS**

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

1 MR. LEITCH: There were no missing parts,  
2 though.

3 MR. HOBBS: There were no missing parts.

4 MEMBER SIEBER: I would like a little more  
5 detail about your inspection. This is an enhanced VT  
6 inspection.

7 MR. HOBBS: The 2005 inspection that was  
8 completed earlier this month was an enhanced VT1  
9 inspection. And that's how we found additional minor  
10 indications on the dryer vane bank endplates.

11 MEMBER SIEBER: And so all of these  
12 indications would show up in a VT as surface cracks.

13 MR. HOBBS: Right.

14 MEMBER SIEBER: Did you do anything to  
15 characterize the cracks as far as morphology, depth,  
16 ligaments, that kind of stuff?

17 MR. HOBBS: Enrico, can you --

18 MR. BETTI: I don't think any of the  
19 cracks in the areas where they were deemed as not  
20 structurally tight are not significant to the  
21 structure. There was no follow-up evaluation in terms  
22 of the --

23 MEMBER SIEBER: Okay. So you didn't  
24 characterize any of these? Would that be a fair  
25 statement?

**NEAL R. GROSS**

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

1 MR. HOBBS: We did characterize. Do you  
2 want to do that link there?

3 MEMBER SIEBER: Well, one way to  
4 characterize is to grind it out and repair it.

5 MR. HOBBS: Right, right.

6 MEMBER SIEBER: So that tells you  
7 something. What did it tell you in this case?

8 MR. HOBBS: Right. And here is some more  
9 detail about our 2004 indications. We did have two  
10 indications of cracks on the steam dams, which you can  
11 see on this diagram here are near the lifting lugs for  
12 the steam dryer. And we did grind those out and  
13 repair those indications. Those were two.

14 MEMBER SIEBER: Why did you choose those  
15 two and not others that might have been similar?

16 MR. HOBBS: We chose these 2 because they  
17 were actually different than the other 18 indications  
18 from 2004. And the reason we chose these is because  
19 these essentially could have been fatigue-related as  
20 a result of we think original manufacturing, the  
21 construction of the dryer. And because this was an  
22 area of potentially higher stress based on a load  
23 definition, we thought it was appropriate to grind  
24 these out and repair these.

25 MEMBER SIEBER: Okay. Now, the steam

**NEAL R. GROSS**

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

1 dryer is not a pressure vessel. So it doesn't fall  
2 under the typical ASME pressure vessel code or piping  
3 or anything. It's just an entity that's out there.  
4 And so you don't have a standard to apply to it.

5 On the other hand, VT is not doing much as  
6 far as doing understanding what the conditions of that  
7 structural piece are because you don't know depth.

8 Do you think that -- and you'll have to  
9 tell me why you think it if you do -- what you're  
10 doing is adequate to determine whether this structure  
11 of the steam dryer will be strong enough to withstand  
12 potential fragmentation, shedding parts, degradation,  
13 distortion, or any of those kinds of phenomena that  
14 would hinder the operation of the reactor?

15 MR. HOBBS: Well, you know, I think that  
16 we did perform the most comprehensive pre-EPU  
17 inspection. I think that the approach we used, which  
18 was a visual enhanced inspection, is the best  
19 technique that is currently provided by the industry  
20 guidelines, such as GE 6.4 --

21 MEMBER SIEBER: Right.

22 MR. HOBBS: -- talks about recommendations  
23 for inspecting your dryers. But this is part of a  
24 comprehensive program for ensuring dryer structural  
25 integrity. And this is kind of a lagging indicator if

**NEAL R. GROSS**

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

1 we had structural integrity challenges.

2 We just want to make sure that the dryer  
3 today is in good shape. And we think as a result of  
4 the visual inspection, that it is. And certainly  
5 compared to inspections of other steam dryers that  
6 have been at EPU conditions, we believe that our dryer  
7 is intact for that.

8 MEMBER SIEBER: Without the sufficient  
9 characterization, you can't do the fracture mechanics,  
10 right, unless you make a lot of assumptions about it?

11 MR. BETTI: Enrico Betti.

12 But for a surface evaluation in the ones  
13 that we had seen and that we did evaluations on, the  
14 surface fracture was assumed to be through all cracks  
15 for that evaluation.

16 MEMBER SIEBER: Okay. So  
17 that's conservative.

18 MR. BETTI: That's conservative.

19 MEMBER SIEBER: Okay.

20 CHAIRMAN DENNING: These particular cracks  
21 that we see here, they're not normally in a  
22 load-bearing region? This is just related with the  
23 lifting of and replacement of the steam dryer. Is  
24 that your interpretation as to what the origin of  
25 those cracks may be?

**NEAL R. GROSS**

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

1 MR. HOBBS: The interpretation relative to  
2 the origin is that the way that the dryer is put  
3 together at the site during its original construction,  
4 you know, you create stress because you take two  
5 pieces and weld them together.

6 We think the fact that these two  
7 indications are 180 degrees apart indicate that it was  
8 due to that joining together of the parts and welding  
9 those in the original construction that caused some  
10 residual stress that relieved itself during initial  
11 operation, most likely the dryer, and resulted in  
12 these indications at this location.

13 This is not a structural member, although  
14 the steam bands do need to basically channel the steam  
15 as it comes up out of the dryer vane banks. So they  
16 are important from a functional perspective.

17 MEMBER SIEBER: What material is used to  
18 build the dryer?

19 MR. HOBBS: Stainless steel.

20 MEMBER SIEBER: And it was not heat  
21 treated after well fabrication? That would be pretty  
22 tough to heat treat stainless steel, right?

23 MR. HOBBS: No, it was not.

24 MEMBER SIEBER: Yes. At the job site, I'm  
25 not sure how you could do it.

**NEAL R. GROSS**

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

1 CHAIRMAN DENNING: Okay. Continue.

2 DR. BANERJEE: I have a couple of  
3 questions. How important are the CFD calculations to  
4 the case you forward? Are they just there as a sort  
5 of supplement or --

6 MR. HOBBS: Yes.

7 DR. BANERJEE: -- are they sort of central  
8 to understanding something?

9 MR. HOBBS: They are both. They are both  
10 the supplement and they are central to understanding  
11 the vortex shedding phenomenon that's occurring in the  
12 vessel. And we'll be talking about how we develop  
13 that CFD model and what we learn from it.

14 Basically the NRC staff asked the question  
15 about vortex shedding more than a year ago. And we  
16 said we needed a tool to understand what the effects  
17 of vortex shedding and hydrodynamic loads are.

18 DR. BANERJEE: So then let me ask you a  
19 supplementary question. There is a computational  
20 error acoustics set of benchmarks, which every code,  
21 which is sort of qualified to do these collocations.  
22 This is set up by NASA. Has this code been tested  
23 against those to see if it works, actually?

24 MR. HOBBS: The benchmarks?

25 DR. BANERJEE: Yes.

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

1 MR. HOBBS: The code we used is the Fluent  
2 code. And I would ask you when we get in that point  
3 of the discussion --

4 DR. BANERJEE: Somebody is going to tell  
5 us what this is --

6 MR. HOBBS: Right.

7 DR. BANERJEE: -- and how it runs and why  
8 you think it's right?

9 MR. HOBBS: Yes.

10 MEMBER SIEBER: Before you leave this  
11 picture, it seems to me that I recall that this dryer  
12 does not have the perforated mesh plates in it that  
13 lighter dryers have and that you intend to install  
14 them. Can you show me where those would fit on here?

15 MR. HOBBS: We do not plan to install  
16 perforated plates. We have a steam separator that is  
17 highly efficient relative to other BWR-free units. So  
18 our steam quality coming out of our separator is high  
19 enough that we can work without having a perforated  
20 plate.

21 MEMBER SIEBER: Okay. That is one reason  
22 why you would install it, is to improve the steam  
23 quality?

24 MR. HOBBS: Right.

25 MEMBER SIEBER: Another reason is as a

**NEAL R. GROSS**

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

1 debris catcher. So you don't feel a need for that  
2 either?

3 MR. HOBBS: Right because our overall goal  
4 relative to dryer structural integrity is not to  
5 generate debris.

6 MEMBER SIEBER: That would be a good first  
7 step.

8 MR. HOBBS: Right, right. A debris  
9 catcher, again, would be sort of a defense-in-depth  
10 that we don't want to get to.

11 MEMBER SIEBER: Do you have something  
12 against defense-in-depth?

13 MR. HOBBS: No, no. I think  
14 defense-in-depth is very appropriate.

15 DR. BANERJEE: At Brattleboro, they said  
16 that -- I don't know how true this is -- in one of the  
17 Quad Cities, pieces of the dryer fell on top of the  
18 core. Is that true?

19 MR. HOBBS: That is not true.

20 DR. BANERJEE: Okay.

21 MR. HOBBS: The initial Vermont Yankee  
22 dryers flow-induced structural analysis combined with  
23 operating experience resulted in Entergy's decision to  
24 proactively modify the dryer at Vermont Yankee in  
25 order to strengthen it for operation at EPU

**NEAL R. GROSS**

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

1 conditions.

2 The VY dryer modification installed in  
3 April 2004 consisted of strengthening of areas  
4 adjacent to the main steam line nozzle shown here in  
5 the highlighted locations, which are vulnerable, as  
6 shown in other BWRs with square hood dryers.

7 The modification consisted of replacement  
8 of the original half-inch outer hood vertical plate,  
9 which you can see here is the area on the vertical  
10 portion of the front hood.

11 Also, we replaced the original  
12 quarter-inch-thick lower horizontal cover plate with  
13 five-eighths-inch-thick plate. We added 3  
14 55-inch-tall gussets to the outer vertical plate and  
15 cover plate junction to increase stiffness.

16 We removed the outer bank internal braces,  
17 which were determined to concentrate vertical plate  
18 stress. And we replaced the tie bars that connect the  
19 dryer banks together with a more rugged design.

20 MEMBER RANSOM: Could you point out where  
21 the steam nozzles are relative to those?

22 MEMBER SIEBER: Yes, right there.

23 MR. HOBBS: Yes. The steam nozzles are  
24 just about adjacent to the gussets, those triangular  
25 shaped components there.

**NEAL R. GROSS**

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

1 MEMBER RANSOM: What? There are two on  
2 each side?

3 MR. HOBBS: Two steam nozzles on each  
4 side, right. And that is actually when you end up --  
5 you have a flat spot on the dryer there to allow the  
6 steam to come off the dryer and exit to the steam  
7 nozzles.

8 Next slide.

9 MEMBER SIEBER: And the steam flow at that  
10 point is down, --

11 MR. HOBBS: Yes, the steam --

12 MEMBER SIEBER: -- which aids in carrying  
13 the moisture, any remaining moisture, away from the  
14 steam line.

15 MR. HOBBS: Right. This is a photo of the  
16 modification being installed in 2004. And this shows  
17 the completed Vermont Yankee dryer-strengthening  
18 modification. Here you can see the new gussets and  
19 the new faceplate and the lower cover plate.

20 CHAIRMAN DENNING: When you talk about  
21 strengthening, basically what you're doing is you are  
22 limiting the vibrational mode. Is that what is really  
23 going on with this, that there is a vibrational mode?  
24 And I don't know if you're going to get into what  
25 these vibrational modes look like.

**NEAL R. GROSS**

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

1           And you are limiting the amount of  
2 deflection that occurs in that vibrational mode. Is  
3 that what you're doing when you talk about  
4 strengthening?

5           MR. HOBBS: Yes.

6           DR. BANERJEE: Has this strategy been  
7 found to be useful in other dryers?

8           MR. HOBBS: Yes. Other boiling water  
9 reactors with square hood dryers have installed this  
10 same modification here. And it has been shown to  
11 improve the strength of the dryer.

12           DR. BANERJEE: Now, if you don't remove  
13 whatever is causing the vibration, this is going to  
14 continue to vibrate, right? And eventually it will  
15 crack again or not?

16           MEMBER SIEBER: Well, it will be  
17 different.

18           MEMBER RANSOM: Vibrate at a higher  
19 frequency, though.

20           DR. BANERJEE: Have you changed something  
21 which would actually prevent it from cracking? You  
22 haven't removed the excitation, right?

23           MR. BETTI: Well, I think we're making the  
24 assumption -- this is Enrico Betti.

25           This was a proactive modification. And we

**NEAL R. GROSS**

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

1 at Vermont Yankee didn't have any evidence, like some  
2 plants have that have had a lot of problems, of some  
3 high-amplitude resonance in the steam system in  
4 reactor domes.

5 So this modification takes care of some of  
6 the low-frequency excitations that typically can occur  
7 inside the domes themselves. And it moves the  
8 fundamental vacancy of this dryer face well above the  
9 standard frequencies, driving frequencies. So it  
10 keeps the structure coupling with the --

11 DR. BANERJEE: So you've changed the  
12 natural frequency response.

13 MR. BETTI: Right, yes, brought it up  
14 above --

15 DR. BANERJEE: Right.

16 MR. BETTI: -- what is typically the --  
17 for most BWRs, what they see is a vibration signature  
18 in the steam systems.

19 DR. BANERJEE: Now, when this is done in  
20 other systems, has it actually proved successful? I  
21 mean, cracking hasn't continued after that. Has this  
22 actually proved successful in sort of reducing the  
23 problem after it's done and operated? What has  
24 happened?

25 MR. BETTI: Yes. There have been mixed

**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 results with this kind of mod. Certainly if you were  
2 to have a system, say, that had 30, 40, 50 current  
3 vibration sources, this is a great mod. It means the  
4 resonance frequency above those functions. So this  
5 dryer design won't respond.

6 But if you were to have a resonance show  
7 up at higher steam flows that was in tune with one of  
8 the response frequencies of this modification, then  
9 the stresses could get large and you could have a  
10 problem with this modification.

11 DR. BANERJEE: So what has been the  
12 experience, actually? Where has it been successful?  
13 Where hasn't it been successful?

14 MR. HOBBS: This modification was actually  
15 first installed on Vermont Yankee and was subsequently  
16 installed at Dresden. Okay? And what was found at  
17 Dresden, which operated for 2004 and 2005, extended  
18 power uprate condition, is that they did find problems  
19 with portions of this modification. And that was  
20 partly due to the fact that their final element model  
21 incorrectly made the connections between this  
22 modification and the dryer. So they did find  
23 indications on portions of this modification here, but  
24 we addressed that specific issue for our modification.

25 And, in addition to that, Dresden and Quad

**NEAL R. GROSS**

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

1 Cities both have high loads in their plants. Now, the  
2 Brunswick plant has installed a similar mod to this.  
3 And they have been operating at 120 percent updated  
4 conditions. And they have not seen problems with this  
5 modification.

6 So I think it is a combination of doing  
7 the modification right and modeling it correctly and  
8 also does your plant have high loads that would  
9 challenge this modification.

10 DR. BANERJEE: What do you mean by "high  
11 loads"?

12 MR. HOBBS: We have a slide coming up  
13 here, two slides, that show what our loads are  
14 compared to Quad Cities. And you will see --

15 DR. BANERJEE: But is it load in terms of  
16 velocities that you're talking about or what is the  
17 load here?

18 MR. HOBBS: Well, it's a combination of  
19 hydrodynamic loads due to vortex shedding phenomena.  
20 And it's also acoustic loads as a result of excitation  
21 from vortex shedding or from excitation of a  
22 resonator.

23 DR. BANERJEE: Well, we wait to see when  
24 you describe that.

25 MR. HOBBS: All right.

**NEAL R. GROSS**

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

1 MEMBER RANSOM: Out of curiosity, you have  
2 frequencies associated with, say, the horizontal  
3 dimension of the plate that you stiffen and also the  
4 vertical dimension. Do you discriminate in terms of  
5 which one you were trying to stiffen and raise the  
6 frequency, I mean, the horizontal mode of vibration or  
7 the vertical flexing?

8 MR. BETTI: This is Rico Betti.

9 The modification had a few effects. The  
10 vertical plate that used to be a half inch is now one  
11 inch. The cover plates previously a quarter are now  
12 five-eighths.

13 MEMBER RANSOM: Right.

14 MR. BETTI: And so that thickness of  
15 material moves the resonant frequency between the  
16 gussets to well beyond what we see as signatures in  
17 our steam system.

18 MEMBER RANSOM: Right. The gussets were  
19 not there before, right?

20 MR. BETTI: Right. The gussets take care  
21 of the fundamental dishing motor that --

22 MEMBER RANSOM: Right.

23 MR. BETTI: They help raise that frequency  
24 up to about 80 units.

25 MEMBER RANSOM: Is that associated with

**NEAL R. GROSS**

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

1 the horizontal dimension you mean or --

2 MR. BETTI: Not completely because it's a  
3 plate structure and the top plate there acts as a --

4 MEMBER RANSOM: Stiffener.

5 MR. BETTI: -- a wide stiffener, it's --

6 MEMBER RANSOM: Sure.

7 MR. BETTI: -- more of this structure is  
8 well-supported in normal to that vertical plate.

9 MEMBER RANSOM: Well, its fundamental mode  
10 would be like a drum head mode and just --

11 MR. BETTI: Yes.

12 MEMBER RANSOM: And, of course, the  
13 gussets will stiffen that.

14 MR. BETTI: And the skirt itself provides  
15 uplift resistance to those gussets; thereby, instead  
16 of having, say, -- you could have had a gusset that  
17 was maybe current and just working on the plate's  
18 fundamental mode, this GE design realized to bring  
19 some of the load down to the base of those gussets and  
20 to convert it back into the skirt.

21 MEMBER RANSOM: In a situation like this,  
22 the thing you would like to hear is that you were able  
23 to identify where the fundamental mode was coming from  
24 and that you stiffened it and raised that frequency to  
25 a high enough frequency that now it is coupled with

**NEAL R. GROSS**

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

1 whatever resonant phenomena exists in the rest of the  
2 system.

3 MR. BETTI: Right. We didn't have  
4 problems in this dryer in this area prior to the  
5 modification, but we based it based on what GE felt  
6 was a design that would take its fundamental frequency  
7 above what typically for BWR systems are the  
8 recognized frequencies of concern.

9 But what we'll show you a little later on  
10 is what we measure at VY currently to be our  
11 frequencies of concern and how we'll monitor for any  
12 changes in those frequencies in the steam system as we  
13 come up. And then we'll be able to evaluate the fact  
14 that those frequencies are in this dryer structure.

15 DR. BANERJEE: Adding those gussets, of  
16 course, gives you additional vortex shedding because  
17 the flow goes across them now. So you've added some  
18 additional sort of modes due to those gussets  
19 themselves, --

20 MR. BETTI: We did. And --

21 MEMBER RANSOM: -- acoustic modes.

22 MR. BETTI: Brian is going to present  
23 something that shows our evaluation of those loads.

24 MEMBER RANSOM: Okay.

25 MR. BETTI: But, in short, you're talking

**NEAL R. GROSS**

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

1 about local forces on a one-inch plate,  
2 five-eighths-inch plate. And the effect of those  
3 localized forces was not significant.

4 MEMBER RANSOM: Another source that was  
5 talked about initially is when you have two outlets  
6 that are close together, unlike these two. There's a  
7 stagnation zone that exists between the two. And  
8 oftentimes it itself will oscillate and cause, you  
9 know, frequencies.

10 And sometimes adding splitter plates or  
11 something like that has been a solution to that  
12 problem. So it's like what you've done in that  
13 regard.

14 MR. HOBBS: Yes. We'll be talking about  
15 that. So the bottom line, this modification was  
16 installed for a potential vulnerability at Vermont  
17 Yankee, not an existing vulnerability.

18 MR. LEITCH: Just so I'm clear, this was  
19 installed in '04. And you took a look in '05.

20 MR. HOBBS: Yes.

21 MR. LEITCH: And it's still okay?

22 MR. HOBBS: No indications, right.

23 MR. LEITCH: Okay. Thank you.

24 MEMBER SIEBER: This turns out to be a  
25 pretty complex geometry. And a calculation that you

**NEAL R. GROSS**

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

1 would do to predict all of these forces and resonant  
2 frequencies is not going to be perfectly exact because  
3 of that complexity.

4 MR. HOBBS: That's a very good point, very  
5 good point. And we are not here to tell you that we  
6 are perfectly exact in our measurements and  
7 predictions for --

8 MEMBER SIEBER: I don't see how you could  
9 be.

10 MR. HOBBS: Right. And that's why,  
11 actually, we couldn't tell you what our load  
12 definition will be of the EPU conditions. And that's  
13 why we have a very controlled monitoring plan to  
14 capture the data and do the monitoring to see if we  
15 have any vulnerabilities that pop up on our way up to  
16 EPU conditions.

17 MEMBER SIEBER: The ultimate engineering  
18 fix is to over-design with whatever corrective  
19 structure you're going to put in there so that you  
20 catch all of the potential failure modes and  
21 frequencies.

22 MR. HOBBS: Right. And we have --

23 MEMBER SIEBER: It sort of looks like that  
24 is what you have done.

25 MR. HOBBS: We have incorporated a lot of

**NEAL R. GROSS**

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

1 uncertainty into our analysis also and accounted for  
2 that to make sure we have a conservative --

3 MEMBER SIEBER: And how did you do that?

4 MR. HOBBS: We'll be talking about that.

5 MEMBER SIEBER: I will be eager to hear  
6 it.

7 MR. HOBBS: Okay. Good. The Vermont  
8 Yankee structural analysis relies on obtaining  
9 fluctuating pressure measurements on the main steam  
10 piping. For the VY dryer analysis of record, the  
11 measurements have been obtained from one strain gauge  
12 location on each main steam line and one reading from  
13 a high-speed pressure sensor installed on the main  
14 steam venturi flow instrument lines.

15 This measurement configuration was used to  
16 develop the dryer acoustic load definition applied in  
17 the current VY dryer stress analysis. To improve  
18 instrument measurement accuracy, we recently installed  
19 48 additional strain gauges consisting of 6 gauges at  
20 8 locations on each main steam line.

21 Four of the locations of the strain  
22 gauges, the newly installed strain gauges, are  
23 approximately seven feet outboard of the main steam  
24 line nozzles, seen here as location number one.

25 The other four locations are approximately

**NEAL R. GROSS**

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

1 45 feet outboard of the main steam line nozzle shown  
2 here as the location two. These are optimal locations  
3 for measurements because they are close to the nozzle,  
4 which minimizes signal attenuation for vortex shedding  
5 and acoustic signatures.

6 Also, there are minimal acoustic sources  
7 in between these two measurements, which allows us to  
8 take these and apply them to our load definition. And  
9 also there is adequate separation between these  
10 measurement locations for collecting data.

11 The original strain gauge locations are  
12 shown here on this figure also. Those are the starred  
13 locations. And the venturi flow devices are also  
14 shown here in the vertical riser heading down the  
15 steam pipes.

16 MR. LEITCH: So, you're not abandoning the  
17 original ones. You'll still have the venturi  
18 high-pressure signal, high-pressure, high-speed  
19 pressure recorder.

20 MR. HOBBS: We don't intend to collect  
21 data on the venturis. The problem with the venturis  
22 -- and we'll be talking about those measurements here  
23 shortly -- is that they had high uncertainty. We were  
24 measuring fluctuating pressure at the end of an  
25 instrument line that was more than 100 feet long. And

**NEAL R. GROSS**

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

1 that instrument line had steam and water, so a  
2 two-phase mixture, in it.

3 And we found that the modes of that  
4 instrument line itself were basically interfering with  
5 our ability to accurately measure what was happening  
6 in the main steam system.

7 MR. LEITCH: Now, all of your sensors are  
8 on the reactor side of the MSIVs. I guess I've had  
9 some experience with high-speed fluctuations in the  
10 turbine control valves, which I think could be  
11 reflected back into pressure fluctuations in the main  
12 steam lines, I mean, very high-speed fluctuations in  
13 the turbine control valves. Are your turbine control  
14 valves steady or is there some fluctuation in that or  
15 have you looked at that?

16 MR. HOBBS: We have looked at that, and  
17 they are steady.

18 MR. BETTI: In 2004, we didn't really want  
19 to fill up this slide, but we put high-speed pressure  
20 trays down near the control valves. And then we also  
21 put them at the venturis. And we also had high-speed  
22 transmitters in the reactor vessel-level instrument  
23 system.

24 And we had strain gauges on the vertical  
25 risers because the industry at the time was making an

**NEAL R. GROSS**

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

1 attempt to define the signatures in these lines, find  
2 what was important and determine what to focus on.

3 As we went forward with industry  
4 experience and developed better technology for  
5 measuring these loads, we determined that, really, the  
6 best thing to do is measure this signal close to the  
7 reactor.

8 So even if there's a signal, say, that  
9 would emanate from the control valves and make it up  
10 through the venturi, the flow in the safety device and  
11 our restrictor, we'll be able to measure that signal,  
12 do a time record of it, and project that acoustic load  
13 back to the dryer because, I mean, our ETR MPRs do  
14 have oscillating signals that bounce in our steam  
15 lines.

16 And we have to damp those out for our  
17 regulator pressure control for pressure regular  
18 control. And when we put the devices down there to  
19 read those, we found signatures on those lines, like  
20 we did other places, and worked through coherence  
21 evaluations, et cetera, and say, "Well, how does this  
22 relate?"

23 There wasn't a lot of coherence between  
24 there and back at the vessel. The important thing now  
25 is that we've put in a refined system to measure the

**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 acoustic loads where we need a measurement.

2 So if we come a mile down the line or ten  
3 feet down the line, as long as we have two points of  
4 measurement on a clean pipe, we'll be able to measure  
5 and project those acoustic loads back toward the  
6 vessel.

7 MR. LEITCH: Okay.

8 MR. BETTI: So the first phase was to  
9 measure everywhere, try to learn.

10 MR. LEITCH: Yes.

11 MR. BETTI: And the second phase is now we  
12 understand the system, know how to calculate it. And  
13 so that's why we're concentrating on measuring the  
14 system up here.

15 The NRC has also asked us to look at the  
16 accelerometers and the like in parallel just to make  
17 sure that our strain gauges are not giving them  
18 different information. We have accelerometers on the  
19 same lines that we'll be talking about.

20 DR. BANERJEE: I take it that you can't  
21 directly install anything on the dryers until we move  
22 to the signal out.

23 MR. HOBBS: The Quad Cities unit 2 did  
24 install instrumentation on a dryer earlier this year,  
25 with a new dryer, right, this year. Instrumenting an

**NEAL R. GROSS**

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

1 existing dryer, such as that of Vermont Yankee, is a  
2 very high-dose effort. And we believe that this  
3 approach here is an adequate way to predict loads on  
4 the dryer.

5 DR. BANERJEE: What has been the  
6 experience? I take it that other people have done  
7 things similar to this to pick up vibrations in other  
8 power uprates. Has there been experience that would  
9 suggest that monitoring vibrations in the steam lines  
10 is indicative of what is happening in the dryers?

11 MR. HOBBS: Yes.

12 DR. BANERJEE: What evidence is there?

13 MR. HOBBS: We have an acoustic circuit  
14 model that we'll be talking about here shortly, which  
15 shows how you take those two measurements on each  
16 steam line and predict using a Helmholtz solution into  
17 the steam dome and onto the face of the dryer. So we  
18 have some detail about that.

19 DR. BANERJEE: Right. That's solving a  
20 Helmholtz equation for the pressure field.

21 MR. HOBBS: Right.

22 DR. BANERJEE: But I'm saying, are there  
23 any actual measurements which you will perhaps have in  
24 Quad Cities now that they have instrumented the steam  
25 dryer, which makes a correlation between measurements

**NEAL R. GROSS**

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

1 of what is happening in the steam dryer and in these  
2 lines? I think this is a crucial issue --

3 MR. HOBBS: Yes.

4 DR. BANERJEE: -- because if these  
5 monitoring locations are okay, then they should have  
6 been okay in the past.

7 MR. HOBBS: Right.

8 DR. BANERJEE: If that is the case, why is  
9 Quad Cities putting a monitor into the dryer now?

10 MR. HOBBS: Well, to answer your first  
11 question, yes, this measurement approach here was  
12 benchmarked against the instrumented Quad Cities 2  
13 dryer. So the actual measurements on the dryer were  
14 compared to the predictions using this acoustic  
15 circuit methodology. So we will be talking about that  
16 and how that --

17 DR. BANERJEE: So the correlation already  
18 exists?

19 MR. HOBBS: Yes.

20 DR. BANERJEE: There is some backup for  
21 this other than just solution of a Helmholtz equation.

22 MR. HOBBS: Yes.

23 DR. BANERJEE: Because there are thousands  
24 of things that could be wrong with that.

25 MR. HOBBS: Yes. There's empirical data

**NEAL R. GROSS**

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

1 to back that up.

2 MEMBER KRESS: And there is the solution  
3 that the Helmholtz equation will give you the right  
4 answer for those Quad Cities?

5 MR. HOBBS: It gives you an answer, and  
6 there is some uncertainty associated with that answer.  
7 And we have taken that uncertainty and applied it to  
8 our --

9 MEMBER KRESS: It normally doesn't couple  
10 the structural. And I think that could make a  
11 difference. How big are those exit pops, for example?  
12 And how thick are they?

13 MR. HOBBS: Those are 18-inch-thick  
14 interdiameter.

15 MEMBER KRESS: That's pretty thick.

16 MR. HOBBS: I'm sorry. Eighteen-inch  
17 piping. So it's interdiameter.

18 MEMBER KRESS: Okay. I was about to say  
19 you're not going to get anything.

20 MR. HOBBS: Right. No. The thickness of  
21 the pipe is not 18 inches.

22 MEMBER KRESS: How thick are they?

23 MR. BETTI: They're .9 inch pipes. And  
24 it's an 18 outside diameter pipe.

25 MEMBER KRESS: That might be sensitive to

**NEAL R. GROSS**

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

1 the frequencies you are talking about.

2 MR. HOBBS: Right.

3 DR. BANERJEE: The problem obviously is  
4 that Helmholtz equation is a far-fielded equation. So  
5 it doesn't have any near-field source terms in it,  
6 which have to come out of a turbulence calculation as  
7 a driver, right?

8 So when you go through this entrance  
9 region or whatever, you're going to generate  
10 turbulence. And there's going to be lot of near-field  
11 stuff there which you're not going to actually see in  
12 this Helmholtz equation.

13 So the expectation that it works is only  
14 correct in a situation where you have got the  
15 near-field noise well-characterized. So it's sort of  
16 unexpected that this will work coming through that  
17 entrance where there is a lot of turbulence.

18 MR. HOBBS: Well, that's right. And  
19 that's the reason we use the CFD modeling tool.

20 DR. BANERJEE: Unfortunately, I don't  
21 think any CFD tool that I'm aware of can do that  
22 calculation, but I am open to listening to how they  
23 did it.

24 MR. HOBBS: Right. Very good.

25 MEMBER SIEBER: Just one quick question.

**NEAL R. GROSS**

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

1 Your coffin is that you are getting the right  
2 interpretation of the results of this has to do with  
3 the coherence of the signals, the paired signals, from  
4 one to the other.

5 And that's if you have coherence in the  
6 signals and then you say that they're in the same  
7 couplet and, therefore, I can rely on any spatial  
8 derivation from that, to what degree are you getting  
9 signal coherence? And how do you measure it?

10 MR. BETTI: We have a little bit of some  
11 of the new strain gauge signal data to share with you  
12 a little bit later here, but we're getting very good  
13 coherence in terms of the signal at those two points  
14 in the steam line. And there's been more --

15 MEMBER SIEBER: Same signatures.

16 MR. BETTI: Same signatures, yes. Yes.  
17 It's almost identical.

18 MR. HOBBS: Next slide. Okay.

19 So the measurements we have taken using  
20 our newly installed strain gauges are reflected in  
21 this figure here, which is representative of main  
22 steam line strain gauge power spectral density  
23 log-scale readings for Vermont Yankee and also for  
24 Quad Cities.

25 Vermont Yankee here is the blue line,

**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 which is the see main steam line location number one  
2 measurement on the new strain gauge data acquisition  
3 system. This is typical of the seven other new strain  
4 gauge measurement locations of Vermont Yankee and  
5 demonstrates the very low vibration at current license  
6 thermal power with limited evidence of high-frequency  
7 acoustic excitation.

8 There are some peaks here on the Vermont  
9 Yankee spectra seen at 30, 45, and 60 hertz, which  
10 don't have significant structural impact in our  
11 structural model.

12 Now, the yellow line shows Quad Cities  
13 vibration levels at the same main steam line strain  
14 gauge location. You will note that Quad Cities has  
15 significantly greater high frequency acoustic  
16 resonance in their steam system, evident here, which  
17 is original license thermal power for Quad Cities.

18 Next slide. This figure adds the Quad  
19 Cities vibration data in log-scale still for operation  
20 at EPU conditions. And if you go to the next slide,  
21 this is on a linear scale.

22 So you can see that there is a significant  
23 increase in the Quad Cities acoustic resonance levels  
24 at EPU conditions in this figure here. And at Quad  
25 Cities, EPU exacerbated the previously existing

**NEAL R. GROSS**

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

1 acoustic excitation phenomenon, which resulted in  
2 their dryer failures.

3 DR. BANERJEE: So the yellow is without  
4 operate and the red is with operate?

5 MR. HOBBS: Yes.

6 DR. BANERJEE: But that's only sort of  
7 like -- the access there is linear or --

8 MR. HOBBS: This is linear.

9 DR. BANERJEE: Yes. So it's only a factor  
10 of two or something?

11 MR. HOBBS: Four.

12 DR. BANERJEE: Four?

13 MR. HOBBS: Right. But these high  
14 acoustic peaks here are what has been determined to  
15 have caused the dryer failures at Quad Cities.

16 DR. BANERJEE: But these are measured in  
17 the steam lines, right?

18 MR. BETTI: Right.

19 MR. HOBBS: These are measured in the  
20 steam lines, right

21 DR. BANERJEE: And are these the same as  
22 are being measured in the dryer, then, or not?

23 MR. HOBBS: There are measurements on the  
24 dryer at Quad Cities that correlate to these steam  
25 line measurements here.

**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 DR. BANERJEE: The same frequencies?

2 MR. HOBBS: Right.

3 CHAIRMAN DENNING: Incidentally, your  
4 ordinate is a little bit strange on there. That is  
5 the one times  $10^{-6}$  down there. Is that really zero?

6 MR. HOBBS: It's really zero, yes.

7 CHAIRMAN DENNING: Another comment. And  
8 that is now the frequency at which we saw in Quad  
9 Cities, this big peak, is way above the area that is  
10 related to where your strengthening occurred, right?

11 MR. HOBBS: Right, yes.

12 CHAIRMAN DENNING: So this wouldn't  
13 directly address that particular issue. I'm sorry.  
14 I mean, we don't know, of course, whether you have an  
15 issue with this high frequency, but, in any event, if  
16 you had, the strengthening that you did would not have  
17 helped against that?

18 MR. HOBBS: That's correct.

19 MEMBER RANSOM: Can you identify what  
20 parts of the steam lines correspond to the different  
21 peaks in that spectrum?

22 MR. HOBBS: Yes.

23 MEMBER RANSOM: I mean, is it the entire  
24 steam line or is it a part of it or --

25 MR. HOBBS: We'll be talking about that

**NEAL R. GROSS**

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

1 here on the next series of slides, actually. So this  
2 strain gauge data that we collected from Vermont  
3 Yankee is converted using the acoustic circuit model  
4 to pressure loads on the dryer. And we'll be talking  
5 about that also momentarily.

6 Although there's no evidence of  
7 high-frequency acoustic resonance at Vermont Yankee  
8 today, we performed an evaluation of main steam branch  
9 lines for potential acoustic excitation. And the  
10 branch lines we looked at are the main steam safety  
11 relief valves, the spring safety valves.

12 We have a HPCI steam supply line; RPCI  
13 steam supply line, which supplied steam-driven  
14 turbines for emergency core cooling. And we also have  
15 blanked-off stub tubes on our main steam lines.

16 So back to this figure here, you can see  
17 the locations of the branch lines on this figure. The  
18 SVs, one on each main steam line, represent the safety  
19 valves. The RVs are the relief valves. You can see  
20 there are some blanks indicated here. The HPCI  
21 ten-inch steam supply line is on the B main steam  
22 line. And the RPCI is on the C main steam line.

23 Now, one thing to note about Vermont  
24 Yankee is that we have only one type of each cavity on  
25 each main steam line; whereas, at Quad Cities, they

**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 have more than one type of cavity on each main steam  
2 line. And those are in close proximity to each other.

3 MEMBER RANSOM: So the frequency is  
4 associated with the length of the branch?

5 MR. HOBBS: Yes, right. That's one  
6 factor, right. And we have a table, actually, coming  
7 up here. But our main steam line monitoring approach  
8 will detect all acoustic excitation that occurs in our  
9 system.

10 So here is our evaluation of potential  
11 acoustic resonance at Vermont Yankee. This shows the  
12 natural frequency of each of the cavities we  
13 evaluated. It shows the velocity at the onset of  
14 resonance, which we predict; also shows the velocity  
15 where resonance is fully developed.

16 And what this shows is that for the relief  
17 valves at today's rate of steam flow of 139 feet per  
18 second, we should be seeing the onset of resonance.  
19 And the relief valve frequency is 116 hertz. But we  
20 have no data that shows us that we're having that  
21 resonance actually occurring.

22 Moving up to EPU flow conditions, it shows  
23 that we may see excitation of the relief valve and the  
24 safety valves. The HPCI and RPCI lines are well below  
25 what we see at rated steam flows. And the blanks are

**NEAL R. GROSS**

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

1 well above. Their frequencies are quite high.

2 Next slide.

3 MR. LEITCH: I assume this evaluation is  
4 done with HPCI and RPCI not being in service, right?  
5 They're just static lines?

6 MR. HOBBS: Yes. Next slide. So this is  
7 just another way to look at this, which is on the  
8 x-axis here, we have main steam velocity in feet per  
9 second. On the y-axis, we have frequency of the  
10 cavities in our main steam system.

11 And you can see that for the rated current  
12 Vermont Yankee velocity of 139 feet per second, the  
13 relief valves have predicted onset of resonance and  
14 full resonance in that block there. And at EPU  
15 condition, you can see the safety valves would show  
16 potential onset for resonance.

17 So we know where to look. We know what  
18 our potential excitation sources are on our main steam  
19 lines. And we don't see today any indication of onset  
20 of resonance.

21 DR. BANERJEE: Just a question. At the  
22 entrance to the steam line and that cavity which is  
23 formed at the dryer, is there sort of potential for  
24 resonances there?

25 MR. BETTI: We'll have Dr. Bilanin. And

**NEAL R. GROSS**

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

1 we'll talk a little bit about how we do the Helmholtz  
2 solution and how CDI backed figures what the source  
3 must be at that nozzle.

4 DR. BANERJEE: Okay.

5 MEMBER KRESS: Do you assume it's all  
6 steam when you do the calculation?

7 MR. HOBBS: Yes.

8 MEMBER RANSOM: All vapor?

9 MR. HOBBS: Right. Because the quality is  
10 greater than 99.9 percent, we essentially ignore the  
11 moisture.

12 CHAIRMAN DENNING: Now, we're about to  
13 enter proprietary information. Is that true? Is that  
14 where we are?

15 MR. HOBBS: That's true, yes.

16 CHAIRMAN DENNING: Okay. So that now we  
17 have to clear the audience of --

18 MR. CARUSO: People who do not have a  
19 nondisclosure agreement with --

20 MR. HOBBS: Continuum Dynamics.

21 MR. CARUSO: -- CDI --

22 MR. HOBBS: Yes.

23 MR. CARUSO: -- have to leave the room.

24 CHAIRMAN DENNING: And how are you going  
25 to determine that?

**NEAL R. GROSS**

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

1 DR. BANERJEE: Let me ask you this while  
2 this is happening. You said that your venturi lines  
3 have sort of got steam water and condensation or  
4 whatever.

5 MR. BETTI: We have a condensate pot that  
6 is very close to the piping that puts steam over the  
7 water. That's the steam water. It's a short amount  
8 of steam.

9 DR. BANERJEE: Oh, okay.

10 MR. BETTI: And then it's all liquid down  
11 to the pressure transducer.

12 DR. BANERJEE: So what you are concerned  
13 with is that that pot damps the high frequencies?  
14 That's why you don't --

15 MR. BETTI: We modeled that. And we  
16 developed a transfer function for those lines, you  
17 know, looking at the acoustics of the sensing line,  
18 which is that as you go through resonance frequencies  
19 of the sensing lines, you have an --

20 DR. BANERJEE: Overlap of some sort.

21 MR. BETTI: -- or a lot has changed in the  
22 signal.

23 DR. BANERJEE: I see. So you can get the  
24 average pressure drops okay, but you can't get the  
25 true signal of the acoustic frequency fluctuations,

**NEAL R. GROSS**

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

1 the high frequencies.

2 MR. BETTI: You can get an idea of that  
3 large uncertainty. You may pick up a 70 percent  
4 uncertainty in values reading for that.

5 DR. BANERJEE: I see.

6 MR. BETTI: If you're close to a harmonic  
7 of the sensing system, it's going to be less reliable.

8 DR. BANERJEE: So the transducer is  
9 actually after a separation part or condensate part,  
10 which is after that. It's all liquid-filled to that  
11 line.

12 CHAIRMAN DENNING: We're not ready to  
13 start into this yet because Ralph still has to get the  
14 telephone line off here, but I do want to check and  
15 see exactly where we are slide-wise because I think  
16 that we've got a lot of slides to go still.

17 We're only scheduled for half an hour  
18 here, but we'll have some freedom beyond that and  
19 compromise other places. But I do want to let  
20 everybody know that we're going to have to move  
21 quickly.

22 So the question is, how many slides do you  
23 have? What's your projection on how much time you  
24 really need to go through that?

25 MR. HOBBS: We are approximately halfway

**NEAL R. GROSS**

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

1 through our entire presentation right now. So I would  
2 expect that we should be able to complete that in an  
3 hour or less depending on the number of questions.

4 CHAIRMAN DENNING: And hour is too long.  
5 So we're going to have to make it less.

6 MR. HOBBS: Okay.

7 CHAIRMAN DENNING: So let's try to finish  
8 up in 45 minutes and try to get through it quickly.  
9 We'll come back and ask questions later if we have to.  
10 Okay?

11 MR. HOBBS: That sounds good.

12 DR. BANERJEE: I guess the issue, at least  
13 of concern to me, to get clarification is how one can  
14 monitor these signals in the steam line and get a good  
15 indication of what is happening inside so that when  
16 you go up in power and you're doing this monitoring,  
17 to make that connection and what evidence do we have.

18 So that is one of the issues. If you  
19 would address that based on how important you think  
20 the CFD calculations are and how much reliance you can  
21 put on them and why you think you can put reliance on  
22 them? There is a bridge.

23 I mean, if you have empirical evidence to  
24 that effect, that would be fine. I would find that  
25 much easier to --

**NEAL R. GROSS**

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

1 MR. BETTI: We submitted empirical  
2 evidence to the staff. We submitted the empirical  
3 evidence to the staff. I mean, we did do it. On the  
4 Quad Cities dryer between GE's instrumentation on the  
5 dryer and the Quad Cities stain gauge installation, it  
6 was very similar to the one that we show here. They  
7 had four strain gauges, not six, at each location, at  
8 almost the same locations.

9 So, you know, we did compare aspects of  
10 the model, acoustic model, we used with the signals  
11 and their ability to predict loads at 27 locations on  
12 the Quad Cities dryer.

13 DR. BANERJEE: Maybe you could just  
14 summarize it in a slide here or something or put it on  
15 the board, what you saw. You know, that would be  
16 useful.

17 CHAIRMAN DENNING: Right. We're ready now  
18 to move into the proprietary phase of this.

19 MR. HOBBS: Okay.

20 CHAIRMAN DENNING: Proceed.

21 MR. CARUSO: The phone is muted at this  
22 point. I've got somebody checking it to make sure.  
23 Okay? And we're going into proprietary session.  
24 Thank you.

25 (Whereupon, the foregoing open session

**NEAL R. GROSS**

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

1 was recessed and the hearing was  
2 reconvened in closed session from 9:46  
3 a.m. to 10:00 a.m., at which time the  
4 open session resumed.)

5 MR. HOBBS: Next slide. The CFD analysis  
6 was used to capture again the hydrodynamic forces.

7 Next slide. This shows the CFD loads  
8 calculated at 100 percent and 120 percent power  
9 conditions. And this location here represents the  
10 dryer face plate adjacent to the main steam line  
11 nozzles for these two conditions.

12 Even though the CFD model was used to  
13 calculate hydrodynamic loads, we found that use of a  
14 compressible fluid resulted in the prediction of  
15 acoustic loads, which are shown here as the red lines  
16 or pink lines with peaks at 30 hertz, 45 hertz, and 60  
17 hertz.

18 So these peaks were acoustic phenomena at  
19 EPU conditions, which we don't see today but the CFD  
20 model predicts will occur as a result of hydrodynamic  
21 forces creating acoustic energy in the system. And  
22 these three peaks here were used in our stress  
23 analysis and contribute a majority of the loads on the  
24 dryer in our structural analysis.

25 So these three peaks here are basically

**NEAL R. GROSS**

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

1 the major components in our load definition for our  
2 dryer.

3 CHAIRMAN DENNING: Does the CFD analysis  
4 extend all the way into the steam line?

5 MR. HOBBS: Yes. We modeled the steam  
6 lines to the main steam header to see if there was any  
7 coupling interaction between adjacent steam lines.

8 MR. CARUSO: But you said these are the  
9 predicted value at your current rated thermal power  
10 level.

11 MR. HOBBS: Ralph, these are both current  
12 power, which is the blue, and EPU conditions. The CFD  
13 model we were able to calculate what the conditions  
14 would be at extended power uprate, which is basically  
15 what is the velocity at extended power uprate.

16 The acoustic circuit model, on the other  
17 hand, requires measurements as input to project loads  
18 on the dryer. So unless you have measurements, which  
19 we don't have for EPU conditions right now, we don't  
20 have an circuit model load at EPU conditions.

21 MEMBER RANSOM: So you do have an estimate  
22 of the frequency, the fundamental mode, of those  
23 lines, right? And they were up around 100 or higher  
24 in frequency?

25 MR. HOBBS: Right.

**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 MR. BETTI: They wouldn't couple with  
2 these.

3 MR. CARUSO: But you're not detecting any  
4 of these.

5 MR. HOBBS: We are not detecting these.  
6 That's correct.

7 MR. CARUSO: So the analytical method is  
8 predicting certain phenomena that should be visible at  
9 current rated power that you're not detecting.

10 MR. HOBBS: Oh, I'm sorry. When you say,  
11 "detecting," you're talking about the blue line here,  
12 right?

13 MR. CARUSO: Well, either one, whatever is  
14 being predicted for current rated thermal power. Are  
15 you detecting what you predict is supposed to be  
16 there?

17 MR. HOBBS: Mr. Betti, can you --

18 MR. BETTI: Yes. I would like to talk to  
19 this a little bit. As Brian pointed out, we  
20 originally ran the CFD model to understand the  
21 hydrodynamic forces, the vortex shedding forces. And  
22 if we go back to the last depiction that Craig had,  
23 what this model showed us is what our people had seen  
24 in the dryer faces, that sometimes you get this little  
25 polished area where you get this vortex shedding load.

**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           Often the question has not been what is  
2           the effect of these really strong vortices on gusset  
3           plates.    The gusset, how will that impact the  
4           vortices? What will these vortices do to the gusset,  
5           that kind of question, the cover plate?

6           Now, the short answer to that, that blue  
7           stripe versus the red stripe, we end up with about a  
8           19 psi if you do the pascal conversion as a vacuum on  
9           that front plate. And that kind of local forces on a  
10          one-inch plate, half-inch gusset, and that five-inch  
11          cover plate had negligible stress impact on the dryer.  
12          Okay?

13          I mean, this model, though, because we ran  
14          a compressible, -- we ran a compressible because we  
15          wanted a little better idea of the actual flow field  
16          in this region where there is a lot of velocity  
17          change. What we found is that the majority of the  
18          pressures that we were reading we determined that when  
19          we were starting to study the results were acoustic.

20          We knew that because basically you can say  
21          these modal responses of the dome, the pressures on  
22          either side of these gussets for the entire  
23          frequencies were the same. You know, we showed you  
24          the average pressure on a quadrant of that big plate.  
25          We found that these loads were acoustic.

**NEAL R. GROSS**

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

1 Now, that CFD model was not built or  
2 expected to give us acoustic results. Unlike the  
3 acoustic model, we didn't get good acoustic boundary  
4 conditions set up, right absorption steam line that  
5 would be flat lying back.

6 It was never our intention to use this  
7 model to calculate acoustic loads because we have a  
8 benchmark methodology for acoustic model where we can  
9 measure loads in the steam line, project those back to  
10 the dryer.

11 What this model was for was to fill in the  
12 gap with acoustic modeling and calculate the  
13 hydrodynamic forces. So what came out of this model  
14 was hydrodynamic forces, plus some acoustic loads.

15 Now, it so happens that the frequencies in  
16 those bump responses that we see on this theoretical  
17 model do match the bumps that we see in the strain  
18 gauges on the steam lines. And they match some of the  
19 theoretical hand calculation frequencies and  
20 frequencies that we have looked at for the molds in  
21 the dome.

22 So what is coming out of this model is  
23 understandable, but the acoustic magnitudes just up  
24 over 30 hertz. This model was never set up to do an  
25 accurate job in that acoustic magnitude.

**NEAL R. GROSS**

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

1           What you also have to consider is that all  
2 of these loads, although they're shown in this  
3 amplified region, are low. They're very low-pressure  
4 variations.

5           So what we're looking for here is some  
6 smoking gun. You know, is there a hydrodynamic  
7 problem that's causing dryer failures? And the  
8 absolute answer from that from a hydrodynamic  
9 standpoint is no. There's nothing hydrodynamically in  
10 either of these two cases that took us months and  
11 months and months to generate data for that should  
12 challenge the dryer.

13           Now, when we ran our analysis Brian will  
14 show out, we didn't strip out this acoustic. We  
15 basically double-dipped this acoustic. And that's  
16 hugely conservative. And we'll talk a little bit  
17 about that because --

18           DR. BANERJEE: I just have to clarify in  
19 my own mind what you mean by "hydrodynamic" and what  
20 you mean by "acoustic." If I understand it, acoustic  
21 is the pressure field. After all, sound is variations  
22 in pressure. Hydrodynamic, I presume you mean the  
23 flow field.

24           MR. BETTI: Pressure field.

25           DR. BANERJEE: But pressure and flow are

**NEAL R. GROSS**

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

1 hand in hand. So why this separation between what is  
2 hydrodynamic and what is acoustic? Maybe somebody can  
3 explain this to me.

4 MR. BETTI: Well, my simple explanation is  
5 that we ran this as an incompressible flow problem.

6 DR. BANERJEE: It wouldn't matter. It's  
7 a low mach number anyway.

8 MR. BETTI: But it would matter in terms  
9 of you wouldn't be seeing anything in terms of signal  
10 after 25 hertz because when we started out running  
11 this model, we did look at it in --

12 DR. BANERJEE: Well, that simply depends  
13 on the resolution of the calculation. If you're doing  
14 a calculation, the pressure field comes out of a Pyson  
15 equation in terms of the hydrodynamics. I mean, the  
16 two are inextricably coupled. And at low mach  
17 numbers, whether it's compressible or incompressible  
18 is more or less irrelevant.

19 Maybe the Fluent people who are here can  
20 educate me on this.

21 MR. HOBBS: Actually, we have a question  
22 from Dr. Ransom here about boundary conditions as  
23 well. So I would like to ask Karl Kuehlert from  
24 Fluent to step up to the microphone here and see if we  
25 can talk about that.

**NEAL R. GROSS**

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

1 Dr. Ransom, could you repeat your question  
2 on --

3 MEMBER RANSOM: Well, I was interested in  
4 what you use for the boundary condition in the CFD  
5 calculation at the wall.

6 MR. HOBBS: Can you talk about the  
7 boundary condition at the wall, Karl?

8 DR. KUEHLERT: My name is Karl Kuehlert  
9 from Fluent. We used a wall boundary condition with  
10 a wall function.

11 MEMBER RANSOM: What is assumed the wall?

12 DR. KUEHLERT: No slip.

13 MEMBER RANSOM: No slip?

14 DR. BANERJEE: You used a no slip  
15 condition at the wall? And you used what, a  
16 Smagorinski model, in the fluid?

17 DR. KUEHLERT: For the separate elements,  
18 yes.

19 DR. BANERJEE: But we know that the  
20 Smagorinski model going to the wall gives you the  
21 wrong results.

22 DR. KUEHLERT: Pardon me?

23 DR. BANERJEE: Is it Smagorinski all the  
24 way to the wall?

25 DR. KUEHLERT: We used a wall function at

**NEAL R. GROSS**

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

1 the wall.

2 DR. BANERJEE: What was the wall function?

3 DR. KUEHLERT: It's a standard wall  
4 function.

5 DR. BANERJEE: Which one?

6 DR. KUEHLERT: I'm not sure I understand  
7 what you're asking me.

8 DR. BANERJEE: What is the wall function  
9 that you used at the wall? Give me the name of it.  
10 There are many, many different wall functions.

11 DR. KUEHLERT: I do not know in detail  
12 what the wall function is based on. It's a wall  
13 function that is equally used for Reynauld Evers  
14 models through this ABS model.

15 DR. BANERJEE: I guess Professor Ransom's  
16 question is of concern because wall functions break  
17 down near separation points. When your sheer stress  
18 goes to zero, then wall functions are usually phrased  
19 in terms of a friction velocity, which require the  
20 wall sheer stress. So there's a singular point there.

21 So how do you actually predict separation?

22 DR. KUEHLERT: Well, in this particular  
23 case, we put more emphasis on the three sheer layers,  
24 as opposed to all friction, because the flow that we  
25 are seeing is going into the vent, coming out of the

**NEAL R. GROSS**

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

1 steam dome. And there is a lot of turbulence  
2 generated in the sheer layer, much more so along the  
3 wall in the boundary layer.

4 MEMBER RANSOM: The problem is you want to  
5 know when the flow separates and when it reattaches  
6 periodically. In order to predict the shedding of  
7 these vortices.

8 CHAIRMAN DENNING: Talk into the mike.

9 MEMBER RANSOM: You want to know when the  
10 flow separates and reattaches in order to predict the  
11 shedding of these vortices. And that is dependent on  
12 what you assume for the boundary condition at the  
13 wall.

14 DR. KUEHLERT: Well, in this case, unlike  
15 in a steady state simulation, we are generating  
16 localities all the time coming from the sheer layer.  
17 So there's no clear separation point defined. You can  
18 only see --

19 MEMBER RANSOM: So, as an example, if you  
20 have flow or river-facing step, where there is  
21 definite separation and reattachment, this is a  
22 classical problem. Is your code benchmarked against  
23 these kinds of data taken from --

24 DR. KUEHLERT: Yes. Again, I have to  
25 refer to two types of benchmarking, one set for steady

**NEAL R. GROSS**

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

1 state analysis using the steady state turbulence  
2 models and what we are interested in here, LES models.  
3 LES models are inherently unsteady. And separation  
4 point moves around all the time. And on a  
5 time-average basis, we can determine what the mean  
6 separation point would be.

7 To this effect, we have submitted  
8 benchmarks for simple geometry, such as flow behind  
9 the cylinder, square cylinder. And, in addition to  
10 that, one internal flow problem with coaxial swelling  
11 jets expanding into a chamber, which includes a facing  
12 step problem.

13 CHAIRMAN DENNING: Okay. I think we're  
14 going to have to move on except there is another  
15 question here which relates to pressures. How does  
16 one differentiate between what is an acoustic pressure  
17 and what is a hydrodynamic pressure, as we seem to be  
18 differentiating here?

19 MR. HOBBS: Okay. I would like Dr.  
20 Bilanin to help out on this.

21 DR. BILANIN: When we talk about an  
22 acoustic pressure field, we look at a pressure field  
23 that is proportional to the first power in velocity.  
24 So the pressure is typically proportionate to the  
25 density times the fluctuation in velocity times the

**NEAL R. GROSS**

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

1 acoustic speed. We talk about a hydrodynamic inner  
2 field. We talk about something that's an order mach  
3 number squared.

4 The pressure field then if you double the  
5 fluctuating velocity, the pressure goes up by a factor  
6 of four.

7 DR. BANERJEE: I have a much simpler view  
8 of this. There are conservation equations for mass,  
9 momentum, and energy.

10 DR. BILANIN: Yes.

11 DR. BANERJEE: Ultimately the pressure  
12 gets phrased into these equations.

13 DR. BILANIN: Yes.

14 DR. BANERJEE: If you take the energy, say  
15 the momentum equation, and take its divergence, the  
16 pressure is related to the velocity for a Pyson  
17 equation. And there is to me no understanding  
18 whatsoever of anything else beyond that. It just  
19 comes out of the momentum equation and the equation of  
20 state.

21 So when you start to distinguish between  
22 hydrodynamic pressure and acoustic pressure, I am  
23 completely confused. It may be that they have regions  
24 where near-field hydrodynamics gives rise to a  
25 pressure field, which is then perhaps describable away

**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 from a wall in terms of a Helmholtz equation, but  
2 those are simply approximations to the equations of  
3 motion at the end.

4 So I don't see what this -- you can say  
5 that I approximated the pressure by a Helmholtz  
6 equation and called it an acoustic pressure. And in  
7 the near-field, I calculated it by Fluent or whatever,  
8 which does a near-field calculation. And I called  
9 that a hydrodynamic pressure.

10 But I think that is the same pressure.  
11 Pressure is pressure.

12 DR. BILANIN: Pressure is pressure, but  
13 one can take the Helmholtz solution and then do an  
14 expansion in terms of mach number. And the zero mach  
15 number, the lowest order solution is proportional to  
16 the velocity fluctuation times the acoustic speed.

17 The next order expansion is the mach  
18 number squared. It's typically what's referred to as  
19 the dynamic pressure, what you feel on your hand when  
20 you put your hand out the window. Okay? That's a  
21 higher order effect. That's a lower pressure  
22 fluctuation than the acoustic pressures here, which  
23 are about an order of magnitude larger.

24 So in the first slide of this  
25 presentation, when the loads that are causing dryer

**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 problems are acoustic in nature, they are typically an  
2 order of magnitude bigger than the pressures you would  
3 calculate if you just looked at the velocity squared  
4 inside the dryer. The velocities in the dryer are  
5 very low, typically over entering the main steam line,  
6 go less than 50 feet per second

7 DR. BANERJEE: So these are just pressure  
8 fluctuations?

9 DR. BILANIN: Yes.

10 DR. BANERJEE: And they don't have the  
11 kinetic energy of the velocity taken into account?

12 DR. BILANIN: That's correct.

13 DR. BANERJEE: All right. I understand.

14 CHAIRMAN DENNING: Continue.

15 MR. HOBBS: The load definition for  
16 Vermont Yankee's dryer, which includes acoustic  
17 circuit loads and hydrodynamic loads, was evaluated  
18 for uncertainty. And we broke down the contributors  
19 for the acoustics circuit model load uncertainty into  
20 several categories: first of all, our signal  
21 uncertainty.

22 Secondly, we have an uncertainty relative  
23 to the frequency peak calculated by the acoustic  
24 model. We also have an uncertainty associated with  
25 the model technique itself. And, finally, there's an

**NEAL R. GROSS**

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

1 uncertainty associated with the location of your  
2 measurements for input to the model.

3 We determined that the acoustic circuit  
4 methodology in our analysis of record was 130 percent.  
5 A substantial portion of this ACM uncertainty value is  
6 a result of the signal uncertainty that we used from  
7 our original signal configuration.

8 The new data acquisition system with  
9 optimal locations of the sensors and model refinements  
10 of the acoustic circuit model will substantially  
11 reduce the ACM uncertainty and improve the accuracy of  
12 our acoustic circuit model loads.

13 DR. BANERJEE: What do you mean by  
14 "uncertainty" here? I mean, uncertainty in relation  
15 to what? Measurements?

16 MR. HOBBS: Predicated courses of action.

17 DR. BANERJEE: But how do you know? Oh,  
18 you have already used the Quad Cities data. The model  
19 uncertainty here is based on the measured versus  
20 predicted --

21 DR. BANERJEE: In Quad Cities.

22 MR. HOBBS: -- in Quad Cities 2 dryer  
23 loads, right.

24 DR. BANERJEE: Okay.

25 MR. HOBBS: The CFD model uncertainty was

1 determined based, as Karl said, on bench-scale  
2 experimental comparison of a non-dryer Fluent  
3 methodology model. The bench-scale uncertainty was  
4 determined to be 15 percent. Factoring in a frequency  
5 uncertainty of 4 percent, we ended up with a total  
6 hydrodynamic load uncertainty of 16 percent.  
7 Uncertainty for --

8 DR. BANERJEE: But these experiments that  
9 they did were extremely simplified.

10 MR. HOBBS: That's correct. We also  
11 compared the CFD model results to other data from  
12 previously instrumented full-scale boiling water  
13 reactor dryers. And what we found looking at those  
14 four BWR dryer measurements is that the 15 percent  
15 uncertainty bounds those data sets by 80 percent on  
16 average.

17 And there was one exception of a single  
18 instrumented dryer location where the CFD model  
19 under-predicted. But in general, we found that our  
20 CFD model came close to the readings on the  
21 instrumented dryers from these BWRs.

22 CHAIRMAN DENNING: Now, you're not talking  
23 about acoustic loads now, are you or are you?

24 MR. HOBBS: We're talking about our CFD  
25 model.

1 CHAIRMAN DENNING: You're talking about  
2 your CFD model. And CFD models that were used for  
3 these others, were they compressible or incompressible  
4 flow?

5 MR. HOBBS: These other BWRs did not have  
6 CFD models associated with them that I was aware of.  
7 We just took the measurements off of those. So it's  
8 a somewhat coarse comparison.

9 DR. BANERJEE: And you took the ones from  
10 Quad Cities 2, right?

11 MR. HOBBS: Yes, right. We looked at  
12 their low-frequency loads that they measured And we  
13 compared those to what we predicted. And even though  
14 the new Quad Cities dryer is a different configuration  
15 than ours, it's got a slanted hood on it to reduce  
16 some of the vortex shedding loads, you know, we feel  
17 that it's in the ball park. It's representative.

18 You know, the NRC safety evaluation for  
19 our power uprate questions the Entergy perspective on  
20 CFD uncertainly. We think it's important to share  
21 with you our perspective on why we believe this  
22 uncertainty assumption for CFD is appropriate.

23 First of all, operating experience  
24 demonstrates that hydrodynamic loads are not as  
25 critical as acoustic loads when assessing dryer

**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 structural integrity. You can see acoustic loads that  
2 cause the structural challenges to the dryers.

3 Secondly, the total Vermont Yankee load  
4 definition is relatively insensitive to hydrodynamic  
5 uncertainty, as reflected by the fact that if you  
6 double the CFD uncertainty, it increases our total  
7 load uncertainty by less than five percent. So it's  
8 relatively insensitive to the CFD model uncertainty.

9 And, finally, the CFD loads, including  
10 their acoustic content, are conservatively added to  
11 the stresses from the acoustic circuit model, which  
12 results in double counting of acoustic loads. So we  
13 believe that our uncertainty for the CFD model is  
14 appropriate.

15 MEMBER RANSOM: Just a point of  
16 clarification. Since all of these are hydrodynamic  
17 loads, when you say "acoustic loads," I guess you mean  
18 loads that are produced by coupling so resonance is  
19 involved, right?

20 MR. HOBBS: Right. And we apologize for  
21 the confusion about some of the terms we're using  
22 here.

23 DR. BANERJEE: Okay. One is a higher  
24 frequency than the other.

25 MR. HOBBS: That's a very simplified way

**NEAL R. GROSS**

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

1 to look at it. The loads calculated by the acoustic  
2 circuit model and the CFD model were input into a  
3 General Electric finite element model of the Vermont  
4 Yankee dryer using ANSYS methodology.

5 All components of the dryer were included  
6 in the finite element model. Also, the finite was  
7 shared with a third party by the --

8 DR. BANERJEE: May I just interrupt one  
9 second? ANSYS has built in today a Fluid Dynamics  
10 calculation called CFX. Why didn't you just do this  
11 integrated calculation, instead of doing this sort of  
12 thing with Fluent and then going to ANSYS?

13 MR. HOBBS: Well, we had our finite  
14 element model developed by GE. And Fluent was  
15 developing the CFD model loads. And due to time --

16 DR. BANERJEE: Coupling of those two is  
17 quite difficult, I would think.

18 MR. HOBBS: Well, it is difficult, yes.

19 DR. BANERJEE: Yes.

20 MR. HOBBS: And I guess if we had to do  
21 this all over again, we would probably look at that  
22 feature and take advantage of it.

23 DR. BANERJEE: Okay.

24 MR. HOBBS: The finite element model for  
25 the VY dryer was shared with a third party by the name

1 of JAR Engineering. This provided an additional  
2 review of the model's adequacy and resulted the  
3 changes which corrected errors in the model, such as  
4 the connection between the front hood gussets and the  
5 horizontal cover plate and dryer support ring.

6 So this is an error which also existed in  
7 the Dresden finite element model. And we took action  
8 to correct that in our version of the ANSYS model. So  
9 the CFD and the acoustic circuit model pressure time  
10 history loads were run separately through the finite  
11 element model as a transient analysis. And the  
12 resulting stresses were combined by square root, some  
13 of the squares. And the loads applied to the same  
14 grid locations to ensure consistent results.

15 The peak alternating stresses calculated  
16 by the finite element model were compared to the  
17 fatigue limits in the ASME boiler and pressure vessel  
18 code and the primary plus secondary stresses to the  
19 applicable ASME code service-level limits.

20 The results of the stress analysis are  
21 shown here. I would like Mr. Betti to discuss these,  
22 please.

23 MR. BETTI: Thanks, Brian.

24 First I would like to just discuss the  
25 general nature of these equations and how we developed

**NEAL R. GROSS**

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

1 peak stresses from finite element stresses. The  
2 finite element model is a plate model, isopermetric  
3 shell elements. We had some solid elements for the  
4 ring girders and others.

5 We actually ran multiple ANSYS time  
6 history analysis. You know, we looked at frequency,  
7 plus or minus frequency, shifts to evaluate the  
8 sensitivity of the frequency.

9 For the CFD modes, as you talked, you  
10 know, we had, if I remember, roughly 140,000 vectors  
11 coming out of the Fluent model, which we spent a lot  
12 of time making sure we fed those right into our ANSYS  
13 model. We ran two sets. We had a 120 percent power  
14 set and the 100 percent power set.

15 We ran each of those through our ANSYS  
16 model. And then we looked at that model for frequency  
17 shifts to see what was most limiting.

18 DR. BANERJEE: What was the CAD package  
19 there? Was it step? How did you go and --

20 MR. BETTI: We wrote our own processes.

21 DR. BANERJEE: You like punishment?

22 MR. BETTI: Yes, I like punishment. I  
23 would like to talk about this a little bit because  
24 remember I said that here we are. We're using this  
25 model to calculate our low frequency, what I call the

**NEAL R. GROSS**

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

1 non-acoustic effects.

2 We didn't really want to be double  
3 counting acoustic effects. We didn't build this model  
4 for acoustic boundary conditions or write damping  
5 values, et cetera.

6 So when we calculated these stresses from  
7 this model, we went back. And then we filtered out  
8 what we believe to be acoustic effects that this model  
9 already would capture correctly based on measured  
10 acoustic responses in the steam system.

11 This stress right here, as we said in  
12 slide 24, would drop down to 167 psi if it didn't have  
13 this double counting method in it, these acoustic  
14 responses in the model.

15 So we had talked to NRC about this. And  
16 we all at the time wanted to maintain conservatism.  
17 So rather than change 1,000 psi to 167, we kept this  
18 load the same after we had looked at it and filtered  
19 it. All right?

20 Now, we looked at all critical components  
21 of that big dryer finite element model. This  
22 particular summary is only showing you one point that  
23 turned out to be most limiting from the standpoint of  
24 peak stress or fatigue assessment.

25 Then what we do is we didn't get to the

**NEAL R. GROSS**

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

1       sophistication to take out a lot of conservatism. So  
2       we take the ANSYS plate stresses. And GE has a method  
3       where they have a Weld geometry factor they developed  
4       from finite element analysis, which, say if we have a  
5       penetration weld that's seven-eighths on a one-inch  
6       plate, they have a conservative geometry factor for a  
7       step increase in stress and multiply that times the  
8       ASME code SIF factor for that weld geometry. And we  
9       come up with basically a combined stress concentration  
10      factor of 4.61.

11                So the stress that we used from the CFD  
12      analysis is this number times this number. And that's  
13      what we determined to be our conservative CFD stress  
14      in this analysis.

15                Now, other plants aren't using anything  
16      near this conservatism. The only reason we do this  
17      is because we don't have a lot of loads out there, and  
18      we can afford to do that.

19                So I just don't want you to think that  
20      this is a realistic assessment of our CFD stresses.  
21      If anything, it's seven, eight times lower than this.  
22      And there is a very conservative stress concentration,  
23      maybe 10, 12 times lower than this number here.

24                Then what we did is we took our signals  
25      from our existing instrumentation in our acoustic

**NEAL R. GROSS**

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

1 model. And we ran those through the finite element  
2 analysis. And this combined location with stress  
3 concentration factors, et cetera, this location turned  
4 out to be critical.

5 So, again, we take the 403 psi stress  
6 times the stress concentration geometry factor. And  
7 we end up at that location with an 18.57 stress.

8 This slide is not that great because here  
9 is the combination that we did. We basically are  
10 taking the combination, the CFD loads that should be  
11 squared, times the load factor ACME, that factor  
12 squared, and that whole thing to the square root.

13 So we're taking the square root sum of the  
14 squares combination of the CFD loads quote and the  
15 acoustic loads quote, multiplying those times our  
16 geometry factor and stress concentration factor. And  
17 we're making sure that's less than a code limit of  
18 13,600. All right?

19 If we had rearranged that equation, we  
20 were trying to determine now what would be the  
21 allowable increase in our acoustic loads to stay  
22 within the code-allowable limit using these  
23 conservative stress assumptions. So we just rearrange  
24 this equation, solve it for load factor, and we end up  
25 with just this equation as a function of the factor

**NEAL R. GROSS**

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

1 that we can multiple our loads times.

2 Now, if you go above right here, what we  
3 had done is we had come out with those two stresses  
4 that we saw on the loads that we looked at. We would  
5 have an ability to increase our acoustic load, our  
6 system-measured acoustic load. If it came up  
7 literally everywhere, we would be able to withstand a  
8 factor of 6.8, 6.78 times the current  
9 acoustic-measured loads in our piping system.

10 Based on the conservative uncertainties we  
11 have applied in this value, if we look at the load  
12 factor in terms of the load uncertainties, that drops  
13 this number down by 3.91. So we come up with a very  
14 conservative acoustic load factor of 2.87.

15 Next slide.

16 DR. BANERJEE: Does this mean that you  
17 don't expect your dryers to crack?

18 MR. HOBBS: If we stay below our limit  
19 curve, which we'll show you momentarily, which takes  
20 into account this load factor, we expect that the  
21 dryer will maintain its structural integrity.

22 DR. BANERJEE: Now, if you did this  
23 analysis on something like Quad Cities before it  
24 cracked, what would you have come up with?

25 MR. HOBBS: With this kind of conservatism

**NEAL R. GROSS**

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

1 on it, there's no way that the Quad Cities would be  
2 acceptable under our methodology. In fact, our next  
3 slide will kind of show you a picture and show you  
4 that.

5 CHAIRMAN DENNING: I would like you to  
6 finish up in ten minutes.

7 MR. HOBBS: Okay.

8 MR. BETTI: We'll do that.

9 MEMBER SIEBER: I think that it's a  
10 mistake to assume that this analysis would demonstrate  
11 that you aren't going to get cracks. I think the  
12 analysis demonstrates you aren't going to get a  
13 failure, which to me is different.

14 MR. BETTI: I guess I have touched on all  
15 of these things right here. We will combine by the  
16 squares method. Briefly, we do that because the  
17 frequency responses of the structure for the two  
18 loadings were completely different. So there are no  
19 closely coupled frequencies from the two results.

20 We used the maximum stresses from the two  
21 CFD cases. And, again, we conservatively used the CFD  
22 loads that included these high-acoustic forces that we  
23 think are very conservative.

24 MR. HOBBS: Okay. So we have just two  
25 more slides to go, and then we'll conclude.

**NEAL R. GROSS**

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

1 This figure demonstrates a Vermont Yankee  
2 dryer structural integrity limit curve based on linear  
3 extrapolation of the acoustic circuit analysis input  
4 and measures relative to the most limiting component  
5 stress margin, as Enrico just described.

6 The green line is the VY level 1 limit  
7 curve. This curve will be applied during power  
8 ascension to ensure that the VY steam dryer structural  
9 integrity is maintained; in other words, that the  
10 fatigue stress limit is not exceeded.

11 This limit curve is very low, especially  
12 when you compare it to the Quad Cities spectra, where  
13 it's yellow here for original license thermal power,  
14 Quad Cities, and red at EPU conditions. If you  
15 applied our green limit curve to Quad Cities, you  
16 could see that, even at original license total power  
17 using our limit curve, they would have exceeded our  
18 ceiling for stress limit.

19 DR. BANERJEE: Why is that curve so much  
20 higher than yours?

21 MR. HOBBS: Why is their curve?

22 DR. BANERJEE: Yes. What is the physical  
23 reason?

24 MR. HOBBS: Well, the difference between  
25 our blue curve, which is our measured values on our

**NEAL R. GROSS**

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

1 main steam piping, and our green curve is 2.87.  
2 That's how much we can tolerate in the way of an  
3 increase in loads.

4 Now, when we go through our power  
5 ascension program, if we see a resonance out at a  
6 frequency that challenges that green curve, we will go  
7 back and reanalyze. We run the acoustic circuit  
8 model. We run the stress analysis. And we'll have a  
9 different green curve here, which may have a peak at  
10 that point because if we determine that we can  
11 tolerate some resonance in that high-frequency region,  
12 then we will adjust our limit curve.

13 CHAIRMAN DENNING: I think it is a  
14 different question. So ahead, Sanjoy.

15 DR. BANERJEE: I was just saying if you  
16 take the yellow curve before Quad Cities went up and  
17 the blue curve, they look somewhat similar below, say,  
18 65 or 85 or whatever.

19 MR. HOBBS: Right.

20 DR. BANERJEE: But, then, there is a  
21 pretty large difference in the higher frequencies.

22 MR. HOBBS: Right.

23 DR. BANERJEE: What is the reason for it?  
24 Do we understand the reason for that?

25 MR. HOBBS: Right. The reason for it that

**NEAL R. GROSS**

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

1 has been determined is that there are relief valves on  
2 the Quad Cities mains steam lines. And there is more  
3 than one relief valve in each main steam line. Those  
4 cause acoustic excitation and coupling between the two  
5 cavities, which are in close proximity to each other.

6 So those have been determined to be the  
7 causes of these high peaks out here at 140-167 hertz  
8 for Quad Cities.

9 DR. BANERJEE: And those are the peaks  
10 which are causing the failures, you think?

11 MR. HOBBS: Those are the peaks that  
12 caused the failures of the original Quad Cities  
13 dryers. Okay?

14 DR. BANERJEE: Okay.

15 MR. LEITCH: So what does level 1 mean in  
16 power ascension? Does that mean you hold where you  
17 are and just analyze or back down to original full  
18 power level or what is the definition of level 1?

19 MR. HOBBS: That's a very good question,  
20 and we're leading into that next.

21 MR. LEITCH: Okay.

22 MR. HOBBS: This shows our dryer  
23 monitoring and test plateaus for power ascension. The  
24 power ascension monitoring will include power increase  
25 steps and test plateaus at each five percent of

**NEAL R. GROSS**

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

1 current license thermal power.

2 Data will be collected hourly for power  
3 increases and within one hour of reaching each test  
4 plateau. And that data includes strain gauges for all  
5 eight strain gauge locations. It includes moisture  
6 carryover data. It includes plant parameters which  
7 might be indicative of potential dryer failure and  
8 accelerometer data.

9 In accordance with the NRC license  
10 condition, if the level 1 limit curve criterion is  
11 exceeded, power will be reduced to the previously  
12 acceptable level within two hours and an engineering  
13 evaluation performed to document continued dryer  
14 structural integrity.

15 So that's the purpose of that green line  
16 there, that if we exceed that, we back down within two  
17 hours to a safe condition.

18 CHAIRMAN DENNING: If you don't mind, we  
19 can read the other viewgraphs. Can we end at this  
20 point?

21 MR. HOBBS: Sure.

22 CHAIRMAN DENNING: Okay. Well, let's do  
23 that, then. We will take a 15-minute break and be  
24 back at 10 minutes before the hour.

25 (Whereupon, the foregoing matter went off

**NEAL R. GROSS**

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

1 the record at 10:34 a.m. and went back on  
2 the record at 10:52 a.m.)

3 CHAIRMAN DENNING: We are still in closed  
4 session. Mr. Scarbrough, would you pick up?

5 MR. SCARBRUGH: Yes, thank you.

6 My name is Tom Scarbrough and I'm with the  
7 Engine and Mechanics Branch in the Office of Nuclear  
8 Reactor Regulation. I'd like to talk to you this  
9 morning about our compren and valuation portion of the  
10 Vermont Yankee proposed EPU amendment.

11 MR. CARUSO: Wait just a second. Are  
12 there members of the public here who are not able --  
13 you do not have a Disclosure, Non-disclosure Agreement  
14 signed under Other Action?

15 (NO RESPONSE.)

16 MR. CARUSO: Anyone here? Have you signed  
17 a Non-Disclosure Agreement yet?

18 PARTICIPANT: No.

19 MR. CARUSO: The meeting is closed at this  
20 point and we'll have to ask you to leave.

21 CHAIRMAN DENNING: Ralph, when is it  
22 likely to be reopened, do you know?

23 MR. CARUSO: We don't know because they're  
24 going to be talking about proprietary information for  
25 a while.

**NEAL R. GROSS**

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

1 CHAIRMAN DENNING: Probably through the  
2 morning?

3 MR. CARUSO: Mr. Applicant, do you have a  
4 Non-Disclosure Agreement signed with contractors for  
5 Vermont Yankee?

6 MR. APPLICANT: I will do that now.

7 MR. CARUSO: If you don't, I'm going to  
8 have to ask you to leave.

9 Is there anyone else?

10 (NO RESPONSE.)

11 MR. CARUSO: This is a proprietary  
12 session. All visitors who don't have an agreement, a  
13 Non-Disclosure Agreement, at this time, you are  
14 requested to leave.

15 MR. SCARBRUGH: Good morning. What I'd  
16 like to do this morning is talk to you about the  
17 Compren evaluation areas that we did in the Vermont  
18 Yankee EPU Amendment Review.

19 The areas included the pipe rupture  
20 locations, the anemic effects, the pressure retaining  
21 components and supports, the nuclear steam supply  
22 system piping, components and supports, the Balance-  
23 of-Plant piping, components and supports, the reactor  
24 vessel and supports, the control rod drive mechanism,  
25 re-circulation of pumps and supports, the reactor

**NEAL R. GROSS**

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

1 pressure vessel internals and core supports, safe  
2 weighted valves and pumps, seismic and dynamic  
3 qualification of equipment, and potential diverse flow  
4 effects. And what I'd like to do is I'll move briefly  
5 through the other components and get to the C Dryers,  
6 since that seems to be the most area of interest.

7 The scope of the review included the  
8 methodology and calculated loads for the constant  
9 pressure power uprate. The stresses and cumulative  
10 achieved usage factors, the acceptance criteria, code  
11 additions and addenda, the functionality impact on the  
12 safe related pumps and valves and the piping over  
13 pressurization, and acoustic and flow-induced  
14 vibration loading and monitoring.

15 MEMBER LEITCH: Was operating experience  
16 a factor in deciding which areas you should evaluate?

17 MR. SCARBRUGH: Absolutely. In this case,  
18 the steam dryer, since we've had so much poor  
19 performance for that, we focused on that quite a bit.  
20 And also, the review for the rest of the REC coolant  
21 components was straightforward. It was very similar  
22 to what we've done in the past for other power  
23 uprates. It's a constant pressure power uprate so  
24 that it simplified the review. So in that area, it  
25 was more straightforward and similar to what we've

**NEAL R. GROSS**

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

1 done in the past.

2 MEMBER LEITCH: But there were some other  
3 areas of operating experience where there were  
4 problems other than the steam dryer, perhaps not as  
5 well publicized and more minor issues like, I think,  
6 main steam isolation valve drain lines and some  
7 pressure switches associated with -- adjacent to the  
8 main steam --

9 MR. SCARBRUGH: Absolutely. We've looked  
10 at those as well, and we emphasize to the licensee the  
11 monitoring program that needs to take effect for  
12 those, and ensure that those components are capable  
13 withstanding the higher flows from the steam lines.  
14 So, yes, we did look at those as well. That was also  
15 part of the operating experience.

16 MEMBER LEITCH: Okay, thank you.

17 MR. SCARBRUGH: In terms of the reactor  
18 plant coolant pressure boundary and Balance-of-Plant  
19 piping, we evaluated those. There was no significant  
20 increase in the temperature or flow for the reactor  
21 coolant pressure boundary piping, with the exception  
22 of the main steam and feed water flow systems. There  
23 were some limited -- limiting issues relating to pipe  
24 supports. There were a couple of pipe supports that  
25 had to be replaced. The other piping was less

**NEAL R. GROSS**

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

1 significantly affected and they all met the Vermont  
2 Yankee Code of Record, the ANSI B31.1 1967 edition.

3 With respect to state-related pumps and  
4 valves, we looked at those components within the scope  
5 of the ASME Code. The review focused on the  
6 functional performance, and we based our review on  
7 acceptance criteria for the design, general design  
8 criteria, since this is a draft general design  
9 criteria plant, and also 10 CFR 50.55(a)(f) for in-  
10 service inspection of those components.

11 With respect to motor-operated valves, we  
12 had previously reviewed the MOV program at Vermont  
13 Yankee under Generic Letters 8910 and 9605 and they  
14 were found acceptable by the staff at that time.  
15 There were only minor system and ambient temperature  
16 changes from the EPU related to MOVs. During  
17 Engineering Inspection Number 2004-008, there were  
18 some weaknesses found in the MOV Program related to  
19 validation of the motor control serve testing and the  
20 lack of formal trending of the results of the testing.  
21 In Supplements 16 and 32, the Licensee addressed those  
22 weaknesses and specified that they would correct them.  
23 And in September, there was a regional inspection,  
24 which verified that those commitments were being  
25 implemented and those were documented in Inspection

**NEAL R. GROSS**

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

1 Report 2005-006.

2 Next, I'd like to get into the Prevention  
3 Adverse Flow Effects Review that we did. As we've  
4 talked about, boiling water reactors have a steam  
5 dryer, which is used to remove moisture. It has no  
6 specific safety function, but it must retain its  
7 structural integrity without release of loose parts  
8 into the reactor vessel or steam system.

9 Quad City Units 1 and 2 experienced  
10 significant damage to their original square-hood steam  
11 dryers during plant operation, in 2002 and 2003, for  
12 Quad City 2 and also in November 2003 for Quad City 1.

13 In early 2005, Exelon replaced those  
14 original steam dryers at Quad Cities with an improved  
15 design and installed instrumentation on the Unit 2  
16 steam dryer to measure the pressure loads and that  
17 collected data is now being used to assess the  
18 accuracy of the analytical methods that we talked  
19 about -- the ones we talked about this morning, the 2-  
20 circuits model.

21 Entergy modified their square hood steam  
22 dryer at Vermont Yankee to improve its structural  
23 capability and you heard about those modifications a  
24 few minutes ago. In terms of the cracks that were  
25 found at Vermont Yankee in the fall of 2005, they were

**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 addressed in Supplement 42 of the EPU Amendment and we  
2 did analyst that those should not propagate any  
3 further. Also, in terms of the recent cracking at  
4 Dresden, we have reviewed that, discussed that with  
5 the Licensee, and as you heard this morning, part of  
6 the problem at Dresden was the Finite element model  
7 did not adequately map out the gussets on that square-  
8 hood dryer at Dresden and that weakness was corrected  
9 at Vermont Yankee earlier this year. So they had --

10 MEMBER BANERJEE: Can you explain how a  
11 Finite element model doesn't map out the gussets?

12 MR. SCARBRUGH: Well, what happened was  
13 when they modeled -- you used to find an element model  
14 to model out the gusset. They assumed in the model  
15 that the gusset went all the way to the support frame.  
16 Actually, it stopped at like that far short of the  
17 support frame. And that's -- that's exactly where the  
18 toe of that weld there, where the gusset came, is  
19 where the crack at issue at Dresden, and then it grew  
20 around the gusset until it got to a point where it  
21 relieved the stress.

22 MEMBER BANERJEE: So if they had done this  
23 right, the finite element, what would they have done  
24 to the gusset?

25 MR. SCARBRUGH: They would have seen that

**NEAL R. GROSS**

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

1 there was a weakness there. What they've done at  
2 Dresden is they've installed -- for shoes underneath  
3 the gusset at Dresden and also at Vermont Yankee. At  
4 Dresden, because they have that higher load, they've  
5 installed what I call "over-shoes" on top of those  
6 shoes to extend, physically extend the gusset to the  
7 support link and then weld it to the support link to  
8 latch it there. Dresden Quad Cities have much higher  
9 loads they have to deal with than what we're seeing at  
10 Vermont Yankee, so they have a much more difficult  
11 problem to deal with.

12 MEMBER BANERJEE: So when you set up a  
13 planned element model, what sort of QA is done to make  
14 sure that it is actually taking the important  
15 phenomena into account?

16 MR. SCARBRUGH: In that case, they -- the  
17 cracking that occurred earlier at Quad Cities and  
18 Dresden with the gusset was up around the top of the  
19 gusset and everybody focused on that, and they just  
20 didn't -- and we just didn't notice that they had not  
21 gone all the way out to the end of the support link.

22 MEMBER BANERJEE: So how did that get by?

23 MR. SCARBRUGH: It's jut part of --

24 MEMBER BANERJEE: I mean --

25 MR. SCARBRUGH: -- it's part of the

**NEAL R. GROSS**

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

1 review. You ask questions and you think it's modeled  
2 and it wasn't.

3 MEMBER BANERJEE: So are there other  
4 things, which can get by like that?

5 MR. SCARBRUGH: There's always that  
6 possibility. That's why we've established this team  
7 to look at that type of review to try to look at all  
8 the possible areas where there could be significant  
9 weaknesses in the model.

10 MEMBER BANERJEE: So then you feel there  
11 are none now?

12 MR. SCARBRUGH: In terms of what we've  
13 done now, in terms of Vermont Yankee, what we see is  
14 that the loadings are very low at Vermont Yankee. And  
15 that's part of what the analysis is going to be  
16 involved as they go up in power, to monitor that load.  
17 As long as the loading stays very low, the  
18 uncertainties and such that we talked about, we do not  
19 have a concern with.

20 MEMBER BANERJEE: What is the physical  
21 reason the loading is low?

22 MR. SCARBRUGH: They're not giving the  
23 excess --

24 MEMBER BANERJEE: Are the velocities  
25 lower?

1 MR. SCARBRUGH: The velocities were lower,  
2 that's true.

3 MEMBER BANERJEE: How much lower?

4 MR. SCARBRUGH: Two hundred feet per  
5 second at Quad and about 168, something like that, at  
6 Vermont Yankee. And what they're seeing is, when you  
7 look at the traces from the main steam line strain  
8 gage data, they're not seeing really any -- the  
9 excitation of any of the resonance in the steam lines,  
10 and so they're getting very low load going back to the  
11 dryer. As long as that stays low, that's part of the  
12 conditions in the safety evaluation is that as long as  
13 it stays low and they don't have any resonance that  
14 jump up and start to approach that limit curve, the  
15 resonance and the loads are very, very small.

16 MEMBER BANERJEE: The theory is that the  
17 dryers are failing due to something that's happening  
18 in the steam line rather than the flow of themselves.  
19 Is that your hypothesis?

20 MR. SCARBRUGH: Right, right. What we've  
21 seen so far is the loads from the -- the shedding  
22 coming off the dryer itself are very low compared to  
23 the tremendous peaks you see at -- for example, at  
24 Quad Cities. And that's why they ended up replacing  
25 their dryers, because they couldn't withstand that

**NEAL R. GROSS**

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

1 type of resonance feed. And even though they had  
2 modified their dryer to put in these same types of  
3 modifications, it still wasn't capable of handling  
4 that strong peak that they were seeing at the EPU  
5 condition.

6 MEMBER BANERJEE: As they said, this was  
7 due to the relief valves, right?

8 MR. SCARBRUGH: They think -- they're  
9 nailing it down, but they think it's coming from the  
10 safe relief valve resonance, right, where the flow  
11 causes a resonance across that relief valve and it  
12 couples with the dryer itself.

13 MEMBER BANERJEE: And the staff agrees  
14 with this?

15 MR. SCARBRUGH: Yes. So far, that's what  
16 we see as well, but the entire review is not complete  
17 on Quad Cities, as to exactly where it's coming from.  
18 That's one of the questions we have for them, is that  
19 they're working on is nail down exactly where it came  
20 from. They have a testing program in place where they  
21 are modeling doing small-scale modeling to look for  
22 exactly where that resonance peak is occurring and  
23 what to do about it.

24 MEMBER BANERJEE: Okay.

25 MR. SCARBRUGH: Okay. The next step we'd

1 like to do is go ahead and introduce the team that NRC  
2 assembled for reviewing this complex problem.

3 First, Dr. Christopher Boyd, who has over  
4 ten years of experience working with CFD issues and  
5 he's worked in this area since joining the NRC in  
6 1996. Dr. S. S. Chen, with an Argon consultant,  
7 helped us with the review of Vermont Yankee 2004. Dr.  
8 Stephen Hambric is head of the Structural Acoustics  
9 Department at the Applied Research Lab at Penn State,  
10 an associate professor in the graduate program to  
11 Acoustics, and has worked with the Naval Surface  
12 Warfare Center and has directed many numerical and  
13 experimental flows -- experimental flow in structural  
14 acoustics research and development programs for the  
15 Navy and the U.S. industry. Dr. Hambric helped us  
16 with the acoustic loading in evaluating acoustic  
17 loads. Dr. Mulcahy has 20 years experience in flow-  
18 induced vibrations with Argon National Lab, primarily  
19 in the Liquid Metal Fast Reader Reactor Program and  
20 he's performed experimental analytical research,  
21 developed loading functions and identify excitation  
22 sources.

23 We have Dr. Vik Shah. He's a mechanical  
24 engineer with Argon National Laboratory and he's been  
25 involved with safety evaluations of the Boiling Water

**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 Reactor Vessel Internals Program project on weld  
2 repair for vessel internals, and he's worked for 20  
3 years prior to joining Argon in aging management of  
4 nuclear power plant components with field experience  
5 at Idaho National Laboratory. And Dr. Shah serves as  
6 the principal investigator for the Argon team. And  
7 then we have Dr. Samir Ziada, who's Chairman of the  
8 Mechanical Engineering Department at McMaster  
9 University. He's has 18 years of industrial  
10 experience in dealing with flow-induced vibrations and  
11 acoustic resonance and he's performed numerous  
12 vibration measurements in power plants and he's  
13 designed and performed small-scale model testing,  
14 including small-scale testing of a BWR steam dryer.

15 So that's our group. We are very proud of  
16 the team we assembled to look at this complex issue.  
17 In terms of --

18 MEMBER BANERJEE: When was the team  
19 assembled?

20 MR. SCARBRUGH: We began last year, before  
21 we did the first review of the Vermont Yankee Steam  
22 Dryer Analysis when we did -- and I'll give you a  
23 little background.

24 MEMBER BANERJEE: And this is specific to  
25 Vermont Yankee or does it include the whole program?

**NEAL R. GROSS**

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

1 MR. SCARBRUGH: The team also -- most of  
2 the team, Argon assists us also with Quad Cities and  
3 Dresden reviews as well and so they're also involved  
4 with that. So there's some overlap.

5 MEMBER BANERJEE: Were they -- did they  
6 review Dresden before this recent finding of the --

7 MR. SCARBRUGH: Dresden was not reviewed  
8 in as much detail by the team. We did not use them as  
9 much for the team for Dresden.

10 MEMBER BANERJEE: How much detail was  
11 attributed?

12 MR. SCARBRUGH: In that case, it was not  
13 a significant amount of detail in terms of the finite  
14 element analysis because, at the time, for Dresden,  
15 the -- Dresden had been operating for over a year or  
16 two at EPU conditions and not seeing significant  
17 problems, even with the old dryer, you know, even with  
18 the original dryer. And so when they beefed it up and  
19 made it stronger, we didn't feel we needed to look at  
20 it in detail at that time because they were adding  
21 more strength, but as we found every step of the way  
22 along this problem, you know, every time we find  
23 something new as we get into it. And eventually, Quad  
24 Cities replaced their dryer and there's discussions  
25 about possibly replacing the dryers at Dresden as

**NEAL R. GROSS**

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

1 well.

2 MEMBER BANERJEE: Is there any problems  
3 with the replaced dryers in Quad Cities?

4 MR. SCARBRUGH: No. And right now,  
5 they've been operating at Quad Cities, both units,  
6 since the spring. They come down -- one of the units  
7 comes down in the spring of next year for an  
8 inspection. They're been monitoring the pressure  
9 sensors and strain gages on the Quad Cities Unit 2  
10 Plant in comparing that to the acoustic circuit model  
11 and we still have issues with them in terms of the  
12 exact uncertainty assumptions for that model, how well  
13 it matches, and that's -- they're currently providing  
14 information to us as we speak.

15 MEMBER BANERJEE: Now, if you say that the  
16 main problem is coming from the steam line, is more or  
17 less what I understand --

18 MR. SCARBRUGH: Yes.

19 MEMBER BANERJEE: -- why did Quad Cities  
20 change their dryer design to reduce vortex shedding  
21 within the dryer itself? This is not a problem, from  
22 what you're saying, right?

23 MR. SCARBRUGH: Right, right. They  
24 designed that dryer a long time ago in terms of our --  
25 the knowledge level where we are. It was a year ago

**NEAL R. GROSS**

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

1 -- over a year ago that they began designing that  
2 dryer, and we've learned quite a bit in just a year's  
3 timeframe in terms of where these loads are coming  
4 from and what the sources are.

5 So they designed it -- it's much stiffer,  
6 it's much more bulky, much heavier -- because they  
7 were intending to -- wherever this load was coming  
8 from, whether it's vortex shedding loads, or acoustic  
9 loads, they were going to beef this up strong enough  
10 that they wouldn't have any problem whatsoever. So  
11 they intended to over-design it for all possible ways  
12 to try to improve it. So it's an improved design  
13 overall, in it -- because it more closely matches the  
14 more recent steam dryer designs of the curved hood and  
15 slanted hoods that came out later. So they sort of  
16 used that same philosophy in terms of designing this  
17 new dryer as well.

18 MEMBER BANERJEE: Okay. Did they ever do  
19 a CFD study?

20 MR. SCARBRUGH: No, I do not think they  
21 did a CFD study. The loads that they saw have been  
22 significant, up in the 150-Hertz range or so, much  
23 higher than where they expected to see anything from  
24 a CFD review. So they focused on the acoustic area.

25 In terms of the modifications, you all

1 went through them earlier, so I won't repeat them.

2 CHAIRMAN DENNING: You didn't actually  
3 tell us what this review team, what their mode of  
4 operation was, how big an effort it was. I mean, what  
5 did the Argon people, for example, do with it? Any  
6 independent analysis or just what did the review team  
7 do?

8 MR. SCARBRUGH: Okay. In terms of the  
9 review, the -- there's a whole series. Let me jump to  
10 -- let me jump to the next slide. There was an audit  
11 that -- the review team assisted the staff last  
12 October, October of -- I'm sorry, August of 2004 at  
13 the General Electric office in San Jose, California.  
14 There, we went over the calculations, the analyses,  
15 the -- we observed some of their modeling on their  
16 computers. We monitored what they were doing in terms  
17 of the scale model testing, that General Electric was  
18 doing. That was for close to a week, the timeframe of  
19 the review team.

20 Following that review, the staff  
21 determined that there were a number of concerns  
22 regarding the -- that original analysis of the steam  
23 dryer. It had been based on a combination of data  
24 from -- actual collected data from various plants and  
25 then it was overlapped and it was extrapolated, and

**NEAL R. GROSS**

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

1 there was a number of issues resulting, that we had  
2 concern for that original analysis.

3 Okay, as a result of that, there was an  
4 audit report which indicated that the staff did not  
5 accept that steam dryer analysis, and we indicated  
6 that Entergy could resubmit an analysis. They did  
7 that in the spring of this year, in Supplements 26, 27  
8 and 29. The Argon team and staff took that  
9 information, reviewed it, and conducted an audit at  
10 the General Electric office in Washington, DC where,  
11 in June of this year, where we discussed with the  
12 Licensee the analysis, the acoustic circuit model,  
13 fluent modeling and such. And they also submitted the  
14 fluent actual data file, which our staff, Dr. Boyd,  
15 ran permutations of that to get a feel for that.

16 At the same time, in parallel to this, the  
17 team also has been assisting the staff with the Quad  
18 Cities review, in parallel, and so that we've been  
19 interacting with Quad Cities on the acoustic circuit  
20 model, which is very similar. It's the same  
21 contractor that developed that. So they've been  
22 assisting us with that review as well in reviewing the  
23 finite element analysis and acoustic circuit model and  
24 such, for Quad Cities as well.

25 And then in -- as based on that June

**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 15<sup>th</sup>/16<sup>th</sup> audit, the staff prepared Requests for  
2 Additional Information that we provided to Entergy,  
3 and that was assisted by Argon, with questions. Then  
4 in August of this year, Entergy submitted the REI  
5 Responses. In August of this year, August 15<sup>th</sup> and  
6 16<sup>th</sup>, one of our staff, John Wu and Dr. Ziada, audited  
7 the GE scale model test facility in San Jose to  
8 evaluate the use of the scale model facility to  
9 validate the acoustic circuit model and then, in  
10 August -- later in August, August 22<sup>nd</sup>/25<sup>th</sup>, the NRC  
11 staff, with the whole team, conducted an audit of the  
12 REI Responses and all the supporting documentation in  
13 more detailed discussions with the Licensee on the 2-  
14 circuit model and the CFD model for Vermont Yankee.

15 In September of this year, Entergy  
16 submitted supplements in response to that audit and  
17 the staff reviewed that and came up with a proposed  
18 draft Safety Evaluation, which we developed and  
19 provided to project staff on September 30<sup>th</sup>. So that  
20 was the -- Argon team, and NRC team and Dr. Ziada have  
21 performed detailed review and interactions with the  
22 Licensee on their analysis, their basis for their  
23 analysis, their assumptions in their analysis, and the  
24 results analysis. So, it was probably more in-depth  
25 than I can remember any review being done by the staff

**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 in terms of the expertise that the staff brought into  
2 this problem. Because we met with ACRS before, a  
3 couple of years ago, we just weren't there. We just  
4 did not have a good understanding of what was going on  
5 with these dryers. It's because of that we decided it  
6 was time to bring in experts, and so we were able to  
7 find people who really understood this issue in much  
8 more depth than we did.

9 MEMBER BANERJEE: So what is the new  
10 understanding that you have now?

11 MR. SCARBRUGH: It's -- in terms of where  
12 the sources are, we have a much better understanding  
13 of what's driving these loads on the dryer and what's  
14 causing the weaknesses in the dryer and where they  
15 are. Where we don't have a good feel for how to  
16 extrapolate that information from the main steam line  
17 strain gates data, up to a precise value for the loads  
18 in the dryer. We know --

19 MEMBER BANERJEE: But that's the issue at  
20 hand, right?

21 MR. SCARBRUGH: Exactly. And that's why  
22 it's very important --

23 MEMBER BANERJEE: So, do you feel that  
24 it's okay to do what they are saying?

25 MR. SCARBRUGH: That's what -- we're going

**NEAL R. GROSS**

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

1 to get to all that. We're going to get to all that.  
2 There's lots of slides, lots of slides. I'm jumping -  
3 - I'm stepping on all my contractor guys' words. But  
4 --

5 MEMBER LEITCH: The Safety Evaluation  
6 Report, I think, is around Page 301. I don't know if  
7 it's right in front of me, but it says that pre-PDPU,  
8 there will be three -- the following three refueling  
9 outages that will inspect the dryers.

10 MR. SCARBROUGH: Yes.

11 MEMBER LEITCH: But there's a table there  
12 that seems to suggest that it's only two. Which is  
13 it? Is there a commitment for three inspections or  
14 two inspections?

15 MR. SCARBROUGH: Well, they should do --  
16 probably in 2007, they should do three.

17 MEMBER LEITCH: Well, that's just a -- you  
18 don't really need to answer that question right now.  
19 I don't want to take the time with it, but it seems to  
20 be just a difference in the verbiage versus the table.  
21 I think the date for one of those pre-EPU inspections  
22 has already passed and, obviously, it's one of those  
23 post-EPU inspections. The date has already passed.

24 MR. ENNIS: This is Rick Ennis. I think  
25 if you -- you're looking at the Commitment Table, and

**NEAL R. GROSS**

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

1 I think if you look at some of those commitments, they  
2 should that at various times, in supplements, they had  
3 made a commitment and later on , it was either  
4 overlapped or superceded by another commitment. And  
5 that's some of the comments. I think, as far as  
6 visual inspection of the dryer, if you look on Page  
7 306, it's Commitment Number 23, Visual Inspection of  
8 the Dryer, and we've got that in Refueling Outages 26,  
9 27, 28, and 25 is the one that they just finished. So  
10 it's three.

11 MEMBER LEITCH: Okay.

12 MR. ENNIS: Right. Those were -- if you  
13 look at some of the comments, it says, "Commitment  
14 Modified by Letter. See Commitment 23."

15 MEMBER LEITCH: Right.

16 MR. ENNIS: Do you see the comments there  
17 on the right? So those were some of the earlier  
18 commitments they made in some earlier letters and then  
19 later on, it was superseded or overlapped with another  
20 commitment. So as far as the latest, if you'd look at  
21 Item 23, and that's the next three outages from now.

22 MEMBER LEITCH: Okay, so there are three?

23 MR. ENNIS: Yes.

24 MR. SCARBROUGH: It's something that an  
25 overview of the steam dryer analysis -- you've heard

**NEAL R. GROSS**

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

1 this, but just to summarize it. Entergy evaluated the  
2 potential steam dryer pressure loads for a combination  
3 of CFD and acoustic circuit model analyses to see if  
4 these focused on the lower frequencies for both the  
5 current licensed thermal power and EPU conditions.  
6 The acoustic circuit model calculated acoustic  
7 pressure loads at high frequencies, but only for the  
8 current licensed thermal power.

9 Then the stresses for individual steam  
10 dryer components were calculated using a finite  
11 element model and from pressure loads from both the  
12 ACM and CFD analyses, and then the peak stresses were  
13 compared to the peak limits and the ASM pressure was  
14 also tested.

15 In terms of the scope of the review, the  
16 team looked at the validation of the CFD and AC  
17 analyses, the uncertainty of the analyses and their  
18 inputs, the fundamental frequency and damping  
19 assumptions, the calculational methodology used in  
20 determining the stresses, the combination of the  
21 stresses, the stress limits that were used, the  
22 margins of those limits, and then the Licensee's plans  
23 for monitoring steam dryer loads and overall  
24 performance.

25 So, next I'd like to ask Drs. Boyd and

**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 Ziada to talk about the CFD analysis and the initial  
2 validation of the ACM.

3 DR. DR. BOYD:: I'm going to speak first  
4 about the CFD review, which is the only review that I  
5 did and then Dr. Ziada, who reviewed the CFD work and  
6 the ACM can follow-on.

7 I'm in the Office of Nuclear Regulatory  
8 Research and we're supporting NRR and the team with  
9 the CFD review. The NRR team provided us with  
10 reports, computer files with the model itself and data  
11 that they received from Entergy as well as background  
12 information. What we did is, we did a fairly careful  
13 review of that and we participated in the audit and  
14 produced a set of Requests for Additional Information  
15 that were answered, and then we participated in an  
16 additional audit to follow-up on those questions and  
17 then we received supplemental responses, which we also  
18 reviewed. And we felt pretty comfortable that we  
19 understood what was done and how it was done and could  
20 make a pretty good review of it.

21 The basic finding is that we believe there  
22 is a significant uncertainty surrounding the CFD  
23 predictions and that the 15 percent suggested  
24 uncertainty is kind of under estimated for this  
25 particular problem. That was our basic finding. And

**NEAL R. GROSS**

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

1 we have a lot of background information that can  
2 support that in various ways.

3 And the second issue that came up in a  
4 supplemental response was the comparison to plant  
5 operating experience. There is some specific test  
6 data. And we tried to take a look at that and what we  
7 found is that the CFD predictions were lower than --  
8 I'm sorry, were higher than much of the plant data,  
9 but the plant data came from different geometries,  
10 taller dryers with slanted hoods, some of it in  
11 locations like the skirt, and we didn't feel like it  
12 was applicable.

13 One point was given to us. It was on the  
14 horizontal cover plate and, in that case, the CFD  
15 model was about 33 percent too low. That was one of  
16 the better points, I guess, for comparison.

17 We didn't feel like you could get a lot  
18 out of that comparison with those single point  
19 measurements on unrelated dryers with unrelated  
20 conditions, comparing it to the CFD model.

21 MEMBER RANSOM: What was the uncertainty  
22 in, the loads that were actually predicted or  
23 frequency of the loads?

24 DR. BOYD: On the CFD model?

25 MEMBER RANSOM: Yes. You --

**NEAL R. GROSS**

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

1 DR. BOYD: Well, the suggested uncertainty  
2 is 15 percent.

3 MEMBER RANSOM: But in what?

4 DR. BOYD: On RMS values.

5 MEMBER RANSOM: RMS value of the forces or  
6 RMS value of frequency?

7 DR. BOYD: I believe they were RMS of the  
8 pressure fluctuations in the model, not forces. That  
9 came from a paper that was submitted along with the  
10 work for a large eddy simulation of confined swirling  
11 coaxial jets.

12 MEMBER RANSOM: Okay.

13 DR. BOYD: So the 15 percent uncertainty  
14 came from basically a two-meter-long test section of  
15 a 2-inch pipe that expanded to a four and a half or  
16 4.8-inch pipe and it had some swirling things in it.  
17 From that, downstream, they had some measurements of  
18 pressure, RMS fluctuations, and they compared them  
19 with the LES simulations and they got this 15 percent  
20 value.

21 MEMBER RANSOM: Was there any attempt to  
22 compare the frequencies that are predicted? It seems  
23 like that's what is important in terms of coupling  
24 with the rest of the system.

25 DR. BOYD: I would have to -- I don't

1 believe the frequencies were compared in this model.

2 MEMBER BANERJEE: I don't believe so.

3 DR. BOYD: Mean axial --

4 MEMBER BANERJEE: I think it was only for  
5 the RMS fluctuations.

6 DR. BOYD: RMS on axial velocity, RMS on  
7 things like that.

8 Our concern would be -- when we looked at  
9 the model, the main source of uncertainty, we felt  
10 like the geometry was reasonable and the modeling  
11 assumptions were reasonable, but the solution  
12 procedure was -- is basically a big challenge. So,  
13 what they found on this 2-inch pipe, is they found  
14 that it was very important to match the upstream  
15 region as well. And in the paper, they used the  
16 quotes, "the RMS fluctuations were grossly under  
17 predicted, with 2.7 million cells." What they did is  
18 they packed an additional 4 million cells just in the  
19 upstream region along the walls, and then they  
20 improved the resolution. So they ended up with about  
21 a 6-million-cell case that was more accurate.

22 Now we're talking about 4.7 million cells  
23 on an entire operating BWR, including the main steam  
24 lines, down to some -- it's just a totally different  
25 scale. In their test model, across an integral length

**NEAL R. GROSS**

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

1 scale to turbulence, they used 10 to 20 cells. In the  
2 upper dome of the steam generator model, they used  
3 less than one cell. The cell size was -- the integral  
4 length scale was larger -- I'm sorry, the cell size  
5 was larger than the integral length scale. So  
6 there's, you know, a big difference in resolution.

7 In the inlet region where the major  
8 concern was, they used about two to three cells across  
9 an integral length scale. So the -- and the problem  
10 is just the scale of the problem is enormous. This  
11 pipe flow problem was at one meter per second on a  
12 small scale and we're comparing it to something that's  
13 much, much bigger.

14 So we didn't feel that the uncertainty  
15 from this pipe model was applicable to our BWR problem  
16 and we were concerned that the wall modeling, for  
17 instance, was relatively inadequate and we had  
18 concerns, you know, along those lines. The entire  
19 upper dome is very complex. The jets are coming out  
20 and they're dancing around and they're interacting  
21 with each other, and there's a large tetrahedral mesh  
22 up there that's significantly larger than what would  
23 be required to resolve the turbulence. So the flow  
24 coming across the step, down into the inlet plenum,  
25 would not be expected to have the correct turbulence

**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 as a sort of a boundary condition coming in to the  
2 vertical and horizontal faceplates.

3 MEMBER BANERJEE: Do you think that there  
4 could be excitations in this region, which are as  
5 important as those coming from the relief valves? I  
6 mean, that might be missed because of the inadequate  
7 resolution or something?

8 DR. BOYD: That was a concern. I mean,  
9 it's hard to predict with these equations without some  
10 experience on very specific geometries like this. One  
11 concern I had was the shedding can be impacted by the  
12 upstream turbulence coming in and the sheer layers,  
13 and none of that was really adequately modeled  
14 upstream.

15 MEMBER BANERJEE: But could the shedding  
16 frequencies get up into these regions, which they  
17 think are causing the damage? You know, they --

18 DR. BOYD: I would say probably not.

19 MEMBER BANERJEE: -- a couple of hundred  
20 Hertz, right?

21 DR. BOYD: Yes. I would think probably  
22 not. But we just don't know. But just looking at the  
23 CFD, in a focused look at the CFD, the concern we had  
24 is that that uncertainty estimate was too low.

25 CHAIRMAN DENNING: You know, it sounds

**NEAL R. GROSS**

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

1 worse than that to me, and I'd like to know whether it  
2 was the impression of any of the people who had  
3 experience with CFD, whether one should totally  
4 discount that CFD analysis, say, 15 percent? I mean,  
5 I think that's extraordinarily low relative to the  
6 uncertainty. Is it so gross an approximation -- my  
7 own experience with CFD in a much smaller problem, was  
8 I saw tremendous sensitivity in pressure differences  
9 to nodalization and I just wonder, is -- was it the  
10 impression of some people that one should just  
11 completely discount the fluent analysis?

12 DR. BOYD: Yeah, there is a train of  
13 thought that it's more qualitative. The Office of  
14 Research was asked to do that calculation a few years  
15 ago when Quad Cities, you know, first started having  
16 problems. And we looked at it for about six months  
17 and did some preliminary things and we considered it  
18 an untenable problem, given our resources. And so  
19 that's what they face. They tried to -- it's a very  
20 difficult problem.

21 MEMBER BANERJEE: Probably, the overall  
22 gross structures that you see seem reasonable.

23 DR. BOYD: I think there are things to  
24 learn from the CFD model. I wouldn't totally discount  
25 it. Again, my concern was this -- our concern was the

**NEAL R. GROSS**

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

1 uncertainty estimate.

2 MEMBER KRESS: But the qualitative  
3 expectation is that the vortex shedding loads and  
4 frequencies are small compared to the acoustic on  
5 downstream. That's a qualitative thing that comes out  
6 of the CFD.

7 MEMBER BANERJEE: That is the issue,  
8 though. I've been missing something.

9 DR. BOYD: Hydro-acoustic coupling comes  
10 to mind as something that would be a concern if  
11 there's possibly some standing waves in the dome. And  
12 there was -- the time step would not be as suitable  
13 for that type of modeling and there are other issues  
14 with that also. But, you know, there is that thought  
15 that something -- there are those kinds of concerns.

16 MEMBER BANERJEE: That would be more the  
17 concern, in the sense that even qualitatively, is  
18 there something being missed in this analysis, which  
19 could be of importance and coupled with the acoustic  
20 wave? So is it really understood well that the  
21 problem is due to rather high frequencies or failures  
22 that are occurring rather than low frequencies?

23 MR. SCARBRUGH: Well, I would think it was  
24 what they had seen from Quad Cities, where they  
25 actually installed a number of pressure sensors on the

**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 steam dryer. They are not seeing much happening down  
2 in the lower frequency range, but they're seeing a  
3 tremendous peak up around 150 Hertz, the higher  
4 frequency range. So, now it is a different designed  
5 dryer, but they're not -- they're not seeing the sort  
6 of activity, you know, the actual measurements from  
7 the dryer. And when they did their scale model  
8 testing, they're not seeing that much either from  
9 General Electric. They're not seeing that much  
10 happening at the lower levels. But, you know --

11 MEMBER BANERJEE: Are these scale models  
12 -- excuse me for interrupting you. Are these scale  
13 models giving results, which are in correspondence  
14 with the full-scale, and could they be used to  
15 understand things better?

16 MR. SCARBRUGH: That's what General  
17 Electric is doing right now. They're taking the data  
18 from Quad Cities and going back and matching it,  
19 correlating it to find out -- where the scale model  
20 didn't see that really high, super high peak there,  
21 you could see some, but you couldn't see it in -- as  
22 high as it was. And so they're going back and trying  
23 to decide, okay, why did it not pick up that high  
24 peak? But in other areas, it's matching pretty well.  
25 In the lower frequency ranges and things like that,

**NEAL R. GROSS**

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

1 it's matching pretty well. But -- so they're having  
2 to go back and re-look at that. So that's part of  
3 GE's ongoing program.

4 MEMBER BANERJEE: I guess the issue which  
5 I'm concerned about, and why I wanted to ask Chris  
6 about this, is if there are phenomena within this --  
7 let's say, the dryer area rather than in the pipe  
8 itself, in terms of failures, then it may be hard to  
9 detect them by looking at sensors along the pipe and  
10 not having one on the dryer. So the real issue is  
11 whether such frequencies, which are of interest, would  
12 be generated within the dryer or not, and whether the  
13 CFT analysis might miss these completely, in which  
14 case, we might say, okay, you know, it looks like the  
15 CFT analysis indicates there's no problem. It only  
16 shows low frequencies there, which are not of concern,  
17 based on our experience base. And now we put all  
18 these sensors on the pipes and we expect the problem  
19 to come from relief valves or whatever, you know, so  
20 that we really think that's an adequate measure to  
21 take instead of putting some instrumentation in the  
22 dryer actually to look.

23 MR. SCARBRUGH: And that is something --

24 MEMBER BANERJEE: And that's really the  
25 issue?

**NEAL R. GROSS**

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

1 MR. SCARBRUGH: Right.

2 MEMBER BANERJEE: How much confidence can  
3 we have in that?

4 MR. SCARBRUGH: Right, and we have talked  
5 about that with the term. We've asked that question  
6 ourselves. Is, you know, by monitoring main steam  
7 lines, if the loads get such that there could be  
8 damage to the dryer, would the main steam line sensors  
9 be able to pick up that higher loads that are  
10 generated. One of the areas that we did was, we asked  
11 -- and as part of the licensed condition -- is that  
12 they have to monitor not only that, but the  
13 accelerometers, to look for lower frequencies for  
14 excitation. Anything that's in the lower frequency  
15 range that might be below the sensitivity level of those  
16 main steam line strain gages. So that's part of what  
17 we're monitoring as well.

18 MEMBER BANERJEE: Would the main steam  
19 line strain gages see excitations, which originate at  
20 the dryers themselves? The high frequency due to flow  
21 and resonances within these cavities and things like  
22 that? Then pick it up on the main stream line?

23 MR. SCARBRUGH: That was one of the  
24 questions we asked in terms of if you start to see  
25 such high turbulence and problems in the dryer that

**NEAL R. GROSS**

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

1 you're starting to get to a damage level, would that  
2 be reflected down? And that -- I'm not an expert in  
3 this area, but my understanding was that you would  
4 start to see some sort of interaction, something  
5 happening downstream, that you get that much  
6 turbulence and excitation going on in the dryer, in  
7 the dryer and reactor pressure vessel that you would,  
8 between the accelerometers and the main steam line  
9 strain gage, you would start to see something abnormal  
10 happening.

11 MEMBER BANERJEE: The problem, though, is  
12 that I was talking to a gentleman who had been  
13 involved in, I think, this acoustic circuit modeling,  
14 and he was saying that the main effect in the boundary  
15 condition comes from the mass flow, not from the  
16 pressure fluctuations. So, I mean, there may not be  
17 mass flow fluctuations coming through, so you might  
18 get a lot of action in the dryer, which is not so  
19 apparent. Maybe this can be cleared up, but let's put  
20 the question in a direct way. Imagine there was a lot  
21 of activity due to turbulence and so on. Within the  
22 region of the dryer cavity, would this be detected by  
23 the sensors, which are currently planned? I think  
24 that's the question that should have a clear answer.

25 MR. SCARBRUGH: Right, and that's why

**NEAL R. GROSS**

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

1 we're jumping over from CFD into acoustics and -- but  
2 we have a different team of people --

3 MEMBER BANERJEE: Yeah, but a CFD is  
4 relevant because, I think, what CFD could address is  
5 whether there could be this possibility --

6 MR. SCARBRUGH: Exactly.

7 MEMBER BANERJEE: -- or not, within the --

8 MR. SCARBRUGH: Yeah, I know. And that's  
9 why I'd like to turn this over, and we have the wrong  
10 guys up here, but for this question, but Dr. Hambric  
11 is right behind you and I'll let him speak now because  
12 he's been trying to get my attention on this issue.

13 MEMBER BANERJEE: Sure.

14 DR. HAMBRIC: Yes, this is Steve Hambric  
15 from Penn State. Actually, Entergy, this morning,  
16 showed some data that they've collected from strain  
17 gages installed on their main steam lines. And the  
18 new data clearly shows acoustic peaks that are  
19 associated with resonances within the fluid inside the  
20 dome itself, very low frequency resonances, that get  
21 excited by the turbulent flow traveling over the dryer  
22 and into the main steam lines. All that turbulence  
23 lights up those modes. So it is showing evidence at  
24 current licensed power conditions of those peaks, so  
25 if the amplitude of the excitation increases and the

**NEAL R. GROSS**

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

1 peaks crank up, you will see that as they go up to the  
2 higher power levels.

3 CHAIRMAN DENNING: How do you know for  
4 sure that's right? I'm sorry. How do you know for  
5 sure that's where they're originating? I understand  
6 you're seeing them out there. How do you know that  
7 they originate from the dome?

8 DR. HAMBRIC: They've done finite models  
9 and scale mode testing and the CFD models and looked  
10 for the acoustic resonances of the cavity itself, and  
11 they're pretty consistent. The frequencies are plus  
12 or minus a few percent, but you see the shapes of the  
13 modes pretty clearly and it makes sense --

14 CHAIRMAN DENNING: Okay.

15 DR. HAMBRIC: -- if you just do quick  
16 calculations of length and speed of sound.

17 MEMBER RANSOM: Would you see rather high  
18 frequencies?

19 DR. HAMBRIC: Yes.

20 MEMBER RANSOM: From strain gage  
21 measurements?

22 DR. HAMBRIC: I'm sorry?

23 MEMBER RANSOM: Were they pressure or  
24 strain gage measurements on that?

25 DR. HAMBRIC: It's an integrated strain

**NEAL R. GROSS**

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

1 gage signal that captures the breathing of the pipe.

2 MEMBER RANSOM: Right, right.

3 DR. HAMBRIC: So what you're seeing is the  
4 acoustic waves emanating from the dome, traveling into  
5 the pipe, and going in the other direction, down  
6 toward the turbans. And so you'd pick up that signal.

7 MEMBER RANSOM: Would you see that at high  
8 frequencies as well?

9 DR. HAMBRIC: Oh, yeah. Yeah.

10 MEMBER RANSOM: So this is not -- so the  
11 pressure, with this coming into the pipe, and somehow  
12 you're able to sense this down the pipe?

13 MRMBER HAMBRIC: Right.

14 MEMBER RANSOM: The things that are going  
15 on in the dome?

16 MRMBER HAMBRIC: Right. So what the dome  
17 is doing is it's kind of breathing and it's pumping  
18 energy into the steam lines, and so it causes the  
19 steam lines themselves to expand in response to that.  
20 And you can pick that up --

21 MEMBER RANSOM: What is the basis for  
22 that? I mean, there's a little pipe and there's a big  
23 dome here.

24 DR. HAMBRIC: Right.

25 MEMBER RANSOM: Why are you going to be

**NEAL R. GROSS**

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

1 able to see that inside this pipe?

2 DR. HAMBRIC: The coupling isn't perfect,  
3 but it is measurable.

4 MEMBER RANSOM: It's weak at higher  
5 frequencies?

6 DR. HAMBRIC: Right. Oh, it is weak, but  
7 you will see it. Now, at high frequencies, we suspect  
8 the main sources are going to come from valves that  
9 are downstream.

10 MEMBER RANSOM: Well, that is the  
11 assumption, right?

12 DR. HAMBRIC: That is the assumption,  
13 right.

14 MEMBER RANSOM: Yeah. If there were high  
15 frequencies generated within the dome, would you see  
16 them? That was the question.

17 DR. HAMBRIC: Maybe is the answer.

18 MEMBER RANSOM: Okay.

19 DR. HAMBRIC: Some of them, you would.  
20 Some of them will probably be filtered out.

21 MEMBER RANSOM: It didn't look that  
22 certain to me, that you would be able to.

23 DR. WU: In order to -- this is John, John  
24 Wu. I am one of the reviewers. I've been involved in  
25 this, you know, for quite a while, for the last couple

**NEAL R. GROSS**

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

1 of years.

2 In order to answer Sanjoy Banerjee's  
3 question, that is the same question we've been asking  
4 ourselves. We've been asking it at Quad Cities and at  
5 Vermont Yankee about, how about a coupling between  
6 acoustics and, like a vortex shedding and turbulence  
7 within the cavity, providing you can expand the vortex  
8 shedding within the cavity? For some reason, quite  
9 recently, we looked at the Quad Cities internal  
10 matrix, which also shows the peak at high frequency.  
11 That's from their shedding mentioned, also from the  
12 pressure sensor measurement, supposed to show the high  
13 frequency. Which is a complete, quite consistent with  
14 the loads, so that's why we say, how to reserve this,  
15 you know. Acoustic can, you know, to -- well, hydro -  
16 - downloading within the cavity. Something like that.

17 But we need -- up to now, we believe we  
18 just see the measurement data and that we pretty much  
19 think that, you know -- the high frequency occurs from  
20 the incidents. So we believe that, you know, high  
21 frequency exists in the pressure on the trial.

22 MEMBER KRESS: This issue could be  
23 resolved if we had string gages on the steam dryer  
24 itself.

25 DR. WU: We do. We do have that, yes.

**NEAL R. GROSS**

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

1 MEMBER KRESS: You have those on both the  
2 new and --

3 DR. WU: On the QC, on the Quad Cities,  
4 too.

5 MEMBER KRESS: On Quad Cities? That's a  
6 different steam dryer.

7 DR. WU: Right. It is.

8 MEMBER KRESS: Well, is it that difficult  
9 to put gages on the Vermont Yankee side?

10 MR. SCARBRUGH: The dosage is very, very  
11 high.

12 MEMBER KRESS: It's a dose issue  
13 application?

14 MR. SCARBRUGH: Yes, yes. That's really  
15 where it is. I mean, they've been modifying it quite  
16 a bit. So they've modified it. They can do the  
17 modification, but the dosages would be quite a bit  
18 just to run those lines out.

19 CHAIRMAN DENNING: Okay. I think we ought  
20 to move on to the AMC validation.

21 MEMBER KRESS: Before you go on, I'd like  
22 to hear a little more about that last bullet. What  
23 are the Licensee conditions that are going to address  
24 this thing?

25 MR. SCARBRUGH: What the intent was,

1 because of the uncertainties regarding the CFD, was in  
2 terms of the monitoring of the main steam line strain  
3 gage data that now will go down to a rather low  
4 frequency level and the monitoring of the acoustic --  
5 of the accelerometers on the main steam lines, looking  
6 for low frequency lows that might be significant, so  
7 that's part of what they're going to be monitoring.  
8 Now, the uncertainty is that, in terms of the limit  
9 curve, the limit curve where they operate now, with  
10 what their sensors are reading, are very far away from  
11 where the limit curve is. If any peak hits a resonance  
12 and strikes that limit curve, they have to stop. That  
13 stops them right there. The analysis was that the  
14 whole -- all of that frequency spectrum goes up and  
15 hits the limit curve. But the condition is much more  
16 stringent on that. If any peak hits it, they have to  
17 stop, and they have to stop at -- whenever they're  
18 monitoring, they have to monitor hourly, and at 5  
19 percent, 10 percent, 15 percent of the original  
20 licensed power, there is a commitment also, that as  
21 part of the NRC staff review, if we have a safety  
22 concern with what's happening with that actual  
23 operational period, then they have to stop and resolve  
24 those issues.

25 So, if they get to a point where any

**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 excitation starts to occur, they have to resolve these  
2 uncertainties and that stops the power increase. And  
3 so that's the condition that addresses it.

4 MEMBER KRESS: On the one basis, did you  
5 decide what level that limit ought to be?

6 MR. SCARBRUGH: The limit curve?

7 MEMBER KRESS: Yes.

8 MR. SCARBRUGH: What they did was, in  
9 terms of how far it was away, that there was like a  
10 hundred percent -- if you look at the weak link and  
11 there's a slide later on that, on the limit curve, but  
12 if you look at the weak link, it's still -- even if  
13 you assume the calculations that they did, they're  
14 still twice as much, a hundred percent, margin up to  
15 that level for the overall. And that's the curve that  
16 they establish. And what we did, we said on top of  
17 that, not only would the entire curve go up there, but  
18 if any peak hits that, that's where we stop. So  
19 that's how we added that additional conservatism into  
20 monitoring of the actual strain gage data, is that if  
21 they see any peak go up and hit that, they have to  
22 stop. Because --

23 MEMBER KRESS: The weak link you are  
24 talking about is on the dryer itself?

25 MR. SCARBRUGH: On the dryer itself, yes,

**NEAL R. GROSS**

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

1 sir.

2 MEMBER KRESS: So the assumption is that  
3 we will basically get no attenuation of that  
4 downstream as it goes through the exit plan and --

5 MR. SCARBRUGH: Well, they have to monitor  
6 -- in terms of things happening downstream, they have  
7 to monitor the piping, the components, walk downs,  
8 inspections, all that has to be done during every 5  
9 percent power level. They have a series of walk downs  
10 they do, and accelerometers, monitoring acceleration  
11 of all the components. And Quad Cities did see these  
12 high peaks start to occur in their accelerometers when  
13 they started to have problems. So, they're going to  
14 be monitoring all of that information at each hold  
15 point and then presenting that to the staff and if  
16 there are any excitation issues, then they're going to  
17 have the holdback.

18 MEMBER KRESS: Thank you.

19 MEMBER LEITCH: Is there any commitment to  
20 monitor quality, other than just upon first reaching  
21 each plateau? In other words, months or a couple of  
22 months downstream, are they required to monitor the  
23 quality?

24 MR. SCARBRUGH: Oh, the motion carryover?

25 MEMBER LEITCH: Yes.

**NEAL R. GROSS**

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

1 MR. SCARBRUGH: Yes, sir, that's part of  
2 the ongoing -- the criteria -- they have  
3 calculational that they do based on the main steam  
4 line gages, and also the moisture carryover. Both of  
5 those. But we want to catch it before it gets to a  
6 moisture carryover issue.

7 MEMBER LEITCH: Sure, but what I'm saying  
8 is there is a requirement to do that upon reaching the  
9 120 -- upon reaching each plateau?

10 MR. SCARBRUGH: Yes.

11 DR. MURPHY: But I'm saying what about  
12 downstream of that? In other words, upon first  
13 reaching it, the moisture carryover is high, but what  
14 about a month, a year downstream? Is there a  
15 commitment to --

16 MR. SCARBRUGH: Right. We expect them to  
17 continue the monitoring of moisture carryover, like  
18 most plants do, just like Quad Cities and Dresden do,  
19 continuously. And any time they see -- just like  
20 Dresden, we've had a couple of cases in Quad Cities  
21 where the moisture carryover has gone up after a rod,  
22 control rod movement. And that same type of  
23 evaluation would be conducted here. If they start to  
24 see an increase in their moisture carryover, they need  
25 to evaluate what's causing it. Sometimes it's caused

**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 by something, you know, as straightforward as a  
2 control rod movement, or at Quad Cities, they had  
3 cases where they actually had dryer fail and then they  
4 saw them go up.

5 MR. SCARBRUGH: But you could have the  
6 dryer failure and not have it affect the moisture  
7 carryover.

8 MR. SCARBRUGH: If you have a crack, yes,  
9 sir. I mean, once it wasn't releasing -- you know,  
10 and then they have to come -- and then they do the  
11 detailed inspections, you know, at the next three  
12 outages to find that. And if they find that, that's  
13 going to put them back to Square One because they  
14 shouldn't see any. With the low loads they're seeing,  
15 they shouldn't see any cracking at all in terms of  
16 this type of fatigue-type cracking.

17 CHAIRMAN DENNING: Okay, let's move on to  
18 the ACM delegation.

19 MEMBER CARUSO: Do you believe that the  
20 failure at Quad Cities was triggered by a rod pattern  
21 change?

22 MR. SCARBRUGH: No, no, no.

23 MEMBER CARUSO: It just happened at that  
24 point?

25 MR. SCARBRUGH: No, no. They've had

**NEAL R. GROSS**

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

1 moisture carryovers at increases at Quad Cities for a  
2 number of different reasons. They've had them for a  
3 stream dryer failure and they've had them for a rod  
4 change.

5 DR. ZIADA: My name is Samir Ziada. My  
6 part on this team was to look at the scale model tests  
7 and the validation of the ACM method on scale model  
8 tests as well as helping FISK with the CFD.

9 Perhaps I can say something very brief  
10 about the scale model tests. Actually, if you look at  
11 the results of this capabilities, you see that you  
12 have the high frequency and low frequency components.  
13 In the scale model tests, you see the low frequency  
14 citation, which is -- what we say, the higher dynamic,  
15 and see at low velocity, and it goes up, the low  
16 velocities with dynamic tests, and it exists at every  
17 flow velocity. Whereas, the high frequency component,  
18 the resonance of it, they become initiated at high  
19 velocity volume, and the winds become initiated, it  
20 becomes very steep. The altitude decreases with  
21 velocity very steep. This seems to correspond to the  
22 measurements in Quad City. Actually, if you see the  
23 Quad City here, you see that the measurements of  
24 vibration and strain and pressure at high power starts  
25 going very steep which really compares well with the

**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 model of this. So the evidence we have now does  
2 indicate that most likely it is the high frequency  
3 component that we need to worry about at the moment.

4 Having said that, the scale model test was  
5 used to validate the ACM and at this time, what they  
6 did is they tried to put the pressure conceal sites at  
7 the same locations as the old locations at VY, Vermont  
8 Yankee and what happened is in the scale model test,  
9 you have the microphone, the sensors are very good  
10 because they are flush-mounted to the pipe. You have  
11 no -- the uncertainties are very small. You know, the  
12 speed of sound, the volume conditions are well  
13 defined, so you have really perfect conditions to test  
14 the validity. The results of this was really not very  
15 good.

16 MEMBER RANSOM: The scale models, are they  
17 just geometric scales or did you scale the fluid also?  
18 The testing of air as opposed to steam?

19 DR. ZIADA: The validation test is being  
20 done on whatever model it is. The model is actually  
21 a Quad City model. It's not a VY model. But the  
22 objective of the validation of the acoustic model is  
23 to -- because you could measure the pressure  
24 distribution inside so that the test was to validate  
25 the method rather than model the VY. So they had two

**NEAL R. GROSS**

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

1 microphones in every pipe and they tried to circulate  
2 it, this whole modification, to, I believe the  
3 distribution, and then compare it with the  
4 measurements that's done on this smaller model. Okay?

5 So, as I said, I would have expected that  
6 that should really have all the test results for this  
7 case. I would call it a simple case compared with the  
8 planned larger effort.

9 The trend was to find, to show that the  
10 results balanced -- the predictions balanced the  
11 measurements and that this brings a lot of  
12 uncertainties because you just try to adjust some  
13 factors to adjust it. So I would say that the  
14 validation in the smaller scale model was really about  
15 heating.

16 MEMBER BANERJEE: Why was that, do you  
17 think? The measurements were good, right?

18 DR. ZIADA: Yes.

19 MEMBER BANERJEE: So is the model bad?

20 DR. ZIADA: You have so many sources, you  
21 have a lot of precipitation in the piping, and  
22 certainly the method can be improved.

23 MEMBER BANERJEE: How big is the pipe?

24 DR. ZIADA: I would think -- correct me if  
25 I'm wrong -- maybe the pipe, maybe one inch, one inch

**NEAL R. GROSS**

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

1 or less.

2 MEMBER BANERJEE: And what is the  
3 velocity?

4 DR. ZIADA: The velocity was the same map  
5 numbers, so the velocity should have been --

6 MEMBER BANERJEE: 160 -- 200 feet per  
7 second.

8 CHAIRMAN DENNING: We have a comment from  
9 --

10 DR. BILANIN: In fairness, the validation  
11 was done blind.. The best parameters were estimated -  
12 -

13 CHAIRMAN DENNING: Hold on one second. I  
14 don't think you're speaking into a mike. I think it  
15 fell down.

16 DR. BILANIN: In fairness, the validation  
17 was done blind. And the best parameters were  
18 estimated for a true speed and other damping factors  
19 from the subscale model. One calculation was done,  
20 and that was supplied for the valuation, so there was  
21 no model tuning done whatsoever for that comparison.

22 MEMBER BANERJEE: And what were the  
23 parameters that were estimated beforehand?

24 DR. BILANIN: Various things, such as  
25 acoustic speed, the amount of losses that occur at

**NEAL R. GROSS**

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

1 steam/water interface. That is modeled in the  
2 calculation, but the radiation condition is downstream  
3 of the pipe, how much damping is in the speed dome and  
4 acoustics of the speed dome itself. So there were  
5 several parameters in the model.

6 DR. ZIADA: So, again, the other aspects  
7 of this validation actually is that the tests were  
8 done at very relatively low flow velocities and the  
9 model which does not correspond to 100 percent of VY  
10 conditions. At these conditions, the relief valve  
11 were not excited, so this, I think, brings additional  
12 uncertainties. Seeing that the noise ratio is a very  
13 important factor when you are doing this and when you  
14 run this with a low speed flow, it means that you have  
15 less turbo participation, as well as loud speakers  
16 were used. I recall that the loud speaker volume was  
17 turned up pretty high. It means that the noise to  
18 signal ratio is also very -- the signal to noise ratio  
19 is politically good.

20 So, all this, I would think that one would  
21 have expected better agreement, and that before, I  
22 think, the team concluded that the validation base was  
23 not really successful on this small scale model. And  
24 we started focusing on a more appropriate condition,  
25 which would be similar to Vermont Yankee and that's

**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 when we started looking at Quad City validation and  
2 doing something similar in VY as well.

3 The validation of VY, of Quad City, I  
4 think, the next team will talk about that.

5 CHAIRMAN DENNING: Oh, that's going --  
6 we're going to have a presentation on the validation  
7 against Quad City 2 later? Is that what you just  
8 said?

9 MR. SCARBRUGH: Actually, right now.

10 CHAIRMAN DENNING: Right now, okay.

11 MR. SCARBRUGH: And so we're going to ask  
12 the other members of the team to come up and we'll  
13 switch out, so they can talk more about the acoustic  
14 circuit model now.

15 MEMBER BANERJEE: Blind tests are very  
16 good. I remember that when these were done for LOFT,  
17 every time we did a blind test before and then we did  
18 the experiment, they never agreed. But after that,  
19 they always did. Every time we did a new test, we had  
20 the same problem. So these methods seldom have any  
21 predictive fodder.

22 MR. SCARBRUGH: Next we're going to have  
23 Doctors Hambric and Shah and Mulcahy walk you through  
24 our review of the acoustic circuit model analysis and  
25 also the ACM input on certain issues.

**NEAL R. GROSS**

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

1 DR. HAMBRIC: By the way, in the Navy  
2 community where I work, we have a term -- maybe other  
3 people use it, but we compare "predictions" versus  
4 "post dictions" and it's just as Sanjoy pointed out,  
5 post dictions are always better.

6 I'm going to talk about the acoustic  
7 circuit model analysis review. We've looked at a  
8 whole lot of information from CDI, as well as from  
9 General Electric and Entergy, as well as Exelon with  
10 the QC people. So I just want to reemphasize that all  
11 of us are working on the QC, as well as the VY  
12 reviews, and that's helped us immeasurably as far as  
13 understanding what we think is going on there.

14 But just to refresh your memory, the  
15 acoustic circuit model relies on measured inputs.  
16 It's not trying to predict from first principles  
17 what's going on inside the dome and the main steam  
18 lines. What it does is it takes measured pressure  
19 waves or pressure amplitudes and phases at two  
20 locations in each steam line and then tries to infer  
21 the weight amplitudes going left and right. They then  
22 couple those main steam line one-dimensional models  
23 with the three-dimensional dome model to try to get  
24 the couple analysis of what's going on everywhere and  
25 what pressure loads are on the steam dryer.

**NEAL R. GROSS**

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

1           Those inputs are synchronized time series  
2           and so everything they're doing is in the time domain.  
3           And as we pointed out a moment ago, the scale model  
4           tests were not all that useful as far as validating  
5           the ACM. And so what we used instead was Quad Cities  
6           2 measurements. For the instrument in the dryer, they  
7           had 27 pressure taps mounted to the outer surface and  
8           in the inner surfaces of the dryer. And they looked  
9           at the broadband pressure levels, as well as the  
10          spikes that you saw at around 150 Hertz and we spent  
11          a lot of time discussing what the errors and  
12          uncertainties are.

13                 Let me also, before I get into that, kind  
14          of point out that the main goal of Entergy and Exelon  
15          is to use these models to come up with conservative  
16          bounds on what the loads are. It's not, can we get  
17          the pressures exactly predicted? It's, are we above,  
18          are we conservatively above the pressures that are  
19          actually impinging on the dryers. So that was our  
20          main focus in the review, is are we conservative and,  
21          if we're not, what is the bias error? What is the  
22          uncertainty that they ought to apply to these  
23          predictions in order to tell them whether there's a  
24          chance that the stresses in the dryer might be over  
25          the allowable limits. So, that was our main focus.

**NEAL R. GROSS**

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

1           It says on the vu-graph that they used a  
2           specific ACM version. So you had heard Dr. Banerjee  
3           refer to a few parameters that they use in the models.  
4           The parameters are damping in the main steam lines,  
5           damping within the dome, and lots of other damping  
6           parameters and sound speeds. So what Entergy did was  
7           they froze the ACM version that they were using and  
8           the froze it to the Quad Cities 2 originally licensed  
9           power condition, 790 Megawatts. So there are  
10          measurements at that condition. There are predictions  
11          at that -- blind predictions at that condition. And  
12          they are basing uncertainties on those comparisons.

13                 Based on all that, they came up with 100  
14          percent uncertainty and that's an amplitude. There  
15          was a question earlier about frequency and amplitude  
16          uncertainties. The AMC isn't going to shift  
17          frequencies. Whatever peak frequencies you see in the  
18          steam lines, those are the peak frequencies you're  
19          going to see in the dryer. So that 100 percent  
20          uncertainty is under the amplitude of the load.

21                 Even after applying that, they presented  
22          in submission to us, a comparison of spectral density  
23          plots in frequency and also RMS overall amplitude  
24          plots and added that 100 percent uncertainty to the  
25          ACM predictions and they compared that to the actual

**NEAL R. GROSS**

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

1 measured data. And there were still under-  
2 predictions.

3 And the other predictions that we've  
4 mostly been focusing on are at the toe ends that you  
5 see at 150 Hertz and so the valve singing frequencies  
6 in QC. Because our main concern is one of those  
7 valves is going to light off and start causing  
8 acoustic waves at very high amplitudes to travel down  
9 the steam lines and hit the steam dryer.

10 And so when we talk about uncertainties,  
11 we're mostly looking at those peaks because that's  
12 what we think is driving PC dryers, the old dryers in  
13 the failed unit.

14 So even after the 100 percent uncertainty,  
15 they're still under predicting, okay. And that under  
16 prediction is addressed in the license conditions that  
17 Tom Scarbrough just mentioned as far as monitoring  
18 what's going on. At any peak, challenges on limit  
19 curve, we're making them go off and do pretty much all  
20 the analyses over again and they have to convince us  
21 that the uncertainties that come up are realistic and  
22 fair and that they're really not challenging the  
23 integrity of the dryer.

24 MEMBER RANSOM: Steve, do you know what  
25 kind of coupling they use between the dome, the steam

**NEAL R. GROSS**

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

1 dome and the line?

2 DR. HAMBRIC: Sure.

3 MEMBER RANSOM: For example, if you use  
4 just continuity a coupling agent and assume a just  
5 continuous change in area, you get one answer, but  
6 another one is a fairly new type entrance effect, and  
7 I forget what the acoustic term is for that, but it's  
8 a circle in the holograph point that you use for the  
9 boundary condition, you get quite a different answer.

10 DR. HAMBRIC: Yeah, they are using a  
11 ladder. They are assuming a fluctuating head loss  
12 across the joint.

13 MEMBER RANSOM: Well, very little head  
14 loss with the brewery-type entrance.

15 DR. HAMBRIC: Right, but it's a  
16 fluctuating, right. So they're including that term in  
17 their coupling between the main steam line 1D acoustic  
18 model and the 3D dome model.

19 MEMBER RANSOM: Okay.

20 DR. HAMBRIC: And they don't have to  
21 calculate that fluctuating head loss to get the answer  
22 on the steam dome, but they can. And they've done  
23 that in some of their submissions.

24 And they also enforce continuity of  
25 particle velocity. That's supported --

**NEAL R. GROSS**

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

1 MEMBER RANSOM: I was just wondering if  
2 that was maybe part of the reasons that there's such  
3 high uncertainty.

4 DR. HAMBRIC: There's that. A lot of the  
5 damping parameters are probably giving you a higher  
6 uncertainty. Some of the things we're looking at for  
7 Exelon now for QC, get into what the actual damping  
8 out to be of the steam froth, they call it, at the  
9 kind of the floor, the water versus steam --

10 MEMBER RANSOM: Compliance.

11 DR. HAMBRIC: All of that tuff, right. So  
12 I think there are a lot of parameters that need to be  
13 fine-tuned, but the point for Entergy is that the  
14 froze their ACM model, one particular model, one set  
15 of parameters, and based on the blind comparison of  
16 measurements, came up with their uncertainty, which we  
17 believe is low. We don't believe that's conservative  
18 enough. But based on that, the fact that we don't  
19 believe it's conservative enough, we applied a lot of  
20 conditions in the license plan.

21 DR. MULCAHY: I'm Tom Mulcahy from Argon.  
22 I'd like to talk to you about another uncertainty, and  
23 that is that they have to measure -- this is not a --  
24 the ACM is not a predictive technique. You have to  
25 measure the pressures in the pipe, in the main steam

**NEAL R. GROSS**

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

1 line in order to come up with the pressures on the  
2 dryer. So there's uncertainties involved there.

3 But before I get into that, I'd like to  
4 put a little perspective onto this that maybe I carry  
5 that others don't, and that is of all the review  
6 papers that I wrote in the 1970's and 1980's and all  
7 the conferences I attended and that, this particular  
8 kind of problem has not been seen before. My current  
9 thinking is that it is the valves singing. They're  
10 the excitation source, and I look at it a little bit  
11 different than acoustic people, but essentially you  
12 have acoustic modes, which are both in the piping and  
13 -- the same mode is in the piping and in the steam  
14 dome itself. And so if you get to the unusual  
15 circumstance where you have a valve singing at an  
16 antinode of an acoustic mode and you've got another  
17 antinode inside the steam dryer, you can excite the  
18 steam dryer. It baffled me how you could get energy  
19 up from these valves which are often 50, 60, 70 feet  
20 down the steam line until I saw some of the acoustic  
21 model analysis that was done with regard to the small  
22 model tests.

23 So, now not only do you have to have this  
24 coupling, this acoustic coupling with the excitation  
25 source, but you also then have to have a frequency on

**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 the structure, which responds to this. So it's a  
2 rather -- in my view, it's a rather unique situation  
3 that you can get all of these parameters to come  
4 together.

5 MEMBER CARUSO: Can I ask you a question?  
6 Are you saying that it's the main steam isolation  
7 valves are resonating because they increase flow  
8 through them or resonance is off the branch line?

9 DR. MULCAHY: It's -- there's vortex  
10 shedding going across the branch line where the valves  
11 are.

12 MEMBER CARUSO: Right.

13 DR. MULCAHY: So the vortices are the same  
14 part of this thing, as we've all heard from wires and  
15 that sort of thing.

16 Another way to look at it is that just  
17 because you have a loud noise, it doesn't mean that  
18 you're going to have structural damage. You have to  
19 have a structure which responds to that. I mean, all  
20 the musical instruments don't fall apart as they're  
21 using them. So I think it's a rather unique  
22 situation.

23 Now, to get back to the -- and it may be  
24 Quad Cities and Dresden because Quad Cities and  
25 Dresden have the high velocities in the main steam

**NEAL R. GROSS**

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

1 lines. Quad Cities goes through, what? It's 70 or 80  
2 percent, you see a blip. Quad Cities -- I mean,  
3 Dresden has actually higher velocities, smaller pipe  
4 diameter than Quad Cities. So it may be that it's  
5 just those particular variances of reactors. All the  
6 other reactors have different scale between their main  
7 steam line and their reactor dome.

8 Getting back to -- I might also add if  
9 this steam dryer had been declared a safety item, we  
10 probably would have been working on this a long time  
11 ago because they had to instrument it and at least at  
12 Dresden you would have seen these peaks coming up  
13 either from a pressure measurement on the dryer or  
14 pressure measurement in the main steam line.

15 Getting back to measuring the pressures,  
16 these guys were really -- this is a daunting thing to  
17 do is to measure the pressures in the main steam line  
18 and they started out with the available parts, the  
19 instrument lines, close to the reactor, and then you  
20 have to put a pressure transducer at the end of this  
21 long line, which has two -- has air boundaries in it,  
22 has water boundaries in it, and you've got to get a  
23 transfer function between that transducer all the way  
24 up to that. And this -- the uncertainty just builds  
25 and builds and builds in these things. So when they

**NEAL R. GROSS**

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

1 started, they were just using these instrument lines  
2 with pressure transducers at the end of them and they  
3 -- the uncertainty was so large that you couldn't  
4 really even make heads nor tails out of it. They then  
5 started to add strain gages to the main steam line.  
6 In the case of VY, I believe it was one strain gage on  
7 each main steam line and now you get into the issue  
8 of, well, what are you measuring with one strain gage  
9 in the circumferential direction on a steam line.  
10 Both Steve and I have had lots of experience in this  
11 area and you've got to eliminate pipe vibrations and  
12 everything like that.

13           So now we've got Quad Cities up to four --  
14 on four strain gages, 90 degrees apart, in order to  
15 eliminate some of the overling modes in the piping,  
16 and they've actually already are glad that they did  
17 it, although when we asked them to do it, they weren't  
18 so glad. VY is now, I was just told when we came in  
19 by Rico, that -- or somebody -- that they now have six  
20 around the circumference of this and the  
21 circumferential direction, which you now only  
22 eliminate the first mode, but can eliminate maybe the  
23 next two modes. And the idea is to deal with the  
24 modes that are in the frequency range of zero to 200  
25 Hertz in the piping.

**NEAL R. GROSS**

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

1                   So that's where they're at now and I don't  
2 know if they showed that data that we've been given,  
3 but they've already had to use essentially these  
4 strain gages to eliminate some of the over predictions  
5 that they've been seeing. What they're doing is  
6 they're lowering the uncertainty of the measurement  
7 technique. It's not absolute now, but the uncertainty  
8 has gone way down because what they were relying on  
9 before was so -- was so -- had such high --

10                   MEMBER RANSOM: Why didn't you just use  
11 flush-mounted transducers?

12                   DR. MULCAHY: You know, if there had been  
13 a safety issue, to start with, they would probably  
14 have had ports in there to put in flush-mounted  
15 transducers. But to go into a main steam line in --  
16 this is an old -- this is a three-year-old plant,  
17 right? It's so hot that -- and you've got to  
18 penetrate the steam boundary and I don't know who  
19 you'd get to okay that.

20                   They've done almost everything besides --  
21 first of all, the main steam line is not the world's  
22 greatest transducer. I mean, you're essentially  
23 trying to make a transducer out of a steam line or an  
24 instrument line. That's not an easy thing to do. The  
25 strains are low, so they would've had to get -- they

**NEAL R. GROSS**

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

1 would've had to update and upgrade their  
2 instrumentation in order to resolve these small  
3 strains that they're seeing. And they'd do bench  
4 tests to see if they could do it. They obviously  
5 can't simulate what's going on in the reactor, but  
6 they do as much as they can, or they've done as much  
7 as they can.

8 CHAIRMAN DENNING: Okay. Thank you.  
9 Continue.

10 MR. SCARBROUGH: Okay. The next slide, I'd  
11 like to talk a little bit about the limit curve margin  
12 and we've talked somewhat about this. And Entergy  
13 showed that this morning. They have a limit curve  
14 that they've established from zero to 200 Hertz  
15 frequency and using the physics circuit and such, and  
16 part of what we did was we indicated to them, during  
17 their audit in August, that the importance of that  
18 limit curve and that you will still maintain  
19 structural integrity of the steam dryer if you get up  
20 toward that limit curve. And that's where they did an  
21 analysis which showed that the stresses, the combined  
22 stresses that they had were from their calculations,  
23 and you saw a little bit this morning about how they  
24 calculated that, was 7,400-psi at their weak link and  
25 the fatigue stress limit from SME is 13,600 at that

**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 point. So even if they did rise up to that level and  
2 hit that, they would still have almost a hundred  
3 percent margin there.

4 But also, as we talked about, any peak,  
5 any single peak can end up affecting that little curve  
6 and makes them stop and -- from the license condition,  
7 and evaluate the uncertainties. So that's how we  
8 added our additional conservatives there.

9 So overall, our findings regarding the  
10 steam dryer stress is that, although as we've  
11 discussed, there's significant uncertainty regarding  
12 the calculation of the stress and the mouth of that  
13 uncertainty, that the current steam line  
14 instrumentation suggests minimal excitation of the  
15 pressure frequency spectra in the main steam lines at  
16 the current licensed conditions.

17 So, it's apparent that the flow in these  
18 stresses are not significantly challenging the fatigue  
19 stress limits from the ASME Code for the dryer.

20 MEMBER BANERJEE: What are the cracks in  
21 the dryer at the moment due to?

22 MR. SCARBRUGH: Most of them were -- they  
23 were IGSCC, okay, and tomorrow you can have the  
24 Chemical Engineer being brought in. They can talk  
25 more about that.

**NEAL R. GROSS**

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

1 MEMBER BANERJEE: But they're all those?

2 MR. SCARBRUGH: They did have some small  
3 fatigue ones down where the end plates fit into the  
4 drain trough and that's a sort of a natural flexing  
5 point, which isn't even -- the weld isn't even really  
6 necessary because the end plate fits in there and it  
7 doesn't move.

8 MEMBER BANERJEE: And those are the only  
9 cracks related to this?

10 MR. SCARBRUGH: Well, they had a few  
11 others, but they're very small. None of them -- they  
12 inspected the areas where the loads are on the outer  
13 hood, and the gussets and modifications, and they  
14 don't see -- they don't see any --

15 MEMBER BANERJEE: Now, they saw a lot of  
16 new cracks when they did some -- the inspection just  
17 before we were in Brattleboro last.

18 MR. SCARBRUGH: Those new ones that they  
19 saw were the ones that were on the end plates inside  
20 the vein beds and it's where -- and that's the IGSEC  
21 cracking where they have a -- It's a channel shaped 8-  
22 inch end plate for those channels. And where the  
23 inlet side comes in, they saw -- they saw some cracks  
24 a couple of inches long. They weren't sure where they  
25 went, but they didn't see them on the other side. So

**NEAL R. GROSS**

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

(202) 234-4433

www.nealrgross.com

1 they -- they were assuming that they just stopped or  
2 maybe that they were there all along, and they just  
3 hadn't seen them before, but they ones that they had  
4 seen previously in 2004, they were still where they  
5 were and they still didn't see any on the outlet side.

6 So, that's where they're getting a little  
7 bit of IGSCC crack in there, it appears, but they're  
8 not getting any fatigue cracking on the vertical welds  
9 there or anything of that nature.

10 CHAIRMAN DENNING: IGSCC is stress and  
11 cracking?

12 MR. SCARBRUGH: Inter Grainger of Stress,  
13 Corrosion and Cracking.

14 MEMBER BANERJEE: Oh. Oh. Did you have  
15 that in Quad Cities, too?

16 MR. SCARBRUGH: Most plants, when -- we've  
17 been sort of monitoring the inspections of all the  
18 steam dryers and all of them see a little bit of IGSCC  
19 during these outages. And they see --

20 MEMBER BANERJEE: But there's no coupling  
21 between these two cracking modes?

22 MR. SCARBRUGH: No, it looks like there  
23 was not --

24 MEMBER BANERJEE: IDSCC crack doesn't grow  
25 due to vibration or anything?

**NEAL R. GROSS**

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

1 MR. SCARBRUGH: No, it just gets to a  
2 point where it relieves -- and you see, you see it in  
3 a lot of the dryers where they get a little bit of  
4 IGSCC from the cold working that occurred in the past  
5 and then it occurs and it relieves itself and then it  
6 stops. But anytime like that, they monitor that  
7 because that's something that they want to make sure  
8 doesn't grow any further.

9 So that's -- what all this does is it  
10 emphasizes the importance of monitoring. And that's  
11 part of our -- the next slide is the monitoring plan.  
12 And they -- Vermont Yankee described the steam dryer  
13 monitoring plan and defined their unacceptable steam  
14 dryer performers where they could get a generation of  
15 loose parts, and these little cracks or tears that  
16 would allow excessive moisture carryover because all  
17 these dryers see little, small, little indications  
18 every time you inspect them. It's just is the nature  
19 of the beast.

20 And then they have a step process where  
21 they go up in power, 2.5 percent steps, and 5 percent  
22 steps, and then they have performance criteria based  
23 on moisture carryover and the steam line data where  
24 they evaluate the data hourly to make sure they're  
25 staying far below the limit curve.

**NEAL R. GROSS**

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

1           Now when we did our review of the  
2 monitoring, we found that there were a number of areas  
3 that needed to be strengthened regarding the  
4 monitoring plan. We needed to -- we wanted to be  
5 provided with the plant data and also actions -- hold  
6 points where we could interact with the Licensee in  
7 discussing these safety concerns. They needed to  
8 resolve the uncertainties. If they hit the limit  
9 curve, and even if they don't hit the limit curve,  
10 within 90 days after EPU issuance, they have to  
11 resolve these uncertainties.

12           They have to monitor the plain  
13 instrumentation for low frequency excitation because  
14 that was one area we thought -- we haven't seen any  
15 excitation in the low frequency areas significant from  
16 the scale model casting or from the Quad Cities  
17 instrument and dryer, but we wanted to make sure that  
18 the Licensee was monitoring that in case there was  
19 something that we missed.

20           And also, we wanted more details regarding  
21 the start-up test procedure and so we provided that to  
22 areas we like to see. Because our experience with  
23 Quad Cities start-up, there were certain areas that we  
24 wanted to make sure were monitored as they went up in  
25 power. So we used that Lessons Learned from Quad

**NEAL R. GROSS**

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

1 Cities for their power start-up after replacing the  
2 dryers and put that into the License Condition.

3 So, the bottom line in terms of our  
4 development of the Licensing Conditions was we wanted  
5 to provide a slow and deliberate power assentation with  
6 lengthy hold points and data evaluation. We wanted to  
7 formalize the plans for improving the strain gage  
8 limitation and we've heard, it's already been  
9 installed and being used now. And there were other  
10 activities that we wanted to formalize that the  
11 Licensee had mentioned in their Supplement 33. We  
12 wanted to specify the contents of the start-up test  
13 procedure. We wanted to go ahead and incorporate  
14 Entergy's License Condition that they had regarding  
15 the long-term implementation of the monitoring plan,  
16 and we wanted to provide for detailed interaction  
17 between the Licensee and the staff during the power  
18 assentation so we could discuss the plant data, the  
19 valuations, and inspections, just like we did for Quad  
20 Cities when they came up in the spring with their new  
21 drives.

22 We sent this out to the Licensee and they  
23 accepted it. They had some minor clarifications which  
24 we didn't consider to be significant to our overall  
25 goal and we put those into the draft's evaluation.

**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 In the next few slides, I have -- I  
2 summarize the License Conditions, and I'll just very  
3 briefly, just go through them for you. In terms of --  
4 the first part is the requirements above 1593,  
5 Original License for Thermal Power. They have to  
6 monitor the newly installed strain gages hourly. They  
7 have to have hold points for 24 hours at 105, 110, 115  
8 percent to collect data and they cannot increase the  
9 power above that point for 96 hours after receipt of  
10 their evaluation of that -- our receipt of that  
11 evaluation of that data. If a frequency peak from the  
12 strain gage data exceeds the limit curve, they have to  
13 return the facility to a power level where the limit  
14 curve was not exceeded and resolve the uncertainties.  
15 And provide that to the staff prior to any further  
16 power increase. They have to monitor the reactor  
17 pressure vessel water level or maintain line piping of  
18 accelerometers, hourly, and this also -- well, we  
19 talked about looking for a low frequency or something  
20 that the main -- a few main strain gages might have  
21 missed --

22 CHAIRMAN DENNING: Why is that an "or?"

23 MR. SCARBRUGH: Oh, because when we  
24 discussed this with them, their water level  
25 experimentation just isn't able to give you reliable

**NEAL R. GROSS**

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

1 data based on what they have. And based on our  
2 experience with the Quad Cities main steam line pipes  
3 and accelerometers, they did pick up excitations at  
4 various levels across the frequency spectra. So we  
5 thought that would be a reasonable way to do it. It  
6 could be either/or. We were focusing on what was in  
7 the lower frequency range, what could give them  
8 something to supplement that.

9 But we wanted to -- in discussing it with  
10 them, they didn't think the water level would give  
11 them any reliable data. So we thought, well, rather  
12 than have them do something which doesn't tell them  
13 anything, we just focused on the accelerometer. So  
14 that's why we did the "or" in there.

15 MR. SCARBRUGH: Just to clarify, the water  
16 level there is considered not reliable for these  
17 purposes. For the purposes for which the water level  
18 instrumentation was put in there, which is a safety  
19 purpose and feed water control, it is satisfactory.

20 MR. SCARBRUGH: Yes, thank you for that  
21 clarification.

22 MR. SCARBRUGH: Just so that it is clear  
23 that we don't have something hanging out there that  
24 says that.

25 MR. SCARBRUGH: Exactly right, thank you.

1 That's a good clarification. Yeah, for this purpose,  
2 they didn't think that they could anything reliable  
3 for monitoring steam dryer excitation from the  
4 frequencies, monitoring the frequencies, and so they  
5 suggested that -- they were asked if they could do  
6 either/or and we were agreeable to that. As long as  
7 they do something that looks for sort of a back-up,  
8 sort of a safety net there just to make sure that the  
9 steam line strain gages -- if they see anything else  
10 happening, that they'll be alerted to that. And if  
11 they do, then they have to respond to that. And if  
12 they see any resonances start to occur in those  
13 accelerometers, then they need to address that with  
14 us.

15 CHAIRMAN DENNING: Okay. Continue.

16 MEMBER LEITCH: Under "B" there, should it  
17 not also say "120 percent?" I realize increasing  
18 beyond that is not applicable, but you still do the --  
19 all the analysis and --

20 MR. SCARBROUGH: Right, because when it  
21 gets to 120 percent -- and I think it's on the next  
22 page -- yeah, we have it on the next page. When they  
23 get down to 20 percent, they have to reevaluate  
24 everything.

25 Then the following, Item (e) there is that

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

1 following the start-up testing, they have to resolve  
2 the uncertainties within 90 days. So they have that  
3 provision there.

4 On the next slide, this were the areas  
5 that Entergy had mentioned in their Supplement 33 and  
6 we thought these were important to formalize as part  
7 of License Conditions. Installation of the strain  
8 gages, they challenged the limit curve. They  
9 reevaluate -- after they reach 120 percent, they have  
10 to reestablish or establish the fatigue load margin,  
11 update the stress report, and reestablish the limit  
12 curve. So they had to redo all of those things once  
13 they get there. If they do have to do an engineering  
14 evaluation, they need to evaluate the frequency  
15 uncertainties, plus or minus ten percent, and any peak  
16 responses within that uncertainty band, they have to  
17 revise the monitoring plan to reflect the long-term  
18 aspects, they have to submit the final report upon  
19 completion, so once they get to 120 percent, they have  
20 to submit their final load definition and then they  
21 have to submit the appropriate proportions of the EP  
22 start-up test procedure prior to power assention. So  
23 they have to do that for us.

24 Then the next slide. We list out what we  
25 wanted to see in the start-up test procedure. This is

**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 what we used as part of the Lessons Learned from Quad  
2 Cities starting up in the spring, the limit curve, the  
3 hold points, the parameters, the inspections, walk  
4 downs, the trend and methods they're going to use to  
5 trim, the acceptance criteria, the actions if they  
6 don't need those acceptance criteria, and the  
7 verifications of the commitments and the planned  
8 actions.

9 CHAIRMAN DENNING: When do you expect to  
10 receive that procedure?

11 MR. SCARBRUGH: I'm sorry?

12 CHAIRMAN DENNING: Have you received that  
13 procedure from them yes?

14 MR. SCARBRUGH: No, I have not received  
15 it.

16 CHAIRMAN DENNING: When do you expect to  
17 receive that from them?

18 MR. SCARBRUGH: Prior to power assensions  
19 and with sufficient time for us to review it. So, we  
20 don't know.

21 CHAIRMAN DENNING: So you're going to  
22 issue another SER?

23 MR. SCARBRUGH: No. No. We don't think we  
24 need to issue another SER. This will be handled the  
25 same way we did handle the Quad Cities start-up where

**NEAL R. GROSS**

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

1 we reviewed the start-up test procedure prior to them  
2 going up, and taking our actions with them on that,  
3 and as they went up in whole points, and interacted  
4 with them that way. So we were going to follow the  
5 same approach we did for Quad Cities.

6 MEMBER BANERJEE: Wasn't the  
7 instrumentation at Quad Cities similar to this?

8 MR. SCARBRUGH: Yes. Quad Cities actually  
9 has a four main steam line strain gages at each  
10 location. In quadrants here, we just learned that  
11 they've actually put six. Because of the potential  
12 for one failing, this way, they always have a back-up.

13 MEMBER BANERJEE: But when you had Quad  
14 Cities go up in power, did you follow exactly the same  
15 procedure here, as here?

16 MR. SCARBRUGH: Yes, exactly as -- I would  
17 say very close. I mean, this -- we modeled this  
18 exactly -- we've got the same guys working on the  
19 other as this, and we did the same -- that's why we  
20 used the same approach. They went up faster and they  
21 actually had a different sort of start-up.

22 MEMBER BANERJEE: But they saw vibrations  
23 and stuff like that, or acoustic modes?

24 MR. SCARBRUGH: Yes, they did, as they  
25 went up.

**NEAL R. GROSS**

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

1 MEMBER BANERJEE: As they went up.

2 MR. SCARBRUGH: And each one had to be  
3 evaluated as they went up. And so there was times  
4 where they held, when they held and had to reevaluate  
5 what they were seeing in the strain gages. So that  
6 process happens. As they go up, there is almost  
7 constant interaction between the staff and the  
8 Licensee as they go up in terms of what the agent has  
9 seen.

10 MEMBER BANERJEE: So now, this was before  
11 the problems with Quad Cities, or after, with the new  
12 trail? When did you have these tests?

13 MR. SCARBRUGH: Oh, this was all in the  
14 spring of this year, or after --

15 MEMBER BANERJEE: So this was when they  
16 put their new dryer in?

17 MR. SCARBRUGH: New dryer. And they  
18 actually had instrumentation on Quad Cities Unit 2 on  
19 the dryer itself. So we were actually looking at the  
20 actual loads on the dryer. And then Quad Cities 1,  
21 they had the main steam line strain gages similar to  
22 here, and we monitored those as they went up. And so  
23 we had the same issues, that whenever there was an  
24 indication of a resonance or a peak, those were very  
25 carefully looked at and we had phone calls and

**NEAL R. GROSS**

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

1 interactions with them before they went further up in  
2 power.

3 MEMBER BANERJEE: And what did you do when  
4 Quad Cities went up first?

5 MR. SCARBRUGH: Oh, the first time?

6 MEMBER BANERJEE: Yes. How did you  
7 monitor that?

8 MR. SCARBRUGH: That was before I was even  
9 involved in this project. I think they just -- I  
10 think they just monitored -- there were no strain  
11 gages on steam lines, so they probably monitored  
12 moisture carryover in the standard way. This was a  
13 surprise to everybody. No one expected these dryers  
14 to have any problem when they went up, and so it was  
15 quite a shock that they failed.

16 MEMBER BANERJEE: I thought a member of  
17 this Committee did, at one point. It was -- he sat  
18 about here, right?

19 CHAIRMAN DENNING: Yeah, he's no longer  
20 with us. He had other things to do.

21 MEMBER BANERJEE: So it was predicted?

22 MR. SCARBRUGH: Yeah. Well, we know a lot  
23 more now than -- at least we know a lot more now than  
24 we did then.

25 CHAIRMAN DENNING: Go ahead. Continue.

1 MR. SCARBRUGH: Okay. Then there was --  
2 the next slide was, 4, 5, and 6, were processes that  
3 Entergy proposed for implementation of the plan, about  
4 what they could change in the plan without NRC  
5 approval, and what they can't, and they have that.  
6 Those items --

7 CHAIRMAN DENNING: On Item Number 5, after  
8 the next three refueling outages, is there -- wouldn't  
9 we want to periodically -- not at every refueling  
10 outage, but wouldn't we want to periodically be again  
11 inspecting visually, or is that part of a normal --

12 PARTICIPANT: It's part of the VIP.

13 MR. SCARBRUGH: Yes, it's part of the --  
14 yeah, BWO and VIP, there's a B139 Report, and there's  
15 also a General Electric SIL, Service Information  
16 Letter, 644, which talks about, you know, ongoing --  
17 you know, this is an ongoing project. So they would  
18 follow those after they finished this more, you know,  
19 stringent thinking. And then they have to report the  
20 results of the inspections within 60 days after --  
21 following each start-up, and submit the results of the  
22 overall plan within 60 days after this initial power  
23 assention.

24 So then, 7 and 8, you know, they continue  
25 on for these -- unless they see a flaw, and then they

**NEAL R. GROSS**

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

1 have to reassess what caused that flaw and they  
2 continue. And then there's an expiration after  
3 they've satisfied all the 5, 6, and 7 issues.

4 MEMBER LEITCH: Should I draw some comfort  
5 from the successful operation at Brunswick? Or are  
6 the Brunswick dryers so different than the Vermont  
7 dryers that it's just not applicable?

8 MR. SCARBRUGH: Well, they're different.  
9 I don't know if they're a slanted or a curved hood,  
10 but they're -- they're slanted. They're different.  
11 And plus, as we've heard, it seems to be just the  
12 combination of hitting the resonance, you know, with  
13 the branch lines, and acoustic -- as the resonance  
14 frequency of the dryer, I mean, you get that  
15 combination. And Dresden seems to have passed through  
16 it on their way up to EPU. So there seems to be, you  
17 know, there's a lot of luck involved here. So I  
18 wouldn't rely on, you know, say that just because  
19 Brunswick is okay, I wouldn't say Vermont Yankee is  
20 going to be okay. That's why I think we should  
21 monitor it very closely as they go up.

22 CHAIRMAN DENNING: Okay. Continue.

23 MR. SCARBRUGH: In terms of the regulatory  
24 commitment, this was a commitment Entergy made to  
25 provide information on the data and the evaluations

**NEAL R. GROSS**

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

1 and walk downs, inspections, at each home point and  
2 then if there were any safety concerns identified,  
3 they would not increase power above that and we would  
4 not consider the License Conditions to be satisfied.

5 So, in conclusion, regarding the overall  
6 comprehend evaluation, we feel that they will continue  
7 to meet their draft, design criteria following  
8 implementation of the EPU. They provided reasonable  
9 assurance that the flow induced effects are not  
10 causing structural problems at the current license  
11 conditions, and we have a series of monitoring  
12 conditions which will ensure that there is careful  
13 evaluation of the data as they go up in power, and so  
14 that if there's any adverse indications from that  
15 data, that we will stop and require Licensee to  
16 evaluate before they continue to power any further.

17 So that basically is our presentation.

18 CHAIRMAN DENNING: Let me make a little  
19 comment and see whether anybody has anything they want  
20 to say relative to it. And that is, it looks to me  
21 like you really have covered everything very well,  
22 unless we really don't totally understand what's going  
23 on, that a problem initiates within the dryer region,  
24 and within the dome, and we really can't see it  
25 propagate. We really can't see it on the steam lines.

**NEAL R. GROSS**

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

1 And I think that Mr. Hambric has the feeling that the  
2 chances are good that even if that were the case, that  
3 we would monitor it out there. But I haven't heard  
4 any strong positive statements yet that, if that were  
5 the case, we'd really be able to monitor it. Do you  
6 have any comments along those lines?

7 MR. SCARBRUGH: Yes. I'll just say that,  
8 you know, in terms of what we've seen so far, in terms  
9 of this, the scale model testing that GE did and the  
10 general -- the Quad Cities Unite 2 instrument dryer  
11 and the CFD, for what it's worth, and the acoustic  
12 circuit model for taking data and projecting it back,  
13 we haven't seen that in terms of something occurring  
14 that we didn't pick up. We have matched pretty well  
15 in terms of what has been the significant piece. We  
16 have seen them in the acoustic circuit -- I mean,  
17 model. I mean, we've seen resonance start to occur.  
18 The main steam line strain gage data show us that  
19 there was something happening there, some resonance  
20 was being hit. We haven't seen something that, like,  
21 for example, in the scale model testing, where there  
22 might have been some peak, that was measured on the  
23 actual dryer, the scale model dryer, that wasn't  
24 picked up downstream. We haven't seen anything like  
25 that, but it's true. That is one reason why we want

**NEAL R. GROSS**

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

1 to monitor the accelerometers very carefully, you  
2 know, to see if there are any resonances that might  
3 occur. But that is an area that, you know, we just  
4 haven't seen it and that's why we want to take a slow,  
5 deliberate process.

6 MEMBER BANERJEE: It would be more  
7 comforting if you had a peak in the dryer region and  
8 showed that you saw it on your monitors on the line.

9 MR. SCARBRUGH: What?

10 MEMBER BANERJEE: All you have is very  
11 negative information.

12 MR. SCARBRUGH: Right. We haven't seen  
13 any, that's correct.

14 MEMBER BANERJEE: So if you could initiate  
15 one, either in your scale model or somewhere else, and  
16 see it in the way you're monitoring it on the steam  
17 lines, that would be more comforting.

18 MR. SCARBRUGH: Now, I know they -- in the  
19 scale model, did initiate ones downstream in the  
20 pinging, to pick it up in the dryer itself. But I  
21 don't know if they initiate anything in the dome  
22 itself and see if that could go the other way.

23 MEMBER RANSOM: Right, that would be --

24 MR. SCARBRUGH: That's a good question and  
25 we can relay that back.

**NEAL R. GROSS**

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

1 MEMBER RANSOM: -- good if you could do  
2 that.

3 MEMBER SIEBER: The ultimate back-up  
4 indication is moisture carryover. You know, all the  
5 theories and all the measurements have nothing to do  
6 with moisture carryover performance and so you can say  
7 that if I see an increase in moisture carryover, that  
8 I've got a problem with the dryer, whether anything  
9 else shows up or not.

10 MR. SCARBRUGH: Right. If they start to  
11 see moisture carryover increase, you know, they have  
12 conditions where they will have to shut down and  
13 evaluate.

14 CHAIRMAN DENNING: Are there other  
15 comments or questions?

16 (NO RESPONSE.)

17 CHAIRMAN DENNING: No?

18 (NO RESPONSE.)

19 CHAIRMAN DENNING: Okay. In that case, we  
20 are going to adjourn until 1:30 p.m.)

21 (Whereupon, the above-entitled matter went  
22 off the record at 12:37 p.m. and resumed at 1:31 p.m.)

23 CHAIRMAN DENNING: You may go ahead and  
24 start.

25 MR. ENNIS: Good afternoon.

1           This afternoon's session we will be  
2 talking about nuclear analysis methodologies. The  
3 lead presenter for this will be Jerry Head, manager of  
4 nuclear analysis, nuclear engineering analysis for  
5 Entergy Nuclear Northeast.

6           We also have up at the table Mr. Fran  
7 Bolger, who is the manager of the LOCA (phonetic)  
8 analysis for General Electric, and Dr. Moore, who is  
9 the manager of nuclear and thermal hydraulics.

10          Now I'd like to turn it over to Mr. Head  
11 to start the presentation.

12          MR. HEAD:   Okay.   I'm using a lapel  
13 microphone.   That seems to be working correctly,  
14 right?

15          All right.   The following presentation,  
16 I'm going to be providing an overview of the nuclear  
17 analytic methods that were used and reviewed in the BY  
18 extended power uprate efforts.

19          This is going to include a short  
20 background discussion to explain the manner in which  
21 the VY core will produce the extended power uprate  
22 power levels that we're looking to go to.

23          I'll also explain a little bit about some  
24 of the things that were going on in the industry at  
25 the time that affected the review, and our interaction

**NEAL R. GROSS**

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

1 with the staff on some of the issues that are going  
2 on.

3 Finally, I'll explain what was proposed by  
4 Entergy to address those concerns that came out of the  
5 other issues that were going on in the industry at the  
6 time, and provide a brief description of the resulting  
7 nuclear analytical methods and safety analysis results  
8 reviewed for VY.

9 We can go past this. First off, let's  
10 talk a little bit about the power uprate. Constant  
11 pressure power uprate is what we are going for for VY.  
12 This is a docketed methodology, pretty straightforward  
13 requirements as far as its analysis required to  
14 support it.

15 There have been questions that occurred in  
16 the last ACRS meeting VY, about how we get there. And  
17 so I wanted to touch a little bit on that.

18 There are two ways to get more energy in  
19 a core. One is, increase enrichment. The other is to  
20 raise the batch fraction, the number of bundles we put  
21 in in each cycle.

22 Typically it's a combination of both of  
23 those. The speed limit, if you will, or the limits on  
24 a particular bundle, are defined by the thermal  
25 margins, the thermal limits that we have established

**NEAL R. GROSS**

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

1 in those - in the analysis that supports it.

2 So what you do with a bundle is limited  
3 already. So what we do in this power upgrade  
4 basically is to put more bundles to work. We spread  
5 the power distribution out further. It's a flatter  
6 radial power distribution.

7 And so when you look across the population  
8 of the core, you don't see any one bundle doing a  
9 significant amount more work than had been done in  
10 past reload designs. You just see more of them.

11 Next.

12 MEMBER SIEBER: In the process you end up  
13 putting more effluents to the vessel walls?

14 MR. HEAD: That is correct. And that is  
15 one of the things that is on the topics - is that on  
16 the topics for tomorrow? It is on the topics for  
17 tomorrow.

18 So not only on the vessel walls, but the  
19 internals as well. Those are part of the things that  
20 you deal with when you go through this process.

21 DR. BANERJEE: Does flattening the core  
22 affect stability? Are you going to talk about  
23 that? MR. HEAD: We'll talk about that a little  
24 bit. You do see some effects. We'll discuss that a  
25 little bit later.

**NEAL R. GROSS**

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

1           As I mentioned before, I wanted to talk a  
2 little bit about what was going on in the industry at  
3 the time that affected this EPU review.

4           Prior to the initiation of the power  
5 uprate project, GE had developed an additional  
6 extension to the BWR operating domain. That is, the  
7 power flow map, how you actually operate one of these  
8 plants.

9           The purpose of that extension of the  
10 domain was to provide additional operating margins.  
11 It also was to provide - it would support power  
12 uprates, although it wasn't necessary specifically for  
13 V1.

14           This particular product was under review  
15 by the staff at the time, so there were a number of  
16 questions on this product that were what we call the  
17 generic docket. It was not specific to VY, but it was  
18 being handled at the same time.

19           And due to the concurrent review of VY and  
20 this product, it was apparent to us, we were getting  
21 confused as well as the staff in a manner, in how we  
22 could separate questions from this operating domain  
23 docket, and the VY EPU.

24           The net result of all that was that the  
25 staff performed probably a more extensive review of

**NEAL R. GROSS**

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

1 previously approved computer codes and methods used  
2 for establishing the core operating limits. Most of  
3 the staff questions and concerns in that area focused  
4 on fuel power uncertainty; the effects of void  
5 history; things like that.

6 So they were good questions, and like I  
7 said, sometimes it was difficult to separate them from  
8 the power uprate and from the operating domain  
9 expansion.

10 As a result, in the difficulty we were  
11 seeing in resolving generic issues, Entergy proposed  
12 what became known as the alternate approach. And this  
13 resulted in a license condition in which the safety  
14 limit minimum critical power ratio would be  
15 conservatively adjusted by a factor of .02.

16 This margin increase was shown as part of  
17 this review to be sufficient to balance staff concerns  
18 that they had so that no additional open methods  
19 issues remain for VY EPU.

20 And what I show on the slide here is  
21 basically a quote, and what's in the SER, the draft  
22 SER right now. If we go above current license thermal  
23 power, we will impose a .02 additional margin on the  
24 safety limitation.

25 DR. BANERJEE: What was the reason that

**NEAL R. GROSS**

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

1 you did this? I mean, why was the staff concerned  
2 about the uncertainty? What led to that?

3 MR. HEAD: Well, there were a number of  
4 different factors that led to it. But what drove us  
5 to go to the .02 was to get final resolution on the  
6 staff questions was going to take a significant amount  
7 of time. There were additional measurements that  
8 needed to be made in the industry and things like that  
9 that would be needed to put it to rest for good.

10 And so what we looked at, and worked with  
11 the staff on, was trying to bound the impact of all  
12 these additional uncertainties that might be out  
13 there, and come up with something that would clearly  
14 show we would be conservative; clearly give them a  
15 path to reach success there from the standpoint of --

16 DR. BANERJEE: But what were the  
17 uncertainties? I mean the fuel design was essentially  
18 one which looked similar to what you were using.

19 MR. HEAD: That's correct.

20 DR. BANERJEE: Was it enrichment  
21 profiles, or what as it?

22 MR. HEAD: It was power distribution  
23 uncertainty, both local and bundle to bundle power  
24 distribution.

25 And also you would see, and it will be

**NEAL R. GROSS**

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

1 discussed later, there were issues about void history,  
2 and the void history effects on power distribution.

3 DR. BANERJEE: So it was related to your  
4 flattening of the core?

5 MR. HEAD: It's hard to say if it was or  
6 not. It was just --

7 DR. BANERJEE: What was it related to,  
8 then?

9 MR. HEAD: The fact that the real crux of  
10 the issue was, when you look back at all of the  
11 methods that have been developed over the years, when  
12 the 10 X10 fuel product line had been introduced, it  
13 had been introduced in a manner that we believe was  
14 consistent with the expectations from the regulators  
15 at the time, but there was not specific gamma scan  
16 measurements of that fuel product type. What had been  
17 done prior to that was, 8X8 or 9X8 fuel product lines,  
18 and even in that data you didn't see a significant  
19 dependency on the lattice type. But there was no  
20 specific 10X10 data available.

21 DR. BANERJEE: It wasn't specific to you.  
22 Anybody that used 10X10 would face that problem?

23 MR. HEAD: That's correct. That's  
24 correct. That's why we said, it was more of a generic  
25 versus an EPU issue. We were already running a 10X10

**NEAL R. GROSS**

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

1 fuel.

2 MEMBER SIEBER: Someday that problem will  
3 be solved. And someday you will come in and want a  
4 little mini increase probably.

5 MR. HEAD: Well, what we'll want to do is  
6 come back and take out the .02 additional conservatism  
7 we put in place, because we needed it at the time to  
8 get the issue resolved on a generic basis.

9 MEMBER LEITCH: So how will that be  
10 implemented? Is that going to be in the tech specs,  
11 the safety limit?

12 MR. HEAD: That's correct.

13 MEMBER LEITCH: It will actually be .02  
14 higher?

15 MR. HEAD: That's correct.

16 MR. LEITCH: Than the number that appears  
17 in the tech spec presently?

18 MR. HEAD: Yes, and no. The tech specs  
19 are a cycle-specific calculation. And if you look at  
20 the history of VY over the past few years since even  
21 before Entergy bought them, we had - cycle 22 became  
22 a significant departure I guess would be the best way  
23 to describe it, from an equilibrium cycle design.

24 Then we went to power uprate. So the  
25 safety limit calculated for VY has changed every

**NEAL R. GROSS**

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

1 cycle. The actual calculated value for cycle 25 right  
2 now is 1.05. What is in the tech specs right now,  
3 which is the number from the previous cycle, was  
4 1.07.

5 So we will impose a .02 penalty, but it's  
6 not going to physically change the number in the tech  
7 specs. We just - it's there.

8 And oftentimes, it's been our experience  
9 in the industry that if you have a cycle design in  
10 which the safety limits calculated for that cycle  
11 actually becomes less, if it doesn't penalize you from  
12 operations, as far as operating maneuvering room, it's  
13 not worth the hassle for us and staff to go through  
14 and actually change it to go back down, because then  
15 subsequently in a cycle you may have the need to go  
16 back up again.

17 All right, when you look at the safety  
18 limit MCPR, and what we were proposing to do here, and  
19 even what the staff had reviewed up to that point in  
20 time, there were a number of fundamental factors that  
21 needed to be reviewed as part of this effort, and  
22 those are listed here.

23 The focus of the staff review from the  
24 time of the alternate approach proposal was to make  
25 sure that that approach was sufficient to bound any

**NEAL R. GROSS**

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

1 additional uncertainty they thought might be present  
2 in these particular areas.

3 And so I'm going to talk about each one of  
4 these separately. The staff will subsequently discuss  
5 the ones that count most here, but I've got a  
6 presentation that touches on each one of them.

7 The first one is the safety limit MCPR.  
8 That is the obvious one.

9 For background, safety limit MCPR is a  
10 limit that ensures that during normal operation, and  
11 during anticipated operational occurrences, 99.9  
12 percent of the fuel rods in the core do not experience  
13 transition boiling.

14 Built into the development of the safety  
15 limit MCPR are process and power distributional  
16 uncertainties. The original power distribution  
17 uncertainties that were established years back used  
18 Monte Carlo techniques. In fact it was a Monte Carlo  
19 in particulate MCMP calculations to determine what  
20 power distributions that we had in the bundles.

21 And these were in part confirmed with  
22 gamma scans. Which goes back to your question earlier  
23 about what is driving this. These gamma scans were  
24 performed on the earlier vintage fuel, and that data  
25 didn't show a significant dependence on lattice

**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 height.

2           However, we had not done 10X10 with the  
3 same scope of work. And so because gamma scans of the  
4 10X10 aren't available, then there is at least some  
5 degree of issue with respect to the uncertainties that  
6 we carry forward.

7           The way we address that, we went back and  
8 looked at the original statistical treatment of the  
9 uncertainties that went into the safety limit MCPR,  
10 and the original process was to use one sigma values  
11 for the uncertainties and the things that were  
12 measured. And when we expanded that to two sigma, we  
13 found that in that particular case we're going to a  
14 higher statistical certainty on the value that we use  
15 for the uncertainty that if you took that work and the  
16 independent code comparisons that we have performed,  
17 that we showed that the .02 was going to be sufficient  
18 to bound anything that we think we might find in gamma  
19 scan data on 10X10 when it actually occurs.

20           And right now that work is actually going  
21 on. We're getting data from overseas, and that work  
22 is going on right now to look at what the 10X10  
23 product line shows.

24           All right, next slide. The next of the  
25 critical power base limits is operating limit MCPR.

**NEAL R. GROSS**

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

1 The GE methodology takes safety limit inquiries as  
2 kind of a baseline. I mean you look at the  
3 anticipated operational occurrences, and the change in  
4 CPR that you see in those occurrences to determine  
5 what the operating limit is. It's additive.

6 I've got a follow-up slide here, if you  
7 want to click on that little background slide. This  
8 gives you sort of a graphical representation of what  
9 we have.

10 Minimum critical power ratio of one. It  
11 means you've got some transition boiling. We back off  
12 that by processing power uncertainties, as I discuss  
13 in the safety limit. We back off that further to  
14 handle the AOOs, and that gives our operating  
15 limit.

16 So somewhere down below that is the  
17 allowed operating range. Typical operation of our  
18 cores, we typically have between five and 10 percent  
19 margin to the operating limit. That gives us  
20 comfortable margin in the way we operate the plant.  
21 It doesn't restrict the operators.

22 So if we could go back to the original.

23 Because there were questions with regard  
24 to the power distribution uncertainties, that question  
25 gets carried forward in the delta CPR calculation as

**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 well.

2 So what we had done there was, we explored  
3 that further with the staff. We looked at what  
4 coefficient - which is another one of the issues that  
5 was out there. We looked at exposure effects on the  
6 fuel, and we performed additional analytical work to  
7 show that.

8 While these uncertainties that we have in  
9 there historically have been actually quite large.  
10 For instance, with voice coefficient, we've got a  
11 significant uncertainty in there from a void  
12 coefficient standpoint. It's like 15 percent, two  
13 sigma. And the sensitivity to that parameter is not  
14 that great.

15 So we went through the analysis, worked  
16 with the staff to show them what was the - what the  
17 results of that actually were.

18 The conclusion of that was with the safety  
19 limit MCPR already conservative by the .02, that no  
20 additional penalty was going to be required for the  
21 operating limit.

22 Next slide.

23 Limits related to local power - there's a  
24 couple of those that we need to talk about. Linear  
25 heat generation rate is the first of these.

**NEAL R. GROSS**

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

(202) 234-4433

www.nealrgross.com

1           This protects the fuel from the things  
2           like fuel centerline melt. One percent cladding  
3           plastics strain. Fuel rod internal pressure. And  
4           there are a couple of other things that go into the  
5           thermal mechanical limit.

6           And again, because the staff is concerned  
7           with the uncertainties that you may have in the power  
8           distribution, we needed to go through and demonstrate  
9           that the uncertainty treatment within this methodology  
10          already was sufficient to bound what we expected to  
11          see in the future.

12          DR. BANERJEE: Excuse me, what computer  
13          code do you use, or is it experiment, for CPR?

14          MR. HEAD: The CPR is the correlation.

15          DR. BANERJEE: It's a correlation?

16          MR. HEAD: That's correct.

17          DR. BANERJEE: It's just a correlation?

18          MR. HEAD: That's correct. Fran, is there  
19          additional discussion we need there?

20          MR. BOLGER: The critical power is  
21          predicted with the GEXL correlation, which is based on  
22          quality. So that has been, that correlation was  
23          developed based on test data from the Atlas test  
24          facility.

25          DR. BANERJEE: And it includes 10X10?

**NEAL R. GROSS**

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

1 MR. BOLGER: Yes, it does.

2 DR. BANERJEE: And this somewhat  
3 mechanical deformation or whatever, do you use a code  
4 for that?

5 MR. HEAD: There's fuel performance codes.  
6 I forget now what exactly they're called.

7 MR. BOLGER: The fuel rod analysis  
8 performed with the Jester (phonetic) mechanical code.

9 MR. HEAD: And again, that is docketed and  
10 licensed methodology. And buried in that methodology  
11 is already a statistical accounting of uncertainties  
12 in power distribution, et cetera.

13 And so we went through the efforts with  
14 the staff to demonstrate that the uncertainties that  
15 were already included in that methodology, and the  
16 conservative assumptions in that methodology, were  
17 sufficient so that it would be bounded by the existing  
18 methodology.

19 DR. BANERJEE: Now, this CPR correlation,  
20 is that steady-state data mainly? Or is that some  
21 transient?

22 MR. BOLGER: The CPR correlation is  
23 developed based on steady-state data. However, there  
24 are transients that are formed with the Atlas facility  
25 which demonstrate the performance or the correlation

**NEAL R. GROSS**

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

1 in a transient condition.

2 DR. BANERJEE: What sort of transients?

3 MR. BOLGER: The transients are turbine  
4 trip type transients. Also, oscillation-type  
5 transients. And I believe also a pump trip type  
6 transient.

7 DR. BANERJEE: So are they relatively  
8 slow transients?

9 MR. BOLGER: The turbine trip transient is  
10 a relatively fast transient. It has a flux peak  
11 that's with a width of approximately a half a second.

12 DR. BANERJEE: So this CPR is more for  
13 dry out or DNB?

14 MR. BOLGER: Dry out.

15 DR. BANERJEE: Just dry out? And so the  
16 transients with a time scale of about a second or two,  
17 it works.

18 MR. BOLGER: That's correct.

19 DR. BANERJEE: You wouldn't expect it to  
20 work for all transients, would you?

21 MR. BOLGER: Well, it's a quality based  
22 correlation, and the mass flux profile, the blend, is  
23 very much nonuniform. So you may expect there to be  
24 some deviation.

25 But we find that it performs very well for

**NEAL R. GROSS**

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

1 various transient types.

2 DR. BANERJEE: So if you have relatively  
3 fast transient, there would be no need for this,  
4 right?

5 MR. BOLGER: Yes.

6 DR. BANERJEE: So how would you get it to  
7 work in that case? What quality would you define?

8 MR. BOLGER: I would expect that for a  
9 very fast transient, you've got a time constant of the  
10 fuel rod itself that comes into play there. It takes  
11 time for a fuel rod to produce additional power, and  
12 the heat flux to go out to the clad.

13 So I would expect at some point that  
14 you're going to be limited by fuel rods --

15 DR. BANERJEE: But the fluid dynamics  
16 moves faster than that.

17 MR. BOLGER: I agree.

18 MR. HEAD: In a transient application the  
19 local quality conditions used in the correlation.

20 DR. BANERJEE: So how is that calculated?  
21 Based on nonequilibrium, or equilibrium?

22 MR. HEAD: The quality is calculated as  
23 equilibrium quality in a transient.

24 DR. BANERJEE: So this is based on  
25 equilibrium quality?

**NEAL R. GROSS**

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

1 MR. HEAD: That is correct.

2 DR. BANERJEE: Okay, so we'll come back  
3 to this.

4 So do you apply this correlation to things  
5 like Atlas and so on as well?

6 MR. HEAD: Yes, we do.

7 DR. BANERJEE: Okay, so return to this.

8 MR. HEAD: All right, as I said before,  
9 the review of this with the staff was to ensure that  
10 the uncertainty treatment we had there already was  
11 sufficient to bound it, including the conservative  
12 assumptions that were already there, and defining the  
13 fuel-specific limits for the fuel types we got.

14 Next slide.

15 LHGR limit is a burn-up dependent limit,  
16 fuel performance is a burn dependent phenomenon.

17 And so because there are questions about  
18 power distribution and our ability to predict what  
19 kind of fuel burn-up and exposure you may have, we had  
20 to go - we went and looked at that process as well.

21 Fuel designs that we currently have out  
22 there right now are licensed to a peak pellet exposure  
23 of 70 gigawatt days per metric ton. The LHGR limits  
24 are defined, as I said, as a function of exposure, and  
25 include Pen power peaking, void reactivity

**NEAL R. GROSS**

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

1 coefficient, bundle power allocation factors, all of  
2 these - beginning to sound like buzz words - but these  
3 were the things that were at issue in the discussions  
4 we had with the staff.

5 The standard method that is used for VY  
6 and indeed for all the GE product line that was  
7 reviewed, and it was determined that the current  
8 uncertainty treatment that we have in the methodology  
9 right now for factors affecting this parameter was  
10 sufficient to retain adequate margin, and no other  
11 changes need to be made here.

12 Next slide is MAPLHGR. This again is a  
13 limit related to local power. It looks at the power  
14 in a bundle on a more global basis, at least at an  
15 axial node. And it is what feeds into the LOCA  
16 analysis for the most part.

17 And in the LOCA analysis we're looking at  
18 peak clad temperature, local oxidation, number of  
19 parameters there as far as acceptance criteria.

20 The review of this limit also had to go  
21 look at the treatment of uncertainties. But what we  
22 found within LOCA space was that the Safer Jester  
23 (phonetic) methodology, which is what is licensed to  
24 do the LOCA analysis with the GE fuel types, has built  
25 into it inherent conservative assumptions on the front

**NEAL R. GROSS**

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

1 end in order to drive maximum peak clad temperature  
2 calculations.

3 And we went through all of those  
4 conservative assumptions, and the uncertainties that  
5 fed into this process and determined that there is  
6 adequate margin there without taking any additional  
7 penalty in this area.

8 Next slide. Shutdown margin. This is  
9 more of a global parameter for the core. It's also  
10 one that's very important as well. And we recognize  
11 the power uncertainties, and the ability to calculate  
12 the depletion of the fuel can have an impact here.

13 So this is obviously one of the things  
14 that we looked at from a standpoint of it being a  
15 concern.

16 CHAIRMAN DENNING: Can you go back to the  
17 maximum average planar?

18 MR. HEAD: Sure.

19 MR. BOLGER: One of the things we  
20 recognize is that you're not really - if you look at  
21 the peak bundle, you're not really doing anything to  
22 the peak bundle that is any different from what the  
23 peak bundle was previously; correct me if I'm  
24 wrong. But what is really happening is  
25 that you're radially flattening the core.

**NEAL R. GROSS**

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

1 MR. HEAD: That is correct.

2 CHAIRMAN DENNING: And so somehow, if  
3 there is a loss of margin, it's somehow related to,  
4 across the core, everything is more event.

5 MR. HEAD: A larger population of bundles  
6 that are close to that limit; yes, that is correct.

7 CHAIRMAN DENNING: And so the thing that  
8 appears to be limiting, or the thing that concerned  
9 you as being limiting, would be its behavior in a  
10 LOCA. And that's what this relates to, is in a LOCA  
11 the fact that you have flattened everything out, and  
12 so you have lots of rods, lots of bundles that are  
13 coming to similar conditions at the same time, does  
14 that have an impact on the safety of the ability to  
15 address LOCA?

16 MR. HEAD: That is correct. But I think  
17 it's in the methodology, and Fran would be the best  
18 guy to answer that.

19 MR. BOLGER: The LOCA methodology, the  
20 SAFER model assumes a core of average bundles. And  
21 then a single hot bundle.

22 As we transition to an EPU type core,  
23 actually the core starts looking more like the SAFER  
24 analysis type core, where you have more bundles at  
25 about the same power level, and perhaps a single

**NEAL R. GROSS**

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

1 bundle at the MAPLHGR limit.

2 CHAIRMAN DENNING: Okay.

3 MR. HEAD: All right, shutdown margin. As  
4 I said, this is a global parameter, and the concern  
5 here is that our ability to predict fuel depletion  
6 might impact our ability to predict shutdown  
7 margin.

8 In this particular case, from a core  
9 design standpoint, shutdown margin is relatively easy  
10 to meet. The way we accomplish that is by the  
11 addition of burnable poisons in the fuel.

12 In my world, gaddalinia (phonetic) that we  
13 use for burnable poison is cheap compared to the  
14 possibility of not meeting a shutdown margin  
15 requirement. Because if you don't meet a shutdown  
16 margin requirement in your tech specs, you've got to  
17 unload a core, start over. It's a huge consequence  
18 from a standpoint there.

19 The standard GE design practice, and  
20 indeed, it's a practice across the industry, is to  
21 design to something greater than what the tech spec  
22 limit is. We designed it greater than one percent  
23 delta K over K. And at times, different utilities  
24 will impose even an additional conservatism on that,  
25 based on what they may have going on within their

**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 plant at the time.

2 Like I said, it's relatively easy to  
3 design a core that meets all the shutdown margin  
4 requirements.

5 And the reason that you do that is not so  
6 much that, like I say, you're afraid of busting the 38  
7 percent limit in your tech specs, but things happen  
8 where for instance a - you know, we design these cores  
9 sometimes a year in advance. We have a transformer  
10 problem, or something, where we have to shut down a  
11 unit early. And that core that we just shut down is  
12 carrying over additional reactivity, and I've got to  
13 be able to absorb that in the design.

14 And so that is part of what feeds into  
15 this conservative approach to always bound ourselves  
16 on shutdown margin.

17 And our experience with this VY has been  
18 very good. We've got real reproducible results. Our  
19 code packages are doing real well, both GE's and what  
20 we do independently as Entergy. So this was very easy  
21 to show that we've got adequate margins.

22 Next slide. Okay, next issue that we  
23 looked at was stability. The stability analysis for  
24 VY is performed to ensure that the 1-D detect and  
25 suppress methodology is sufficient to preserve safety

**NEAL R. GROSS**

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

1 limit MCPR in the event we have TH instability  
2 event.

3 The prevention portion of that solution  
4 includes a separate administratively controlled  
5 exclusion and buffer region that is evaluated every  
6 cycle. Those boundaries on our power to flow map  
7 actually change depending on the cycle design.

8 The second part of the detect and suppress  
9 portion is a solution is a flow biased eight purim  
10 (phonetic) flux grand grip that prevents oscillations  
11 of a sufficient magnitude. That scram setpoint feeds  
12 into the analysis to determine whether or not the  
13 stability solution for the plant for that cycle is  
14 going to be valid. And it's looked at every cycle.

15 We don't change the setpoint necessarily,  
16 but we do change the boundaries in the power to flow  
17 map.

18 DR. BANERJEE: Is it adjusted during the  
19 cycle? Or does it need adjustment?

20 MR. HEAD: We typically bound the entire  
21 cycle. But it's a training problem. It's an issue  
22 with operations.

23 So we typically just bound it once, and  
24 cover it for the entire cycle.

25 DR. BANERJEE: Why do you take just the

**NEAL R. GROSS**

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

1 1-D solution?

2 MR. HEAD: VY is one of - it's a small  
3 core, and the oscillations in a small core are  
4 typically core-wide.

5 MR. BOLGER: The term 1-D is not  
6 indicating that it's a one-dimensional model. It's  
7 open 1-D. There were a number of different options.

8 DR. BANERJEE: Ah, I was wondering. So  
9 what is this option, can you explain to me? What is  
10 the option - well, 1-D then has administrative control  
11 of this PF region and so on, right?

12 MR. HEAD: Here's a power to flow map that  
13 shows the exclusion regions. The red line here shows  
14 the exclusion region. We also have under there the  
15 buffer region. And when we operate the plant, we  
16 never go here intentionally.

17 You could have a run back where you are up  
18 here operating, and you have a pump trip that will  
19 take you back down in here. The immediate corrective  
20 action by operators is to drive rods and get down out  
21 of that region. Because you have a susceptibility  
22 while you're down here to initiate a thermohydraulic  
23 instability event.

24 So that is part of the solution.

25 DR. BANERJEE: That's operator action.

**NEAL R. GROSS**

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

1 MR. HEAD: That's right. You don't go  
2 here. If you do have an oscillation when you're down  
3 here, you've got an trip setpoint up there that will  
4 trip the plant if the operators don't take action  
5 already.

6 DR. BANERJEE: This is option 1-D?

7 MR. HEAD: That's option 1-D

8 Option 3 is - you'll have to explain  
9 there. There are a couple of different ones in  
10 existence out there. Some of the larger cores that  
11 can have localized stability issues are option 3,  
12 right?

13 But what we've got for VY is 1-D, which is  
14 detect and suppress.

15 DR. BANERJEE: So the analysis that this  
16 is based on is not 1-D?

17 MR. HEAD: That's correct, it's not. It's  
18 just the terminology.

19 DR. BANERJEE: So what is the analysis  
20 it's based on? How many Ds?

21 MR. HEAD: Want to get Doug to cover that?  
22 Doug is an expert in stability from GE.

23 MR. NEWKIRK: Doug Newkirk with GE.

24 The analysis to calculate the exclusion  
25 region is ODSY-based, which is a 1-D kinetics

**NEAL R. GROSS**

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

1 thermohydraulic code.

2 DR. BANERJEE: Plus the radial, it takes  
3 radial variations into account?

4 MR. NEWKIRK: That is correct. The  
5 bundles are grouped into bundle groups, so the radial  
6 difference in power is accounted for.

7 DR. BANERJEE: And so it couples to a  
8 thermohydraulic model which is channel by channel in  
9 this radial group? Or each radial group is  
10 characterized by sort of an average channel or  
11 something?

12 MR. NEWKIRK: That's right. All of the  
13 channels in the core are grouped into channel groups  
14 that are at a certain power level. And so you start  
15 with, you'll model some individual hottest channels.  
16 But then the other ones are grouped together by power,  
17 and so you have a descending power for each channel  
18 group.

19 DR. BANERJEE: So the analysis is in real  
20 time? Or is it in modes?

21 MR. NEWKIRK: No, Odyssey is a frequency-  
22 based code, so it calculates the gear ratios. So the  
23 exclusion region is based on a .8 core to K ratio  
24 criteria with a .15 adder onto the Odyssey calculated  
25 K ratio.

**NEAL R. GROSS**

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

1 DR. BANERJEE: So you can get radial  
2 modes, but you can't get azimuthal codes in this code;  
3 is that correct?

4 MR. NEWKIRK: In -- ?

5 DR. BANERJEE: In your calculations.

6 MR. NEWKIRK: The kinetics model that's  
7 being applied is a one dimensionally axially, so the  
8 radial component is averaged. Now thermohydraulically  
9 the bundles are grouped into a number of different  
10 radial groups.

11 DR. BANERJEE: Right. But the kinetics  
12 are - I just don't understand.

13 CHAIRMAN DENNING: Are the oscillations  
14 top bottom then? They're not radially around?

15 DR. BANERJEE: They're not azimuthal.

16 CHAIRMAN DENNING: They're not azimuthal.

17 DR. BANERJEE: But they are radial.

18 CHAIRMAN DENNING: I don't know.

19 MR. NEWKIRK: The kinetics model will  
20 predict variations in the axial direction. It's a  
21 one-dimensional axial kinetics model.

22 CHAIRMAN DENNING: Track G is not used  
23 then for stability?

24 MR. NEWKIRK: Well, it's not used in this  
25 exclusion region methodology.

**NEAL R. GROSS**

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

1 DR. BANERJEE: But it could be, right?  
2 Or not?

3 MR. NEWKIRK: Well, Track G is a time-  
4 dependent code. So that could tell you where  
5 oscillations could begin on the power flow map. But  
6 the approved methodology is to use a frequency based  
7 code and calculate the K ratios.

8 CHAIRMAN DENNING: And when you go to  
9 power uprate, how does the exclusion region - what  
10 happens to the exclusion regions? Does it get bigger?

11  
12 MR. NEWKIRK: In this particular case, the  
13 exclusion region did get a little bit bigger, but that  
14 is as much as function of the actual core design as it  
15 is anything else.

16 You see those lines move from cycle to  
17 cycle sort of independent of - even when we had  
18 constant power for past cycles, they moved  
19 periodically.

20 CHAIRMAN DENNING: What is recent BWR  
21 operating experience? Do BWRs in the last 10 years  
22 get into regions in which --

23 MR. HEAD: Absolutely. Nine Mile was the  
24 most recent I think in the U.S., right?

25 MR. NEWKIRK: There was actually - Nine

**NEAL R. GROSS**

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

1 Mile Point Two had an instability event three years  
2 ago. And Perry had an instability event last  
3 December.

4 CHAIRMAN DENNING: And how were they  
5 recognized?

6 MR. NEWKIRK: You saw oscillations on the  
7 APRMS. But then those plants are larger plants that  
8 have the Option solution, and they have an automatic  
9 suppression function. It's called the OPRM. It's a  
10 brand new plant.

11 DR. BANERJEE: But radially flattening  
12 the core does increase its propensity to instability,  
13 doesn't it? Or does it?

14 MR. NEWKIRK: Well, actually, the lower  
15 radial peaking factor does help stability. Typically  
16 when you have higher peaking, that will exacerbate  
17 instability.

18 DR. BANERJEE: Is this because of  
19 leakage? Or why is that?

20 MR. NEWKIRK: It's just the power shapes,  
21 power distribution.

22 DR. BANERJEE: Okay. But this core, how  
23 is it sort of - it is validated for a core of this  
24 size and shape?

25 MR. NEWKIRK: Is the code validated?

**NEAL R. GROSS**

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

1 DR. BANERJEE: Yes.

2 MR. NEWKIRK: Yes, it is.

3 DR. BANERJEE: For something of this  
4 nature? So how was it validated?

5 MR. NEWKIRK: There were instability tests  
6 at Vermont Yankee as a matter of fact back in the '80s  
7 that were, they were decay ratio tests. And the Audit  
8 C code was that qualified versus that test data. And  
9 then it's been validated against other plants as well,  
10 other larger --

11 MEMBER LEITCH: That curve that shows the  
12 APRM flow bias scram (phonetic), the AL after that,  
13 does that mean that's the alarm when the scram is on?

14 MR. NEWKIRK: That's the analytical limit.

15 MEMBER LEITCH: Analytical limit?

16 MR. NEWKIRK: And so what you see  
17 established in the field is backed off from that, down  
18 to a lower power level.

19 MEMBER LEITCH: Okay. I was thinking that  
20 looks like a pretty high --

21 MR. NEWKIRK: It is, it is very high.

22 MEMBER LEITCH: So now take me through  
23 this again. You lose a reserve pump for example, and  
24 you move down toward that instability region.

25 The operator then drives rods.

**NEAL R. GROSS**

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

1 MR. HEAD: Right. He would drive rods and  
2 come down.

3 MEMBER LEITCH: And tries to get down out  
4 of that region.

5 MR. HEAD: That's correct.

6 MEMBER LEITCH: And if that is not  
7 successful --

8 MR. HEAD: If he sees oscillations he will  
9 punch it out. He would scram the reactor.

10 MEMBER RANSOM: I've got a question. It  
11 doesn't have to do with stability. But when you  
12 flatten the power out over the bundles, it seems to me  
13 that I recall that under some LOCA conditions you  
14 depend on breakdown of CCFL and the upper plenum and  
15 the sprays then allow downflow through some of the  
16 outer bundles and research in the higher power  
17 bundles, as a means of coolant, which you presumably  
18 would lose if you just flatten it completely.

19 MR. HEAD: You say CCFL, you're talking  
20 about LOCA? What are you referring to there?

21 MEMBER RANSOM: Countercurrent flow of the  
22 CC and LOCA analysis, right, so you get a  
23 multidimensional effect. You get downflow through  
24 some of the bundles, and other flows to the higher  
25 power bundles.

**NEAL R. GROSS**

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

1 MR. HEAD: That is correct. You would  
2 probably see an impact of that.

3 MR. BOLGER: I think this has come up  
4 before, and maybe Dan can answer it.

5 MR. PAPONE: Dan Papone, GE. We have  
6 discussed this in previous power uprate and EPU  
7 reviews here. And effectively it's in a way a self-  
8 limiting phenomena. Yes, you will, with more bundles  
9 in that average power range, you will hold up more  
10 water in CCFL at the top of those bundles, but that  
11 water that is being held up is being held up in the  
12 region of the coarse spray. That tends to subcool the  
13 peripheral region. We'll get the breakdown in the  
14 peripheral channels in bringing that pool of water to  
15 the peripheral channels.

16 So as we flatten the power, hold up more  
17 water, and tend to hold up that water, that feedback.  
18 In fact that self-limiting effect, where the subcool  
19 in the peripheral region.

20 So from that standpoint --

21 MEMBER RANSOM: What verification do you  
22 have of that? I mean originally you did all of these  
23 tests --

24 MR. PAPONE: Right, and that's where we  
25 developed the experimental basis for that hold up, and

**NEAL R. GROSS**

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

1 what happens with the breakdown specifically in the  
2 peripheral bundles, and also at the same time the  
3 venting center --

4 MEMBER RANSOM: So your comments then are  
5 based on core calculations?

6 MR. PAPONE: Primarily on the 30 degree  
7 sector test.

8 MEMBER RANSOM: You've done sector tests  
9 under the average conditions?

10 MR. PAPONE: No, this is in the - whatever  
11 their test bases were. I haven't been able to cover  
12 those to see how they applied, to what extent they  
13 have. But basic phenomena is that --

14 MR. PAPONE: Okay, continue.

15 MR. HEAD: Okay, one other things with  
16 respect to the stability, since we are trying to  
17 preserve safety limit MCPR without penalty, the .02  
18 adder that we've put on there carries forward in this  
19 analysis as well.

20 And so given that, the VY power uprate was  
21 founded by the existing methodology with that term  
22 applied.

23 I mentioned earlier when we were  
24 discussing shutdown margin the Entergy actually  
25 maintains, develops and maintains core physics models

**NEAL R. GROSS**

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

1 using independent methods from GE. We use that to  
2 verify and challenge the vendor of core designs. We  
3 look at critical safety analysis inputs.

4 We use these models to follow our cores.  
5 We see things probably - I know more frequently for  
6 instance than GE does. We work closely with our site  
7 reactor engineers to watch these cores as they're  
8 burning to try to identify any trend that may be  
9 showing up.

10 We also use those same tools to evaluate  
11 operational experience that is coming out of the  
12 industry out there, and we factor that into our  
13 processes going forward.

14 CHAIRMAN DENNING: If you're in mid cycle,  
15 and you have to shut down for a period of time, and  
16 then you have to decide things like how long am I  
17 going to operate? What am I going to do in my next  
18 fill analysis, do you do that analysis, or does GE do  
19 that analysis?

20 MR. HEAD: We both do it, provide  
21 verification for one another there. So the answer is,  
22 we both do it.

23 With respect to the VY models, when  
24 Entergy bought Vermont, they were operating in cycle  
25 22. We went back to cycle 20, did benchmarking

**NEAL R. GROSS**

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

1       against 20 through 24. The data - we're operating in  
2       25 right now. We just started up a few weeks ago, and  
3       those models are holding - they're matching the plant  
4       quite well, all the benchmark data we have on them  
5       looks good.

6                   MEMBER LEITCH: You're on 24-month cycles?

7                   MR. HEAD: No, we're on 18-month cycles.

8                   MEMBER LEITCH: And do you have all of the  
9       same type of fuel, all the 10X10s?

10                   MR. HEAD: That's correct.

11                   MEMBER SIEBER: You may want to take  
12       advantage of your modeling capabilities to satisfy  
13       some of your quality assurance requirements with  
14       regard to your fuel vendors?

15                   MR. HEAD: We do that. When we go down to  
16       what is called the mini-review in the reload process,  
17       we often have - we compare notes. We're looking at  
18       differences there. We see differences in the methods.  
19       There are differences between the two.           But we  
20       typically understand those, and when we see something  
21       we don't understand, we typically get the guys  
22       together and figure out what's going on there.

23                   MEMBER SIEBER: Well, that's a good  
24       practice. I encourage that.

25                   MR. HEAD: And go to the next slide, if

**NEAL R. GROSS**

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

1 you would.

2 We actually used those independent methods  
3 as part of this effort here. If there were questions  
4 down on the lattice level as far as calculational  
5 methodologies. We did a number of detailed  
6 comparisons between CASMO-4, which is the tool that we  
7 used, and TGBLA06. A number of different cases,  
8 different voids, different exposure steps, different  
9 lattices even.

10 That, coupled with what the staff was  
11 doing helios we were able to get a real good handle on  
12 how well the methodologies were hanging together.

13 What we saw in all these results was what  
14 we would expect to see based on industry experience  
15 out there. The bad thing about having two different  
16 code sets is, you get slightly different answers  
17 sometimes. You have to reconcile that, and understand  
18 what is going on.

19 But if they're markedly different, it  
20 typically means you got an error someplace that you've  
21 got to go chase down.

22 All right. This section here, I was just  
23 going to briefly go through some of the safety  
24 analysis results. This will be discussed in further  
25 detail by the staff later today.

**NEAL R. GROSS**

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

1 Part of the constant pressure power for a  
2 topical says that we will go look at specific safety  
3 analysis on a cycle specific basis. These are some of  
4 those results. The thermal hydraulic stability we  
5 talked about to some extent already. I'm sure there  
6 will be other discussions about this.

7 Overpressure protection, and the  
8 anticipated operational occurrences there. Again, the  
9 results were satisfactory, well below the ASME limit  
10 that we have.

11 ATWS, which is one of the events that is  
12 truly impacted by the power upgrade, again, the  
13 acceptance criteria for that is staying below the ASME  
14 limit. And come below that, the suppression pool  
15 temperatures that you see, due to that postulated  
16 event, are well below the criteria that we have for  
17 acceptance.

18 And we verified that the standby liquid  
19 control system that you actually used to mitigate the  
20 Atlas event has adequate margin.

21 DR. BANERJEE: Are you going to talk more  
22 about Atlas?

23 MR. HEAD: This was it. I think the staff  
24 has additional discussions on that possibly.

25 We've got the experts here if you've got

**NEAL R. GROSS**

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

1 specific questions you want to talk about.

2 DR. BANERJEE: Well, the first line  
3 there, the heat pressure is 1490.

4 MR. HEAD: That's correct.

5 DR. BANERJEE: How much uncertainty in  
6 that? What have you established?

7 MR. BOLGER: The ATWS basis is a nominal  
8 basis and does not require any additional  
9 uncertainties. However, the methodology does include  
10 some conservatisms.

11 In particular, the set points in the  
12 safety relief valves that are used are set above  
13 nominal. Also, the capacity used for the safety  
14 release VARs are utilized are uncertified capacities,  
15 which is typically about 10 percent lower than what  
16 nominally would happen.

17 And lastly, in the analysis assumptions  
18 specified by Entergy, one of the safety valves was not  
19 credited, which adds some additional conservatism on  
20 the peak pressure.

21 DR. BANERJEE: Now in Atlas, have you  
22 talked about Atlas to this committee before? I don't  
23 recall, because I haven't attended all the meetings.  
24 If it's been discussed, it's been discussed. Who  
25 presented the results of Atlas, and what the

**NEAL R. GROSS**

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

1 transients looked like, and oscillations, and how you  
2 calculated these oscillations. MEMBER

3 KRESS: We did this in a generic fashion back in the  
4 early '90s.

5 DR. BANERJEE: Well, we went to GE, and  
6 we had a presentation there. And at that point I  
7 remember they were using TRACG, and they had lots of  
8 problems in doing the calculations.

9 So what has changed, and what has not?

10 CHAIRMAN DENNING: We're definitely  
11 interested. Let's pursue it a little bit.

12 MR. BOLGER: The TRACG is utilized in the  
13 Atlas instability portion of the methodology. Those  
14 were - those were submitted and approved a number of  
15 years ago.

16 Calculations were done based on  
17 initializing at the MELA (phonetic) condition with a  
18 pump trip. The case went into oscillation, and TRACG  
19 was utilized to predict fuel, whether there was fuel  
20 dryout and fuel failure type issues, and also,  
21 mitigating strategies.

22 More recently, we've been doing some  
23 additional TRACG type analysis for our operating  
24 domain expansion, and have also demonstrated the  
25 adequacy of fuel margins for instability events with

**NEAL R. GROSS**

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

1 fuel types through our 10X10 fuel type.

2 DR. BANERJEE: The TRACG calculations I  
3 remember from a few years ago, the oscillations were  
4 very large, very rapid, and it seemed very difficult  
5 to calculate. And in particular problems of dryout or  
6 not dryout, and things like this. Because both the  
7 size of the oscillations and the relatively high  
8 frequency.

9 It would be at least interesting in this  
10 case to see what analysis has been done in this - and  
11 how it's been done. I understand that you used ODYN  
12 (phonetic) rather than TRACG? Or I don't know exactly  
13 what was done.

14 MR. BOLGER: For the peak pressure  
15 analysis, and for the suppression pool temperature  
16 analysis was based on the ODYN methodology. ODYN is  
17 a one-dimensional model, and it is able to predict  
18 reactor vessel pressure due to an Atlas, and  
19 corresponding effects of what will happen once you get  
20 the resert pump trip, which will lower the power. And  
21 then further in time water level is reduced, and how  
22 does the event proceed from there?

23 And then at such time you have boron  
24 injection, and how does the event proceed from there?

25 And based on that, we can determine what

**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 the integral steam flow is into the suppression pool,  
2 and from there we can determine what the suppression  
3 pool temperature is.

4 DR. BANERJEE: Now, does ODYN follow  
5 these oscillations and things as well?

6 MR. BOLGER: No, ODYN does not predict  
7 oscillations. The scenario which is evaluated for the  
8 power uprate does not include an oscillation.

9 The basis for Atlas instability is  
10 retaining the original track analysis basis because  
11 the event -- the post-trip condition of the event, the  
12 power flow condition event, is unchanged from a power  
13 flow standpoint relative to what was submitted  
14 previously.

15 CHAIRMAN DENNING: Let me see, take me  
16 through that again.

17 You're saying that for the power uprate  
18 you did not have to do this Atlas instability analysis  
19 because you were saying that the basis was unchanged  
20 from previous; is that what you just said?

21 MR. BOLGER: That is correct. That the  
22 argument that was presented in the constant power  
23 pressure uprate submittal -

24 VOICE: This is proprietary. This is  
25 going into GE proprietary space. Can we hold this

**NEAL R. GROSS**

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

1 until we close the session a little bit later?

2 MR. BOLGER: Sure.

3 CHAIRMAN DENNING: Okay, well, questions  
4 about this slide. This is EPU numbers?

5 MR. BOLGER: That is correct.

6 CHAIRMAN DENNING: And when you say,  
7 pressure regulator failure, that is a complete  
8 failure? In other words, thermal trip without bypass?

9 MR. BOLGER: The way the pressure  
10 regulator fails open, the regulator fails open, that  
11 causes a reduction in pressure, and you get a low  
12 pressure isolation.

13 And then when you isolate the reactor, it  
14 turns into a pressurization event, and that is where  
15 the pre-pressure occurs, on the tail end of the  
16 closure of the MSIBs.

17 MEMBER LEITCH: And this assumes some  
18 operator action to start the standby liquid pumps? I  
19 mean this plant does have automatic standby injection;  
20 is that correct?

21 MR. BOLGER: That's correct.

22 MEMBER LEITCH: So what time is assumed  
23 for the operator to start the standby liquid control  
24 pumps?

25 MR. HEAD: I don't have that information

**NEAL R. GROSS**

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

1 right now. It is going to be on the present tomorrow,  
2 is it not?

3 MR. BOLGER: That's correct.

4 MEMBER LEITCH: Okay, I can wait until  
5 tomorrow.

6 I guess just the question is going to be,  
7 is that time appreciably different than it was before  
8 EPU conditions? But we can wait until tomorrow.

9 MR. ENNIS: We'll talk specifically to  
10 that tomorrow.

11 MEMBER LEITCH: Okay.

12 MR. HEAD: We lump all those operator  
13 actions the effects of timing, the EPU effect on  
14 timing, is all in one presentation I believe tomorrow.

15 MEMBER LEITCH: Okay, we can do that  
16 tomorrow, thank you.

17 MEMBER WALLIS: This peak pressure is only  
18 for a very short time?

19 MR. HEAD: Duration is - until slick  
20 starts driving it down?

21 MR. BOLGER: Do you have a slide on that?

22 MR. HEAD: I don't believe I do.

23 MEMBER WALLIS: Well, my question was, I  
24 think the slick system only pumps up to 1,400 PSI?  
25 That's what it says in its specification.

**NEAL R. GROSS**

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

1 MR. BOLGER: The pressure peaks out, and  
2 then drops back down I think after about 30 seconds or  
3 so, the pressure gets back down.

4 MEMBER WALLIS: So for that period of time  
5 the slick system cannot pump against the pressure?

6 MR. BOLGER: That's correct.

7 MEMBER WALLIS: It doesn't make any  
8 difference?

9 CHAIRMAN DENNING: Now, as far as the  
10 suppression pool temperature is concerned here, this  
11 is an area, regime, where there is an MPSH problem; is  
12 that true?

13 MR. ENNIS: That's correct.

14 CHAIRMAN DENNING: But for a shorter  
15 period of time, a couple of hours, is that what the --

16 MR. ENNIS: That's correct. And that's in  
17 the presentation next week, right?

18 CHAIRMAN DENNING: Do we want to go into  
19 the closed session? Since we are not too far from  
20 when we get to the end of this we're going to break  
21 anyway.

22 MR. HEAD: We've gone one slide left.

23 CHAIRMAN DENNING: Yes. After that, then  
24 we're going to have to - we can't start up until 3:15  
25 anyway, can we? So we might as well just go into the

**NEAL R. GROSS**

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

1 closed session right now?

2 DR. BANERJEE: Yeah.

3 CHAIRMAN DENNING: We'll go into the  
4 closed session right now. Because after that session,  
5 then we'll take a break.

6 (Off-mike conversation)

7 DR. BANERJEE: You have one more slide,  
8 right, before we go into the closed session?

9 MR. HEAD: Yes.

10 CHAIRMAN DENNING: You can go ahead and do  
11 the summary slide.

12 MR. HEAD: In summary, the EPU is done  
13 with - those methods were applied for all the analyses  
14 that were doing for VY. And again, because we had a  
15 couple of things going on in the industry, I believe  
16 it contributed to the staff's desire to do a little  
17 bit of additional review here.

18 And that review took us into looking at  
19 the uncertainties that we had built into the current  
20 methodologies.

21 What came out of that, again, was the  
22 decision on Entergy's part to conservatively bound any  
23 concerns the staff may have with those uncertainties,  
24 and impose that .02 safety limit adder.

25 (Off-mike conversation)

**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  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

CHAIRMAN DENNING: Okay, we're in closed session.

(Whereupon, the proceedings went into closed session at 2:28 p.m.)

CERTIFICATE

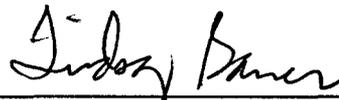
This is to certify that the attached proceedings before the United States Nuclear Regulatory Commission in the matter of:

Name of Proceeding: Advisory Committee on  
Reactor Safeguards  
Subcommittee on Power Uprates  
Open Session

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.



---

Lindsay Barnes  
Official Reporter  
Neal R. Gross & Co., Inc.

# Steam Dryer

## Presentation Overview

---

- Background & Operating Experience
- VY Dryer Inspections
- VY Strengthening Modification
- VY Main Steam Vibration
- VY Structural Analysis
- Power Ascension Monitoring

# Steam Dryer

## Key Points

---

1. Acoustic Loads Are Primary Source of Dryer Degradation
2. Important to Monitor For Acoustic Loads
3. Acoustic Circuit Methodology Can be Used to Project Dryer Loads From Steam Line Signals
4. EPU Can Exacerbate Existing FIV Vulnerabilities

# Steam Dryer

## Background & Operating Experience

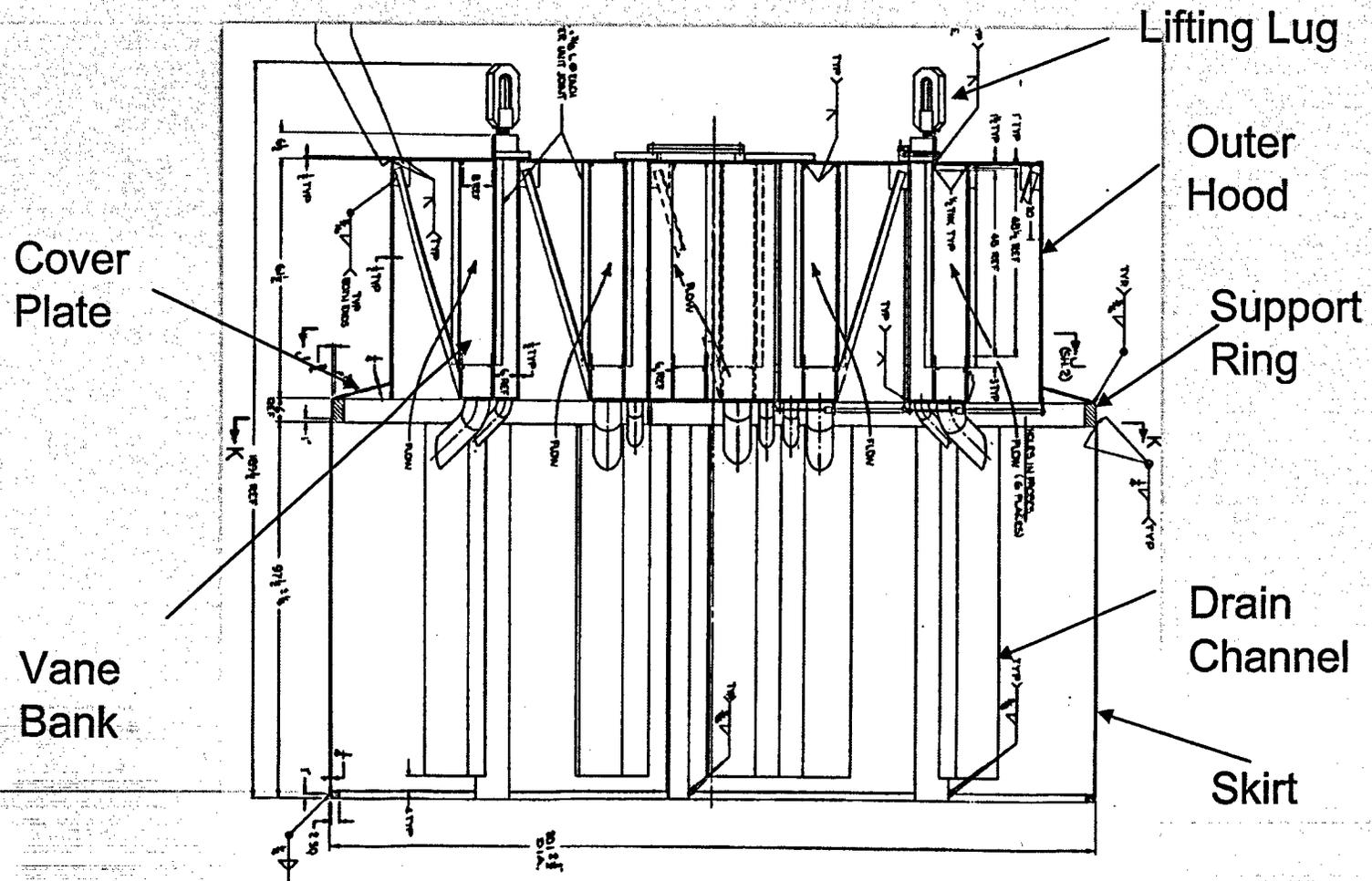
---

- BWR Dryer Operating Experience
  - Pre-EPU
  - EPU
- Entergy VY Industry Involvement
  - Extensive Benchmarking
  - BWROG EPU Committee
  - Dryer CFD Analysis Lead
- Entergy Has Incorporated Operating Experience



# Steam Dryer

## Dryer Construction



# Steam Dryer

## VY Dryer Visual Inspections

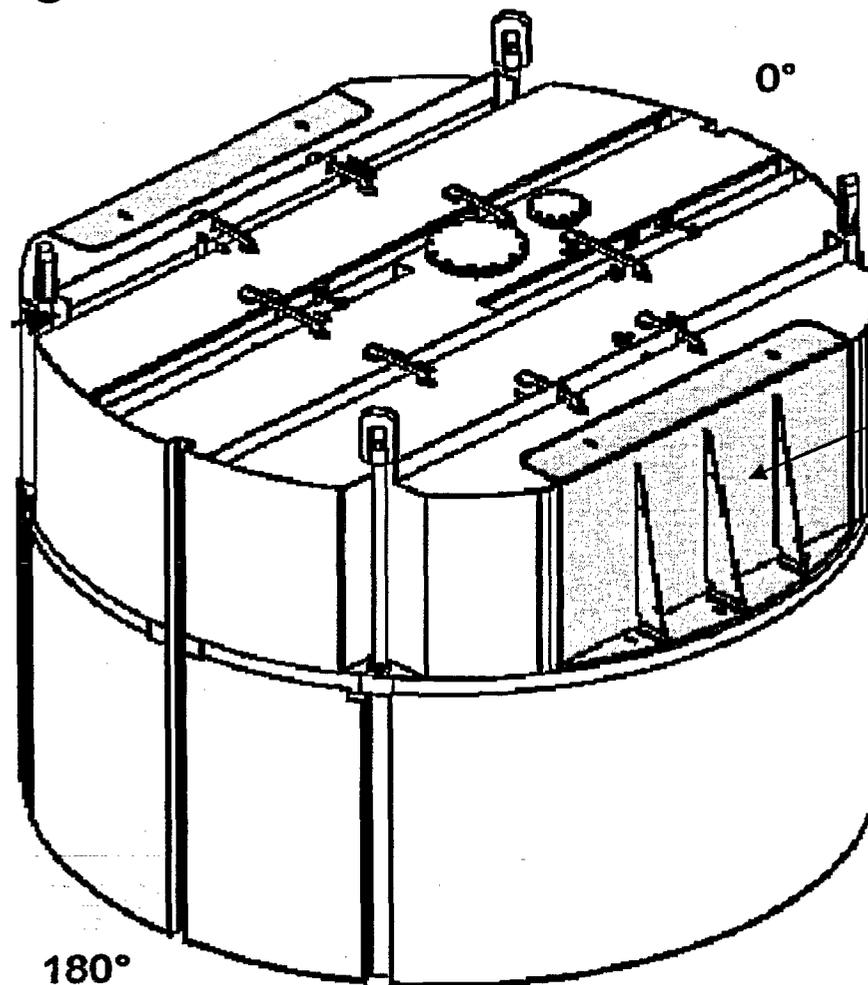
---

- Spring 2004
  - All Interior & Exterior Locations
- Fall 2005
  - Repaired & Modified Areas
    - No Indications
  - 2004 Indications Left-as-is
    - No Growth
  - Augmented Inspection of Dryer Vane Bank Endplates
    - No Significant Structural Indications

# Steam Dryer

## VY Dryer Strengthening Modification

Figure 1: Modification Locations



- Areas Strengthened:**
- Vertical Hood
  - Top Hood
  - Cover Plate
  - Tie Bars
  - Gussets (new)

# Steam Dryer

## VY Dryer Strengthening Modification

---

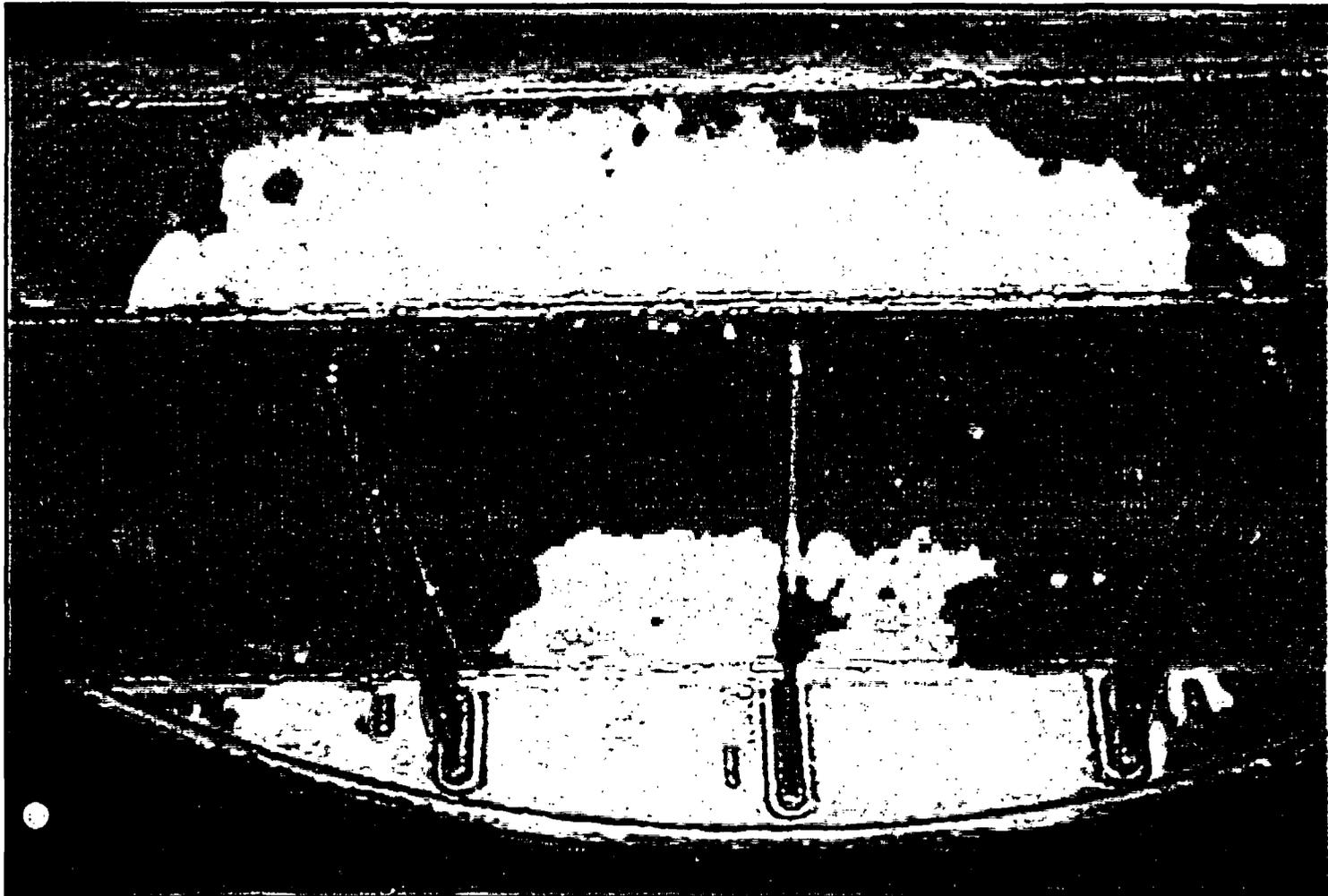
**Figure 2: Modification Installation**



# Steam Dryer

## VY Dryer Strengthening Modification

**Figure 3: Completed Modification – Outer Hood, Cover Plate, Gussets**



# Steam Dryer

## VY Main Steam Vibration

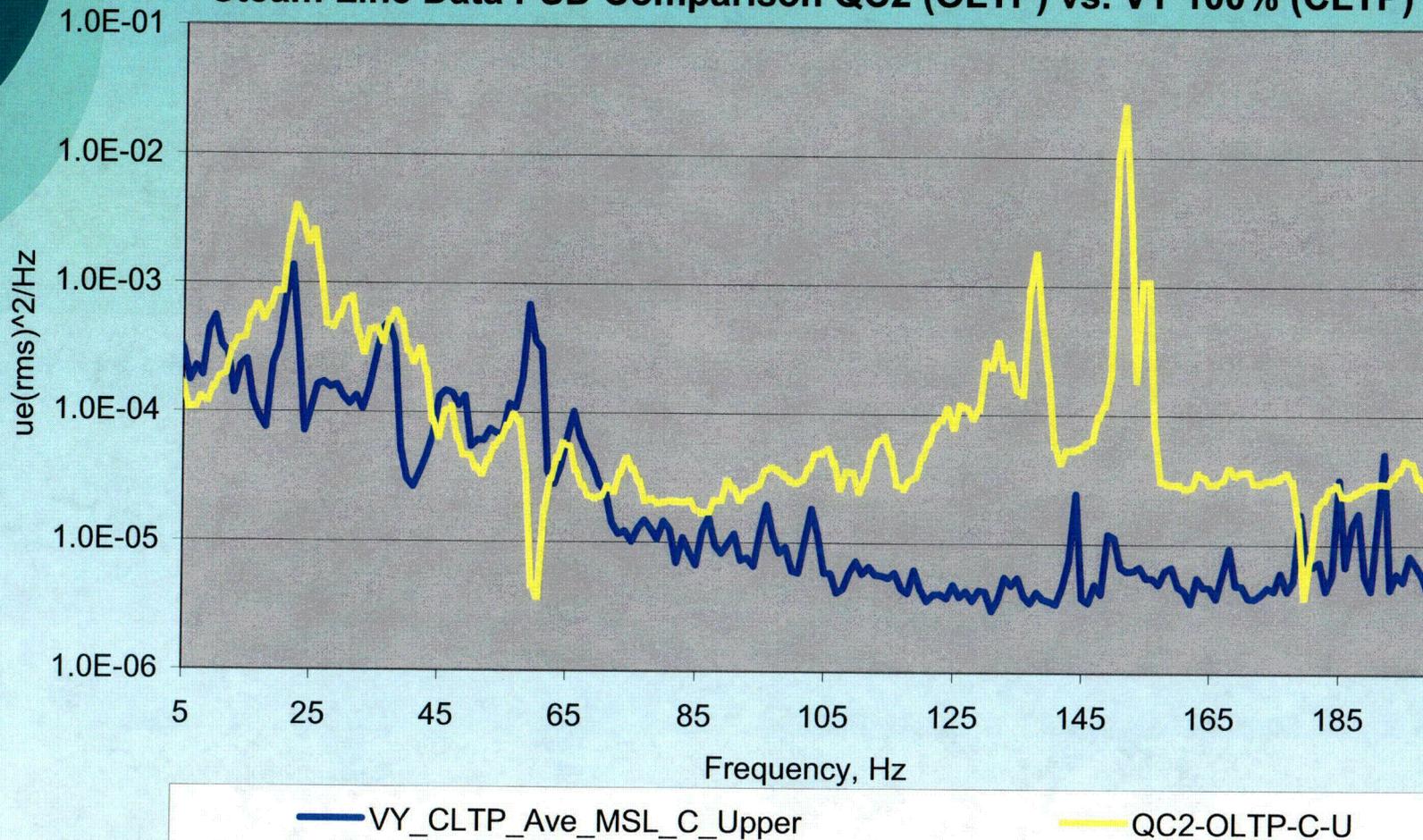
---

- Main Steam Fluctuating Pressure Measurements
  - Original
    - Strain Gages: 4 Locations, 2 SG's at Each
    - Venturi Instrument Line Sensors (4)
  - New
    - Strain Gages: 8 Locations, 6 SG's at Each
  - Accelerometers
    - 21 Accelerometers on MSL's
  - VY Main Steam System Has Low Vibration at CLTP

# Steam Dryer

## VY Main Steam Vibration

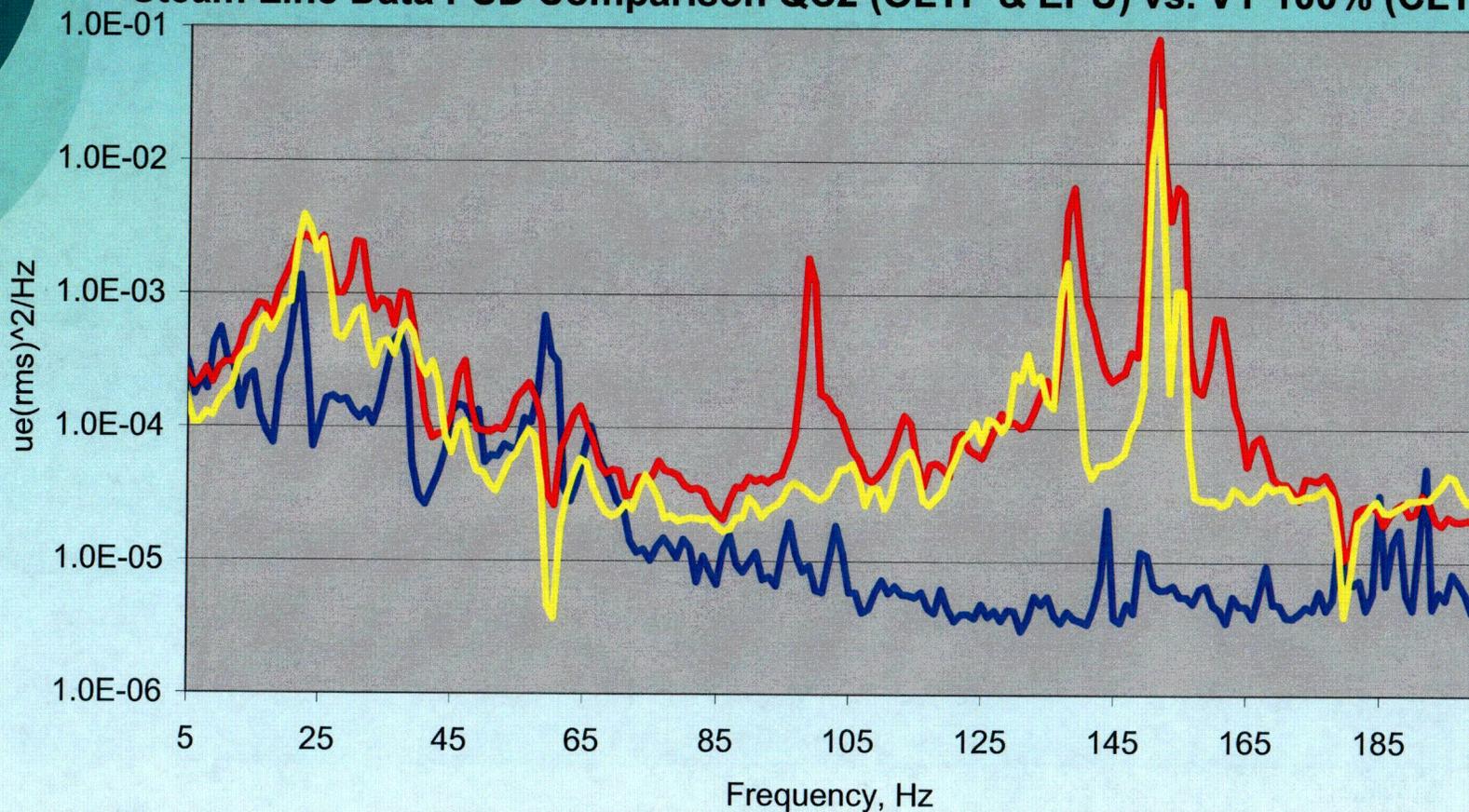
**Figure 4: VY Strain Gage Measurements vs. Quad Cities Steam Line Data PSD Comparison QC2 (OLTP) vs. VY 100% (CLTP)**



# Steam Dryer

## VY Main Steam Vibration

**Figure 5a: VY Strain Gage Measurements vs. Quad Cities (Log) Steam Line Data PSD Comparison QC2 (OLTP & EPU) vs. VY 100% (CLTP)**

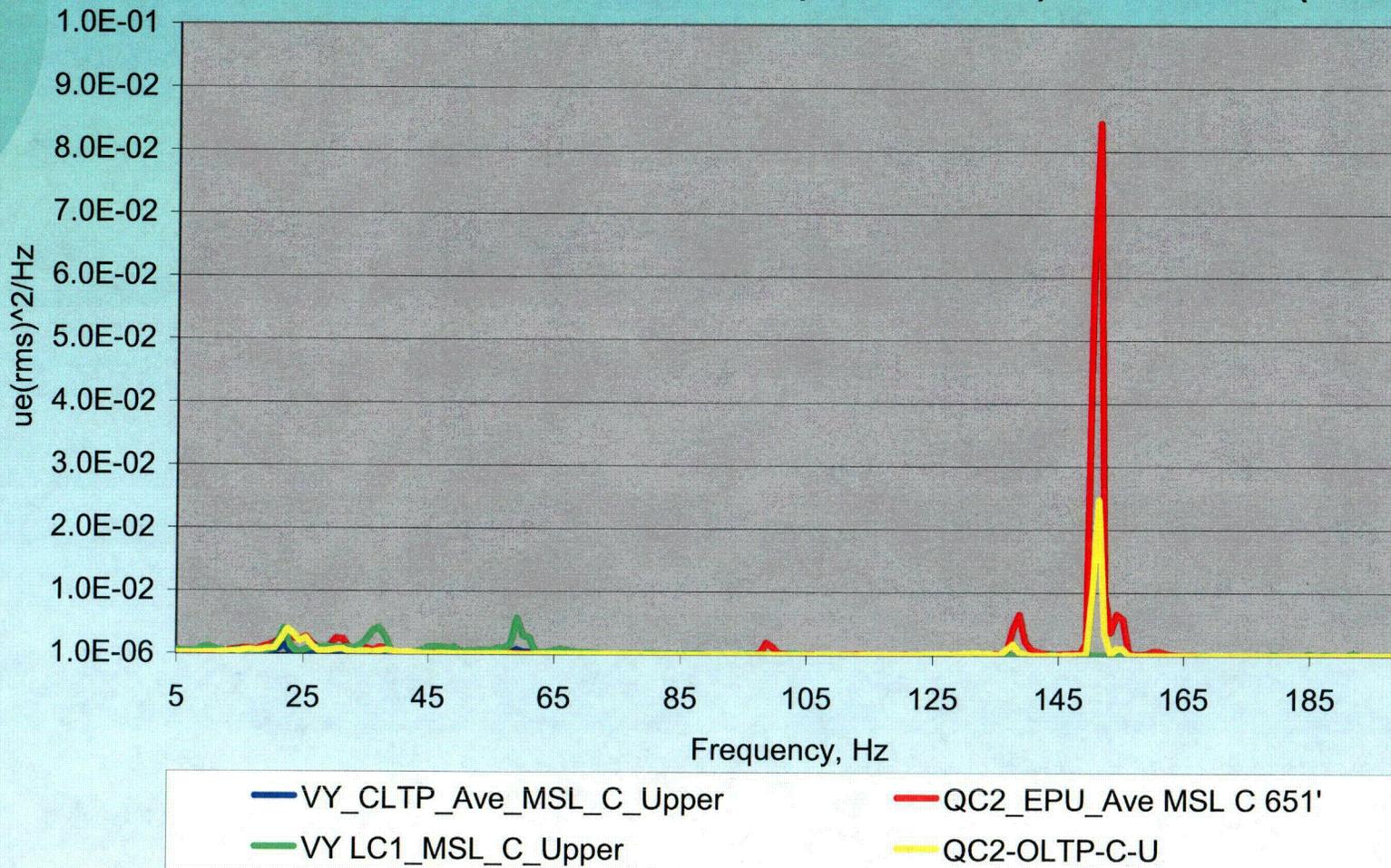


— VY\_CLTP\_Ave\_MSL\_C\_Upper    
 — QC2\_EPU\_Ave\_MSL\_C\_651'    
 — QC2-OLTP-C-U

# Steam Dryer

## VY Main Steam Vibration

**Figure 5b: VY Strain Gage Measurements vs. Quad Cities (Linear) Steam Line Data PSD Comparison QC2 (OLTP & EPU) vs. VY 100% (CLTP)**



# Steam Dryer

## VY Main Steam Vibration

---

- Main Steam Branch Line Potential Acoustic Resonators
  - Safety Relief Valves
  - Spring Safety Valves
  - HPCI Steam Supply Line
  - RCIC Steam Supply Line
  - MSL Blanks
- MSL Monitoring Will Detect All Excitation

# Steam Dryer

## VY Main Steam Vibration

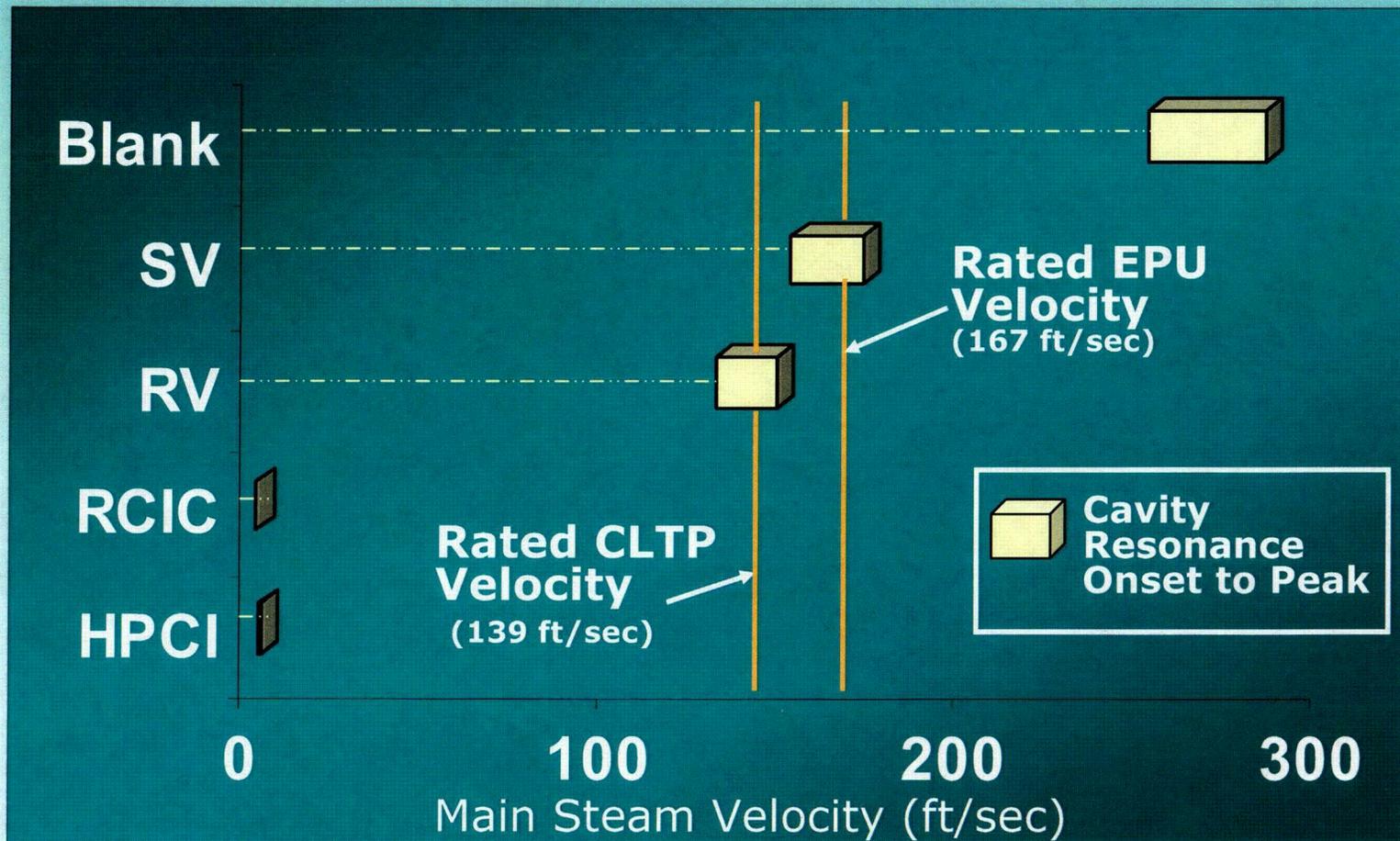
**Table 1: Main Steam Resonance Evaluation**

<b>Cavity</b>	<b>HPCI</b>	<b>RCIC</b>	<b>RV</b>	<b>SV</b>	<b>BLANK</b>
<b>Frequency (Hz)</b>	<b>1.3</b>	<b>1.9</b>	<b>116</b>	<b>134</b>	<b>222</b>
<b>Avg. Velocity @ Onset (ft/sec)</b>	<b>2.1</b>	<b>1.1</b>	<b>130</b>	<b>151</b>	<b>251</b>
<b>Avg. Velocity @ Resonance (ft/sec)</b>	<b>2.4</b>	<b>1.3</b>	<b>147</b>	<b>171</b>	<b>284</b>
<b>CLTP Vel. (ft/sec)</b>	<b>139</b>				
<b>EPU Vel. (ft/sec)</b>	<b>167</b>				
<b>Potential Acoustic Excitation CLTP?</b>	<b>No</b>	<b>No</b>	<b>Yes</b>	<b>No</b>	<b>No</b>
<b>Potential Acoustic Excitation EPU?</b>	<b>No</b>	<b>No</b>	<b>Yes</b>	<b>Yes</b>	<b>No</b>

# Steam Dryer

## VY Main Steam Vibration

**Figure 6: Potential Cavity Resonance Range vs. Main Steam Velocity**



# Proprietary Information – Closed Session

---

# Proprietary Information – Closed Session

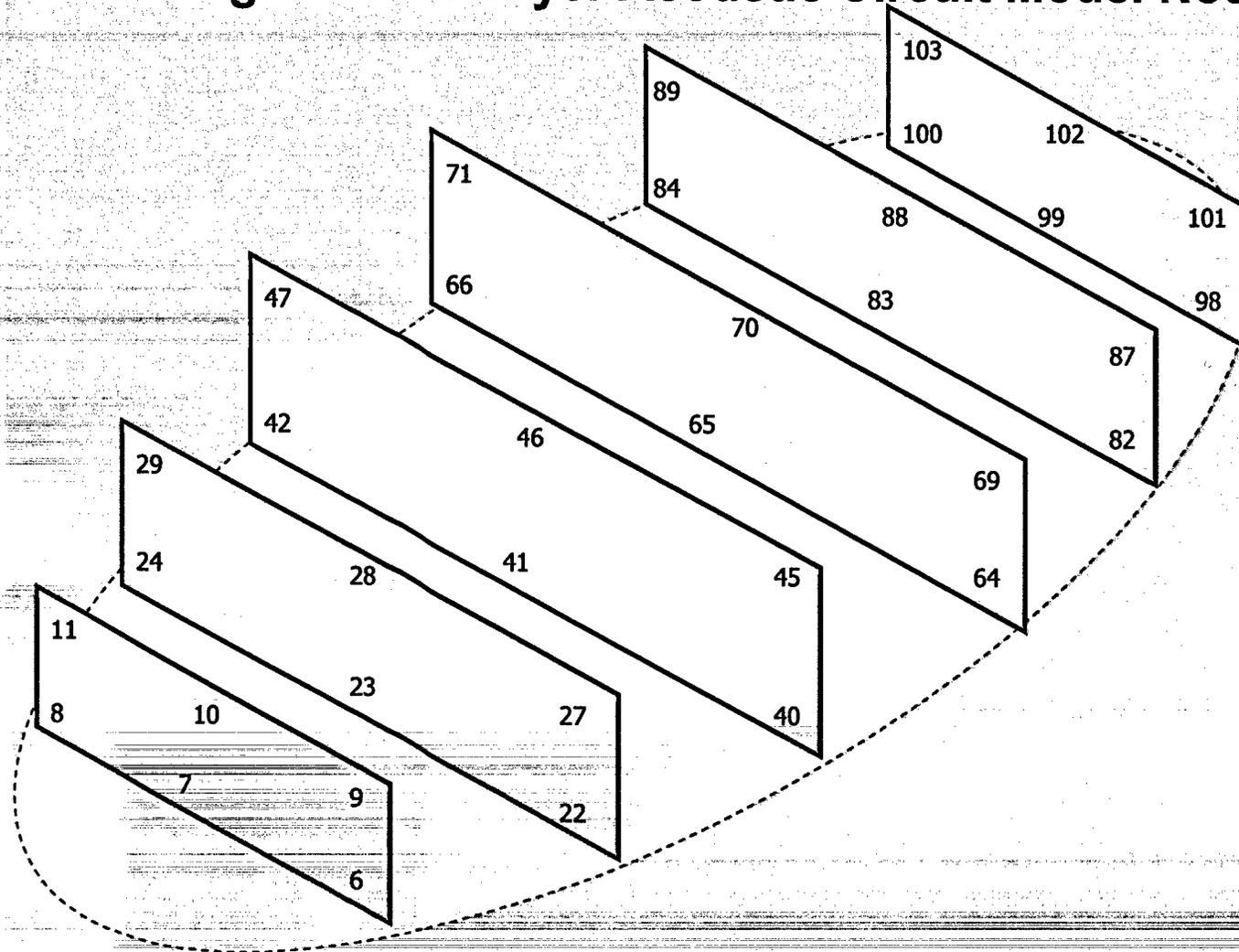
---

# Proprietary Information – Closed Session

# Steam Dryer

## VY Structural Analysis – Acoustic Circuit Loads

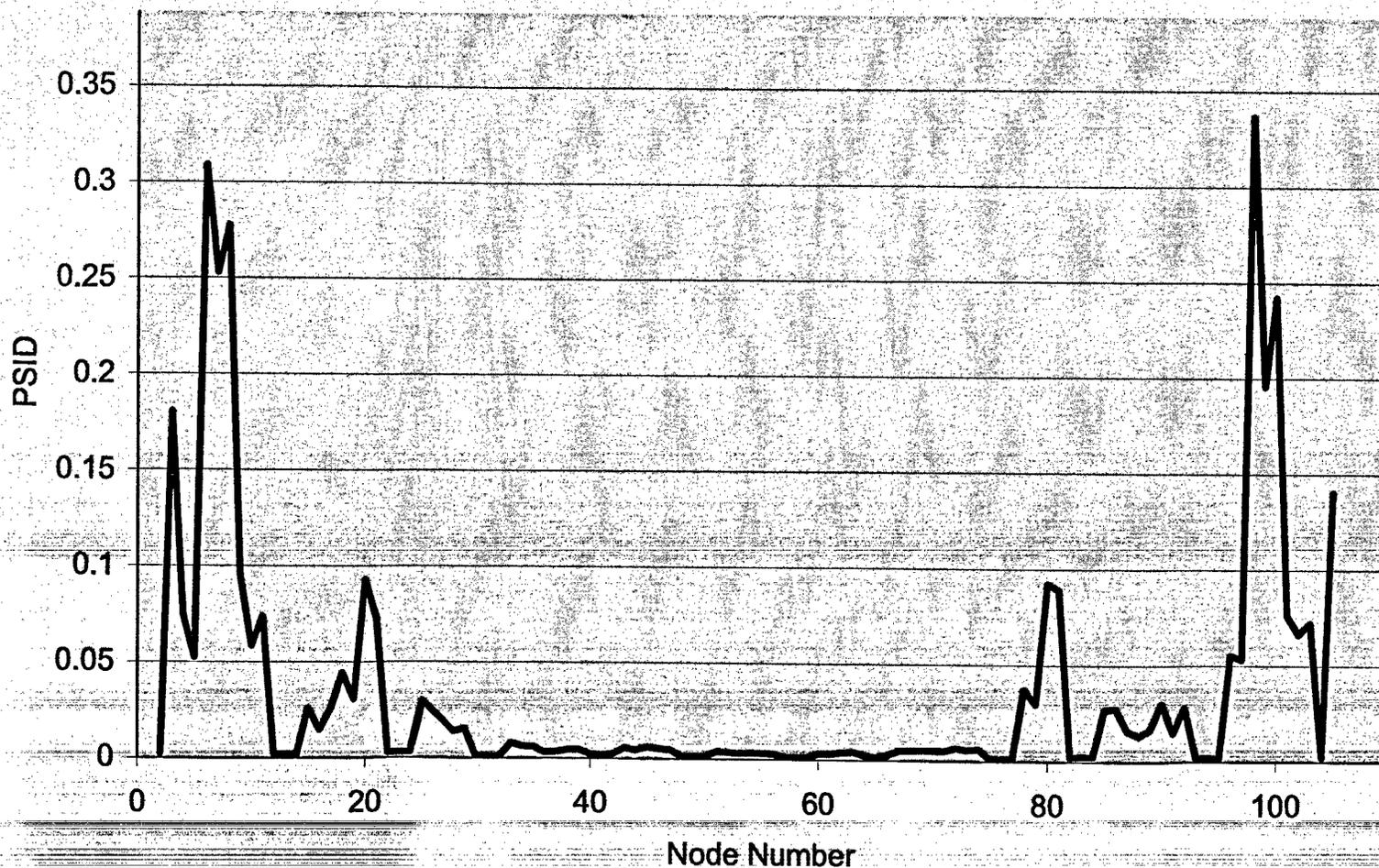
**Figure 8: VY Dryer Acoustic Circuit Model Nodes**



# Steam Dryer

## VY Structural Analysis – Acoustic Circuit Loads

Figure 9: VY Dryer Loads vs. ACM Node (Max. Absolute)



# Steam Dryer

## VY Structural Analysis – CFD Model

---

### CFD Analysis Used to Capture Hydrodynamic Forces Not Simulated by ACM

- Unsteady Large Eddy Simulation Model
- Compressible Flow
- 4.6M Cells, Required 10 Processors  
Three Weeks to Simulate Each Load Case
- CFD Analysis Performed for CLTP and EPU Conditions. Both Load Conditions Used in Structural Analysis.

# Steam Dryer

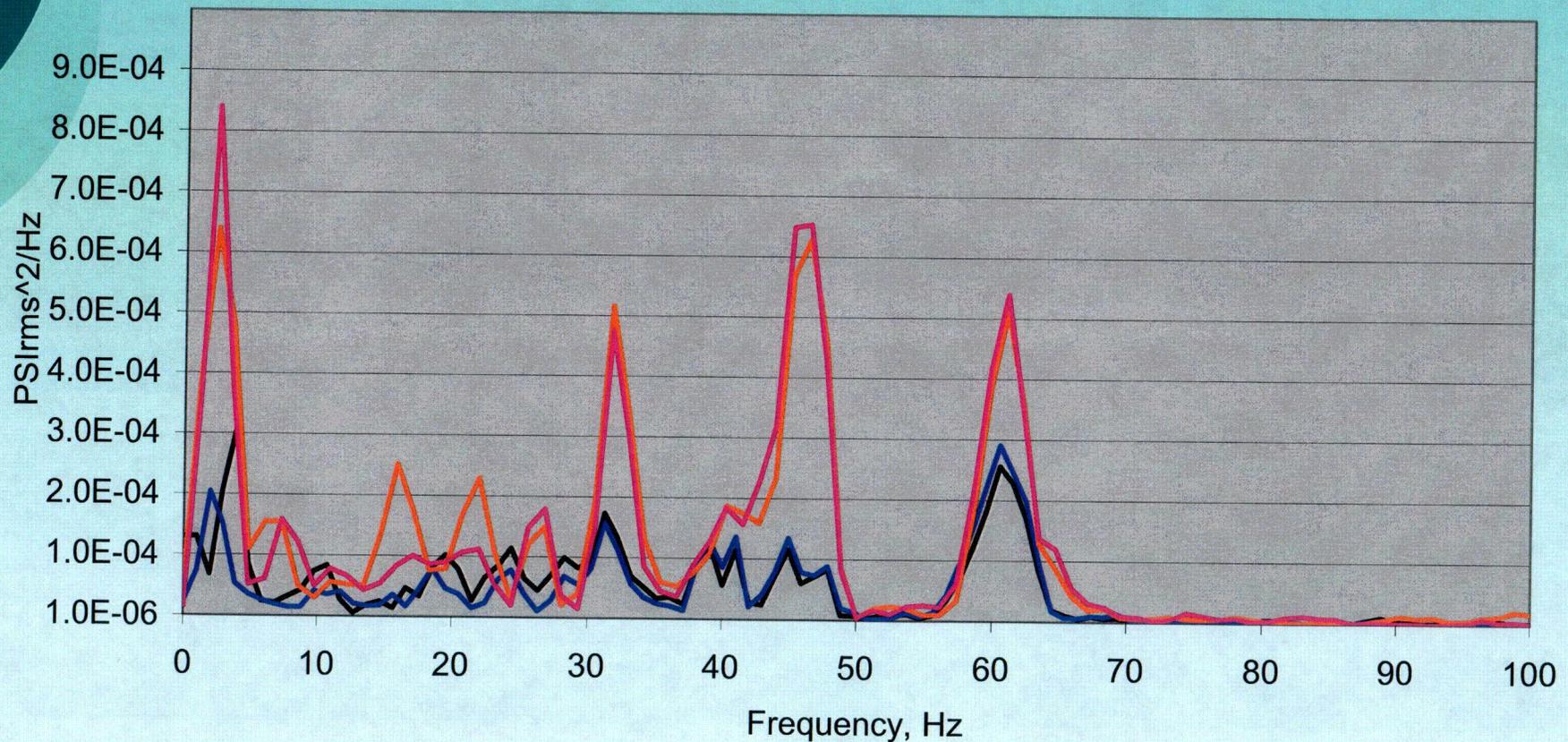
## VY Structural Analysis – CFD Model



# Steam Dryer

## VY Structural Analysis – CFD Loads

**Figure 11: VY Dryer CFD Loads Adjacent to Main Steam Nozzles  
CFD Loads 100% & 120% Power**



— 100% Avg.DP-1   
 — 100% Avg.DP-2   
 — VY CFD 120% Avg.DP-1   
 — VY CFD 120% Avg.DP-2

# Steam Dryer

## VY Structural Analysis – CFD Results

---

- Compressible Flow Resulted in Significant Acoustic Loads
  - Loads above 25 Hz, Primarily Acoustic
  
- Large Hydrodynamic Forces Primarily in the Area of the Nozzle
  - Little Affect on Heavy Dryer Components
  
- Acoustic Portion of CFD Load Increase Dryer CFD Stress From 167 psi to 1112 psi. Therefore, CFD Conservatively Bound Hydrodynamic Affects.

# Steam Dryer

## VY Structural Analysis – Load Definition Uncertainty

---

- ACM Load Uncertainty – 130%\*
  - Contributors:
    - Signal Uncertainty
    - Frequency Peak Uncertainty
    - Model Uncertainty
    - Location Uncertainty
  - Hydrodynamic Load Uncertainty – 16%
    - Includes Frequency Uncertainty
    - Basis: Bench Scale Methodology Testing

\*The new data acquisition system, optimal location of sensors, and model refinements from full scale test data will substantially reduce this uncertainty.

# Steam Dryer

VY Structural Analysis – Finite Element Model

---

**Figure 12: VY Dryer Finite Element Structural Model**



# Steam Dryer

## VY Structural Analysis – Results

### VY Dryer CLTP Stress Analysis – Limiting Component Weld at Top of Vertical Face

ANSYS CFD stress	1112	psi
Most Limiting of 100% and 120% CFD Cases		
ANSYS ACM stress	403	psi
Weld x SIF	4.61	
Peak CFD Stress $4.61 \times 1112$	5124	psi
Peak ACM Stress	1857	psi

# Steam Dryer

## VY Structural Analysis – Results

---

### VY Dryer CLTP Stress Analysis – Limit Curve Factor

- o Acceptance Level Level 1
- o Peak Stress Limit 13,600 psi
- o ASME C Limit LCF1
- o Minimum Load Factor 6.78
- o Uncertainty of Load Factor 3.91
- o Load Factor Minus Uncertainty 2.87

$$(CFD2 + (LCF*ACM)^2)^{1/2} * Wf * Sif \leq Lf * Salt$$

$$LCF = [((Lf * Salt) / (Wf * Sif))^2 - CFD2]^{1/2} / ACM$$

# Steam Dryer

## FIV Load Combination

---

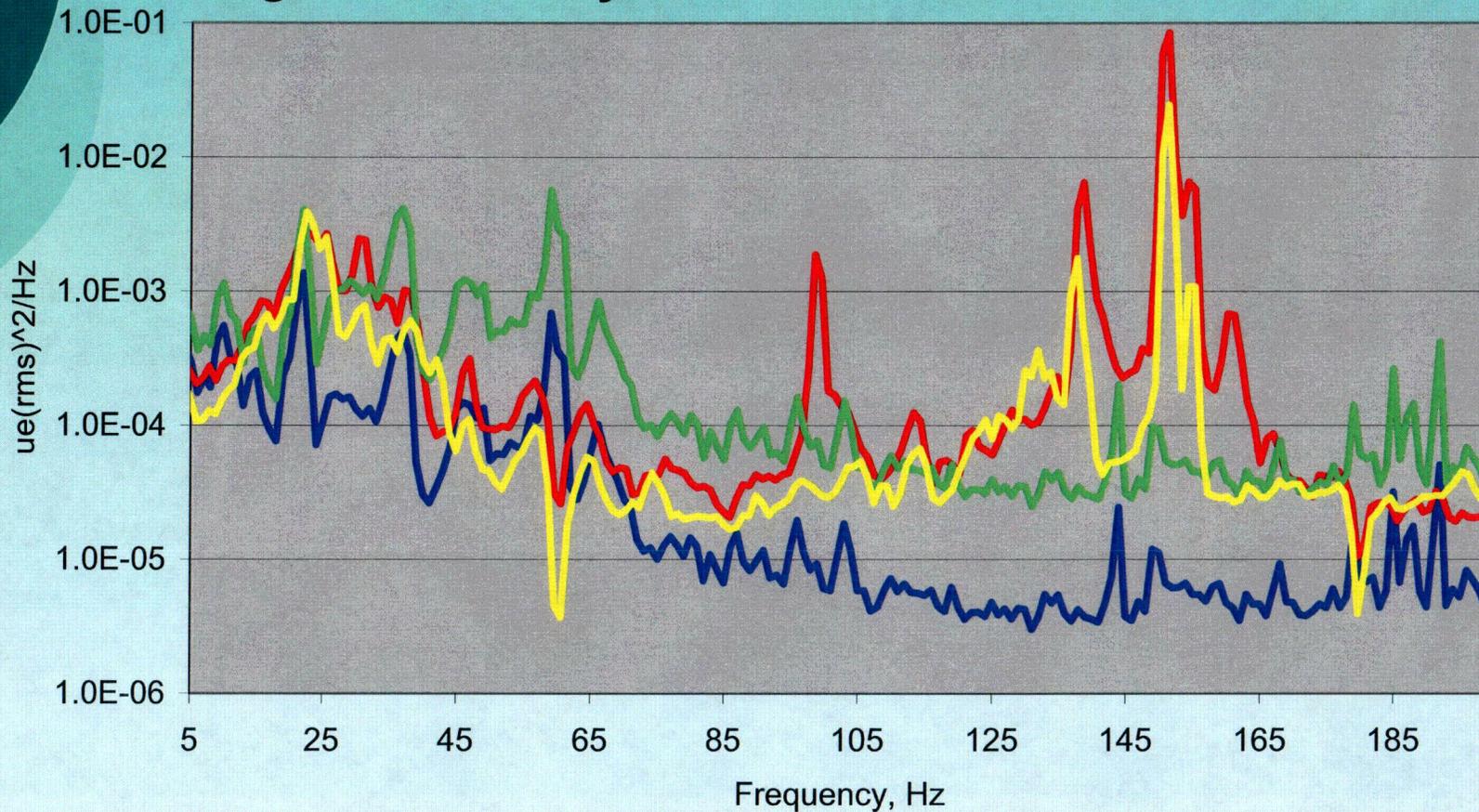
- CFD Stress and ACM Stress Combined by SRSS Methodology
- Maximum CFD Stress From the 100% and 120% Used
- Conservative in the Fact That CFD was Intended to Add Hydrodynamic  $V^2$  Effects Only

# Steam Dryer



## Power Ascension Monitoring – VY Limit Curve (Log Scale)

**Figure 13: VY Dryer Level 1 Power Ascension Limit Curve**



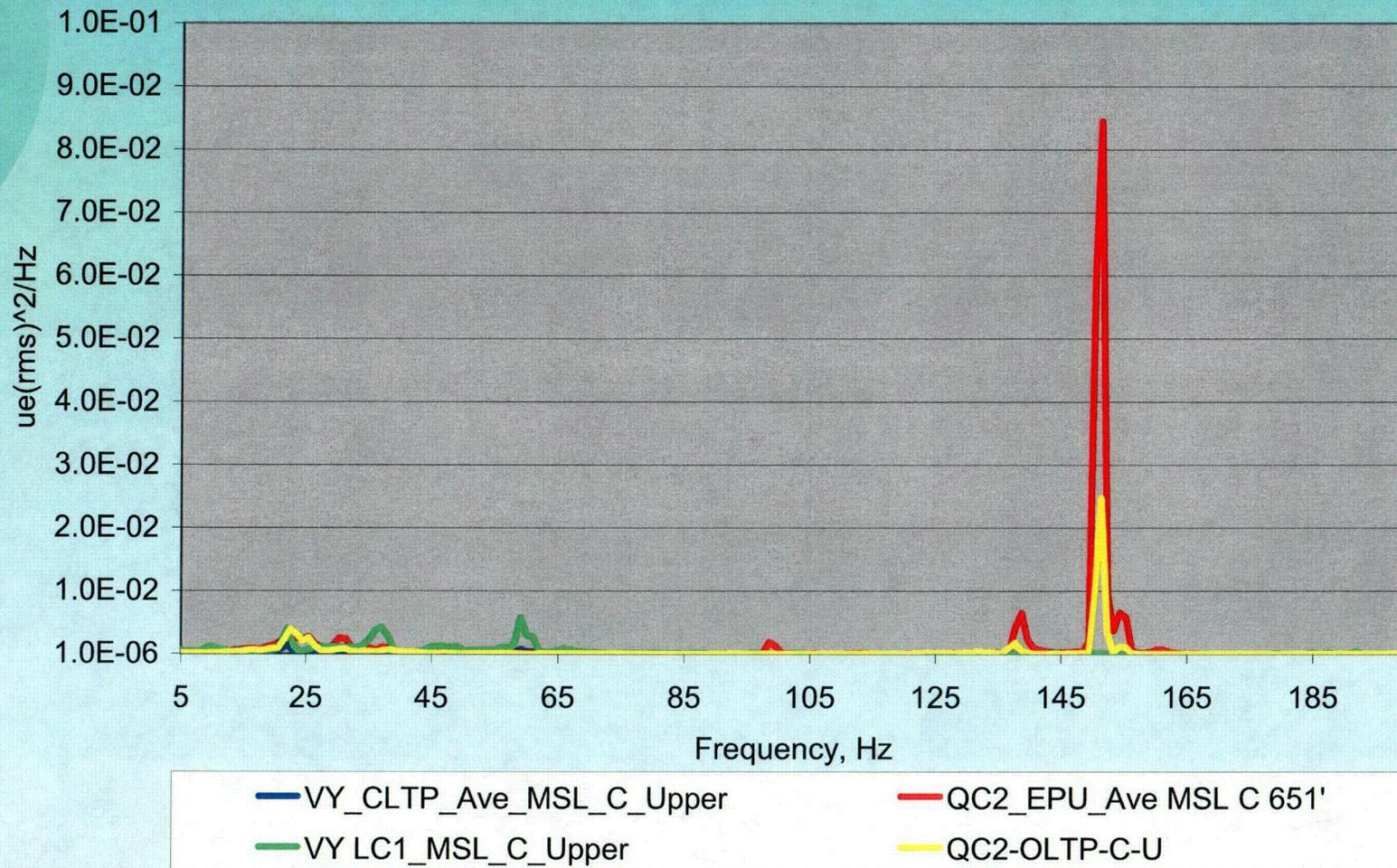
COB

# Steam Dryer



## Power Ascension Monitoring – VY Limit Curve (Linear Scale)

**Figure 14: VY Dryer Level 1 Power Ascension Limit Curve**

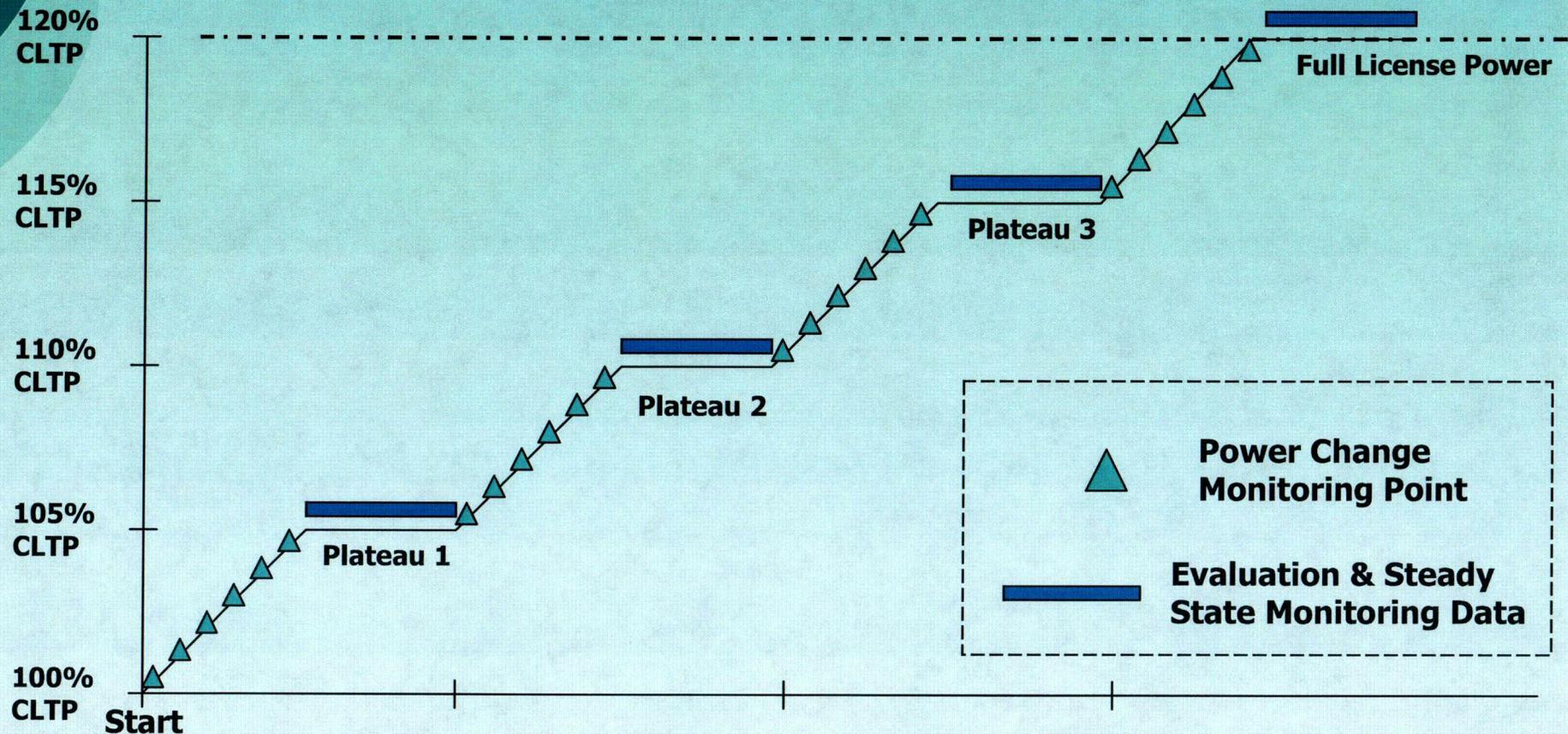


# Steam Dryer

## Power Ascension Monitoring – Test Plateaus

Figure 15: Dryer Monitoring & Test Plateaus

Power Ascension Target: 120% CLTP



# Steam Dryer

## Conclusions

---

- Operating Experience Incorporated
- Low Vibration at CLTP
- Conservative Load Definition
- Controlled Power Ascension  
Monitoring Plan
- Margin to Code Allowable Fatigue  
Limit at CLTP

---

# VY Residual Heat Removal and Core Spray Suction Strainers

# RHR & CS Suction Strainers

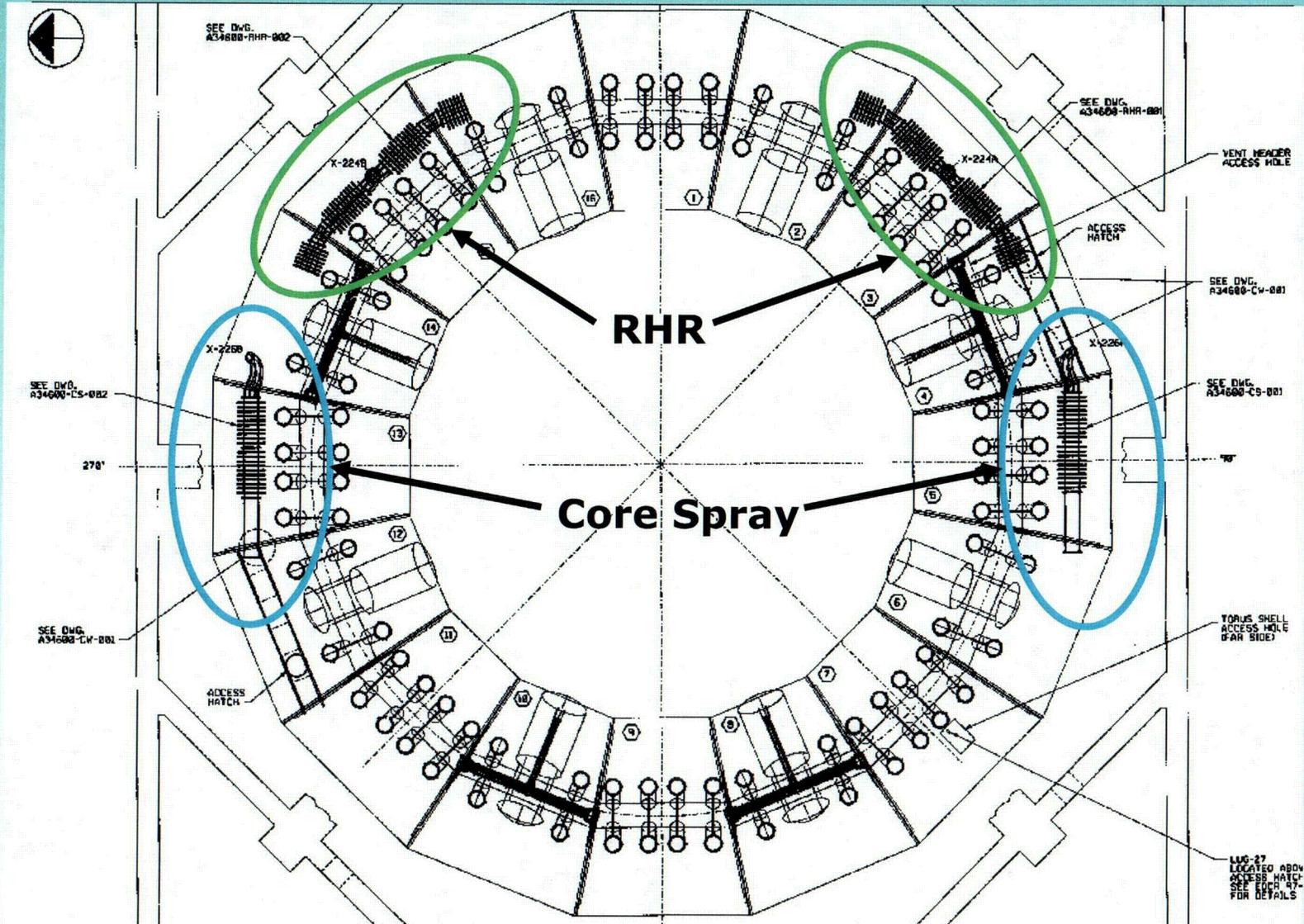
## Presentation Overview

---

- Residual Heat Removal & Core Spray Suction Strainer Arrangement
- Stacked Disc Strainer Design
- Conservative Debris Quantities Used for Design
- Debris Head Loss Testing
- Prevention of Air Ingestion

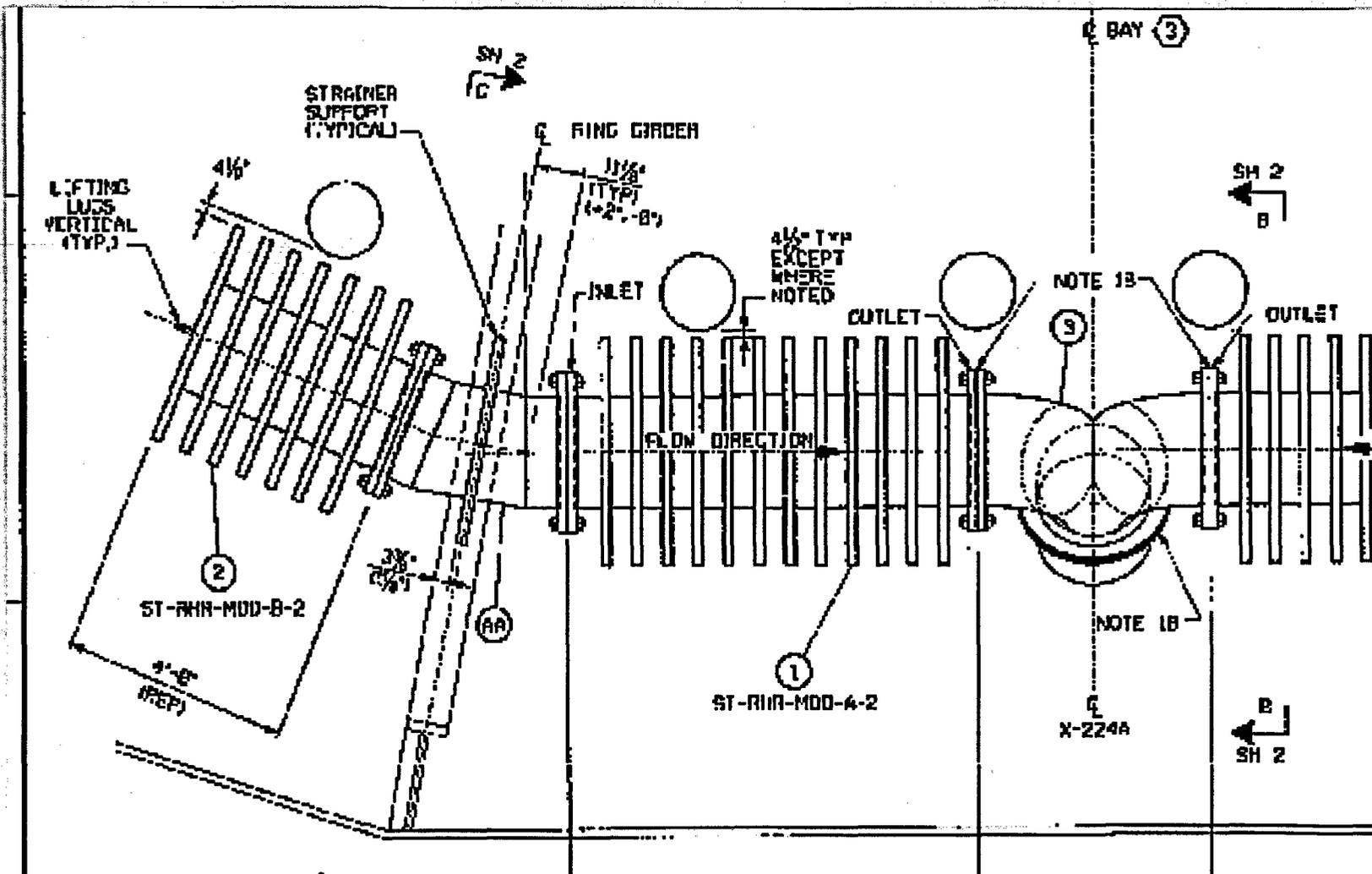
# RHR & CS Suction Strainers

Figure 1 Plan Arrangement in Suppression Pool



# RHR & CS Suction Strainers

## Figure 2a RHR Strainer Detail









# RHR & CS Suction Strainers

Table 1: Comparison of Test Strainer vs. VY Strainers

	Prototype II Strainer	RHR Strainer Modules - one side of each "rams head" tee		Core Spray Strainer Modules
	Cantilever module	One "Beam" type module	One cantilever module	One of two identical "beam" type modules in series
Number of modules/penetration	1	2	2	2
Flange/Core Tube Outer diameter	24 inch	24 inch	24 inch	24 inch
Core tube inner diameter	23 inches	23 inches	23 inches	23 inches
Disk outer diameter	40 inches	47 inches	47 inches	47 inches
Active length/module	48 inches	73.5 inches	41 inches	69.5 inches
Total length/module	54 inches	84 inches	47 inches	84 inches
Disk width	1.81 inches	2 inches	2 inches	2 inches
Gap width	2 inches	4 ½ inches	4 ½ inches	5 ½ inches
Number of disks/module	13	12	7	10
Gap diameter	26 inches	26 inches	26 inches	26 inches
Diameter of circumferential disk stiffeners	NA	35.19	35.19	35.19
Placement of circumferential disk stiffeners	NA	end disks only	end disks only	end disks only
Perf plate slot size	1/8 inch	1/8 inch	1/8 inch	1/8 inch
Perf plate % open area	40 %	40 %	40 %	40 %
Rated flow capacity, each module	5,000 to 10,000 gpm	7,100 gpm	3,489 gpm	4,600/2 gpm
Strainer module surface area	169 ft <sup>2</sup>	254 ft <sup>2</sup>	151 ft <sup>2</sup>	217 ft <sup>2</sup>
Core tube orifice sizes	2.6 to 5.9 in <sup>2</sup>	3.3 to 7.0 in <sup>2</sup>	6.7 to 17.9 in <sup>2</sup>	3.1 to 11.6 in <sup>2</sup>

# RHR & CS Suction Strainers

Table 2: VY Strainer Specifications & Approach Velocity

Parameter	Units	RHR Case 1	RHR Case 2a	CS-ST	CS-LT
Flow	GPM	7400	14200	4600	4000
Strainer Flow	GPM	3700	7100	4600	4000
Strainer Area	SQ FT	404.32	404.32	432	432
Approach Velocity based on Total Perf. Plate Area	FT/SEC	0.020	<b>0.039</b>	0.024	0.021
Circumscribed area	SQ FT	142.98	142.98	165.98	165.98
Approach Velocity based on Circumscribed Strainer Area	FT/SEC	0.058	<b>0.111</b>	0.062	0.054

# RHR & CS Suction Strainers

## Debris Quantities & Head Loss Design

---

- Designed for Conservative Suppression Pool Debris
- Head Loss Correlation Validated Through Testing
  - Debris Mixes & Low Approach Velocities (VY strainer design)
- Head Loss Correlation to Suppression Pool Temperature
  - Viscosity & Density Adjustments

# RHR & CS Suction Strainers

Table 3: Torus Debris Source Term

INSULATION CLASS	INSULATION COMPONENT	UNITS	URG Recommended Value	QUANTITY
Fibrous Insulation	Nukon Insulation	lbm	Calculated Value	365
	Fibermat Insulation	ft <sup>3</sup>	Calculated Value	18
	TempMat	lbm	Calculated Value	29
Closed Cell Foam Insulation	Armaflex Insulation	ft <sup>3</sup>	Calculated Value	23.3
Sludge	Sludge from Drywell Dust and Dirt	lbm dry	150	150
	Sludge from Torus	lbm dry	NS	622
	Total Suppression Pool Sludge	lbm dry	Calculated Value	772
Rust Flakes	Rust Flakes	lbm	50	50
Inorganic Zinc (IOZ) & Epoxy Paint in Zone of Influence	Qualified Coating Debris	lbm	85	85
Other Debris Sources	Other; (IOZ Coating Debris, Zinc Dust from Drywell)	lbm	Calculated Value	99
Un-Qualified Coatings	DBA Coating Debris, except IOZ	ft <sup>2</sup>	Calculated Value	73538
	IBA Coating Debris, except IOZ	ft <sup>2</sup>	Calculated Value	46978
				11

# RHR & CS Suction Strainers

## Containment Coatings

---

- Original VY Containment Coating was Assumed to be Unqualified for Strainer Design
- Coatings Were Subsequently Inspected & Tested
- Torus Re-Coated (below water level) in 1998 With Qualified Coating
- 2004 Torus Sludge Removed: 75 lb
  - Head Loss Assumes 772 lb

# RHR & CS Suction Strainers

## Submergence & Air Ingestion

---

- ARL Tests (NUREG/CR-2772)
- $D = 2$  ft
- $S = 3.5$  ft
- $Q = 12,000$  gpm (max)
- $Fn = 0.8$
  
- No air-core vortexing.

# RHR & CS Suction Strainers

## Submergence & Air Ingestion (cont.)

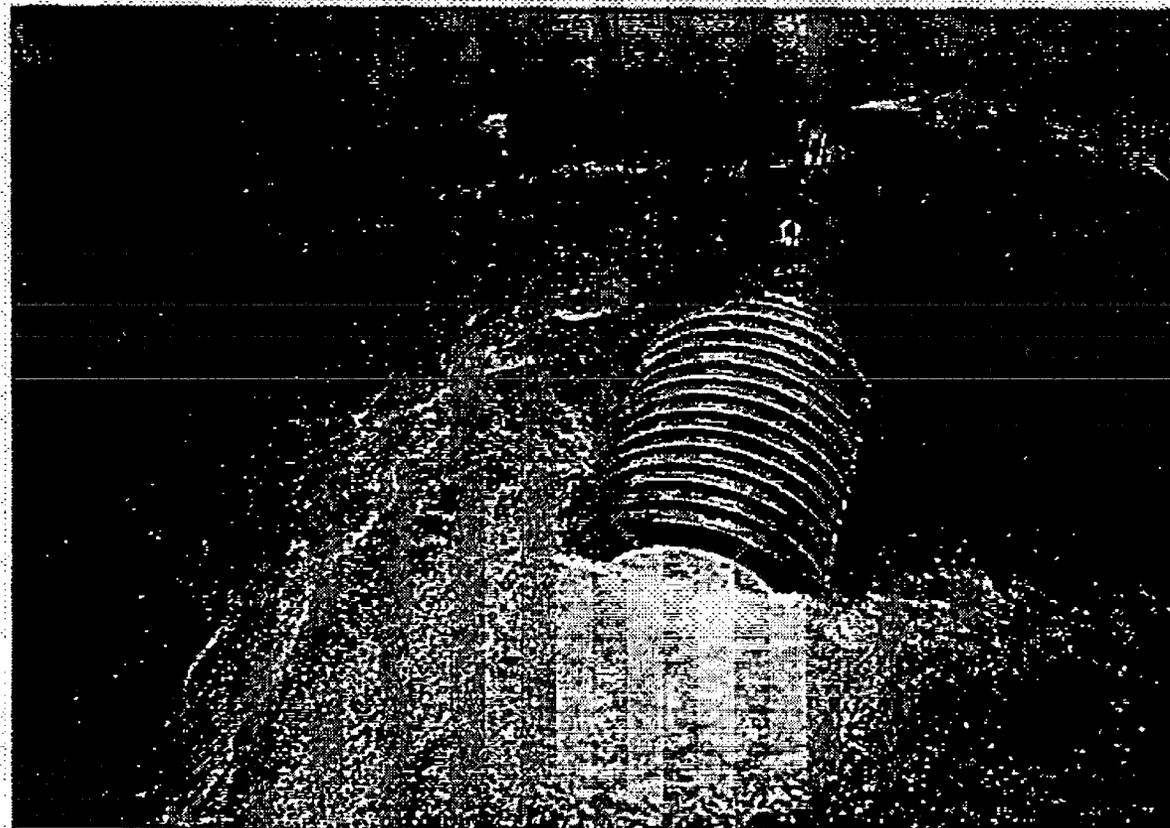
---

- EPRI Test of PCI Stacked Disk Prototype
  - $D = 2 \text{ ft}$
  - $S = 1.5 \text{ ft}$  (top exposed)
  - $Q = 10,000 \text{ gpm}$
  - $F_n = 1.11$
- 
- No vortexing observed.

# RHR & CS Suction Strainers

## Submergence & Air Ingestion (cont.)

The photograph below was taken of the half submerged strainer during that test. With the water flow rate started at 5000 gpm, and increased to the maximum of 10,000 gpm, the strainer would not vortex. As can be seen from the photograph, there were a few air bubbles formed but there was no vortexing.



# RHR & CS Suction Strainers

## Submergence & Air Ingestion (cont.)

---

- CS @ 4600 gpm (max flow rate)
- Submergence = 4.0 ft
- $Fn = 0.29$  (based on core tube D)
- $Fn = 0.0055$  (based on surface area)
- No vortex

# RHR & CS Suction Strainers

## Submergence & Air Ingestion (cont.)

- RHR @ 14,200 gpm (7100 gpm per branch)
- Submergence = 5.3 ft
- $Fn = 0.38$  (based on core tube D)
- $Fn = 0.0085$  (based on surface area)
- No vortex.

# RHR & CS Suction Strainers

## Submergence & Air Ingestion (cont.)

---

- Minimum Submergence To Top of Debris Bed
- CS = 1.8 ft,  $F_n = 0.0055$
- RHR = 3.3 ft,  $F_n = 0.0085$
- No entrainment of floating debris (e.g. Armafex)

# RHR & CS Suction Strainers

## Submergence & Air Ingestion (cont.)

---

- Vertical drop from strainer to pump inlet
- RHR = 7 ft
- CS = 8.5 ft
- No air-core vortices.
- Suction lines keep full and static head not degraded.

# RHR & CS Suction Strainers

## Conclusion

---

- Conservative Debris Quantities Used for ECCS Head Loss Design
- Design Criteria Are Not Affected by EPU
  - Debris Quantities
  - Pump Flow Rates
  - Submergence



# Entergy Vermont Yankee Extended Power Uprate

---

Nuclear Analytical Methods

Presentation to the  
Advisory Committee On Reactor Safeguards  
Extended Power Uprate Subcommittee  
November 29, 2005

# Nuclear Analytical Methods

---

- Background
- Licensing Condition
- Summary of the methods review for VY

# Background

---

- Constant Pressure Power Uprate
  - Larger batch fractions
  - Same thermal limits apply
  - Flatter radial power distribution

## Background

---

- NRC review of GE's proposed expansion of operating domain
  - Questions regarding standard GE methodologies
  - Questions extended to VY EPU submittal

Extensive review of computer codes and methods for establishing operating limits

# License Condition

---

- SLMCPR +0.02
- "When operating above 1593 MWth, the SLMCPR shall be established by adding 0.02 to the cycle specific value calculated using NRC-approved methodologies..."

# Summary of the Methods Review for Vermont Yankee

---

- Safety Limit MCPR
- Operating Limit MCPR
- Linear Heat Generation Rate
- Peak pellet exposure
- Maximum Average Planar LHGR (MAPLHGR)
- Reactivity (SDM)
- Stability

# Critical Power Based Limits

## Safety Limit MCPR

---

- Uncertainties related to the prediction of local power
- Current bases for uncertainties
  - Analytic benchmark (MCNP)
  - Retrospective confirmation with gamma scans
  - Gamma scans for 10x10 unavailable
- Alternate Approach = +0.02 SLMCPR adder

# Critical Power Based Limits

## Operating Limit MCPR

---

- SLMCPR +  $\Delta$ CPR for AOOs
- Standard method and application to VY reviewed
  - Including uncertainty treatment
  - Alternate calculation
- VY bounded by existing methodology

# Limits Related to Local Power

## Linear Heat Generation Rate (LHGR)

---

- Thermal-mechanical (fuel centerline melt, 1% cladding plastic strain, fuel rod pressure, etc.)
- Standard method and application to VY reviewed
  - Including uncertainty treatment
  - Conservative assumptions used to derive the fuel specific limit
- VY bounded by existing methodology

# Exposure Limit

## Peak Pellet Exposure (PPE)

---

- Related to the LHGR limit & analysis
- Standard method and application to VY reviewed
  - Including uncertainty treatment
  - Conservative assumptions used to derive the fuel specific limit
- VY bounded by existing methodology

# Limits Related to Local Power



## Maximum Average Planar LHGR (MAPLHGR)

---

- ECCS LOCA based – PCT, local oxidation, etc.
- Standard method and application to VY reviewed
  - Including uncertainty treatment
  - Conservative assumptions – approach designed to maximize PCT
- VY bounded by existing methodology

# Limits Related to Reactivity

## Shutdown Margin (SDM)

---

- Control of core reactivity
- Standard method and application to VY reviewed
  - Including uncertainty treatment
  - Design practice considers  $\geq 1.0\% \Delta k/k$  to ensure meeting TS limit  $0.38\% \Delta k/k$
- VY bounded by existing methodology

# Limits Related to Stability

## Option 1-D Solution

---

- Preserve the SLMCPR in the event of a thermal-hydraulic instability
- Administratively controlled P/F exclusion regions + detect & suppress
- Standard method and application to VY reviewed
  - Including uncertainty treatment
- VY bounded by existing methodology

# Entergy Independent Methods

---

- Entergy develops and maintains core physics models using independent methods (CASMO/SIMULATE)
- Used to verify/challenge fuel vendors on core designs and critical safety analysis inputs
- Used to "follow" operation of every core to help identify/evaluate potential adverse trends

# Entergy Independent Methods

---

- Detailed TGBLA06/CASMO-4 comparisons performed
  - 5 different lattices
  - > 25 exposure steps
  - Multiple void cases (0, 40, 70, 90%)
  - K-infinity
  - Actinide Isotopics
  - Local peaking
  - Void Coefficient

# Safety Analysis Summary

---

- Thermal Hydraulic Stability
  - VY utilizes the Option 1D solution which credits the APRM flow biased scram (rescaled for EPU)
  - The Option 1D operating regions and stability MCPR requirements are analyzed every cycle.
  
- Overpressure Protection and AOO
  - MSIV closure with flux scram peak pressure 1328 psig (< ASME limit 1375 psig)
  - 80 inches of margin to TAF for loss of feedwater

# Safety Analysis Summary

---

- ATWS

- Pressure regulator failure peak pressure 1490 psig (< ASME limit 1500 psig)
- 190.5°F suppression pool temperature (< 281°F limit)
- SLC relief valve margin verified

- ECCS-LOCA

- Licensing Basis PCT 1960°F (50°F increase vs CLTP)

# SUMMARY

---

- NRC approved methods applied for VY analyses
  - Additional review for VY EPU
  - Adequate treatment of uncertainties for limits
  - Other safety analysis results acceptable
  
- SLMCPR +0.02



# Entergy Vermont Yankee Extended Power Uprate

---

Presentation to the  
Advisory Committee On Reactor Safeguards  
Extended Power Uprate Subcommittee  
November 30, 2005

# Flow Accelerated Corrosion

## Topics

---

- Program Overview
- EPU Impact
- Conclusion



# Flow Accelerated Corrosion Overview

---

- Programmatic Approach to Monitor FAC  
Program Meets Generic Guidance
  - Generic Letter 89-08
  - EPRI NSAC-202L
  - Use EPRI CUEWORKS Software to

# Flow Accelerated Corrosion

## Overview

---

- Typically 25 to 35 Components Inspected Each Outage
- Repeat Inspections in Condensate & Feedwater show Minimal FAC Wear
- Significant Amount of FAC Resistant Piping
  - Extraction Steam System Piping Originally Constructed Using FAC Resistant Material
  - Replacement of Degraded Components With More FAC Resistant Materials

# Flow Accelerated Corrosion

## Replacements With FAC Resistant Materials

---

- Equipment
  - All Feedwater Heater Shells Replaced with FAC Resistant Material
  - LP Turbine Casings Replaced with FAC Resistant Material

# Flow Accelerated Corrosion Replacements With FAC Resistant Materials

---

- Large Bore Piping
  - Moisture Separator Drains Downstream of Level Control Valves
  - Heater Drain Piping Downstream of Level Control Valves at new Feedwater Heaters
  - Feedwater HP Flush and Feedwater Pump Recirculation Lines Connecting to Condenser
- Turbine Cross Around Lines

# Flow Accelerated Corrosion Replacements With FAC Resistant Materials

---

- Small Bore Piping
  - Main Steam Drains From HPCI and RCIC Turbine Steam Supply Lines in Rx. Bldg. to Condenser
  - Main Steam Leads Continuous Drain Through Restriction Orifice To Condenser
  - AOG Steam Supply Drain Lines To Condenser
  - Turbine Bypass Valves First Seal Leakoff Lines
  - High Pressure Feedwater Heater Vent Lines

# Probabilistic Safety Analysis

## VY PSA Overview

---

- Internal Events
  - Level 1 (Core Damage Frequency)
  - Level 2 (Release Frequency)
  
- External Events (IPEEE Study)
  - Internal Fires (EPRI FIVE Method)
  - Seismic (EPRI SMA Method)
  - Other External Hazards (NRC SRP Review)
    - Winds, Ext. Floods, Transportation, etc.

# Probabilistic Safety Analysis

---

- Reflects Current Plant Configuration
- NEI Peer Review in Y2000
  - All Category A & B Facts and Observations Resolved
- VY PSA Maintained and Routinely Updated to Reflect Current Plant Configuration and Operating Experience

# Probabilistic Safety Analysis

## Potential PSA Impacts Due to EPU

---

- Hardware Changes
- Procedural Changes
- Configuration Changes
- Power Level

# Probabilistic Safety Analysis

## EPU Impacts

---

- No New Accident Sequences Identified
- No Significant Impact:
  - IE Frequencies
  - Only One Success Criteria Change (1 additional SSV for ATWS)
  - Due to Hardware Changes
  - Due to Procedural Changes
- Slight Decrease in Time Available for Some Post-Initiator Operator Actions

# Probabilistic Safety Analysis

## ATWS Operator Actions

---

<b>ACTION</b>	<b>CLTP</b>	<b>EPU</b>
Operator Inhibits ADS	6.2 min.	5.4 min.
Operator Initiates SLC (MSIVs Isolated)	6 min.	5.3 min.
Operator Bypasses MSIV Low Level Isolation Interlocks	4 min.	3.4 min.

# Probabilistic Safety Analysis Methodology

---

- Level 1 & 2 Internal Events (Quantitative)
- External Events (Qualitative)
- Shutdown Events (Qualitative)

# Probabilistic Safety Analysis

## Conclusions

---

- Very Small Risk Increase (CDF)
  - $\Delta\text{CDF} = 3\text{E-}7/\text{ry}$
  
- Small Risk Increase (LERF)
  - $\Delta\text{LERF} = 1\text{E-}7/\text{ry}$
  
- No Significant Risk Impact from External Events and Shutdown

# Flow Accelerated Corrosion

## EPU Impact

---

- No Additional Systems Have Been Added to the FAC Program Due to EPU
  
- EPU Flow and Temperature Changes
  - Maximum Flow Increases 24.6% in Feedwater
  - Maximum Temperature Increase of 18.4°F in Final Feedwater
  
- Bounding Estimate of Changes in FAC Wear in Single Phase Systems to be Proportional to Changes in Flow Velocities for EPU

# Flow Accelerated Corrosion

## EPU Impact

---

- Updating CHECWORKS Models with Recent Outage Inspection Data and EPU Parameter Changes for Performing Component Selection for RFO 26
- Currently Planning For 50% Increase In The Number Of Inspections Performed For The Next 3 Refueling Outages To Monitor Potential Changes Due To EPU

# Flow Accelerated Corrosion

## Conclusion

---

- Minimal Changes in Existing FAC Wear Rates Expected with Implementation of EPU
- No Impact on FAC Program Scope or Methodology
- Increased Inspections Planned For Next Three Refueling Outages

# Pressure Temperature Limit Curves

## EPU Impact

---

- Fluence ( $> 1$  Mev)
  - CLTP Fluence Calculation and PT Curves Updated in 2003
  - PT Curves based on peak neutron fluence of  $1.24 \times 10^{18}$  n/cm<sup>2</sup>
  - Fluence Calculation Updated for EPU
    - Increase RPV ID Fluence Rate (Flux) by 26%
  - RPV ID Surface Integrated Peak Fluence
    - CLTP -  $2.99 \times 10^{17}$  n/cm<sup>2</sup>
    - EPU -  $3.18 \times 10^{17}$  n/cm<sup>2</sup>
- TS PT Curves remain bounding for EPU operation

# Operator Training, Procedures and Actions

## Operational Impacts

---

- Operation of all (3) Reactor Feedwater Pumps
  - Recirc Runback/Pump Trip
- Additional Rod Pattern Adjustments
  - Reactor Recirculation Flow Window Reduced
- Slight Reduction in Operator Action Times for Certain Events
- Balance of Plant Modifications Improve Plant Performance and Component Reliability

# Operator Training

---

- Simulator was Modified to Support EPU
- Training on Modifications
- On-going Training With Modifications Installed for the Past 2 Years
- Operating Crews Were Trained at EPU Conditions
- Power Ascension / Transient Test Training Prior to Performing EPU

# Operator Procedures

---

- Some Abnormal Procedure Changes Due to EPU
- New Steam Dryer Integrity Procedure
- No New Emergency Procedure Actions or Strategies
- Minor Revisions to Emergency Procedure Graphs Due to EPU

# Operator Actions / Timelines

---

- No New Operator Strategies
- The Time it Takes to Perform Required Actions Did Not Change
- Operations and Training Completed Time Validations for Time Critical Actions
- The Time Required to Perform Certain Actions has Decreased
- Operator Actions Remain Within the Allowable Time Windows

# ACRS Subcommittee on Power Upgrades

---

NRC Staff Review of Proposed Extended Power Upgrade  
For  
Vermont Yankee Nuclear Power Station



November 29-30, 2005

# Opening Remarks

---

Cornelius Holden  
Deputy Division Director  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

# Introduction

---

**Rick Ennis**

Senior Project Manager

Division of Operating Reactor Licensing

Office of Nuclear Reactor Regulation

# Topics for 11/29

---

- Mechanical and Civil Engineering
  - ▶ Safety Evaluation (SE) Section 2.2
- Reactor Systems
  - ▶ SE Section 2.8

# Topics for 11/30

---

- Materials and Chemical Engineering
  - ▶ SE Section 2.1
- Electrical Engineering
  - ▶ SE Section 2.3
- Human Performance
  - ▶ SE Section 2.11
- Plant Systems
  - ▶ SE Section 2.5
- Source Terms and Radiological Consequences
  - ▶ SE Section 2.9
- Health Physics
  - ▶ SE Section 2.10
- Risk Evaluation
  - ▶ SE Section 2.13

**NON- PROPRIETARY VERSION**

**(slides 4-13 thru 4-22 are deleted)**

**Component Evaluation for  
Vermont Yankee  
Proposed EPU Amendment**

---

**Thomas G. Scarbrough**  
Senior Mechanical Engineer  
Mechanical & Civil Engineering Branch  
Office of Nuclear Reactor Regulation

# Evaluation Areas

---

- Pipe Rupture Locations and Dynamic Effects
- Pressure-Retaining Components and Supports
  - ▶ NSSS Piping, Components and Supports
  - ▶ Balance of Plant Piping, Components, and Supports
  - ▶ Reactor Vessel and Supports
  - ▶ Control Rod Drive Mechanism
  - ▶ Recirculation Pumps and Supports
- RPV Internals and Core Supports
- Safety-Related Valves and Pumps
- Seismic and Dynamic Qualification of Equipment
- Potential Adverse Flow Effects

# Scope of Review

---

- Methodology, Loads for Constant Pressure Power Uprate
- Stresses and Cumulative Fatigue Usage Factors
- Acceptance Criteria, Code Editions and Addenda
- Functionality Impact on Safety-Related Pumps and Valves, and Piping Overpressurization
- Acoustic and Flow-Induced Vibration Loading and Monitoring

# RCPB and BOP Piping and Supports

---

---

- Reactor Coolant Pressure Boundary and Balance-of-Plant piping systems evaluated for EPU conditions
- Limiting main steam and feedwater piping and supports evaluated for higher thermal loads and flow rate
- Other piping less significantly affected by EPU conditions
- Calculated stresses less than ANSI B31.1 Code-allowable limits

# Evaluation of Safety-Related Pumps and Valves

---

- Safety-related pumps and valves within scope of ASME Code
- Review focused on EPU effects on functional performance of pumps and valves
- Review acceptance criteria based on draft GDC and 10 CFR 50.55a(f)

# Motor-Operated Valves

---

- MOV program previously reviewed under GLs 89-10 and 96-05
- Only minor system and ambient changes for MOVs from EPU
- Engineering Inspection 20004008 found weaknesses in MOV program
- Supplements 16 and 32 addressed MOV weaknesses
- In Sept. 2005, NRC region verified implementation of MOV commitments

# Potential Adverse Flow Effects

---

- Steam dryer function
- Quad Cities steam dryer failure
- Quad Cities replacement steam dryers
- Vermont Yankee modified steam dryer
- NRC staff review with technical expert assistance

# NRC Review Team

---

- Dr. Christopher Boyd, RES
  - ▶ BS (ME), MS (ME), PhD (ME)
- Dr. S. S. Chen, ANL consultant
  - ▶ BS (CE), MS (Eng Mech), MA (CE), PhD (Eng Mech)
- Dr. Stephen A. Hambric, Head, Structural-Acoustics Dept, Applied Research Laboratory, Pennsylvania State University
  - ▶ BS (ME), MS (ME), DSc (ME)
- Dr. Thomas M. Mulcahy, ANL consultant
  - ▶ BS (Eng Mech), PhD (Theor. & Applied Mech)

# **NRC Review Team**

## **(continued)**

---

- Thomas G. Scarbrough, NRR
  - ▶ BA (Physics), BNE (NE), MS (ME)
- Dr. Vikram N. Shah, ANL
  - ▶ BS (ME), MS (ME, Metallurgy), PhD (Eng Mech)
- Dr. Cheng-Ih (John) Wu, NRR
  - ▶ BS (ME), MS (ME), PhD (ME)
- Dr. Samir Ziada, Professor and Chair,  
Mechanical Eng. Dept, McMaster University
  - ▶ BSc (ME), M.Eng (ME), PhD (ME)

# Steam Dryer Modifications

---

- Outer hood vertical plates
- Reinforcing gussets
- Lower horizontal cover plates
- Upper horizontal cover plate sections
- Removal of internal bracing
- New tie bar design

# 2004 Steam Dryer Analysis

---

- Excitation sources not adequately identified
- Technically justifiable load definition not provided
- Methodology not justified as realistic
- Potential non-conservative assumptions
- Extrapolation of pressure peaks not validated

## **2005 Steam Dryer Analysis**

---

- Supplements 26 (3/31), 27 (4/5), and 29 (6/2)
- June 15-16: Audit at GE office in DC
- Supplements 30 (8/1) and 31 (8/4)
- August 15-16: Audit at GE Test Facility in CA
- August 22-25: Audit at GE office in DC
- Supplements 33 (9/14) and 34 (9/18)
- September 30: Draft SE

# Development of License Conditions and Commitment

---

- License conditions and commitment will:
  - ▶ Provide slow and deliberate power ascension with lengthy hold points and data evaluation
  - ▶ Formalize plans for MSL instrumentation and other pre-startup activities
  - ▶ Specify EPU startup procedure contents
  - ▶ Incorporate Entergy's proposed license condition
  - ▶ Provide for detailed interaction to address plant data, evaluations, walkdowns, inspections, and procedures
- Supplement 36 accepted license conditions and commitment with minor clarifications

# Summary of License Conditions

---

---

- 1. Requirements for operation  $>1593$  MWt:
  - ▶ a. Monitor 32 MSL strain gages hourly
  - ▶ b. Hold for 24 hours at 105, 110, and 115% OLTP, and not increase power for 96 hours after receipt
  - ▶ c. If limit curve exceeded, return to acceptable power level and resolve uncertainties
  - ▶ d. Monitor RPV water level or MSL accelerometers hourly; and if resonances significantly exceeded, stop power ascension and provide evaluation to NRC prior to further power ascension
  - ▶ e. Resolve uncertainties, or return facility to OLTP, within 90 days of EPU amendment

- 2. Entergy shall implement following actions:
  - ▶ a. Install 32 MSL strain gages and enhance system
  - ▶ b. If limit curve challenged, re-evaluate dryer loads, re-establish limit curve, and perform assessment
  - ▶ c. After reaching 120% OLTP, establish margin, update stress report, and re-establish limit curve
  - ▶ d. If evaluation required, perform analysis to address frequency uncertainties and peaks
  - ▶ e. Revise SDMP to reflect long-term monitoring, consistency with GE SIL 644, and NRC contact
  - ▶ f. Submit final load definition after power ascension
  - ▶ g. Submit related portions of startup procedure

- 3. Startup test procedure shall include
  - ▶ a. stress limit curve
  - ▶ b. specific hold points and duration
  - ▶ c. hold point activities
  - ▶ d. parameters to be monitored
  - ▶ e. inspection and walkdowns during hold points
  - ▶ f. methods to trend plant parameters
  - ▶ g. acceptance criteria for monitoring and trending
  - ▶ h. actions if acceptance criteria not satisfied
  - ▶ i. verification of commitments and planned actions

- 4. Above OLTP, operating limits, required actions, and surveillances in SDMP shall be met with specific attributes not reduced without NRC approval
- 5. During next 3 RFOs, conduct visual dryer inspection of all accessible, susceptible locations
- 6. Report inspection results within 60 days of RFO startup, and submit SDMP results within 60 days of power ascension

- 7. Condition 4 requirements continue for one cycle with extension if unacceptable structural flaw detected
- 8. License condition shall expire when Conditions 5, 6, and 7 satisfied.

# Summary of Commitment

---

- Entergy will provide information on plant data, evaluations, walkdowns, inspections, and procedures associated with license conditions to NRC prior to power ascension above 1593 MWt or each hold point, as applicable.
- If any safety concerns identified, Entergy will not increase power above 1593 MWt or applicable hold point, and the specific license condition requirements will not be satisfied.

# Conclusion

---

- Vermont Yankee components will continue to meet draft GDC following EPU implementation
- Reasonable assurance that Vermont Yankee steam dryer is within structural limits for CLTP
- EPU amendment acceptable with respect to component evaluation
- License conditions and commitment establish provisions for monitoring and evaluating plant data, and taking prompt action if necessary, during EPU operation

**Fuel and Reactor Systems Evaluation  
Vermont Yankee EPU  
[Non-Proprietary Version]**

---

**Muhammad M. Razzaque  
Zena Abdullahi  
Reactor Systems Engineers  
Reactor Systems Branch  
Division of Systems Safety and Analysis  
Office of Nuclear Reactor Regulation**

# Review Scope

---

- **Staff reviewed the impact of EPU on**
  - ▶ **Fuel system and nuclear design**
  - ▶ **Thermal-hydraulic design**
  - ▶ **Overpressure protection**
  - ▶ **SLC system**
  - ▶ **Transient analysis**
  - ▶ **LOCA**
  - ▶ **ATWS**
  - ▶ **GE methods**

# Review Method

---

- **Scope of EPU evaluations generally followed NRC-accepted, generic EPU guidelines and evaluations (ELTR-1, ELTR-2, and CPPU)**
- **Analyses and evaluations are based on NRC-approved methodologies, analytical methods, and codes**
- **Followed the EPU review standard (RS-001)**

# Fuel System and Nuclear Design

---

- VY fuel is the GE-14 design (100% core)
- Peak bundle power will increase from [ ] MWT to [ ] MWT after EPU
- Thermal limits (SLMCPR, OLMCPR, MAPLHGR, and LHGR) will be determined in the reload analysis
- Hot excess reactivity and shutdown margin will be determined in the reload analysis consistent with GESTAR-II

# **Thermal-Hydraulic Design (Stability)**

---

- **VY is an Option-ID long term solution plant**
- **Relies on prevention, detection and suppression**
- **Reload analysis will follow the staff-approved methods and hence acceptable**
- **Equipment installed and operable - no changes required for EPU**
- **Setpoints for detection & suppression established using approved methods**

# Overpressure Protection

---

- **Overpressure analysis is based on 102% EPU power level and was performed for equilibrium core**
- **Staff-approved method ODYN was used**
- **Peak pressure calculated was 1328 psig (< ASME limit of 1375 psig)**
- **Most limiting pressurization event will be analyzed for each reload**

# Standby Liquid Control System

---

- **Manually initiated system**
- **Pump discharge test pressure increased from 1320 psig to 1325 psig**
- **SLCS shutdown capability is reconfirmed for every reload**
- **Adequate margin (123 psig) for the pump discharge relief valve to inject against system pressure**

# Reactor Core and Fuel Performance (Transient Analysis)

---

- Loss of feedwater analyzed using the equilibrium core
- [ ]
- Reload analysis will use staff-approved methods

# **ECCS Performance (LOCA)**

---

- **Staff-approved methods SAFER/GESTR are used**
- **A representative equilibrium core was used**
- **Most limiting PCT increased 50 degrees F to 1960 degrees F (<2200 F) for EPU**
- **Staff performed audit calculations**
- **Reload analysis will include LOCA analysis**
- **Comply with 10 CFR 50.46 and Appendix K requirements**



# **METHODS EVALUATION**

---

# TOPICS

---

- **APPLICABILITY OF NRC-APPROVED METHODS TO EPU CONDITIONS**
- **ALTERNATIVE APPROACH (Margin Evaluation)**
- **VYNPS METHODS REVIEW CONCLUSIONS**

# **APPLICABILITY OF NRC-APPROVED METHODS TO EPU CONDITIONS**

---

- **OVERALL VYNPS REVIEW OBJECTIVE**
- **PRESENTATION FOCUS**
- **NEUTRONIC METHODS APPLICABILITY**
- **REVIEW OBJECTIVE**
- **AVAILABLE CODE ASSESSMENT**
- **MEASUREMENT QUALIFICATION**
- **SLMCPR METHODOLOGY**
- **EVALUATING MEASUREMENT QUALIFICATION**
- **STAFF CODE ASSESSMENT CONCLUSION**
- **INTERIM MEASURE**

## **OVERALL VYNPS REVIEW OBJECTIVE**

---

- **Confirm applicability of the NRC-approved methods to VYNPS EPU conditions**
  
- **Presentation Focus:**
  - ▶ **Evaluate accuracy of neutronic method for current fuel designs and EPU operating conditions**

## PRESENTATION FOCUS

---

- Accuracy of lattice physics (TGBLA) and core simulator (PANACEA) is important:

- ▶ [

- ]

- ▶ [

- ]

- ▶ [

- ]

## NEUTRONIC METHODS APPLICABILITY

---

- Review indicates that neutronic methods are being applied outside NRC-approved range (70% void fraction)  

- VYNPS EPU maximum powered bundles are operating at a higher exit void fraction of [   ]
- Maximum powered bundles set limit (e.g., SLMCPR)

## **REVIEW OBJECTIVE**

---

- **Evaluate if there are any changes in accuracy of neutronic method for current fuel designs at EPU operating conditions (high bundle power/flow conditions)**
- **Determine if uncertainties applied to safety analyses are supported by qualification and assessment of neutronic methods**

## **AVAILABLE CODE ASSESSMENT**

---

- **Transverse Incore Probe (TIPs) and Code-to-Code comparisons not sufficient to quantify uncertainties for all key parameters without baseline measurement data for current fuel /lattice designs and operating strategies**

## MEASUREMENT QUALIFICATION

---

- **Comprehensive qualification of GENE's steady state neutronic method (TGBLA04/PANAC10) reviewed in 1985 was based on fuel designs and operating strategy of the time**
- **Submittal approving TGBLA06/PANAC11 (1996) contained code-to-code comparisons with assessment limited to [ ] void fraction**

# SLMCPR METHODOLOGY

---

- **SLMCPR Methodology**

- ▶ **SER restrictions require gamma-scans confirmation of pin and [ ] uncertainties**
- ▶ **No gamma-scan data available to validate GE14 [ ] and pin power peaking as operated**

# EVALUATING MEASUREMENT QUALIFICATION

---

- Measurement data also need to confirm accuracy of [ ] calculation
  - ▶ Affects LHGR predictions

## **STAFF CODE ASSESSMENT CONCLUSION**

---

- **For current fuel designs and operating strategies (EPU), additional measurement database is needed to benchmark any changes in accuracy of neutronic methods' and to quantify uncertainties**



# **ENERGY ALTERNATIVE APPROACH**

---

- **MARGIN EVALUATION**

- ▶ **DESCRIPTION OF ALTERNATIVE APPROACH**

- ▶ **EXAMPLES OF MARGIN EVALUATION**

- **SLMCPR**

- **LHGR**

- **VOID COEFFICIENT**

## DESCRIPTION OF ALTERNATIVE APPROACH

---

- Identifies key parameters, fuel design limits and safety analyses affected by potential inaccuracies in neutronic methods that could lead to higher uncertainties
- Selected following as affected by potential inaccuracies in predictions of pin and [ ] power peaking and reactivity response
  - ▶ SLMCPR,
  - ▶ LHGR ,
  - ▶ Exposure limit,
  - ▶ MAPLHGR,
  - ▶ OLMCPR,
  - ▶ SDM
  - ▶ STABILITY

## **DESCRIPTION OF ALTERNATIVE APPROACH**

---

- **Entergy proposed increasing SLMCPR margin by 0.02**
- **Increased uncertainties in LHGR, but did not result in changes in the operating kw/ft or the LHGR limit**
- **Evaluated conservatism and uncertainties applied in calculation of all other key parameters, fuel design limits and safety analyses**
- **Concluded additional margin increases not warranted**

## **EXAMPLES OF MARGIN EVALUATION**

---

- **Staff reviewed conservatism and uncertainties applied to all principle topics covered in Alternative Approach**
  
- **Presentation cover following examples of affected fuel design limits and key parameters**
  - ▶ **SLMCPR affected by potential inaccuracies in pin and bundle power prediction**
  
  - ▶ **LHGR affected by potential inaccuracies in pin and bundle power predictions**
  
  - ▶ **LHGR also affected by accuracy of internal rod pressures**
  
  - ▶ **Void Coefficient affected inaccuracies due to assuming all nodes operate with 40% depletion history for the branch cases**

## SLMCPR EVALUATION

---

- Entergy increased [ ] and pin power peaking uncertainty component ( $\sigma_{\text{peak}}$ )
- Uncertainties derived from [ ] measurement (gamma-scan data)
- Higher uncertainties obtained using [ ] uncertainty treatment methodology
- Application of higher uncertainties to the SLMCPR resulted in a SLMCPR change of 0.02

## SLMCPR EVALUATION

---

- **SLMCPR change of 0.02 is relative large value**
- **For most SLMCPR amendments requests, changes within 0.02**
- **Only a significant change in the SLMCPR methodology leads to change within 0.03**
- **VYNPS core configuration and cycle-specific SLMCPR value would reflect any changes due to EPU core design**
- **Additional 0.02 would be added to the cycle-specific SLMCPR value**

## **SLMCPR EVALUATION CONCLUSIONS**

---

- **Additional margin in SLMCPR provides additional confidence potential inaccuracies in bundle and pin power peaking would not result in non-conservative SLMCPR**
- **Additional margin in SLMCPR propagates to other safety analyses**
- **Staff finds SLMCPR increase of 0.02 as an interim measure reasonable and acceptable.**

# LHGR EVALUATION

---

- **Limit peak fuel rod kw/ft to ensure that**
  - ▶ **Diametric strain would not result in 1% plastic strain (e.g., due to differential pellet/cladding creep and swelling)**
  - ▶ **Fuel centerline melt would not occur during transient**
  
- **LHGR limit**
  - ▶ [ ]
  - ▶ [ ]
  
- **Plants could operate with bundle/ peak pin at LHGR limit**

## LHGR EVALUATION

---

- **Uncertainty increases**

- ▶ **Pin [ ] uncertainties applied to the LHGR**
- ▶ **Increased [ ]**
- ▶ **Including other uncertainties, total value becomes [ ]**
- ▶ **Confirmed GENE applies [ ] uncertainty to generation of LHGR limit (statistical treatment in rod internal pressure calculations)**
- ▶ **Uncertainty increase did not result in reducing the LHGR limit because [ ] uncertainty already applied**

# LHGR EVALUATION

---

- **Evaluated conservatism in generation of LHGR limit**

- [ ]

- ▶ [ ]

## LHGR EVALUATION

---

- **GENE currently evaluating GE14 pin power peaking**  
[ ]
- [ ]
- **GENE will submit new fuel thermal-mechanical methodology LTR**

## LHGR EVALUATION CONCLUSIONS

---

- [ ] and pin power peaking uncertainties increased
- Some conservatism in generation of LHGR limit
- Accept current LHGR margin evaluation [ ]

]

# VOID REACTIVITY COEFFICIENT EVALUATION

---

- Void reactivity coefficient defined as  $C_v \equiv 1/k(dk/k\alpha)$  is key parameter to assess core reactivity response during AOO
- Defined as change in reactivity for given change in moderator density due to event
- Objective is to determine impact [ ]
- [ ]

# VOID REACTIVITY COEFFICIENT EVALUATION

---

- ORNL performed confirmatory analyses (HELIOS)
- Results
  - ▶ Showed that depletion at high VF does have an impact
  - ▶ Cv values are dependent upon VF history, particularly at high burnup [ ]
  - ▶ Cv deviates from linearity at higher instantaneous void conditions



# **Electrical Engineering**

---

**Narinder Trehan**  
Electrical Engineer  
Electrical & Instrum. & Controls Branch  
Division of Engineering  
Office of Nuclear Reactor Regulation

# **Environmental Qualification (EQ) of Electrical Equipment**

---

- Acceptance criteria for EQ equipment based on 10 CFR 50.49
- EQ for safety-related equipment located inside containment based on MSLB and LOCA conditions and resultant temperature, pressure, humidity & radiation consequences for EPU
- EQ for safety-related equipment located outside containment based on MSLB and or other HELB conditions and resultant temperature, pressure, humidity & radiation consequences for EPU
- Licensee has adequately addressed the effects of EPU to meet requirements of 10 CFR 50.49

# Offsite Power System (Grid Stability)

---

- Acceptance Criteria based on draft GDC 39
- Existing generator VAR capacity is 563 MWE at 0.9 PF and 330 MVAR (626 MVA)
- Licensee experienced generator vibration at loading greater than 150 MVAR. Generator was rewound with rating of 684 MVA at 0.969 PF and existing rotor was re-insulated to increase MVAR capability
- 220 MVAR from generator is needed to maintain system voltages
- Under EPU, MWE will increase to 667 MWE. MVAR capability will remain at pre-EPU capability of 150 MVAR

# Offsite Power System (Grid Stability) (continued)

---

- Licensee has installed 60 MVAR capacitor banks at 115 kV switchyard to maintain proper system voltages
- Grid study was provided by the licensee. The staff finds it acceptable

# Main Onsite Components

---

- Main generator
  - ▶ Rated at 626 MVA. Rewind generator to 684 MVA by replacing water cooled stator bars. Final output of 667 MWE and 150 MVAR at rated power output. Cooling heat exchanger was replaced
- Main transformer
  - ▶ Rated at 675 MVA. Adequate because loading is 650 MVA (684 MVA - 34 MVA house load)
- Isophase bus
  - ▶ Rated at 17.9 KA. Will be upgraded to 19 KA by modification

## **Main Onsite Components (continued)**

---

- Unit auxiliary transformer
  - ▶ Rated at 39.2 MVA FOA (forced oil and forced air cooling). Power uprate output is 34.4 MVA.  
Adequate
- Startup transformers
  - ▶ Two startup transformers each rated at 28 MVA. Power uprate loading is 17.9 MVA on one transformer and 24.8 MVA on other. Adequate
- AC onsite and DC onsite power systems
  - ▶ No changes to loads

# Station Blackout (SBO) -Background

---

- VY was approved to cope with SBO for 8 hours with an alternate AC (AAC) power source
- The AAC power source at VY is the Vernon Hydro Station (VHS)
- The AAC power source was assumed to be available within 10 minutes and as a result, no coping analysis was required

## **SBO - Evaluation**

---

- NRC inspection team determined that the AAC power source would not be restored from VHS within the expected 10-minute time frame during an SBO resulting from a regional grid disturbance
- As a result of the above concern, VY determined that the AAC power source will be available within 2 hours
- The combination of the annual black-start testing of the AAC source together with the energization test of the emergency bus (conducted every operating cycle) provides assurance that 2 hours is sufficient time to get AAC power at VY emergency bus

## **SBO - Evaluation (continued)**

---

- SBO coping strategy is changed to 2 hours without any AAC power source, and 6 hours with AAC power source
- The following plant systems and components were reviewed to assure that the systems have availability, adequacy and capability to cope for 2 hours without AC power source:
  - ▶ Condensate inventory, RCS inventory, battery capacity, loss of ventilation, containment isolation, compressed air/gas systems, torus temperature, procedures and training

## **SBO - Conclusion**

---

- The AAC power source will be available at VY within 2 hours and the plant can cope 2 hours without the AAC power source and the remaining 6 hours with the AAC power source
- VY is in compliance with 10 CFR 50.63 at the EPU power level

# Human Performance

---

James Bongarra  
Engineering Psychologist  
Reactor Operations Branch  
Division of Inspection Program Management  
Office of Nuclear Reactor Regulation

# **Human Factors Engineering Evaluation**

---

- **Areas of Review**

- ▶ Programs, procedures, training, and human system interface design features that are related to operator performance

- **Purpose**

- ▶ Assure that operator performance is not adversely effected by the proposed Extended Power Uprate (EPU)

# Regulatory Criteria Basis

---

- RS-001, “Review Standard for Extended Power Uprates Draft Review Standard for Power Uprates,” Matrix 11
- 10 CFR 50.120
- 10 CFR Part 55
- Generic Letter 82-33
- Standard Review Plan Chapter 18.0, “Human Factors Engineering”

# **RS-001, Matrix 11, Standard Questions Related to Affects of EPU**

---

- Emergency and Abnormal Operating Procedures
- Operator Actions Sensitive to Power Uprate
- Control Room Alarms, Controls, Displays
- The Safety Parameter Display System (SPDS)
- Operator Training Program and Control Room Simulator

# Emergency and Abnormal Operating Procedures

---

- No new procedures required
- Emergency Operating Procedures (EOPs)
  - ▶ Minor changes for parameter thresholds and decay heat level graphs
  - ▶ No effect on accident mitigation strategy
  - ▶ EOPs will be changed as needed
  - ▶ Training on EOP revisions will be provided
- Abnormal Operating Procedures (AOPs)
  - ▶ Some operator actions may be affected by uprate
  - ▶ AOPs will be changed as needed
  - ▶ Training on AOP revisions will be provided

# Operator Actions Sensitive to Power Uprate

---

- EPU has minimal effect on operator responses to transients/accidents
- Automation of one manual operator action - recirculation runback of a single reactor feedwater pump trip
- One new operator task -control room switches will be used to close normally open valve in the torus vent line in response to a fire in the reactor building
  - ▶ Actions straightforward, adequate time available (~ 40 minutes)

# Operator Actions Sensitive to Power Uprate (continued)

---

- Small reductions in time for some operator actions due to increased decay heat
- Estimated completion times for these actions, based on licensee interviews with Operations and Training personnel, are well under the EPU time limits, for example:
  - ▶ Initiate automatic depressurization system (ATWS scenario): available time reduced from 6.2 min to 5.4 min, estimated completion time is 1.5 min
  - ▶ Initiate standby liquid control given main condenser failed: available time reduced from 6.0 min to 5.3 min, estimated completion time is 2.2 min

# **Control Room Alarms, Controls, Displays**

---

- EPU will affect:
  - ▶ Main steamline flow indicators
  - ▶ Feedwater flow indicators
  - ▶ Main steam flow/feedwater flow recorder
  - ▶ Condensate flow recorder
- Modifications will be completed using human factors review and operator input
- Training on modifications will be provided

# **Balance-Of-Plant (BOP) Systems**

---

**Devender Reddy**  
Reactor Systems Engineer  
Plant Systems Branch  
Division of Systems Safety and Analysis  
Office of Nuclear Reactor Regulation

# **Scope of Review for BOP Systems (RS-001, Matrix 5)**

---

- **Internal Hazards**
  - ▶ Flooding, Missile Generation, and Pipe Failures
  
- **Fission Product Control**
  - ▶ Main Condenser Evacuation System, Turbine Gland Sealing System, etc.
  
- **Component Cooling and Decay Heat Removal**
  - ▶ Spent Fuel Pool Cooling, Service Water, Auxiliary Cooling, and Ultimate Heat Sink

# **Scope of Review for BOP Systems (Cont'd)**

## **(RS- 001, Matrix 5)**

---

- **Balance-of-Plant Systems**
  - ▶ **Main Steam, Condensate and Feedwater, and Circulating Water Systems**
  
- **Waste Management Systems**
  - ▶ **Gaseous, Liquid, and Solid Waste Management Systems**
  
- **Additional Review Areas**
  - ▶ **Emergency Diesel Fuel Oil Storage and Light Loads**

# **BOP Systems**

## **Review Areas of Emphasis**

---

- Spent Fuel Pool Cooling
- Service Water System/Ultimate Heat Sink
- Auxiliary Cooling Water
- Condensate and Feedwater System

# Spent Fuel Pool Cooling

---

- The estimated heat loads for batch off-load will remain within the design capacity of the safety-related standby fuel pool cooling system (SFPCS).
- For full-core off-load, administrative controls will be used to ensure that the pool temperature and time to boil will continue to satisfy licensing-basis considerations.

# **Service Water System & Ultimate Heat Sink**

---

- The service water system (SWS) provides cooling water for essential and non-essential components.
- The Connecticut River is credited as the ultimate heat sink (UHS) whenever the SWS is available.
- The current SWS capability and flow balance are sufficient for EPU conditions.

# Alternate Cooling System (ACS)

---

- ACS is relied upon in the event the SWS becomes unavailable due to a failure of Vernon Dam or due to fire or flooding in the intake structure.
- The source of cooling water for ACS is the west cooling tower (CT-2) deep basin.
- The licensee's inventory and evaporative loss analysis confirmed that at least seven days of cooling capability will be available for EPU.

# Condensate and Feedwater System

---

- Reduced Operational Capability
  - ▶ 3 RFPs / 3 CPs required for full power operation
  - ▶ Loss of an RFP and/or a CP pose new operational challenges (reactor trip, loss of feedwater)
- Modifications to compensate for Reduced Capability
  - ▶ RFP Suction Pressure Trip Logic (NPSH, Sequential Delay)
  - ▶ RFP Trip on CP Trip
  - ▶ Recirculation Runback on RFP Trip
- License Condition to Confirm Acceptable Performance

# Condensate and Feedwater System (Cont'd)

---

- License Condition:

The licensee shall perform transient testing that:

- ▶ Entergy shall confirm through performance of transient testing that the loss of one condensate pump will not result in a complete loss of reactor feedwater.
- ▶ Entergy also confirm through performance of additional transient testing and/or analysis that the loss of one reactor feedwater pump will not result in a reactor trip.

## **BOP Systems - Summary**

---

- The staff finds the proposed EPU to be acceptable with respect to BOP area, based on the consideration that acceptable transient performance of the condensate and feedwater system will be demonstrated prior to commencing full power EPU operation in accordance with the provisions of the Licensing Condition.

# Source Terms and Radiological Consequences Analyses

---

Michelle Hart

Health Physicist

Probabilistic Safety Assessment Branch  
Division of Systems Safety and Analysis  
Office of Nuclear Reactor Regulation

# Source Terms for Radwaste Systems Analysis

---

- RS-001 Matrix 9, EPU SE Section 2.9.1
- Radiation sources in reactor coolant analyzed for CPPU conditions
- Continue to meet requirements of 10 CFR Part 20, 10 CFR Part 50, Appendix I, and draft GDC-70

# **DBA Radiological Consequences Analyses**

---

- RS-001 Matrix 9, EPU SE Section 2.9.2
- Separate Alternative Source Term (AST) amendment request
  - ▶ AST full-scope implementation per 10 CFR 50.67
  - ▶ Amendment #223 issued March 29, 2005
- Dose analyses assumed proposed EPU conditions
  - ▶ 1950 MWt (102% of 1912 MWt)
- Followed RG 1.183 guidance unless justified
- All DBAs meet 10 CFR 50.67 and SRP 15.0.1 dose acceptance criteria both offsite and in the control room

# **DBA Dose Analyses in AST Submittal**

---

- LOCA
  - ▶ Half TS containment leakage value after 24 hours
  - ▶ Use of SLC system for suppression pool pH control
  - ▶ Iodine removal by drywell sprays
  - ▶ Iodine deposition in main steam lines and condenser
- MSLB
- FHA
- CRDA
- No control room isolation assumed for any DBA
  - ▶ 3700 cfm unfiltered intake

# AST LOCA Dose Analysis

---

- Justification for credited use of SLC system for pH control
  - ▶ Reliability of system
  - ▶ Procedures, compensatory measures and training
  - ▶ Suppression pool buffering adequacy
- Justification for credited iodine deposition in main steam piping and condenser
  - ▶ Seismic ruggedness of credited alternate leakage treatment pathway
  - ▶ Acceptable elemental and particulate iodine removal methodologies and assumptions

# **Health Physics - Occupational and Public Radiation Doses**

---

---

**Roger Pedersen**  
Senior Health Physicist  
Plant Support Branch  
Division of Inspection Program Management  
Office of Nuclear Reactor Regulation

# Occupational Radiation Doses

---

- Normal Operations -sufficient plant radiation shielding design margin. No change to the current FSAR plant radiation zoning.
- Design Basis Accidents -post-accident personnel access to vital areas (TMI Lessons Learned Action Plan Item II.B.2.). Still meet draft GDC 11 and II.B.2 dose criteria with EPU inventory of radionuclides.

# Public Radiation Doses

---

- Compliance with 40CFR190 - 25 mrem/year to a member of the public
- Increased N-16 gamma sky shine from turbine/condenser at EPU power levels with noble metal/hydrogen injection chemistry
- Pre-EPU 15 mrem/yr (13.4 mrem/year N-16 shine) increases to 20.2 mrem/year (18.6 mrem from direct radiation and sky shine)

# Conclusion

---

- Meets the requirements of 10 CFR Part 20, 10 CFR Part 50, Appendix I, NUREG 0737, and draft GDC 11
- NRC staff finds the licensee's proposed EPU acceptable with respect to radiation protection and ensuring that occupational radiation exposures will be maintained as low as is reasonably achievable

# **VYNPS Extended Power Uprate NRC Staff Review of Risk Evaluation**

---

---

**Martin A. Stutzke**

Senior Reliability & Risk Analyst  
Probabilistic Safety Assessment Branch  
Division of Systems Safety and Analysis  
Office of Nuclear Reactor Regulation

## **In a Nutshell...**

---

- Licensee has adequately modeled and/or addressed the potential risk impacts of the proposed EPU.
- Risks are acceptable because RG 1.174 risk acceptance guidelines are met.
- The proposed EPU does not create “special circumstances” that rebut the presumption of adequate protection provided by the licensee meeting the currently specified regulatory requirements.

# Extended Power Uprate Risk Evaluations

---

- VYNPS EPU submittal is not risk-informed
- Per RS-001, Rev. 0, “Review Standard for Extended Power Uprates,” Matrix 13, “Risk Evaluation,” risk evaluations are performed to:
  - ▶ Demonstrate that risks are acceptable, and
  - ▶ Determine if “special circumstances” exist (as defined in SRP 19, App. D) that could potentially rebut the presumption of adequate protection provided by the licensee meeting the currently specified regulatory requirements.

# Scope of the Risk Evaluation

---

- Full-power Level 1 PRA
  - ▶ Internal events, including internal flooding: linked event tree approach, implemented in RISKMAN
  - ▶ External events: qualitative approach
    - Seismic: EPRI Seismic Margins Method (SMM)
    - Internal fires: EPRI FIVE methodology
    - High winds, external floods, and other external events (HFO-related risks): review against SRP requirements, as allowed by NUREG-1407
- Full-Power Level 2 PRA (not simply LERF)
- Shutdown events: qualitative approach
- PRA quality

# Impact of EPU on Initiating Events

---

- Small increase in turbine trip frequency.
- No other changes to initiator frequencies made:
  - ▶ Reduced turbine bypass capacity does not affect frequency of transient initiators.
  - ▶ No impact on LOOP frequency:
    - Hardware modifications to maintain MVARs,
    - Continue existing actions to preserve grid stability, and
    - LOOP frequency used higher than recent RES data.